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Health inequalities and personalized advertising: A pathway to equity?

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Abstract

Health inequalities persist despite significant global advancements in health and well-being. While social determinants of health, such as income and education, are well-documented contributors, commercial determinants — especially advertising exposure— play an increasingly influential role. This study examines the relationship between advertising and health inequalities, focusing on how personalized digital advertising may exacerbate these disparities. The literature review reveals that disadvantaged communities have historically been disproportionately exposed to advertisements for health-harming products, a pattern consistent across traditional media and globally. Additionally, the critical analysis undertaken here of digital advertising practices highlights the potential risks of personalized advertising in reinforcing health disparities. These risks include algorithmic biases, issues related to data practices, and content loops that may perpetuate stereotypes and unhealthy behaviours. However, the study also identifies opportunities where personalized advertising could promote health equity by delivering targeted, health-enhancing messages to underserved populations. This research contributes to the broader discourse on health equity by highlighting the dual role of advertising as both a risk factor and a potential tool for positive health intervention. It underscores the urgent need for comprehensive regulatory frameworks that address the evolving landscape of digital advertising, ensuring it serves public health interests rather than perpetuating inequality.

Keywords

Health disparities, personalized advertising, health equity, privacy, algorithmic bias, audience targeting, public health campaigns, data-driven personalization, vulnerable populations, preventive health.

Resum

Les desigualtats en salut persisteixen malgrat els importants avenços mundials en salut i benestar. Encara que està ben documentat el paper que tenen determinants socials de la salut com els ingressos i l'educació, els determinants comercials, especialment l'exposició a la publicitat, tenen un paper cada cop més influent. Aquest estudi examina la relació entre la publicitat i les desigualtats en salut centrant-se en com la publicitat digital personalitzada pot agreujar aquestes disparitats. La revisió de la bibliografia revela que, històricament, les comunitats desafavorides han estat exposades de manera desproporcionada a anuncis de productes perjudicials per a la salut. Aquest patró s'ha detectat en diversos mitjans tradicionals i a escala mundial. A més, l'anàlisi crítica de les pràctiques de publicitat digital que s'ha dut a terme aquí posa de manifest els riscos potencials de la publicitat personalitzada a l'hora d'accentuar les disparitats en salut. Aquests riscos inclouen biaixos algorítmics, problemes relacionats amb les pràctiques de dades i bucles de contingut que poden perpetuar estereotips i comportaments poc saludables. No obstant això, l'estudi també identifica oportunitats en què la publicitat personalitzada podria promoure l'equitat en salut mitjançant l'entrega de missatges dirigits i amb un efecte positiu per a la salut a les poblacions desateses. Aquesta investigació contribueix al discurs més ampli sobre l'equitat en salut destacant el doble paper de la publicitat com a factor de risc i com a eina potencial per a una intervenció positiva en salut. Subratlla la necessitat urgent de marcs reguladors integrals que abordin el panorama canviant de la publicitat digital per garantir que afavoreixi els interessos de la salut pública en lloc de perpetuar la desigualtat.

Paraules clau

Disparitats en salut, publicitat personalitzada, equitat sanitària, privadesa, biaix algorítmic, segmentació d'audiències, campanyes de salut pública, personalització basada en dades, poblacions vulnerables, salut preventiva.

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Health inequality and advertising exposure

Over recent decades, substantial global human health and well-being advancements have been achieved. Nonetheless, continued progress is hindered by persistent inequalities both between and within populations. The latest report from the Organisation for Economic Co-operation and Development (OECD) on well-being across its member countries underscores that health inequalities among different population groups remain deeply entrenched. While disparate outcomes by age and gender have narrowed over the past decade, this reduction is, at times, attributed to comparatively more significant declines in outcomes among younger individuals and men rather than universal improvements (OECD, 2024). If current trends continue, inequalities in health will persist over the next two decades (Raymond et al., 2024).

The World Health Organization (WHO) defines *health inequality* as systematic, avoidable, and unfair differences in health outcomes between populations or social groups (Carmona & Loza, 2009; McCartney et al., 2021; WHO, 2022). These inequalities are primarily caused by social stratification and economic inequality (Riley, 2020; McCartney et al., 2013), which result from complex social, political, financial, and environmental interactions and often accumulate over lifetimes and generations (Sadana & Blas, 2013).

Understanding health inequalities and their underlying causes remains challenging and essential (Lucyk & McLaren, 2017). Social determinants of health, which encompass income, education, employment, housing and access to health care, are perhaps the most widely recognised factors shaping health disparities (Daniel et al., 2018). These determinants influence daily living conditions and access to resources, leading to significant variations in health across socioeconomic groups. Social determinants outweigh behavioural factors, including lifestyle choices such as diet, physical activity and substance use, or biological and genetic factors (Lipman & Lobo, 2017).

However, the factors that influence health outcomes do not end here. More recently, corporate policies, practices, and products have been identified as powerful influencing factors on health inequalities. The so-called *commercial determinants of health* involve private sector strategies and actions that promote products and behaviours with negative impacts on health, encompassing unhealthy commodities, harmful business practices, and broader market-driven forces (Bhugra & Ventriglio, 2023; Kickbusch et al., 2016; Mialon, 2020). This influence is facilitated by globalization, corporate structures, and neoliberal ideologies (de Lacy-Vawdon & Livingstone, 2020), and they operate through political practices, preference shaping, legal environments, and product promotion (Galea & van Schalkwyk, 2023).

The significant influence of commercial determinates on health disparities is particularly evident in the alarming rise of non-communicable diseases, which now stand as the leading cause of premature mortality worldwide (Collins et al., 2023). The burden of non-communicable diseases disproportionately affects disadvantaged groups, especially in low- and middle-income countries, contributing to over 86% of premature deaths in these areas (Collin & Hill, 2016; WHO, 2023). This pattern highlights the pressing need for targeted interventions to address the systemic factors fuelling this rise (Lee & Freudenberg, 2020).

A significant barrier to effectively addressing and preventing non-communicable diseases is the role of transnational corporations that profit from products like tobacco, alcohol, and processed foods, each of which significantly increases disease risk. By actively promoting these products, these industries not only heighten the incidence of non-communicable diseases but also drive poor health outcomes and diminish quality of life (Collins et al., 2023).

Regulatory frameworks have sought to mitigate these risks by imposing restrictions on the marketing and advertising of such products, particularly when targeting vulnerable populations. At the international level, the WHO has established guidelines, such as the WHO Framework Convention on Tobacco Control (WHO, 2015) which mandates restrictions on tobacco advertising, promotion, and sponsorship. Similarly, the WHO has issued recommendations to limit the marketing of unhealthy foods and beverages to children, emphasizing the need for stronger regulatory measures to protect public health (WHO, 2023). However, enforcement remains inconsistent across jurisdictions, and digital advertising strategies have led to new challenges for regulatory oversight.

In the context of online media, digital platforms have become primary channels for advertising harmful products, leveraging personalized advertising techniques that raise concerns about consumer privacy and ethical targeting. Regulations such as the General Data Protection Regulation (GDPR) in Europe and the California Consumer Privacy Act (CCPA) aim to provide users with greater control over their personal data, indirectly affecting how companies can target individuals with marketing (de la Torre, 2018; Hoofnagle et al., 2019). Additionally, specific measures, such as the European Audiovisual Media Services Directive (AVMSD), impose restrictions on advertising unhealthy foods and alcohol in children's programming, including online video-sharing platforms (Vlassis, 2022). However, the evolving nature of algorithm-driven advertising necessitates continuous regulatory adaptations to address loopholes and emerging risks.

Beyond formal legislation, self-regulatory frameworks play a significant role in shaping industry practices. Various sectors have established voluntary codes of conduct to guide ethical advertising, such as the International Chamber of Commerce's Advertising and Marketing Communications Code and the Responsible Marketing Codes adopted by major food and beverage corporations. These initiatives outline principles for responsible advertising, including restrictions on marketing unhealthy products to minors (ICC, 2025). Nevertheless, concerns persist regarding their effectiveness, as compliance remains voluntary, and enforcement mechanisms are often weak.

More recently, the regulation of influencer marketing has

emerged as a critical area of policy intervention, given the increasing reliance of brands on social media personalities to promote their products. Several jurisdictions have introduced specific legislation addressing the transparency and accountability of influencer marketing. For instance, the European Commission's Digital Services Act (DSA) mandates clearer disclosure of paid partnerships, while countries like France and Spain have implemented stricter guidelines requiring influencers to explicitly label sponsored content, particularly when promoting products with public health implications (Cauffman & Goanta, 2021). These measures reflect a growing recognition of the need to regulate digital advertising strategies that circumvent traditional restrictions, ensuring that health-harming products are not deceptively marketed to vulnerable consumers.

Despite these regulatory efforts, gaps remain in effectively governing the digital advertising ecosystem, particularly in addressing algorithmic bias and opaque targeting practices. These challenges underscore the need for a deeper understanding of how advertising contributes to health inequalities, especially in the context of emerging digital marketing strategies.

Objective

This study examines the relationship between advertising and health inequalities through a systematic literature review and a critical analysis of the emerging risks associated with digital advertising practices. Specifically, it synthesizes existing research on how algorithmically delivered personalized advertising shapes exposure patterns across sociodemographic groups, potentially exacerbating disparities in health outcomes. Additionally, the study explores the opportunities of personalized advertising in public health contexts, assessing its role in either reinforcing or mitigating health inequalities. By doing so, this research aims to provide a nuanced understanding of the mechanisms through which advertising influences health disparities and to contribute to ongoing regulatory and policy discussions aimed at promoting health equity.

Methodology

This study followed a two-step methodological approach. First, a systematic literature review was conducted to synthesize existing research on the relationship between advertising and health inequalities. To this end, searches were performed in two of the most comprehensive and reliable academic databases: Scopus and the Web of Science Core Collection (WoS). The search strategy was designed to identify studies containing the terms health, advertising, and unequal in their title, abstract, or keywords. Boolean operators were applied to ensure a broad yet focused selection of relevant documents, using the following query: 'health AND advertising AND unequal*'.

The initial search yielded 138 records in Scopus and 99 in WoS, totaling 237 documents. After removing 67 duplicates, 170 unique records remained. To ensure linguistic accessibility, studies not written in English, Spanish, or Catalan were excluded (n = 3; French, Persian, and German). Additionally, non-peer-reviewed documents —including book chapters (n = 7), books (n = 1), conference reviews (n = 1), letters (n = 1), opinion articles (n = 2), notes (n = 1), and editorials (n = 1)— were also excluded. This process resulted in a final selection of 153 peer-reviewed articles and conference proceedings.

Studies that did not address the role of advertising in health inequalities were subsequently excluded. Only 18 articles published between 1992 and 2024 explicitly examined disparities in advertising exposure based on sociodemographic factors in relation to health-related topics. Given the high specificity of this research focus, an additional 13 relevant studies were identified through backward and forward citation tracking, ensuring a more comprehensive mapping of the existing literature. This methodological step allowed for the inclusion of studies that, while not captured by the initial database search, provided valuable insights into the relationship between advertising exposure and health inequalities.

Second, the study conducts a critical analysis that examines the potential risks of algorithmically delivered advertising, drawing on insights from the broader literature on personalization. This analysis explores how these risks could manifest in the context of health inequalities, particularly in shaping exposure to unhealthy products and reinforcing existing disparities.

This approach relies on a theoretical extrapolation, using existing evidence on the unintended effects of personalization to anticipate how these dynamics may influence health-related disparities. The argument is grounded in both empirical studies and theoretical frameworks, highlighting key areas of concern for future research and policymaking.

Literature review: the traditional role of advertising in health inequalities

The results of the literature review indicate that, over time and across different regions, disadvantaged communities have consistently been exposed to a higher volume of advertising for products harmful to health. Beginning with tobacco advertising, which has traditionally been promoted in lower-income countries worldwide to a disproportionately high degree —contributing to higher consumption rates and an increased cancer burden in these regions (Tomatis, 1992)— a similar pattern can be observed for other equally harmful products.

In the United States, the prevalence of outdoor advertising for unhealthy products has long been disproportionately higher in low-income neighbourhoods and those with larger Latino and African American populations, compared to wealthier neighbourhoods predominantly inhabited by White and Asian residents (Cassady et al., 2015; Lowery & Sloane, 2014; John

et al., 2009; Kong et al., 2024; Roberts et al., 2015; Venugopal et al., 2022; Wilson & Till, 2012). Recent studies confirm that this pattern persists, with low-income areas facing heightened exposure to advertisements promoting food, alcohol, tobacco, and sugary beverages (Zahid et al., 2022).

These disparities in advertising exposure extend beyond outdoor spaces and disproportionately impact ethnic minority groups across various media platforms, such as magazines and television. African American and Hispanic individuals in the United States, including both women and youth, are disproportionately exposed to advertisements for harmful products, such as tobacco while encountering fewer ads promoting positive health outcomes relative to their Caucasian and non-minority counterparts (Duerksen et al., 2005; Nicksic et al., 2022). Similarly, television networks targeting children and adolescents from low-income or racial minority backgrounds broadcast a higher frequency of advertisements for fast food and sugary drinks (Powell et al., 2014; Rudd Report, 2021).

Similar patterns emerge in other regions. In the United Kingdom, children from disadvantaged backgrounds are more frequently exposed to television and outdoor advertisements for unhealthy foods and beverages compared to their wealthier peers (Adams et al., 2011c; Nairn & Opree, 2021; Olsen et al., 2021; Scott et al., 2023; Thomas et al., 2019). In Australia, advertising for less healthy products is slightly more frequent in socioeconomically disadvantaged areas (Maganja et al., 2024). In Uganda, a study found that healthier food advertisements were more prevalent in high-income areas, highlighting a similar divide (Dia et al., 2021). In Spain, children from lower socioeconomic backgrounds are exposed to nearly double the number of television advertisements for unhealthy foods and beverages compared to children from higher socioeconomic backgrounds (Royo-Bordonada et al., 2024). Additionally, while alcohol advertising is perceived as omnipresent in high-income neighborhoods, it is more youth-oriented in lower-income areas (Molina de la Fuente et al., 2021).

Although some studies offer nuanced perspectives (Adams et al., 2011a; Adams et al., 2011b; Lee et al., 2015; Macinko et al., 2003; Robertson et al., 2021; Simard et al., 2024), literature reviews consistently highlight a pattern of unequal advertising exposure: worldwide, minority and low-income children and adolescents are disproportionately targeted by advertisements for unhealthy foods and products compared to their wealthier peers (Backholer et al., 2020; Grilo et al., 2021).

This body of research provides strong evidence that disadvantaged communities, particularly minority and low-income groups, are systematically exposed to higher levels of advertising for unhealthy products. However, it is important to note that most studies focus on high-income countries, particularly the United States and the United Kingdom, while research in low- and middle-income countries remains scarce. This geographic bias limits our understanding of how these disparities manifest in different regulatory, economic, and cultural contexts, potentially causing us to miss important regional variations.

To synthesize these findings, Table 1 presents a summary of key studies, outlining their geographical focus, the type of products advertised, and the main conclusions.

The impact of unequal advertising exposure on health outcomes

Food advertising strongly influences children's and adolescents' intake, choices, preferences, and purchase requests, reinforcing unhealthy patterns over time and heightening the risk of childhood obesity (Radesky et al., 2020; Coleman et al., 2022; Boyland et al., 2022; Arrona-Cardoza et al., 2023). Furthermore, it fosters persistent demands and has been linked to increased materialism, a greater reliance on advertising, and lower self-esteem among children (Carthy et al., 2022; Nairn & Opree, 2020). Similarly, gambling advertising promotes positive attitudes toward gambling, leading to increased participation and associated risks, again mainly affecting children and other vulnerable groups (McGrane et al., 2023).

However, this disparity in advertising exposure is not limited to products that can harm health, such as gambling, alcohol, junk food or tobacco, but also includes an exclusion from positive health-promoting advertisements (Datta et al., 2020; Tan, 2015). Health-related advertising may contribute to discrimination by excluding certain social groups from health treatment or healthy lifestyle promotion messages.

Thus, the ability to direct advertising toward specific audiences while excluding others inherently generates discrimination. As we have seen, this selective targeting can contribute to health inequities, especially among vulnerable groups.

As the reader may have noted in the literature review, much of the existing research has explored traditional forms of advertising, such as outdoor and television ads, while there remains a significant gap in understanding how these dynamics play out in digital spaces. The digital landscape, where younger generations are increasingly consuming media, presents a unique context that is not adequately addressed by current studies. Given the precision of algorithmically driven advertising, it is essential to examine how data-driven practices might not only perpetuate existing disparities but also introduce new forms of exclusion and inequality in exposure to both harmful and health-related messages. This growing shift toward personalized advertising requires a deeper understanding of its mechanisms and consequences, especially for vulnerable populations.

In the following section, we will explore the potential implications of these digital advertising practices, focusing on how they operate and affect the exposure of vulnerable groups to both harmful and beneficial messages.

Table 1. Overview of literature on unequal exposure to unhealthy product advertising

Study	Region	Product Advertised	Main findings
Adams et al., 2011	UK	Food (HFSS)	Lower-income viewers had higher exposure to food ads
Adams et al., 2011b	UK	Outdoor food ads	More outdoor food ads in low-income areas
Adams et al., 2011c	UK	Food & beverages	Food ads were more common in magazines for wealthier audiences
Cassady et al., 2015	USA	Food & beverages	More unhealthy food ads in low-income & minority areas
Datta et al., 2020	Pakistan	Tobacco control	Tobacco control policies more effective among higher-educated groups
Dia et al., 2021	Uganda	Food & beverages	86% of ads around schools promoted unhealthy products
Duerksen et al., 2005	USA	Health-related ads	Fewer health-positive ads in magazines for Black & Hispanic women
John et al., 2009	USA	Tobacco	Tobacco marketing targeted disadvantaged communities
Kong et al., 2024	USA	Tobacco	Attractive tobacco descriptors more common in Black neighbourhoods
Lee et al., 2015	USA	Tobacco regulations	Tobacco regulation violations varied by neighbourhood
Lowery & Sloane, 2014	USA	Harmful ads	More harmful ads in low-income areas
Macinko et al., 2003	Various	Income inequality & health	Income inequality strongly linked to poor health outcomes
Maganja et al., 2024	Australia	Unhealthy products	Unhealthy products more frequently promoted in disadvantaged areas
Matthay et al., 2023	USA	Alcohol & cannabis	Stricter alcohol & cannabis policies in high-poverty communities
Molina de la Fuente et al., 2021	Spain	Alcohol	Alcohol ads perceived as omnipresent in high-income areas, youth-targeted in low-income ones
Nairn & Opree, 2021	UK	TV ads	Low-income children were more susceptible to advertising & materialism
Nicksic et al., 2022	USA	Tobacco	Higher tobacco ad exposure among Black & Hispanic youth
Olsen, 2021	Scotland	Unhealthy product ads	More unhealthy product ads in low-income areas
Powell et al., 2014	USA	Food & beverages	Higher fast food & sugary drink ad exposure for minority youth
Roberts et al., 2015	USA	Tobacco	Menthol cigarette ads more common in Black-majority areas
Robertson et al., 2021	UK	Food & drink ads	Most bus stop ads promoted unhealthy products
Royo-Bordonada et al., 2024	Spain	Food & beverages	Children from lower-income backgrounds exposed to twice as many food ads
Rudd Report, 2021	USA	Unhealthy foods	Black & Hispanic youth disproportionately exposed to unhealthy food ads
Scott et al., 2023	UK	Unhealthy products	Unhealthy product ads more prevalent in disadvantaged neighborhoods
Simard et al., 2024	USA	Cannabis	Restrictive cannabis sales policies more common in low-income areas
Tan, 2015	USA	Cancer treatment ads	Cancer treatment advertising exposure varied by income & education
Thomas et al., 2019	UK	Unhealthy foods	Disadvantaged youth consumed more unhealthy food & had higher ad exposure
Tomatis, 1992	Global	Tobacco	Tobacco ads stricter in high-income countries than in developing nations
Venugopal et al., 2022	USA	Vape shops	Vape shops concentrated in socially disadvantaged areas
Wilson, 2012	USA	Alcohol	Alcohol ads more prevalent in lower-income, Black & Hispanic areas
Zahid et al., 2022	USA	Unhealthy products	Low-income neighbourhoods had a higher concentration of unhealthy ads

Source: Author.

The role of personalized advertising in health inequalities

Data-driven advertising leverages consumer information and analytics to deliver highly personalized and targeted marketing messages by collecting, processing, and analyzing digital traces to align with individual preferences (Aiolfi et al., 2021; Lee & Cho, 2019; Strycharz & Segijn, 2022). While traditional advertising formats —such as TV, radio, print media, and billboards— lack the precise targeting capacity of online advertising and often result in expenditures reaching broad audiences that may not engage with the content, online advertising offers much more refined approaches.

Technological advances, particularly in mobile phones and AI, have expanded the capacity for demographic, psychographic, behavioural, and geographic targeting, making personalization more precise (Vold & Whittlestone, 2019; Kim et al., 2019). Advertisers can now align ads with users' immediate activities —such as searching, browsing, or watching videos (Goldfarb, 2014)— and assess real-time ad impact by tracking user interactions, enabling more efficient resource allocation by focusing on engaged audiences (Blake et al., 2015).

This enhanced targeting minimizes scattering losses and increases return on investment. Proponents argue that it also benefits consumers by increasing ad relevance and engagement through messages that resonate with their preferences and needs (Aaker et al., 2000). However, critics point to significant ethical concerns, including manipulative practices and potential inequalities in exposure across demographic groups (Aiolfi et al., 2021; Nadler & McGuigan, 2017; Ali et al., 2019).

Examining the risks associated with this targeted approach is crucial to comprehensively understanding the implications of personalized advertising on health equity. The following section outlines critical risks posed by personalized advertising in health equity, detailing how these practices may disproportionately affect vulnerable populations and exacerbate existing inequalities.

A) Privacy issues

Individuals' privacy is probably the most studied challenge when analysing the unintended effects of personalized advertising, and the number of studies covering the topic has increased exponentially in recent years as advertising has come to rely on "collecting, storing, extracting, inferring, using, selling, and sharing consumer information to personalize and tailor advertising messages" (Boerman & Smit, 2023, p. 60).

The widespread use of digital platforms for health-related services has led to an unprecedented accumulation of sensitive user data concerning both physical and mental health (Surani et al., 2023). Research consistently demonstrates that confidential health data collected by these platforms is frequently repurposed for targeted advertising, often without explicit user consent (Marelli et al., 2021; Downing & Perakslis, 2022). Many fertility and mental health apps, for instance, routinely gather extensive data, including users' locations, contact information, and even their mental or physical health status, and then share this information with third-party entities. This practice raises significant ethical concerns regarding user autonomy and data security, as users may be unaware of the extent to which their personal information is utilized for commercial purposes (Downing & Perakslis, 2022; Kemps, 2023; Mozilla Foundation, 2023).

Through data gathered on social media and health apps, algorithms have the capability to direct ads at vulnerable populations, including individuals with specific health conditions (Bol et al., 2020; Downing & Perakslis, 2022). Such practices not only threaten user privacy but also create opportunities for potentially manipulative advertising strategies that could influence users' health behaviours in ways that may not align with their best interests (Bol et al., 2020; Grundy et al., 2019; Mozilla Foundation, 2023).

However, this vulnerability extends not only to explicitly sensitive health information but also to data that, on the surface, may appear unrelated to health. For instance, behaviours such as frequently reading posts on topics like fertility or pregnancy can allow algorithms to infer a user's health-related intentions or conditions (Marks, 2020).

This dynamic creates two forms of inequality. First, individuals who already suffer from health issues may become disproportionately targeted by advertising strategies that exploit their vulnerabilities. This heightened targeting exposes them to a greater volume of ads that prey on their health conditions, potentially exacerbating emotional distress and financial strain. In this case, the inequality arises from their pre-existing health vulnerabilities, which make them more susceptible to exploitative advertising tactics.

Second, individuals who have shown interest in specific health-related topics —whether by browsing health content, following social media accounts, or interacting with health-related apps— might be targeted by advertisers who infer their concerns. These algorithms could identify patterns of behaviour, such as searching for symptoms or health information, and use this data to serve personalized ads. This type of inequality would not be created by an overt expression of health concern, but by the inference of such concerns based on digital behaviour, leading to increased exposure to targeted content that exploits these inferred vulnerabilities for profit.

Despite the growing number of privacy regulations, such as the General Data Protection Regulation (GDPR) in Europe and the California Consumer Privacy Act (CCPA), which impose strict limits on data collection and usage, personalized advertising remains a pervasive force in the digital ecosystem (de la Torre, 2018; Hoofnagle et al., 2019). These regulations aim to enhance consumer autonomy by granting individuals greater control over their personal data, requiring explicit consent for data processing, and imposing transparency obligations on advertisers and platforms. However, while these legal frameworks have placed constraints on certain invasive practices, they do not entirely eliminate the risks associated

with algorithmic personalization in advertising. The continued reliance on inferred data —rather than explicitly provided health information— demonstrates how advertisers adapt to regulatory landscapes, using behavioural patterns to tailor advertising strategies while remaining within legal boundaries, meaning that even legally compliant advertising can still exploit an individual's vulnerability.

Thus, the lack of transparency and security regarding even seemingly innocuous data contributes to a system where certain populations are more exposed to potentially exploitative advertising. This not only deepens existing inequities in healthcare access and support but also amplifies the risk of individuals being targeted by harmful products or unproven health remedies. As we have seen, these vulnerabilities are compounded by the way data-driven advertising practices personalize and target individuals, often reinforcing existing biases.

B) Algorithmic entrapment and content loops

Another critical risk posed by algorithmic advertising is the phenomenon of algorithmic entrapment and content loops. Intensive personalization algorithms, such as those found on platforms like YouTube or TikTok, have the ability to develop strong and potentially harmful recommendation patterns in a short period of time, locking users into content loops that reinforce biases and misconceptions (Schellingerhout et al., 2023; Hussein et al., 2020).

This is due, in part, to the algorithm's reliance on personalization features to determine what content to recommend next. While this approach may create a more personalized experience, it also increases the risk of exposing users to misleading or harmful information, as the algorithm amplifies content with a high engagement potential, regardless of its accuracy or reliability (Hussein et al., 2020).

This phenomenon has been studied primarily in the field of disinformation, which represents a major public health problem (Laxa, 2022; Hoang et al., 2021). Prolonged exposure to false or biased content can affect public perception and individual decisions about health and safety issues, leading to confusion and distrust in legitimate sources of information (Zucker, 2020). Thus, a person interested in pseudoscientific topics, for example, can quickly find himself surrounded exclusively by content in this vein.

Moreover, escaping algorithmic profiling is particularly difficult. For people who are, for instance, in recovery from eating disorders, algorithmic recommendations can be especially harmful, inadvertently exposing them to triggering content such as diet-related videos or posts based on past viewing behaviours, even if the user actively tries to avoid those topics (Golbeck, 2024). This same phenomenon can occur with other problems such as gambling, self-harm, or suicidal ideation.

These dynamics highlight a fundamental flaw in engagement-driven algorithms: they are not inherently designed to prioritize users' well-being or mental health, focusing instead on maximizing interaction time and engagement (Golbeck, 2024). Although companies have started to invest in content moderation, these efforts often fall short of aligning with research-based strategies for effectively identifying and mitigating harmful content (Arora et al., 2021; Golbeck, 2024). Consequently, content moderation remains insufficient in both speed and accuracy when compared to the rapid, precise recommendations generated by algorithms, which can readily amplify potentially harmful content.

Personalized advertising is integrated into these algorithmic content loops, leading users exposed to misinformation to receive targeted ads and promotions that align with the biases reinforced by the algorithm. As users engage with misleading or pseudoscientific content, they are more likely to encounter ads for products, services, or even scams that exploit their interests or fears, further entrenching them in these loops. This dual exposure to both content and advertising driven by engagement-based algorithms not only reinforces misinformation but also preys on users' vulnerabilities, deepening the potential for exploitation and harm.

In sum, algorithmic content loops pose significant risks by reinforcing misinformation and exposing users to potentially harmful content, often without the users' explicit intent. The integration of personalized advertising within these loops exacerbates the issue, as engagement-driven algorithms prioritize interaction over accuracy or user well-being. Without stronger safeguards, these systems will continue to amplify biases and vulnerabilities, making it increasingly difficult for individuals to break free from harmful content cycles.

C) Algorithmic bias and exclusion

Lastly, one of the most concerning risks of personalized advertising is its ability to reinforce inequalities through algorithmic biases in ad distribution. A fundamental issue in algorithmic advertising is that bias is often an emergent property of the optimization processes that govern ad distribution, rather than a result of direct human intervention. Modern digital advertising platforms rely on machine learning algorithms that optimize ad placement based on engagement metrics, historical interactions, and predicted relevance. These models are designed to maximize click-through rates and conversions, but in doing so, they can reinforce and perpetuate pre-existing disparities (Imana et al., 2021; Ali et al., 2021). For example, when algorithms detect that a certain demographic group is more likely to engage with a particular type of ad, they will allocate ad impressions accordingly, leading to self-reinforcing cycles of exposure. This means that groups that historically have received more exposure to certain types of ads —whether beneficial or harmful— are likely to continue receiving similar content.

Beyond engagement-based optimization, the bidding structures of online ad platforms also contribute to differential ad exposure. Many digital advertising systems use real-time bidding (RTB), where advertisers compete for ad placements

based on demographic and behavioural data. Since certain user segments are more desirable to advertisers, their ad impressions become more expensive, leading to resource-constrained campaigns disproportionately reaching lower-cost audiences (Cauffman, 2021; Lambrecht & Tucker, 2019). In the health sector, this can mean that preventive health campaigns or public service announcements fail to reach critical at-risk populations because advertisers cannot afford to outbid commercial campaigns targeting more lucrative demographics.

Moreover, the lack of transparency in digital ad distribution systems makes bias difficult to audit or regulate. Unlike traditional advertising, where ad placement was clearly observable, digital advertising operates within proprietary and opaque algorithmic systems. Researchers and policymakers face challenges in tracking who is being exposed to which ads, under what conditions, and with what effects (Ali et al., 2019; Dalenberg, 2018; Rieder & Hofmann, 2020). Without meaningful oversight, the potential for algorithmic bias to deepen health inequalities remains a significant yet largely unregulated risk.

These issues are especially relevant in advertising related to health or products that may undermine health. Studies have shown that ad-serving algorithms disproportionately expose certain demographic groups —mainly women, older adults, and individuals with poorer health status— to health-related content (Bol et al., 2020). These risks are even more concerning when advertisements target younger audiences. Research on children's exposure to advertising reveals that the ads they receive on their mobile devices are significantly shaped by factors such as age, gender, and socioeconomic status (Feijóo & Sádaba, 2022). This segmentation can amplify existing inequalities and contribute to health disparities, as younger users, whose digital behaviours are closely monitored by algorithms, may be exposed to targeted ads that reinforce stereotypes or promote products potentially harmful to their health and well-being (Radesky et al., 2020).

In this context, the combination of algorithmic opacity, inference-based targeting, and RTB structures in digital advertising markets creates an environment where disparities in ad exposure not only persist but intensify over time. Without effective regulation ensuring greater transparency in ad targeting and delivery processes, these systems will continue to favour certain population groups while leaving others at a disadvantage, further reinforcing structural inequalities in access to health information and resources.

Beyond risks: Personalized advertising as an opportunity for health equity

Conversely, the full potential of personalized advertising can be interpreted from a different perspective. While personalized advertising carries notable risks —including privacy concerns, algorithmic loops that reinforce harmful content, and unequal exposure to potentially detrimental ads for vulnerable groups— these same technologies hold significant promise for public health efforts. In the hands of institutions or organizations focused on promoting health and prevention, personalization can be a powerful tool for delivering tailored, impactful messages to diverse audiences, effectively addressing specific needs and behaviours.

On the one hand, personalization allows health campaigns to align messages with the preferences, cultural contexts, and linguistic needs of different audiences. By tailoring messages to resonate personally, public health initiatives can become more relevant and engaging for individuals, which research has shown can significantly improve audience receptivity. When audiences perceive ads as relevant to their circumstances and values, they respond more positively, showing greater trust, favourable attitudes, and a higher likelihood of sharing the message with others (De Keyzer et al., 2021; Hayes et al., 2021; Loureiro et al., 2023). Additionally, well-executed personalization has been shown to increase engagement and alleviate privacy concerns, striking a balance between effectiveness and consumer trust (Loureiro et al., 2023).

In terms of adaptability, personalized communication can enhance effectiveness by tailoring not only the content but also the style of delivery. For example, using relatable characters, culturally adapted language, or context-specific imagery fosters stronger connections between audiences and health messages, making people feel truly addressed rather than passively targeted (Olsen & Pracejus, 2020). Campaigns that allow for user interaction or content customization —such as choosing relevant topics— can generate even greater engagement and positive attitudes, demonstrating the potential of personalized health messages to resonate deeply with target audiences (Walrave et al., 2018).

Moreover, personalization technologies offer public health campaigns a distinct advantage through data processing capabilities. The ability to analyse vast amounts of data in real time enables the early detection of behavioural patterns that could be redirected toward healthier choices or preventive actions (Ramírez-Cifuentes et al., 2020). By identifying signs of health-related risks or harmful habits as they emerge, campaigns can offer timely interventions, adjusting messages or resources to support informed health decisions.

Finally, personalization technologies, especially those powered by artificial intelligence, enable health campaigns to reach underserved communities by adapting the format, tone, and even language of messages to fit the specific needs and contexts of these groups. As digital platforms develop more advanced personalization tools, health organizations can utilize these innovations to promote equitable access to health information, ensuring that essential health messages reach individuals who might otherwise lack access to such resources (Schmälzle & Wilcox, 2021).

At its core, digital personalization has the potential to make health campaigns more inclusive and effective. By intelligently

leveraging personalized communication, health institutions can address specific needs within diverse communities, promoting a more equitable and impactful approach to health promotion.

Discussion

Historically, advertising has played a complex role in shaping health inequalities, particularly through promoting unhealthy products in vulnerable communities. Traditional advertising has disproportionately targeted lower-income and marginalized groups with messages promoting tobacco, alcohol, and ultra-processed foods, thereby influencing the social determinants of health and contributing to poorer health outcomes within these populations. The advent of digital advertising has not only extended these disparities but has also introduced new mechanisms that amplify selective exposure to harmful content. Through advanced segmentation, digital advertising now facilitates precision targeting that heightens the risk of exposing vulnerable groups to potentially harmful products and messages, reinforcing patterns of inequality in health outcomes.

The digital economy introduces an additional layer of complexity by reshaping consumer vulnerability. In this context, vulnerability transcends traditional definitions of disadvantage and becomes a universal condition, characterized by a susceptibility to exploitation rooted in power imbalances and intensified by digital personalization (European Parliament, 2021; Helberger et al., 2022). As digital platforms collect and analyse vast amounts of user data, their capacity to personalize content in real time enables them to manipulate consumer choices more effectively. This process of behavioural targeting leverages data-driven insights into users' personal and psychological states, creating tailored environments where even rational consumers may find themselves vulnerable to persuasive messaging (Calo, 2014; Hill & Sharma, 2020).

This phenomenon is further complicated by the opaque nature of data collection and usage. Digital platforms can infer users' vulnerabilities —whether related to health conditions, emotional states, or socio-economic factors— through seemingly neutral behavioural data, such as search history or app usage patterns (Grundy et al., 2019; Mozilla Foundation, 2023). By fostering situations that heighten consumer susceptibility, these platforms leverage the architecture of digital interactions and the dynamics of data-fuelled relationships to exploit vulnerable states, thus systematically exposing certain populations to higher risks of manipulation (Helberger et al., 2022).

However, despite these risks, digital personalization also offers substantial potential for positive impact, particularly within public health initiatives. When used ethically, personalization can provide an opportunity for health campaigns to deliver tailored, relevant health messages to diverse audiences, aligning content with cultural, linguistic, and contextual factors that foster engagement and trust (De Keyzer et al., 2021; Loureiro et al., 2023). Studies have demonstrated that personalized messages can enhance receptivity, trust, and even the likelihood of audience members sharing health-promoting content with others (Hayes et al., 2021; Loureiro et al., 2023). This adaptability is especially valuable in reaching underserved populations, where customized messaging —delivered in relatable formats with appropriate visuals, tone, and language— can bridge gaps in health literacy and access (Deng et al., 2019; Walrave et al., 2018).

Furthermore, real-time data analysis enables health campaigns to detect behavioural patterns indicative of health-related risks, allowing for timely interventions that can steer individuals toward healthier choices (Paganelli et al., 2022). This capability, facilitated by advanced AI technologies, strengthens public health efforts by making it possible to address emerging needs dynamically and responsively, thereby promoting preventive behaviours and early interventions. In this way, digital personalization, if implemented transparently and with ethical oversight, can contribute meaningfully to reducing health disparities and supporting equitable health outcomes.

In sum, while traditional advertising has long influenced health inequalities, digital advertising introduces a heightened capacity for selectivity that exacerbates these inequalities, particularly among groups already susceptible to poorer health outcomes. The personalization of digital advertising not only targets individuals based on inferred vulnerabilities but also excludes others from beneficial health-promoting messages, further marginalizing those already at a disadvantage. This form of selective exposure poses significant risks for health equity, particularly as digital marketing practices continue to evolve with minimal regulation. Addressing these disparities requires acknowledging the contextual and often hidden nature of vulnerability within the digital economy, where consumer helplessness is amplified by technological precision and a lack of transparency in data practices.

A more effective regulatory approach should prioritize limiting the amount of data available for ad targeting and increasing transparency in algorithmic decision-making. While large platforms are already subject to certain auditing requirements and maintain ad libraries for transparency, these measures remain insufficient and fail to provide clear insights into targeting mechanisms. Current regulations must go further by restricting the use of inferred sensitive data in advertising, as platforms continue to profile users based on behavioral patterns that reveal vulnerabilities without explicit consent. Additionally, greater algorithmic transparency —not just in ad repositories but in how targeting models operate— would be crucial to assessing biases and ensuring fair ad distribution.

At the same time, stricter regulations on the advertising of harmful products such as ultra-processed foods, sugary beverages, and gambling services are urgently needed. While some jurisdictions have imposed restrictions on these products in traditional media, digital platforms allow advertisers to bypass such regulations through microtargeting and influencer partnerships. Expanding these restrictions to digital environments

—by limiting personalized advertising for high-risk products and enforcing stricter disclosure requirements— would help prevent predatory marketing practices that disproportionately affect vulnerable groups.

Ultimately, ensuring that personalized advertising does not deepen health inequalities requires a shift from reactive transparency measures to proactive regulation. Without meaningful limits on data collection and algorithmic targeting, digital advertising will continue to exploit inferred vulnerabilities, reinforcing disparities in health outcomes. Stronger enforcement, coupled with industry accountability, is necessary to prevent data-driven advertising from becoming yet another mechanism of exclusion in the digital economy.

Limitations and Future Research

This study contributes to ongoing debates on the intersection of digital advertising and health inequalities by critically examining the mechanisms through which algorithmic personalization exacerbates disparities. However, several limitations should be acknowledged. First, while this analysis highlights key challenges related to targeting, data privacy, and algorithmic bias, further empirical research is needed to quantify the extent of these disparities and their direct impact on health outcomes. The lack of transparency in digital advertising ecosystems continues to hinder efforts to systematically track and audit ad distribution patterns, making it difficult to assess the full scope of algorithmic discrimination.

Second, this study primarily draws from research conducted in Western contexts, where technological infrastructures and regulatory frameworks shape digital advertising in specific ways. There remains limited research on how personalized advertising operates in non-Western regions, particularly in low- and middle-income countries, where digital platforms are rapidly expanding but often with fewer consumer protections. Future research should explore how variations in regulation, platform policies, and digital literacy influence the impact of personalized advertising on health inequalities in these regions.

Finally, given the dynamic nature of digital advertising technologies, ongoing research is essential to assess how emerging developments —such as AI-driven predictive analytics, biometric data usage, and cross-platform ad integration— may further influence health disparities. Future studies should not only examine the risks but also identify potential policy interventions and alternative advertising models that could minimize harm while leveraging digital tools for public health promotion.

By addressing these gaps, future research can help develop more comprehensive regulatory strategies and ethical advertising practices that ensure digital personalization does not exacerbate health inequalities but instead contributes to more equitable health communication.

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