

Datafied female health

Sociotechnical imaginaries of femtech in Danish public discourse

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Abstract

The digitalization of health promises individual empowerment while raising the threat of collective surveillance. Conceptualizing these threats and promises as sociotechnical imaginaries, we explore how issues of datafied female health are articulated in Danish public discourse. Empirically, we work with a large data set of Danish news media coverage of algorithmic technologies in the past 10 years (2011–2021). We locate coverage of female-oriented health technologies (or femtech) by using the data sprint methodology to track the emergence of such technologies as a topic of public concern. Across the data, we identify two broad sociotechnical imaginaries: one zooming in on individual uses of femtech, the other focusing on the collective benefits of public health initiatives. We conclude that sociotechnical imaginaries of femtech are increasingly entangled in everyday life, making female bodies knowable through algorithms and data. As such, female health becomes subject to instrumental rationality, not lived reality.

Keywords

femtech, sociotechnical imaginaries, female health, data sprint, danish media

Introduction

Gender inequality is a deep-rooted problem in the healthcare sector. When suffering from non-gender-specific health conditions, like cardiovascular diseases, women and girls are more frequently misdiagnosed and underdiagnosed than men and boys (Perez, 2019). This inequality may be explained by the fact that women are underrepresented in medical trials (Geller et al., 2006; Geller et al., 2011) and in medical school curricula (Perez, 2019), which install the male body and its reactions to medicine and treatment as the norm. Simultaneously, health issues related to the female body remain understudied (Slawson, 2019; Vechery, 2021), rendering issues like premenstrual syndrome, endometriosis, autoimmune diseases, and complications after pregnancy and childbirth – intrinsic to womanhood – to be endured rather than treated, let alone cured. Still, female health is not completely overlooked; to the contrary, female reproductivity has been a key focus in scientific knowledge production. The advance of infertility treatments and of pregnancy monitoring systems, however, have not rendered women's health a public concern but only served to push reproductive risk and responsibility deeper into women's private spheres (Alemling, 2020). Thus, everyday health experiences are highly gendered, with women being both underrepresented and overexposed.

Against this background, femtech has developed both as an extension of the scientific focus on female reproductivity and as a possible solution to the gender inequality in healthcare (Agarwal, 2021). Here, femtech is to be understood as a broad category of innovative products and services that includes, but is not limited to, technologies for fertility self-tracking, digital counselling on pregnancy and nursing, online menopause health platforms, pelvic health technologies, and tools for ovarian-, breast-, and cervical-cancer diagnosis (Tonti, 2019). At present, fertility tracking is the largest and most developed sub-field within femtech, as becomes clear from the over 300 fertility tracking apps that were available in 2016, with a total download of 200 million worldwide (Eschaler et al., 2019). Fertility tracking is equally prevalent in a Danish context, where fertility self-tracking is an integral part of infertility treatments at public hospitals (Petersen et al., 2022; Sundhed.dk, 2022). This indicates the interrelations of technological innovations and public health, suggesting the relevance of the Danish context as an illustrative case of digital transformations of healthcare in fully developed welfare states. The perception and reception of femtech in this context may, as we shall detail below, point towards general trends of datafied female health.

Returning to the femtech industry, the main selling proposition is that the collection of women's health data may empower women to make better and more informed choices, contribute to dismantling taboos linked to the female body, and further the understanding of and ability to resolve women's health issues (Weiss, 2018; Agarwal, 2021). Thus, there are strong indications of a discourse that posits femtech as an "unquestionably positive process, devoid of dangers and beneficial to all" (Kuntsman et al., 2019, p. 2) – what Lupton (2014) names the "techno-utopia of digital health solutions." While

femtech is gaining momentum within the industry, academic interest is only slowly turning from the elucidation of persistent inequalities concerning women's reproductive health (Marshall, 2002; Thompson, 2005) and/or technologically re-enforced biases (Perez, 2019; Wachther-Boettcher, 2018) towards scrutiny of the various dimensions of femtech innovation. Existing studies tend to focus rather narrowly on women's experiences of fertility self-tracking (Grenfell et al., 2020; Hamper, 2020; Del Busso et al., 2022; Petersen et al., 2022). Here, self-tracking is generally perceived as a form of biopower (Sanders, 2017), and period tracking, in particular, as body politics (Della Bianco, 2021). Extrapolating from these studies, we suggest that femtech can be conceptualized as enabling participatory surveillance (Lupton, 2015a; Barassi, 2017). To further explore this claim, we shift attention from personal experiences of self-tracking to the interrelations of everyday practices and public discourses.

Situating discourses of individual empowerment/surveillance within the conceptual context of what Jasanoff and Kim (2009) term sociotechnical imaginaries, we ask: *how are issues of datafied female health articulated in Danish public discourse?* Empirically, we work with a large data set of Danish news media coverage of algorithmic technologies over 10 years (2011–2021). Methodologically, we locate coverage of femtech within this data set and analyse the resulting subset, beginning with a data sprint workshop (Jensen et al., 2017), which enables a descriptive analysis of the emergence and development of femtech as a topic of concern. On this basis, we critically examine currently dominant sociotechnical imaginaries of femtech and discuss the resulting entanglements of gender, media, and health in Danish (female) citizens' everyday experiences of their (bodily) reality.

We begin by presenting the broader field of digital health and then zoom in on the development of femtech as a particular response to the gendered challenges of this field. Based on the empirical analysis, we conclude that Danish sociotechnical imaginaries of femtech largely confirm Lupton's critique of the solutionism and hype of techno-utopias. More specifically, we identify two imaginaries: one zooming in on individual uses of femtech (e.g., period-tracking apps), the other focusing on the collective benefits of public health initiatives (e.g., AI-supported diagnosis of breast cancer). We end with a discussion of the increasing entanglements of individual women's everyday health experiences with sociotechnical imaginaries of femtech, suggesting that these entanglements make female bodies knowable through algorithms and data. Thereby, female health becomes subject to instrumental rationality, not lived reality.

Digital health

Digital health is an umbrella term used to describe healthcare (including prevention, detection, prediction, and communication of illness and other health issues) that is supported by digital technologies. It includes categories such as digital medicine, health tech, eHealth, mobile health, wearable devices or internet of things (IoT), health information

technologies, tele-health, and personalized or precision medicine (Baumgartner, 2021; Vayena et al., 2018). Thus, digital health denotes a host of technological innovations within the field of medicine and covers a variety of interactions between human bodies and technologies; from self-tracking apps and digital communication platforms, including social media platforms, to AI-driven detection of diseases and AI-supported treatment (Lupton, 2018).

Digital health initiatives create meaningful and empowering opportunities for human well-being and health but also risk reproducing unequal power relations and further marginalization of minorities, e.g., in articulating ideal patient subjects (Lupton, 2018; Lundgren et al., 2021). In particular, digital health technologies risk excluding human sensory and affective experiences in the pursuit of precision while simultaneously attributing more responsibility of health to the individual, ignoring how social and systemic aspects affect personal health (Baumgartner, 2021). This double bind of individual responsabilization without recognition of individual experience is integral to digitalization (Hintz et al., 2019). As such, it is not limited to digital health developments, but it is a particularly acute problem in this field, as it redefines what might be understood by and expected from digital health citizens (Petraiki et al., 2021). Thus, becoming a digital health “cyborg” whose actions are systemically as well as personally recognizable is neither an easy nor an unproblematic task (Lupton, 2015b).

The digitalization and datafication of public health have emerged as central public concerns, as can be observed at global, European, and national levels of governance. Digital health technologies and interventions are generally celebrated for their potentials and promises of making healthcare more time-, cost-, and labour-effective as well as more personalized, secure, and accessible (European Commission, n.d.; WHO, 2021; Baumgartner, 2021; Kuntsman et al., 2019; Murray et al., 2016; Triantafyllidis & Tsanas, 2019).

In the national context of Denmark, the public healthcare system is already highly digitized, with electronic health records and digital communication between healthcare professionals and the citizens in place (Thygesen & Ersbøll, 2011). In Denmark, all citizens are provided with a personal identification number at birth or immigration, to which all interaction with the state is recorded, including each citizen’s individual health data (Hoeyer, 2019). This gives Denmark a unique data source for population studies (Tupasela, 2017), and the country has been called an “epidemiologist’s dream” (Bauer, 2014). The public authorities’ tracking of citizens has not traditionally been perceived as controversial (Hoeyer, 2018), but in the light of new technologies, the use of big data, personalized medicine, and data infrastructures, there is an increasing need to understand the governance and accountability of citizens’ health data (Hoeyer et al., 2019). As a welfare state with a fully public and highly digitalized healthcare system, Denmark is an interesting case in terms of citizens’ perceptions of femtech innovations for private use and as part of public healthcare. What may be learned from this case will not only be interesting in itself

but can inform the broader conceptualization of femtech as an emergent topic of public concern.

Taking on a critical digital health studies perspective (Lupton, 2018), we regard digital health technologies as sociocultural artefacts that interact with human bodies in “simultaneously social, digital, material, affective and sensory” assemblages (Lupton, 2018, p. 20). Through this approach, we understand femtech as expressing specific meanings/knowledges about the female body, effecting “how people experience corporality in the context of their engagements” (Lupton, 2018, p. 26) with digital health technologies and the data they collect/produce.

Femtech

Femtech has emerged as a sub-sector within digital health, which is comprised of “services, products, and software designed to address the unique biological and medical needs of women” (Wiederhold, 2021, p. 697). The concept of femtech, a portmanteau of “female” and “technology”, was coined by Ida Tin, one of the early pioneers in the industry. It encompasses technologies that address women’s health such as fertility tracking, mediated pregnancy and nursing counselling, and online contraception provision (Tonti, 2019). The last years’ rapid growth of the industry has expanded its scope, which now also includes menopause health platforms (Capriccio, 2019), smart sex toys (Goodhill, 2019), pelvic health technologies (Folkendt, 2019), and ovarian-, breast-, and cervical-cancer diagnosis and treatment (Baretto et al., 2021).

Whatever the specific topic and take, femtech addresses gender inequality issues in healthcare (Weiss, 2018) and is promoted as a means of closing the gender gap in health (Agarwal, 2021). First and foremost, femtech products and services offer individual women increased understanding and knowledge about their bodily functions. This enables more effective diagnosing and treatment for women, as, for example, tracking period symptoms facilitates diagnosing endometritis, a disease that is largely ignored in traditional healthcare (Weiss, 2018). Hence, the data that specific femtech innovations generate is not only useful to the individual; rather, aggregated data can be used to advance medical research and knowledge on women’s health issues (Barreto et al., 2021). In sum, femtech may empower individuals and increase focus on women’s health, contributing to the process of dismantling taboos about the female body and women’s health issues (Weiss, 2018; Agarwal, 2021) and enabling more women to seek help, get correctly diagnosed, and receive proper care.

However, closer scrutiny reveals that femtech solutions are often geared towards socioeconomically privileged, health literate, and/or white, cis women (Krishnamurti et al., 2022). As most of these products rely on and reproduce normative femininities and heterosexist notions of female sexuality, their liberating potential becomes questionable (Hendl & Jansky, 2022). The narrow understanding of women is particularly troubling; femtech ostensibly aims to close gaps in access to healthcare among socioeconomically

marginalized groups, but the reproduction of dominant norms does exactly the opposite for underserved individuals and communities who find their access to healthcare shaped – and restricted – by intersectionalities of class, gender, and race.

Other critics point out that the digitalization of female health inherently individualizes the responsibility of female health concerns, which is particularly alarming in conjunction with the questions of reproductive surveillance raised by reproductive self-tracking (Mishra & Suresh, 2021). The flurry of “delete your period tracking app” social media posts that were shared in early response to the overturning of *Roe v. Wade* illustrates this point urgently and tragically (McQuillan, 2022).

These concerns point to emergent tensions within the techno-utopian vision of digital health – or, perhaps, more precisely, to competing dystopian visions. Such struggles between different understandings and interpretations of current events and future possibilities are often conceptualized as sociotechnical imaginaries, and this concept also serves as fulcrum for our analysis of Danish articulations of femtech visions. Before turning to the specific methodology, let us unpack the current use of sociotechnical imaginaries in research on digital developments.

Sociotechnical imaginaries

Denoting the ways in which people’s understanding of social life are technologically embedded, the concept of sociotechnical imaginaries has become widely applied within science and technology studies and its adjacent fields (Sismondo, 2020). While Jasanoff and Kim (2009, p. 120) originally defined the concept quite specifically as “collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects,” subsequent uses have developed the meanings of both “sociotechnical” and “imaginary” to stretch what might be invoked by the combination of these two concepts.

Such stretching is inherent to Jasanoff’s (2015, p. 6) later definition of sociotechnical imaginaries as “collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of social life and social order attainable through, and supportive of, advances in science and technology.” Sociotechnical imaginaries, we might say, are the public articulations of people’s everyday experiences with technology, which are shaped by and give shape to those experiences. In what follows, we begin from this broader definition, turning first to further examination of its conceptual roots and, second, to its most recent and more specific application in relation to the development of digital technologies.

Conceptual roots

When unpacking the concept of sociotechnical imaginaries, it should first be noted that the idea of the *sociotechnical* is itself a combination of two terms – the social and the technical – that suggests the inevitable relationality of the two. There is no social real-

ity that is not technically mediated and no technology that is not shaped by the social context(s) of its development and use (Orlikowski, 2007). Here, technology is but a specific form of materiality, one subset of a broader sociomateriality, as is also a foundational assumption of the approach to digital health to which we adhere (see Lupton, 2018). While sociomateriality is intrinsic to human experience, many scholars end up focusing on either the social or the material end of this constitutive relationship (Gulbrandsen et al., 2020). Jasanoff and Kim (2009) are no exception; they implicitly assume sociotechnical entanglement, but seemingly privilege the social by adding the notion of “imagineries” to the conceptual mix.

The addition of imaginaries, Jasanoff and Kim argue, alerts us to the fact that “the capacity to imagine futures is a crucial constitutive element in social and political life” (2009, p. 122). Here, they invoke Castoriadis’s notion of “social imaginaries” to suggest that “imagination helps produce systems of meaning that enable collective interpretations of social reality” (Jasanoff & Kim, 2009, p. 122). In Castoriadis’s own writing, social imaginaries are, indeed, oriented towards the future, but importantly, they are also interpretations of the present – and they are enacted as much in everyday interactions in the (informal) context(s) of civil society as they are the results of (high) politics.

As Castoriadis makes clear, the “imaginary” is neither a figment of the imagination nor a (mirror) image of something else; rather, it is constitutive of social reality; the imaginary “is the unceasing and essentially undetermined (social-historical and psychical) creation of figures/forms/images, on the basis of which alone there can ever be a question of ‘something’. What we call ‘reality’ and ‘rationality’ are its works” (Castoriadis, 1987, p. 3). The imaginary, we might say, enables the material enactment of the social. Here, “technical” becomes the addition that alerts us to how sociomaterial imaginaries are, today, shaped by and give shape to technological developments (Dahlman et al., 2021) – and to people’s everyday experiences of technology.

Contemporary applications

This foundational understanding of imaginaries as constitutive figures of thought has proven to be a particularly rich starting point for studying contemporary social shapings of the technical, particularly as involving people’s visions of algorithms, data, and, increasingly, artificial intelligence (AI).

Bucher (2017) explores everyday encounters between people and algorithms, defining “the algorithmic imaginary” as “the way in which people imagine, perceive and experience algorithms and what these imaginations make possible” (p. 31). More specifically, she introduces an affective lens to argue that human–algorithm encounters are both wholly ordinary and entirely uncanny, as people struggle to understand the relationships between the data traces they leave on, for instance, social media sites, and the content that the algorithms of these sites curate for them.

Focusing on the data side of this relationship, Guay and Kirch (2022) identify historically and geographically anchored sociotechnical imaginaries of digital personal data, showing how these different imaginaries have enabled different regulatory developments in the US and the EU. Thus, these authors re-articulate the link between social and political imaginaries, emphasizing how legal initiatives are also central to the mutual constitution of political institutions and sociotechnical systems. Data imaginaries, they conclude, are constituted around tensions between technological innovation and economic gains, on the one hand, and privacy risks and data rights, on the other. Dependent on historical and geographical context, such tensions become productive of different regulatory regimes, geared towards market-based compensation of consumers (the US) or state-market based rights of citizens (the EU).

Emergent and contextual as imaginaries of algorithms and data are, they are relatively established when compared to AI imaginaries. Sartori and Bocca (2022) show that sociotechnical imaginaries around AI are largely constituted in and as narratives of hope and fear, explaining that such constitution leads to affective polarization between equally exaggerated utopian dreams of the automated future and dystopian visions of a world controlled by machines. The clash of these two imaginaries, they conclude, constitutes a state of AI anxiety, a generalized worry about “the openness of the future, especially when it comes to technology” (Sartori & Bocca, 2022, p. 11).

Zooming in on the Danish context, Hockenfull and Cohn (2022) show how the sociotechnical imaginary of (hopeful) “hype” seems to be stronger in this context, at least when focusing, as these authors do, on the “tech scene” – that is, on the context in which new (digital) technologies are developed and marketed. In the broader context of public debate in Danish newspapers, Hansen (2022) demonstrates the coexistence of conflicting AI imaginaries, which pits the machinistic automation and control of AI systems against “intelligence amplification” (IA) that arises from human–machine collaboration. In line with Sartori and Bocca (2022), Hansen (2022) finds that the existence of and clash between different imaginaries leads to uncertainty concerning current developments and future prospects of AI, which, importantly, reduces the chances for people to shape socio-technical developments in desired and desirable ways. Specifically, AI comes to dominate to the detriment of IA.

We begin our analysis from existing conceptualizations of sociotechnical imaginaries as well as analytical applications of the concept to broad digital technological developments, zooming in on a specific “sociotechnical configuration of gender normativity” (Costanza-Chock, 2020). The particular entanglement that we trace involves the shaping of technologies through existing gender norms and the potential for these technologies to, in turn, confirm and/or reform these normativities in the context of healthcare. In detailing these interrelations, we follow Hansen (2022), who posits that newspaper coverage is not only indicative of, but actively gives shape to, sociotechnical imaginaries. In what follows, we detail our uptake of this methodological cue.

Methodological considerations

As indicated above, sociotechnical imaginaries are often controversial. Whether dichotomous pairs of utopian and dystopian visions or more specific articulations of competing interpretations, the existence of different imaginaries is important since such differences can help us, as researchers and citizens, understand the emergence of new technologies and the consequences of human interactions with them. Specifically, we are concerned with the reconfiguration of women's experiences of healthcare: As new, highly sophisticated technologies make promissory claims of closing gender gaps and empowering women but appear to mainly do so for already privileged groups in rich countries, how should we understand and evaluate these technologies? And how should we, as individual citizens and social collectives, act in relation to them?

To explore the emerging public interest in and debate on femtech, we used the mixed methods of data sprints and controversy mapping. Ontologically, controversy mapping draws on Actor-Network Theory (ANT) and focuses on actors as a network and networks as actors, i.e., an "actor is a network of associations, and a network is an ensemble of entities acting together" (Venturini & Munk, 2022, p. 135). As such, controversy mapping involves following the trajectories of competing sociotechnical imaginaries, whether emerging in parallel to each other or in direct competition.

Practically, data sprints are processes for identifying and mapping controversies. The data sprint method has been developed by European digital STS researchers, and data sprints are defined as "intensive research and coding workshops where participants coming from different [...] background[s] convene physically to work together on a set of data and research questions" (Venturini et al., 2018, p. 158). Like other "fast approaches" such as hackathons, the key idea of a data sprint is to stage a close collaboration between data scientists and so-called issue experts, such as stakeholders or researchers, who have extensive knowledge of/particular interest in a topic. Any given data sprint is conditioned by various factors, including but not limited to the group it brings together, the research interests of this group, the data around which the sprint is organized, and the organization of the sprint itself along with the available methodological tools and skills.

To understand the emergence of femtech as a topic of public concern, we engaged in a data sprint organized by colleagues from the Tantlab at Aalborg University. As part of the Algorithms, Data & Democracy project, we had access to all Danish news media coverage of relevant topics from 2011–2021. More specifically, our colleagues had created a data set of articles, posts, and other items that included the words "algorit*", artificial intelligence ["kunstig intelligens"], "AI" or machine learning ["maskinl ring"] – in total, 34,688 articles (Munk et al., 2023). Using structural topic modelling, they had created a map of the data set and made it searchable. While the choice to use this data set, with its predefined timeframe and topical delineation, was primarily pragmatic (e.g., based on availability), it was immediately clear that it captures the emergence and establishment of femtech in Danish media (see Figure 1 for an overview of number of articles per year). This

allowed us to explore the growing public interest in and debate about femtech. We now proceed to describing the specific steps of searching, collecting, and analysing the data that we followed during and after the data sprint.

Data collection

Using our 10-year data set as a starting point, we first searched for “femtech” to identify articles that specifically and explicitly included this term (i.e., lexical mentions). The search resulted in merely 13 hits, indicating that Danish media do not use the word femtech very often. This initial finding invites two possible explanations: either femtech simply has not made a mark on the Danish public debate, despite growing global interest (Agarwal, 2021) and in the local Danish context (Arrouas, 2017); or it is merely the specific term that has not come into common Danish.

Deciding to test the second option, we expanded our search for femtech-related concepts and built a search string of words that would encapsulate common femtech definitions. As the data set was already delimited to tech-related coverage (by the initial search terms of algorithm, artificial intelligence, and machine learning), we focused on female health. The resulting search string included the following terms: pregnant, prevention, fertility, menstruation, infertility, contraceptive pill, breast feeding, natural cycles, orgasm, breast cancer, mammography, uterus, ovulation, vagina, ovaries, (health* and woman/en), midwife, gynecologist, menopause, femtech, and fem tech. This search resulted in 672 articles, which became the initial data set for this article.

Two of the authors then selected 31 articles from the set (one each from 2011, 2012, and 2013; three each from 2014, 2015, 2016, and 2017; and four each from 2018, 2019, 2020, and 2021) for a thematic pilot coding, using an inductive coding approach. Both coders coded the same articles, producing two lists of codes, which were compared and combined into a coding scheme consisting of 10 codes (for an overview, see the first order concepts in Figure 2).

However, of the 31 articles, 17 were deemed irrelevant, as they did not deal with aspects of femtech in any discernible way. This large number of irrelevant articles made us reconsider our search string. The two coders identified the broad search term (health* AND woman/en) as yielding most of the irrelevant articles, and excluding this item was subsequently found to result in a smaller and more relevant data set. A search on the altered search string resulted in 354 documents, which was reduced to 327 after the removal of obvious duplicates. These 327 articles constitute the revised and final empirical foundation of this article (for an overview, see Figure 1; for the full list, see Appendix 1). For ease of reference, we simply use the number indicated in the first column of the appendix when quoting a particular article in the analysis.

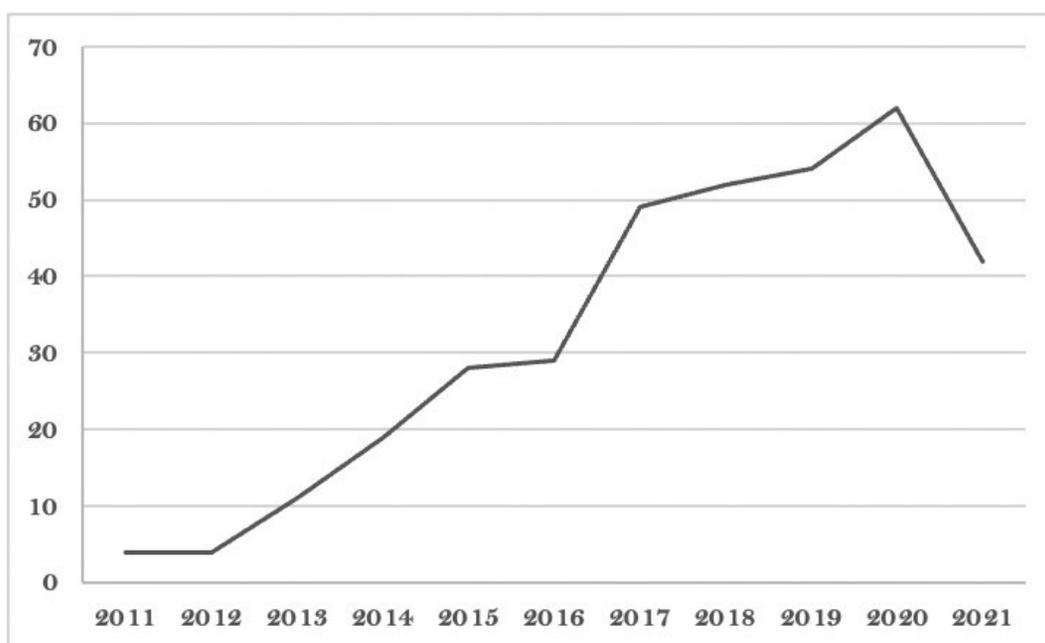


Figure 1: Number of articles per year

Data coding

The 327 articles were coded in two rounds by the same two authors. First, all articles were deductively coded using the inductively developed coding scheme from the pilot study to identify the material that deals thematically with any aspect of femtech, broadly defined. The two coders divided the 327 articles between them and each coded half. Of the 327 coded articles, 177 were deemed irrelevant: 22 due to the discovery of additional duplicate articles and 154 due to off-topic content. With a starting point in the coded material, the two coders then inductively coded for attributes and characteristics of, as well as intentions, hopes, and visions for, femtech, as articulated in the Danish news media.

Relying on the interpretative tradition from grounded theory (Strauss & Corbin, 1998; Charmaz, 2006; Gioia et al., 2013), the coders shifted between empirically identifiable first-order abstractions (e.g., breast cancer) and theoretically informed second-order abstractions (e.g., cost-efficiency and accuracy). While inspired by Gioia and colleagues (2013), we follow Mees-Buss et al. (2020) in taking a more interpretative approach. Thus, we assume that technology is performed and sociotechnically constructed as articulations of, for instance, the promissory potentials of these technologies.

The second round of coding led to 14 theoretically and empirically informed second order concepts (see Figure 2), from which we, grounded in our theoretical framework on sociotechnical imaginaries, could derive two general imaginaries of femtech in the Danish news media context: imaginaries of *individual adoption* and *collective potentiality*. The analysis consists of a close reading of the data coded in the second round, where atten-

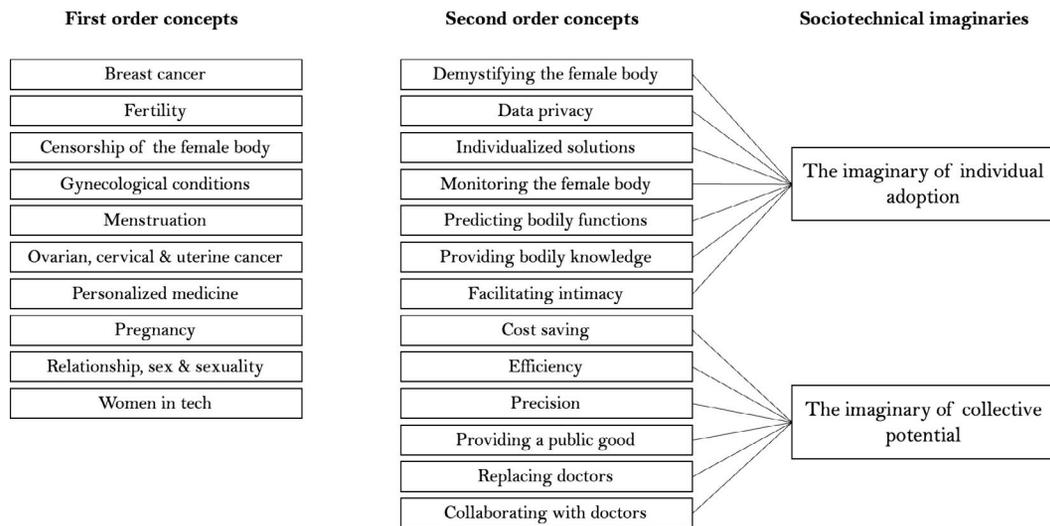


Figure 2: Data structure

tion was paid to both what was said and how it was said, thus emphasizing the particular over the general. Understanding sociotechnical imaginaries as collectively imagined forms of social life reflected in technological projects (Jasanoff & Kim, 2009), we especially looked at how the articulations of femtech in the data (re)produce understandings of female bodies and female health. Through this process, we have detailed the two imaginaries, specifying their “figures/forms/images” and the “reality” or “rationality” they constitute. Further, we sought to nuance the two sociotechnical imaginaries, showing how they are made up of distinct “sub-imaginaries” that create tension within each imaginary as well as controversy between them.

Our analytical strategy consists of a move back into second order concepts and a close reading of the coded material to unpack the articulation of imaginaries and the controversies involved. We use this analysis as the basis for our concluding discussion, which asks the question of how the social (discursive articulations and societal norms) and the material (digital technologies and human bodies) is entangled in the Danish news media’s production of femtech as reality and rationality.

Analysis

Studies of sociotechnical imaginaries, especially those focusing on imaginaries of AI, typically find a distinction between a tech-optimistic and a tech-pessimistic imaginary (Hansen, 2022; Sartori & Bocca, 2022). Although our study is part of a data set that is defined by its interest in AI and related digital technologies, this dichotomy is not replicated at the level of femtech imaginaries, which are, instead, articulated within a positive imaginary. As such, examples of femtech are often mentioned in passing, presented as illustrations of how technologies are already put to good use, or of their positive poten-

tials. They may be part of dichotomous controversies, but they feature predominantly on the tech-optimistic side of the debate. This is not to say that only one coherent imaginary exists. Rather, variations are not articulated along the lines of good and bad, but around the individual user, on the one hand, and the collective health system, on the other.

In what follows, we pursue these two imaginaries, but let us add one further initial observation. Some studies find that imaginaries develop over time, shifting from one emphasis to the other (Guay & Kirch, 2022), and we might have expected our data, which covers a 10-year period, to show similar tendencies. However, femtech and its related search terms are heavily clustered in the last five years of the data set, from 2017 to 2021 (see Figure 1 for an overview of this temporal distribution). Therefore, we are dealing with a snapshot rather than a diachronic development, but the imaginaries we have identified are nevertheless temporally distinct. Thus, the imaginary of individual femtech usage focuses on how the technologies are already applied, presenting an image of an existing reality and its various consequences. The imaginary of collective or populational health, to the contrary, is oriented towards future potentialities rather than present applications, imagining a future in which the Danish public health system is served by AI tools for diagnosing and treating women's diseases. Based on these two initial distinctions, we have labelled the two imaginaries: individual adoption and collective potentiality.

The sociotechnical imaginary of individual adoption

Many of the articulations in our data set present stories of individual women's adoption of new technologies, focusing on the use of period tracking apps, which are the most established and most frequently mentioned examples of femtech. Here, the news media articles about femtech center around particularities of the female body, drawing attention to bodily dis/functions, to bodily ir/regularity, and, most of all, to a human desire to really understand the (female) body. As such, the imaginary of individual adoption of femtech encompasses several different visions of how digital technology can help individual women re/connect with their bodies and/or digitally enhance bodily functions or correct dysfunction. Within this imaginary, we have found that two specific types of femtech are at the center of attention: period tracking, articulations of which point to how technology is used to track, manage, and control female fertility; and sextech, which is covered with reference to how technology can enhance, connect, or replace bodies in sexual situations.

In the context of period tracking apps, enhanced control over bodily functions is a particularly strong motif. Using period tracking apps to get an overview of the menstrual cycle is becoming a widespread practice all over the world, and many of the articles simply describe the technology and indicate how to use it. These articles cover the basics: "The app has a built-in calendar, which shows the likelihood of becoming pregnant for each day" (60). The more advanced: "You can combine your fitness data with data about

your menstrual cycle and get better control of your chance of getting pregnant as well as more understanding of your mood swings” (172). And the personal experience:

Every day I note down how much I’m bleeding, whether I have a headache or abdominal pain. This means that my app is now able to foresee my monthly cycle and that I receive a message when I, according to the calculations, can expect my period to start, when I enter the fertile phase, am ovulating or pms. (243)

Period tracking apps are presented as a cheap and effective way of optimizing the chances of getting pregnant and reducing the risk of having to spend large sums of money as well as emotional energy on fertility treatment. Before the introduction of fertility apps, many women had limited knowledge about the variation in fertility across the menstrual cycle, creating a knowledge gap, which fertility apps turned into a market opportunity. Smartphone apps, then, have become an established part of many women’s and couples’ processes of becoming pregnant, helping them gain knowledge about individual fertility cycles. This technological development aligns with social changes, which have turned what might otherwise be viewed as a fairly low-tech matter into a process that relies increasingly on technological support:

It should not be necessary to have a smartphone to procreate, but more and more people choose to have children later in life, which means that it is not necessarily as easy to become pregnant as the sexual education in school said it was. Data may be able to cure that. (60)

As the apps have developed, they have become so sophisticated and precise that they can not only be used to support pregnancy but also to prevent it. One app, Natural Cycles, which combines information about the menstrual cycle with daily temperatures, is certified for use as contraception. This makes the app “just as effective as the contraceptive pill and condoms” (91). While the predominant sentiment is that this way of managing fertility is cost effective, individualized, and secure, there is also some hesitancy: “Just imagine that an app tells you if it is a good idea or not to have unprotected sex with your partner tonight” (91). There seems to be something uncanny about an app that knows so much about you – maybe even more than you know yourself. Similarly, the idea of involving an app in intimate sexual relationships is sometimes viewed as taking digitalization a step too far, so far that it becomes important to underline the role that the app is actually playing: “Don’t you worry, the app is not actively in bed with you, but by collecting data about the menstrual cycle and health its algorithm is calculating when the woman is ovulating and predicts when she is most fertile” (60).

Here, an interesting dilemma emerges, as the articles, on the one hand, articulate the value of feeding the period tracking apps with data: “the longer you use Glow [a fertility app], the better it becomes at predicting the next period and ovulation” (60) and “if a woman measures her temperature each morning with a thermometer that is sufficiently

precise, then the phone can decide if it is a contraception free day or a day when e.g. a condom is necessary" (99). On the other hand, however, there is concern for the amount of knowledge the apps gain about individual users and what that information can be used for. This problem has been accentuated after the overturning of *Roe v. Wade*, but it is already present in our data set, though delimited to the US context: "In February, *The Wall Street Journal* reported that a widespread app called *Flo Period and Ovulation Tracker* was one of no less than 70 apps that forwarded data to Facebook" (211). When the coverage zooms in on the Danish context, sharing data is perceived to be unproblematic and safe, a point that, as we shall see, is central to the imaginary of collective potentiality.

Turning first to the coverage that articulates sub-imaginaries around sextech, the emphasis is on technological potentials to enhance relationships, with little concern for the limits of technological intimacy. Here, the coverage details how technology can connect people and "create intimacy between two persons who cannot touch each other" (141), whether due to geographical distance or physical disabilities. As one newspaper article puts it, the technology enables sexual encounters "where she is in a hotel room in USA being vibrator stimulated by him, who sits with the power and the smartphone in Denmark" (196). Another article highlights the technological breakthrough for people who are physically disabled, for example, people living with paralysis, as a "paralyzed person can have sexual interaction with the person who uses the dildo" (144). "Smart dildos" are also seen to support "new and safer forms of prostitution" (141), where the sex worker does not need to be in the same physical room as the client, thereby reducing the risk of violence and abuse.

While these technologies may facilitate intimacy across distances and between bodies in novel and striking ways, the media coverage of them predominantly reproduces heteronormative (power) relations. Sextechs are frequently depicted as being used by women, but the focus is less on female enjoyment or lust and more on the one who manages the smart dildo (through brain waves or smartphones): a person who is directly or indirectly depicted as a man. In the sub-imaginary that focuses on sextech, then, a heterosexual male perspective dominates, and the female body, its lust, and enjoyment are painstakingly missing from this particular vision.

Issues of female desire are, however, at the center of another cluster of technologies: computer games that aim to demystify the female body. With a focus on erotica and bodily sensations, these games are developed to "provoke feelings, sensations, and reflection" (133). One such game offers a metaphorical journey through the four phases of a menstrual cycle; another game lets the player stimulate and experience a female orgasm by interacting with a pixilated image of female genitalia. As one of the game developers says: "The female orgasm is somewhat of a mystery and not something that we talk about very often. So, it was interesting for us to demystify it" (133). The game is not thought of as a learning tool or one-to-one simulation, but rather a sensational experience that

forefronts the diversity of female bodies, lust, and pleasure. As such, the game is seen as a counterreaction to the overflow of male sexuality and women as sexual objects in digital gaming – and, as we saw above, in the development of digital sextech.

What this vision has in common with the sub-imaginaries that center around sextech and period tracking apps, respectively, is a focus on the demystification of the female body and a vision of digitally enhanced insights about and control over this body. The coverage predominantly presents this development in positive terms: “When we monitor the body with smart technology, we are in a sense brought closer to the body” (185). Somewhat paradoxically, then, femtech becomes a medium for women to know more about themselves, coming closer to their bodies through technological means rather than by direct encounters with and experiences of them. We return to this point in the concluding discussion, but first turn to unfolding the imaginary of collective potentiality.

The sociotechnical imaginary of collective potentiality

The sociotechnical imaginary of how femtech can change the health system focuses less on the individual body and more on the societal advantages that new technologies may bring. As mentioned, the Danish case is somewhat special, as the health sector is not only predominantly public, with universally guaranteed free healthcare for all, but also thoroughly digitalized and datafied, following a long tradition of collecting and using citizens’ health data for medical research. Thus, it is taken for granted that healthcare is technologically supported – and that this is a good thing: “The healthcare system has to be in constant development to live up to the demands of both efficiency and better treatment” (313). As indicated above, while issues of data privacy are reported critically when placed in the US context, sharing data in the Danish context – or, more precisely, with the Danish health system – is predominantly viewed as contributing to a common resource.

One example of how this common resource might be used – AI-supported diagnosis of breast cancer – features heavily in our data set. Denmark has a well-developed program for detecting breast cancer, where all women in the age group of 50 to 69 years old are scanned every other year. At present, every mammogram is evaluated by two radiologists to ensure diagnostic accuracy. A third radiologist is consulted in case the two first disagree. This advanced program results in a large workload for the country’s radiologists, who are often under pressure, and the program is a hefty item on the public healthcare budget. Hence, the mammography program, as presented in our data, offers a good opportunity for exploring the potentials and consequences of AI as diagnostic support.

While AI has not yet become implemented as a standard in the Danish program, the data set contains many accounts of both national and international programs and trials exploring how AI can be used to decrease costs and increase precision as well as efficiency. For example, one study at Houston Methodist Hospital shows that “artificial intelligence has made it possible to analyse mammograms 30 times faster than radiologists with a precision of 99 per cent” (92). Similarly, a Danish region is introducing AI to

their breast cancer screening program to “reduce response time and prevent delays in relation to screenings” (350). By either replacing a radiologist or using AI as a diagnostic support, increased efficiency and reduced costs are envisioned as the main benefits of the new technologies. Significantly, “AI radiologists” are not yet introduced, but the coverage expresses unreserved support for them: “It is not yet allowed to leave the task of analysing x-rays to computers, but it is expected to happen shortly, since the precision is so high and since it will free up thousands of specialists’ work hours” (92). AIs will not only be as good as human doctors but are envisioned as being even better at the job: “New study shows that an AI is better at detecting breast cancer than a radiologist of flesh and blood. Deep learning algorithms are so good that they are outperforming radiologists at the hospital” (251).

By using medical resources in a more efficient way, the AIs are seen to provide a public good. More women are screened and more accurately diagnosed, using less resources. Thus, there are monetary, medical, and societal reasons to implement AI as a tool for diagnosis and, potentially, treatment. Many doctors view AI technologies as a support in their diagnostic work, as a tool that can facilitate the decision-making. However, some are hesitant to fully implement these technologies, arguing that there is already a good system in place. This reflects the present state of affairs in which the technologies have not yet been implemented, but there is a growing consensus that they will soon be ready to supplement human doctors and alleviate strained systems; it is just a question of time before “the doctor robots are at a level where the medical science wants to ‘hire’ them” (132).

The case of mammography screenings is not the only one present in the data set, but it is the most developed, and it is indicative of the general imaginary of collective potentiality, which focuses solely on societal benefits and assumes that what will be good for society will be good for individual women. Faster and more precise diagnosis may indeed be an individual as well as a collective good, but the coverage does not concern itself with any other potential consequences. As such, the collective and the individual imaginaries share the assumption that “knowledge is power”, reproducing a rationality of autonomy and control at the collective as well as the individual level. We now turn to our concluding discussion of this rationality and its concomitant reality.

Concluding discussion

Sociotechnical imaginaries give shape to and are shaped by technological developments (Dahlman et al., 2021), thereby articulating the entanglements of the social and the technical. In the case of femtech, we see this duality in the different temporalities of two general imaginaries, one establishing current individual uses of the technology, the other envisioning its future collective application. In either case, the imaginaries articulate an instrumental rationality that is both embedded in the involved technologies and shapes

how these technologies may be used. The “sociotechnical configuration of gender normativity” (Costanza-Chock, 2020) that is expressed and realized here reproduces existing gender norms *and* technological visions – that is, the social and the technical is entangled in such a way as to uphold currently dominant regimes of power/knowledge (Lupton, 2018).

More specifically, sociotechnical imaginaries of femtech are organized around the idea(l) of data as a conduit for knowledge; the female body becomes available to individual understanding and control when rendered as data points, and the same rationality supports visions of efficiency and precision at the collective level. The datafication of female health experiences may reveal otherwise hidden patterns and enable individual women to gain knowledge of and take control over their bodies’ most intimate “secrets”. But this very language also reproduces an understanding of female intimacies as secretive, mysterious, and, significantly, conquerable. Here, the experiences of individual women, as documented in existing research (Grenfell et al., 2020; Hamper, 2020; Del Busso et al., 2022; Petersen, 2022), is replicated at the societal-discursive level.

The biopower (Sanders, 2017) and body politics (Della Bianco, 2021) of these imaginaries are particularly clearly expressed in the coverage of sextech, which reproduces heterosexual normativities of active male partners and passive female recipients. Further, norms of participatory surveillance (Lupton, 2015a; Barassi, 2017) are apparent in the collective imaginary, where women are positioned as objects of medical knowledge. In this imaginary, enhanced precision and efficiency are primarily constructed as collective goods of which individual women are secondary beneficiaries.

The currently most prevalent use of femtech in the form of apps for individual (period) tracking seemingly reverses this order, making individuals the main beneficiaries of information that may secondarily benefit societies (e.g., through better data for research or through the aggregate increase in female reproductive and sexual health). This reversal has the effect of responsabilizing women, positioning the everyday monitoring of one’s own health as an individual task (Almeling, 2020). Thus, the general rationality of coming to know female bodies through the externalization of data and standardization of knowledge is reproduced; the apps may promise personalized insights, but deliver standard deviations.

In sum, sociotechnical imaginaries of femtech make female bodies knowable through algorithms and data, organizing individual adoption and collective potentialities according to an instrumental rationality of control – of externalizing data and acting in accordance with predictable patterns of utility maximization. Individual women and societal actors alike may gain knowledge of female health, but they do not become more intimate with women’s wellbeing. Thus, the everyday experiences to which the sociotechnical imaginaries of femtech speak are of (further) mediation of female health rather than (collective or individual) empowerment.

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