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Review

Urban Visual Pollution from Outdoor Advertising: A Systematic Review of Environmental Exposure, Governance, and Sustainability Implications

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Abstract: Outdoor advertising has become an increasingly prominent component of urban environments, generating growing concerns regarding environmental exposure, public health, governance, and sustainability. Although research on outdoor advertising has expanded considerably, existing evidence remains fragmented across disciplines, with limited synthesis of its environmental, regulatory, and sustainability implications. This study aimed to systematically review the literature on outdoor advertising in urban settings, focusing on environmental exposure, governance approaches, and sustainability-related outcomes. A Systematic Literature Review (SLR) was conducted following the PRISMA 2020 guidelines. Literature searches were performed in Scopus, PubMed, and ScienceDirect, covering studies published between 2016 and 2026. After identification, screening, eligibility assessment, and quality appraisal using the Mixed Methods Appraisal Tool (MMAT), 51 studies were included in the final synthesis. The findings indicate a substantial increase in research output after 2021, reflecting growing academic interest in the broader societal impacts of outdoor advertising. Thematic analysis identified three principal themes: Environmental Exposure, Governance, and Sustainability Implications. Environmental Exposure emerged as the dominant theme, accounting for 54.9% of the included studies, with research primarily examining unhealthy food advertising, driver distraction, visual pollution, and public health risks. Governance studies emphasized regulatory frameworks and urban management strategies, whereas sustainability-focused studies highlighted concerns related to visual quality, landscape preservation, environmental quality, and sustainable urban development. Methodologically, the field remains dominated by quantitative approaches, including Geographic Information Systems (GIS), spatial analysis, observational studies, and experimental techniques such as eye-tracking and virtual simulations. Evidence from the reviewed studies suggests that outdoor advertising should be understood not only as a marketing communication medium but also as an environmental and governance issue with implications for public health and sustainable urban development. Future research should expand evidence from low- and middle-income countries, strengthen policy evaluation studies, and further investigate sustainability dimensions, including energy consumption, material life cycles, waste generation, and ecological impacts associated with outdoor advertising systems.

Keywords: outdoor advertising; environmental exposure; visual pollution; governance; sustainability; urban environment

1. INTRODUCTION

Outdoor advertising has become an increasingly visible component of contemporary urban environments, reflecting the expansion of commercial communication within public spaces. Historically, outdoor advertising has helped shape urban identity, visual culture, and landscape perception, influencing how cities are experienced and represented by residents and visitors. Studies have shown that advertising infrastructure played an important role in constructing commercial landscapes and urban consciousness, particularly during periods of rapid urban transformation (Armand, 2018b, 2018a). The evolution of outdoor advertising from traditional billboards and banners to digital and data-driven advertising systems has significantly increased the scale, visibility, and complexity of advertising exposure in cities. Recent technological developments have introduced digital billboards, interactive displays, and smart advertising systems that enable more

targeted and dynamic communication (Yoo, Piscarac, and Truong, 2024; Yu *et al.*, 2024). While these innovations offer economic and communication benefits, they have also raised concerns about visual intrusion, information overload, and the cumulative effects of advertising saturation in urban landscapes (Chung *et al.*, 2022; McQuoid *et al.*, 2023).

Increasing attention has therefore been directed toward outdoor advertising as an urban environmental issue. One of the most frequently discussed concerns is visual pollution, which refers to the excessive presence of visual elements that disrupt the aesthetic coherence of urban environments. High densities of billboards, banners, and digital displays may contribute to visual clutter, reduce the attractiveness of public spaces, and alter perceptions of urban identity and landscape quality (Czajkowski *et al.*, 2022; Borowiak *et al.*, 2024; Chen *et al.*, 2025). Beyond visual impacts, outdoor advertising is also a form of environmental exposure, as its messages are encountered repeatedly in everyday public spaces. Unlike other media channels that can be selectively accessed or avoided, outdoor advertising is embedded within streetscapes, transportation corridors, commercial districts, and areas surrounding schools. Research has documented the concentration of unhealthy food, alcohol, and tobacco advertisements in public spaces, particularly in socioeconomically disadvantaged neighborhoods and areas frequented by children and adolescents, raising concerns regarding public health inequalities and behavioral influences (Adjoian, Dannefer, and Farley, 2019; Handayani *et al.*, 2021; Seidenberg *et al.*, 2022; Bell, Egli, and Garton, 2026; Cavero-Esponera *et al.*, 2026)

In addition to public health concerns, outdoor advertising has been associated with transportation safety and urban livability. The increasing use of large-format and digital advertising displays has prompted investigations into their effects on driver attention and cognitive processing. Experimental studies employing eye-tracking technology, virtual reality environments, and driving simulators have demonstrated that outdoor advertisements can attract visual attention and increase cognitive workload, potentially affecting road safety and transportation performance (Stavrinos *et al.*, 2016; Jin, Zhang, and Chen, 2025). These findings suggest that outdoor advertising should be evaluated not only as a marketing tool but also as an environmental factor that influences urban experiences, safety, and quality of life.

The growing complexity of outdoor advertising has also created important governance and sustainability challenges. Regulatory frameworks are increasingly required to balance commercial interests with public health objectives, environmental quality, and urban aesthetics. Several studies have emphasized the role of advertising regulations, zoning controls, and urban planning strategies in managing the location, density, and visibility of outdoor advertisements (Bell *et al.*, 2026; Herrera & Pasch, 2018; Hinton *et al.*, 2024). At the same time, sustainability concerns have emerged regarding the environmental footprint of advertising infrastructure. The expansion of digital billboards has raised questions about energy consumption and light pollution, while traditional advertising materials contribute to waste generation and resource use throughout their lifecycles. Recent studies have therefore highlighted the need for more sustainable advertising practices, including circular-economy approaches, environmentally responsible materials, and integrated urban sustainability strategies (Ananthapavan *et al.*, 2026; Cuc & Secan, 2024; Yoo *et al.*, 2024; Yu *et al.*, 2024).

Despite the growing volume of research, the existing evidence remains fragmented across multiple disciplinary domains. Studies on visual pollution primarily focus on urban aesthetics, whereas public health research emphasizes exposure to advertising for food, alcohol, and tobacco. Other studies investigate driver distraction and transportation safety, while governance and sustainability issues are often examined separately within planning and policy contexts. Consequently, there is limited synthesis of how outdoor advertising simultaneously contributes to environmental exposure, governance challenges, and sustainability implications within urban environments. To address this

gap, this study systematically reviews the existing literature to synthesize evidence on environmental exposure associated with outdoor advertising, examine governance approaches used to regulate advertising infrastructure, and evaluate the sustainability implications of outdoor advertising for contemporary urban development.

2. METHODS

2.1 Study Design

This study employed a systematic literature review to synthesize evidence on environmental exposure, governance approaches, and sustainability implications associated with outdoor advertising in urban environments. The review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, which provide a transparent and systematic framework for literature identification, screening, eligibility assessment, and inclusion (Page *et al.*, 2021). PRISMA has been widely adopted across disciplines to improve the methodological rigor and reporting quality of systematic reviews.

2.2 Search Strategy

A comprehensive literature search was conducted on 28 May 2026. Scopus was used as the primary database because of its extensive coverage of peer-reviewed journals and rigorous indexing standards (Lasda Bergman, 2012). The search strategy employed keywords related to outdoor advertising, including “outdoor advertising”, “billboard”, and “signage”, combined using Boolean operators (AND, OR). The initial search retrieved 134 records from Scopus, while supplementary searches identified 11 additional records from PubMed and 7 additional records from ScienceDirect, yielding 152 records before duplicate removal and screening. Detailed search strings for each database are presented in Supplementary Table S3. All retrieved records were exported for duplicate checking, screening, and eligibility assessment in accordance with the PRISMA 2020 guidelines.

2.3 Eligibility Criteria

Studies were included if they met the following criteria:

- 1) Examined outdoor advertising, billboards, signage, or related advertising infrastructure in urban environments.
- 2) Investigated environmental, visual, health, behavioral, governance, planning, or sustainability-related impacts.
- 3) Studies were published between 2016 and 2026, written in English, available in full text, and published in peer-reviewed journals.
- 4) Were peer-reviewed publications (accessible full-text), excluding editorials, commentaries, conference abstracts, book reviews, dissertations, and other non-peer-reviewed documents.

Only peer-reviewed journal articles retrieved from Scopus, PubMed, and ScienceDirect were considered for inclusion in this review. This approach was adopted to ensure the quality, reliability, and scientific rigor of the evidence synthesized.

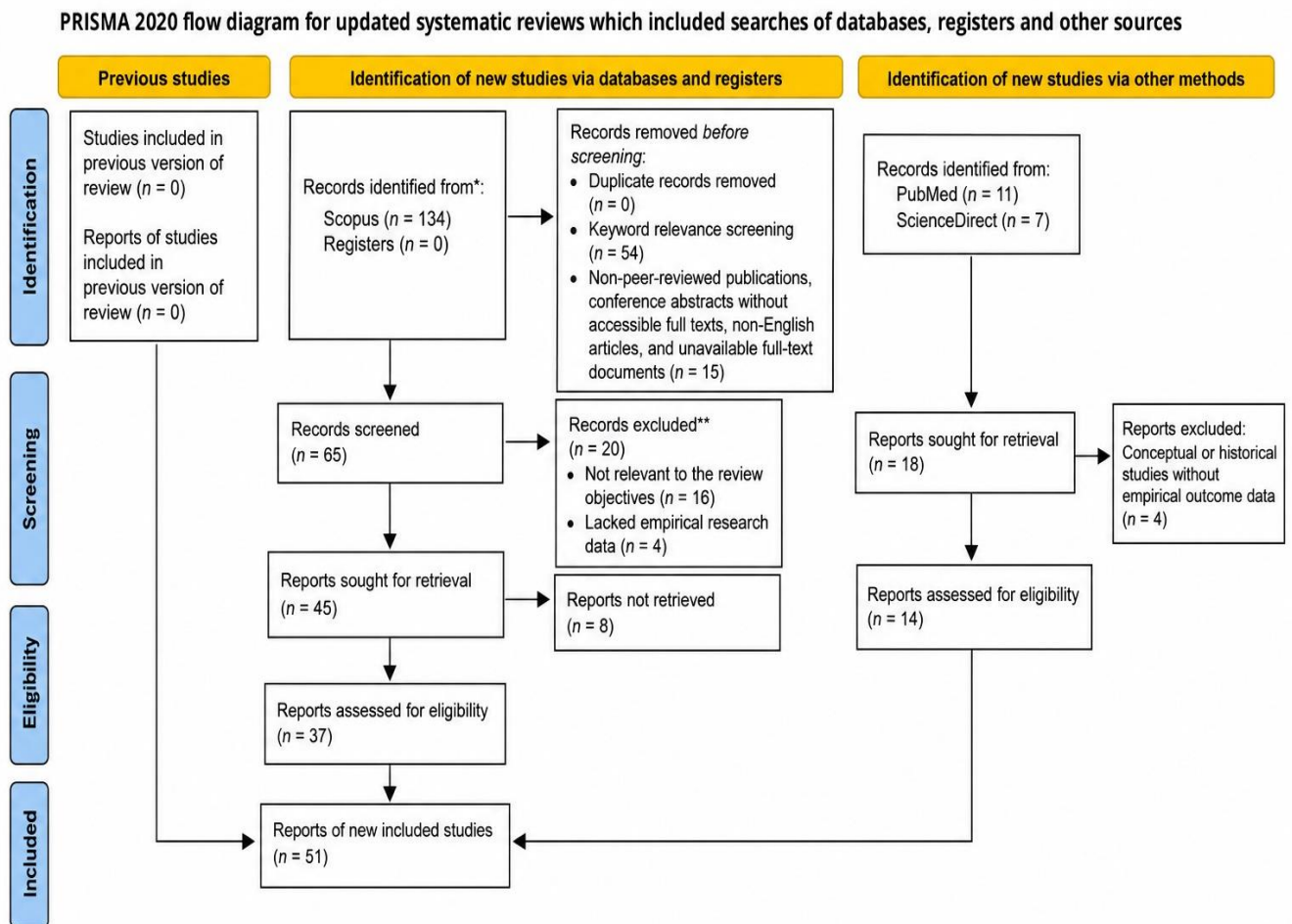
2.4 Study Selection

The study selection process followed the PRISMA 2020 framework and consisted of identification, screening, eligibility assessment, and inclusion stages.

During the identification stage, records retrieved from all databases were combined, and duplicate entries were removed. The remaining records were screened based on publication year, title, and abstract relevance. Studies that did not address outdoor advertising or were clearly unrelated to the review objectives were excluded.

The full texts of potentially relevant studies were subsequently assessed against the predefined eligibility criteria. Articles meeting all inclusion criteria were retained for qualitative synthesis. The complete study selection process, including the number of records identified, screened, excluded, and included, is presented in Figure 1.

Following screening and eligibility assessment, a total of 51 studies were included in the final review.



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/register).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

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Figure 1. PRISMA 2020 Flow Diagram of the Study Selection Process

2.5 Data Extraction

Data extraction was conducted using a standardized extraction form developed for this review. Information extracted from each study included author(s), publication year, country, study design, research methods, key findings, and thematic characteristics. In addition, studies were coded according to emergent thematic categories identified during the synthesis process.

The extracted information was subsequently synthesized using thematic analysis to identify recurring patterns, emerging themes, and research trends across the included studies.

2.6 Quality Assessment

The methodological quality of the included studies was assessed using the Mixed Methods Appraisal Tool (MMAT) 2018. Following MMAT guidelines, each study was first classified by methodological design: qualitative, quantitative descriptive, quantitative non-randomized, quantitative randomized, and mixed-methods. Studies were then evaluated using the five design-specific MMAT criteria.

For reporting consistency, appraisal results are presented using a standardized Q1–Q5 format, where Q1–Q5 represent the five MMAT criteria applicable to each study design category. Studies were classified into overall quality categories based on the number of criteria satisfied.

Detailed MMAT ratings, including Q1–Q5 assessments and overall quality classifications for all included studies, are provided in Supplementary Table S1. No studies were excluded solely on the

basis of methodological quality assessment; however, quality appraisal was considered in the interpretation and synthesis of findings.

3. RESULTS

3.1 Study Selection Result

The study selection process followed the PRISMA 2020 guidelines (Figure 1). The primary search identified 134 records from Scopus. Supplementary searches in PubMed and ScienceDirect were performed after completion of the primary Scopus screening to identify additional eligible studies not captured in the primary database. Supplementary searches identified an additional 11 records from PubMed and 7 records from ScienceDirect, yielding a total of 152 records before screening. After excluding records through keyword relevance screening ($n = 54$) and publication or accessibility criteria ($n = 15$), 65 records remained for title and abstract screening. Subsequently, 20 records were excluded because they did not meet the review objectives or lacked empirical evidence. Full texts of 45 articles were sought for retrieval; 37 were assessed for eligibility. Fourteen additional eligible studies identified through supplementary database searches were also assessed. Ultimately, 51 studies were included in the qualitative synthesis.

3.2 Characteristics of Included Studies

3.2.1 Publication Trends

Figure 2 illustrates the keyword co-occurrence and dominant research topics identified across the included studies published between 2016 and 2026. The most frequently occurring terms include outdoor advertising, visual pollution, public health, food environment, and policy, indicating that recent research has increasingly focused on the environmental, health, governance, and sustainability dimensions of outdoor advertising. The prominence of these keywords reflects a shift from conventional marketing-oriented studies toward broader interdisciplinary perspectives that address urban environmental quality, public health protection, and sustainable urban development.



Figure 2. Keyword Co-occurrence and Research Focus in Outdoor Advertising Studies (2016–2026)

Keyword analysis indicates a clear shift in outdoor advertising research from conventional marketing perspectives toward broader concerns related to environmental exposure, public health, and urban sustainability. The most frequently occurring terms include *outdoor advertising*, *visual pollution*, *public health*, *food environment*, and *policy*, reflecting increasing attention to the societal impacts of advertising within urban environments. Research published between 2016 and 2026 has increasingly examined the relationship between outdoor advertising and environmental exposure, particularly regarding visual pollution, the promotion of unhealthy food, driver distraction, and urban well-being (Meuleners, Roberts, and Fraser, 2020; Trapp *et al.*, 2022; Wray *et al.*, 2023). Furthermore, the emergence of keywords such as *marketing regulations*, *eye-tracking*, *digital twin*, and *human-centered design* suggests growing interest in governance

interventions and technology-based approaches for assessing and managing advertising impacts in sustainable cities (Schmälzle *et al.*, 2023; Yu *et al.*, 2024; Ananthapavan *et al.*, 2026).

3.2.2 Geographic Distribution

The included studies were conducted across diverse geographic settings, including North America, Europe, Asia, Africa, and Oceania. A considerable proportion of studies originated from developed countries such as the United States, the United Kingdom, Australia, and Canada. However, studies from emerging and developing economies, including China, South Africa, Poland, and several Asian countries, were also represented. This geographic diversity indicates that concerns regarding outdoor advertising are not limited to specific regions but have become a global urban issue with varying social, environmental, and regulatory contexts.

Number of included studies by country.

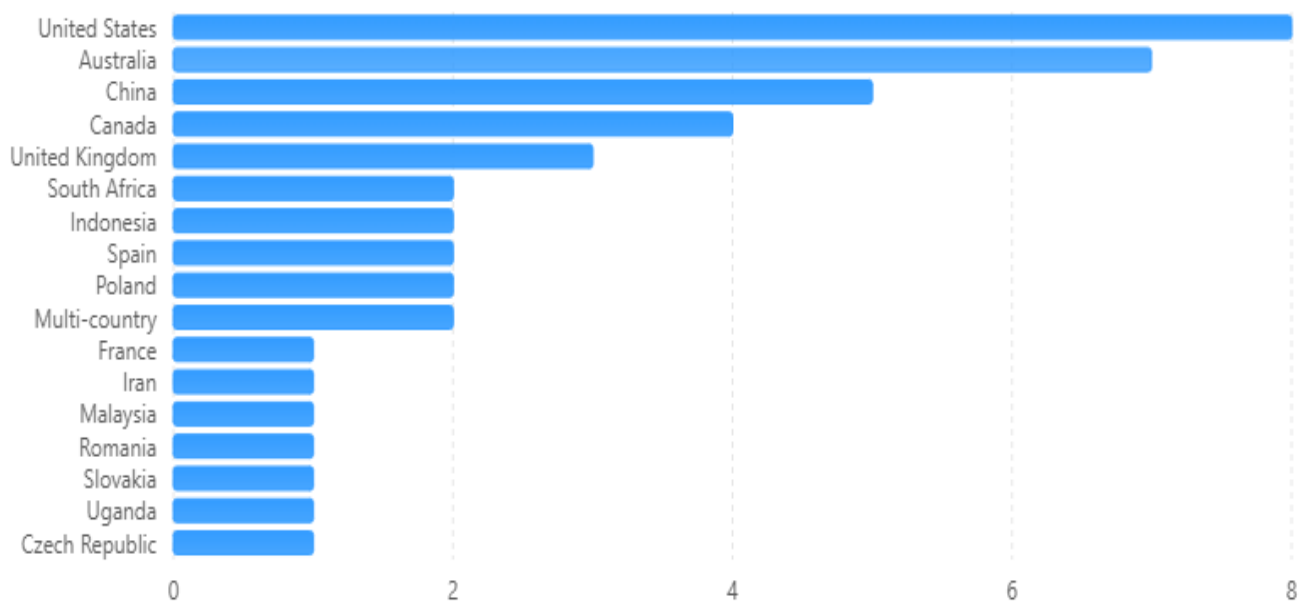


Figure 3. Geographic Distribution of Included Studies (2016-2026)

Based on Figure 3, most studies were conducted in the United States and Australia, followed by China and Canada. Research from developing countries such as Indonesia, Uganda, and Malaysia was comparatively limited, indicating a geographical imbalance in the literature and the need for broader evidence from diverse urban contexts. Based on the World Bank Country and Lending Groups classification (World Bank, 2026), most studies originated from high-income economies. In contrast, evidence from upper-middle- and lower-middle-income countries remained limited. This distribution indicates a geographical imbalance in the literature. It highlights the need for further research in rapidly urbanizing regions, where outdoor advertising and visual pollution are becoming increasingly important issues in urban governance and sustainability.

3.2.3 Study Designs and Methodological Characteristics

The included studies employed diverse methodological approaches, with GIS and spatial analysis ($n = 16$) and qualitative and policy analysis ($n = 16$) being the most common. Experimental and simulation studies accounted for nine studies, while cross-sectional designs were identified in six studies. Only a small number of studies used mixed-method approaches or economic evaluation models ($n = 2$ each). This distribution indicates a strong emphasis on spatial exposure assessment, policy evaluation, and experimental investigation of the visual and behavioral impacts of outdoor advertising.

3.3 Quality Assessment

The MMAT appraisal results are summarized in Supplementary Table S1. Among the 51 studies included in the review, 41 (80.4%) were classified as high quality, while 10 (19.6%) were classified as moderate quality. No studies were assessed as low quality. Moderate-quality studies were primarily policy reviews, historical analyses, semiotic studies, and qualitative investigations that reported limitations in methodological transparency, sampling procedures, or bias control measures.

Although no studies were excluded based on methodological quality, the appraisal results informed the interpretation of findings during the narrative synthesis. Evidence supported by multiple high-quality studies was considered more robust and was therefore given greater interpretative weight. In contrast, findings derived predominantly from moderate-quality studies were interpreted more cautiously and used mainly to complement emerging themes rather than to support primary conclusions. Consequently, the quality assessment helped evaluate the strength, consistency, and reliability of the synthesized evidence.

3.4 Thematic Classification

To provide a clearer understanding of the literature's intellectual structure, the included studies were classified into thematic categories based on their primary research focus. Through an inductive thematic analysis, three dominant themes were identified: Environmental Exposure, Governance, and Sustainability Implications. This classification facilitates a systematic interpretation of how outdoor advertising has been examined across public health, urban management, and sustainability perspectives. Figure 4 presents the thematic distribution of the 51 included studies and highlights the relative prominence of each theme within the existing body of knowledge.



Figure 4. Distribution of Research Themes in Outdoor Advertising Studies Based on Thematic Analysis (n = 51)

The thematic analysis identified three principal themes within the literature: Environmental Exposure, Governance, and Sustainability Implications. Among these, Environmental Exposure emerged as the most dominant theme, representing 28 of the 51 included studies (54.9%). Studies classified within this theme primarily examined the influence of outdoor advertising on public health exposure, driver attention, road safety, and visual environments. Several studies investigated children's exposure to unhealthy food advertising around schools and public spaces (Trapp *et al.*, 2021; Li *et al.*, 2025; Bell *et al.*, 2026), while others explored the effects of digital billboards on driver distraction and traffic safety (Stavrinos *et al.*, 2016; Meuleners *et al.*, 2020; Wilson & Casper, 2016). Research in this category frequently employed GIS-based spatial analysis, exposure mapping, cross-sectional surveys, and experimental methods to evaluate the relationship between advertising environments and human behavior (Wray *et al.*, 2023; Zhao *et al.*, 2025).

Governance was identified in 11 studies (21.6%) and focused on regulatory frameworks, policy implementation, urban management, and institutional responses to outdoor advertising. These studies emphasized the role of governments and regulatory agencies in controlling advertising density, content, and placement to reduce adverse social and environmental impacts (Dulebenets, Ozguven, and Moses, 2018;

Chung *et al.*, 2022; Whitton *et al.*, 2025). Governance-related research also highlighted challenges in balancing commercial interests with public health objectives and urban environmental quality, particularly in rapidly urbanizing settings (Ananthapavan *et al.*, 2026; Mohamadpour *et al.*, 2024).

The third theme, Sustainability Implications, accounted for 12 studies (23.5%). This theme addressed broader concerns regarding visual pollution, urban aesthetics, environmental quality, and sustainable urban development. Several studies examined how outdoor advertising affects perceptions of urban landscapes and contributes to visual degradation (Borowiak *et al.*, 2024; Urban *et al.*, 2020). Other studies discussed sustainable approaches to advertising management, including the reuse of advertising materials, environmentally responsible design, and the integration of advertising regulation into sustainable city planning (Cuc & Secan, 2024; Yu *et al.*, 2024). These findings indicate a growing recognition that outdoor advertising should be considered not only as a marketing instrument but also as a factor influencing long-term urban sustainability.

Overall, the thematic distribution demonstrates that current research remains strongly concentrated on Environmental Exposure, whereas Governance and Sustainability Implications receive comparatively less attention. This pattern suggests that future studies should adopt more integrated approaches that combine public health, regulatory, and sustainability perspectives to inform better urban policy and the management of outdoor advertising in contemporary cities.

4. DISCUSSION

4.1 Comparison with Existing Literature

The findings of this review are broadly consistent with previous studies identifying outdoor advertising as an influential environmental determinant of public health, urban aesthetics, and governance outcomes. The predominance of the Environmental Exposure category (54.9%) confirms that contemporary research has increasingly shifted from viewing outdoor advertising solely as a marketing medium toward understanding its broader environmental and societal consequences. This trend aligns with earlier reviews and empirical studies that highlight the role of advertising exposure in shaping food consumption behaviors, visual attention, and risk perception in urban environments (Meuleners, Roberts, and Fraser, 2020; Trapp *et al.*, 2022).

A substantial proportion of the included studies examined unhealthy food and beverage advertising in public spaces, particularly around schools, transportation corridors, and residential neighborhoods (Dia *et al.*, 2021; Martin-Payo *et al.*, 2022; Ruggles *et al.*, 2023; Brear *et al.*, 2024; Wentzel *et al.*, 2024; Li *et al.*, 2025; Bell, Egli, and Garton, 2026; Cavero-Esponera *et al.*, 2026; Zhao *et al.*, 2026). These findings reinforce the assumptions of Food Environment Theory, which argues that environmental cues influence dietary decision-making and health outcomes. Similar observations have been reported in prior public health research, in which outdoor advertising was identified as a component of obesogenic environments that disproportionately affect children and adolescents (Chung *et al.*, 2022; Francis *et al.*, 2025). Compared with earlier studies focusing primarily on individual behavioral factors, recent evidence increasingly emphasizes the environmental context in which health-related decisions occur.

The review also confirms growing support for the Commercial Determinants of Health (CDoH) perspective, which interprets outdoor advertising as a mechanism through which commercial actors shape population health outcomes (Jenneson *et al.*, 2025; Ananthapavan *et al.*, 2026). Existing literature has traditionally emphasized consumer choice and personal responsibility; however, the studies reviewed here suggest that advertising exposure functions as a structural determinant of health that warrants regulatory intervention. This observation is particularly evident in studies evaluating policy restrictions on unhealthy food advertising and their potential public health benefits (Scott *et al.*, 2023; Ananthapavan *et al.*, 2026).

Beyond public health concerns, the present review extends previous literature by demonstrating the increasing prominence of urban visual pollution and sustainability issues. While earlier research largely concentrated on advertising effectiveness and consumer engagement, more recent studies investigate visual clutter, landscape degradation, aesthetic quality, and environmental sustainability associated with billboard installations (Borowiak *et al.*, 2024; Cuc & Secan, 2024; Madlenak & Madlenakova, 2025). This shift reflects

a broader recognition that outdoor advertising influences not only consumer behavior but also urban livability and environmental quality. Nevertheless, compared with health-related studies, research addressing sustainability implications remains relatively limited, indicating an important gap in the literature.

Another notable development is the increasing adoption of advanced methodological approaches, including Geographic Information Systems (GIS), spatial exposure modeling, eye-tracking analysis, virtual reality experiments, and digital twin technologies (Schmälzle *et al.*, 2023; Eddine, Mulatti, and Biondi, 2024; Yu *et al.*, 2024). These methods provide more precise measurements of advertising exposure and cognitive responses than traditional observational approaches. Consequently, the field has evolved from descriptive assessments to predictive, data-driven analyses that inform evidence-based urban planning and regulatory decision-making.

Despite these advances, the geographic distribution of studies reveals a persistent imbalance. Most evidence originates from high-income countries such as Australia, the United Kingdom, Canada, and the United States, while studies from low- and middle-income countries remain scarce (Adjoian, Dannefer and Farley, 2019; Puspikawati *et al.*, 2021). As a result, existing theoretical and policy frameworks may not fully capture the social, cultural, and regulatory realities of developing regions. Future research should therefore expand empirical investigations in underrepresented settings to improve the global applicability of evidence concerning outdoor advertising, environmental exposure, and urban governance.

4.2 Practical and Policy Implications

The findings of this review have important implications for policymakers, urban planners, public health practitioners, and the outdoor advertising industry. The dominance of the Environmental Exposure category suggests that outdoor advertising should no longer be viewed solely as a commercial communication tool but also as an environmental factor influencing health-related behaviors, urban experiences, and community well-being (Meuleners, Roberts, and Fraser, 2020; Trapp *et al.*, 2022). Consequently, decisions regarding billboard placement, content regulation, and advertising density should be integrated into broader urban governance and public health strategies.

From a public health perspective, the reviewed studies consistently demonstrate that exposure to unhealthy food and beverage advertising is concentrated around schools, transportation routes, and residential neighborhoods frequented by children and adolescents (Li *et al.*, 2025; Wray *et al.*, 2025; Bell, Egli, and Garton, 2026). These findings support implementing stricter zoning regulations to restrict unhealthy food advertising in child-centered environments. Policymakers may also consider incorporating outdoor advertising controls into obesity prevention and health promotion programs, particularly in low- and middle-income settings where regulatory frameworks remain underdeveloped (Adjoian, Dannefer and Farley, 2019; Zhao *et al.*, 2026). Furthermore, evidence of higher exposure levels in socioeconomically disadvantaged communities underscores the need for equity-oriented policies to address disproportionate advertising burdens on vulnerable populations (Jenneson *et al.*, 2025).

For urban planning and environmental governance, the growing body of research on visual pollution highlights the importance of managing the aesthetic and environmental impacts of outdoor advertising. Several studies suggest that excessive billboard density, poorly coordinated signage, and large-scale digital displays can contribute to visual clutter and reduce the quality of the urban landscape (Madlenak *et al.*, 2023; Borowiak *et al.*, 2024). Municipal authorities should therefore establish evidence-based guidelines governing billboard location, size, illumination, and visual integration with surrounding urban environments. Such measures can support more sustainable and visually coherent cities while balancing economic interests with environmental quality.

The review also highlights the increasing use of advanced technologies, including Geographic Information Systems (GIS), eye-tracking methods, virtual reality simulations, and digital twin systems, to assess advertising exposure and human responses (Schmälzle *et al.*, 2023; Bonneterre, Zerhouni, and Boffo, 2024; Eddine, Mulatti, and Biondi, 2024). These technological developments provide opportunities for regulators

and practitioners to monitor advertising impacts more accurately and evaluate policy interventions using real-time data. Evidence-based monitoring systems may improve regulatory enforcement and facilitate more adaptive advertising governance frameworks.

For the outdoor advertising industry, the findings emphasize the importance of adopting socially responsible and sustainable advertising practices. As public concern regarding health impacts, visual pollution, and environmental sustainability continues to increase, advertisers may benefit from aligning commercial objectives with broader societal goals. This includes reducing the promotion of products associated with adverse health outcomes, improving visual design standards, and considering environmental sustainability throughout the advertising lifecycle (Borowiak *et al.*, 2024; Cuc & Secan, 2024).

Overall, the evidence suggests that effective management of outdoor advertising requires a multidisciplinary approach involving collaboration among public health agencies, urban planners, environmental authorities, and industry stakeholders. Integrating scientific evidence into planning and regulatory processes will be essential for minimizing adverse environmental and health impacts while maximizing the potential benefits of outdoor advertising within sustainable urban development strategies (Yu *et al.*, 2024; Ananthapavan *et al.*, 2026).

4.3 Study Limitations

Several limitations should be considered when interpreting the findings of this systematic review. First, although the review followed a structured PRISMA-based approach, the included studies were predominantly conducted in high-income countries, particularly Australia, Canada, the United Kingdom, and the United States (Trapp *et al.*, 2022; Wray *et al.*, 2023). Consequently, the evidence base may not fully reflect the social, cultural, and regulatory contexts of low- and middle-income countries, where outdoor advertising governance and public health challenges can differ substantially (Adjoian, Dannefer and Farley, 2019; Puspikawati *et al.*, 2021). This geographic imbalance may limit the generalizability of the findings globally.

Second, the reviewed literature exhibited considerable methodological heterogeneity. Studies employed a wide range of approaches, including cross-sectional surveys, spatial analyses, observational audits, experimental designs, eye-tracking methods, and virtual simulations (Schmälzle *et al.*, 2023; Eddine, Mulatti, and Biondi, 2024). While this diversity provides a comprehensive understanding of the impacts of outdoor advertising, it also complicates direct comparisons across studies and limits opportunities for quantitative synthesis.

Third, the review focused exclusively on peer-reviewed journal articles published in English between 2016 and 2026. As a result, relevant evidence published in other languages, grey literature, government reports, or policy documents may have been excluded. This restriction may introduce publication and language biases, particularly in regions where research is disseminated outside international academic journals.

Finally, the thematic distribution of the included studies was heavily concentrated on environmental exposure and food advertising, whereas comparatively fewer studies addressed governance mechanisms, sustainability implications, cultural dimensions, and social equity concerns (Borowiak *et al.*, 2024; Cuc & Secan, 2024). Furthermore, the cultural and social identity dimensions of outdoor advertising remain underrepresented despite evidence of their relevance to nation-building and public communication (Tajuddin & Zulkepli, 2019). Although these themes are increasingly recognized as important components of outdoor advertising research, the available evidence remains limited. Consequently, the review may underrepresent emerging perspectives related to sustainable urban development, digital transformation, and environmental justice.

Despite these limitations, the review provides a comprehensive synthesis of contemporary evidence. It offers an updated understanding of how outdoor advertising influences environmental exposure, public health, urban governance, and sustainability outcomes across diverse urban settings.

4.4 Future Research Directions

The findings of this review highlight several important directions for future research. First, greater attention should be devoted to low- and middle-income countries, where evidence regarding outdoor advertising exposure, governance mechanisms, and health impacts remains limited. Most existing studies originate from high-income settings such as Canada, Australia, the United Kingdom, and the United States, creating a geographic imbalance in the current knowledge base (Trapp *et al.*, 2022; Wray *et al.*, 2023). Future studies should investigate how cultural, socioeconomic, and regulatory differences shape outdoor advertising practices and their impacts in underrepresented regions, including Southeast Asia and Sub-Saharan Africa (Adjoian, Dannefer, and Farley, 2019; Puspikawati *et al.*, 2021).

Second, future research should move beyond the dominant focus on food advertising and school-zone exposure to explore broader dimensions of outdoor advertising, including visual pollution, urban aesthetics, environmental sustainability, social equity, and digital advertising infrastructures (Borowiak *et al.*, 2024; Cuc & Secan, 2024). Expanding the thematic scope of research would provide a more comprehensive understanding of the role of outdoor advertising within contemporary urban environments.

Third, methodological diversification is needed. Quantitative and cross-sectional approaches dominate the reviewed literature, while qualitative, mixed-method, and longitudinal studies remain relatively scarce. Future research should integrate multiple methodological perspectives to capture better the behavioral, psychological, and social mechanisms underlying advertising exposure and its long-term effects (Schmälzle *et al.*, 2023; Eddine, Mulatti, and Biondi, 2024). Such approaches would improve causal understanding and strengthen the evidence base for policy interventions.

Fourth, emerging technologies offer significant opportunities for advancing outdoor advertising research. Tools such as eye-tracking systems, virtual reality simulations, Geographic Information Systems (GIS), artificial intelligence, and digital twin platforms can provide more accurate assessments of advertising exposure, visual attention, and behavioral responses (Schmälzle *et al.*, 2023; Yu *et al.*, 2024). Future studies should evaluate how these technologies can support real-time monitoring and evidence-based urban governance.

Future studies should also examine the extent to which compliance and enforcement mechanisms influence the effectiveness of advertising regulations, as evidence from environmental management sectors suggests that regulatory compliance is a key determinant of environmental outcomes (Quinto *et al.*, 2023). While several studies advocate restrictions on unhealthy food advertising, particularly around schools, empirical evaluations of policy implementation and long-term outcomes remain limited (Ananthapavan *et al.*, 2026; Zhao *et al.*, 2026). Future investigations should develop predictive, policy-oriented models to evaluate alternative regulatory scenarios and identify the most effective strategies to balance public health protection, urban sustainability, and commercial interests.

Collectively, recent evidence suggests that outdoor advertising influences public health through multiple pathways. Billboards can affect visual comfort and environmental appreciation (Adam *et al.*, 2022), contribute to perceptions of visual pollution (Urban *et al.*, 2020), shape health-related behaviors through persuasive communication (Mohamadpour *et al.*, 2024), promote unhealthy consumer products (Basch *et al.*, 2019), and disproportionately target socioeconomically disadvantaged communities (Zahid *et al.*, 2022). These findings support the need for interdisciplinary approaches integrating ergonomics, urban planning, public health, and advertising regulation.

5. CONCLUSION

This systematic literature review synthesized evidence from 51 studies published between 2016 and 2026 to examine the evolving landscape of outdoor advertising research, with particular emphasis on environmental exposure, governance, and sustainability implications. The findings reveal a substantial increase in scholarly attention over the past decade, reflecting growing concerns regarding the public health, environmental, and social consequences of outdoor advertising.

The review identified Environmental Exposure as the dominant research theme, followed by Governance and Sustainability Implications. Within the Environmental Exposure theme, studies most frequently examined unhealthy food advertising around schools, driver distraction, and visual pollution. This finding highlights growing global concern about children's and adolescents' exposure to unhealthy food marketing in public spaces (Trapp et al., 2022; Wray et al., 2023). Consistent with prior evidence, outdoor advertising was found to play a significant role in shaping dietary behaviors and health outcomes, particularly in school and community settings (Francis et al., 2025; Bell, Egli, and Garton, 2026). The dominance of theoretical perspectives such as *Food Environment Theory*, *Social Ecological Theory*, and *Commercial Determinants of Health* further demonstrates the growing recognition of outdoor advertising as an environmental and structural determinant of health rather than merely a marketing communication tool (Chung et al., 2022; Jenneson et al., 2025). While environmental exposure and governance issues are relatively well-documented, evidence on sustainability implications remains limited, underscoring the need for further investigation into energy use, material life cycles, waste generation, and ecological impacts associated with outdoor advertising systems.

A key finding of this review is the predominance of the *Environmental Exposure* category, which accounted for 54.9% of the included studies. This trend indicates that contemporary research increasingly focuses on the broader impacts of outdoor advertising on public health, road safety, urban visual quality, and environmental sustainability (Meuleners, Roberts, and Fraser, 2020; Trapp et al., 2022). Evidence from several studies suggests that advertising exposure in transportation corridors, school zones, and urban public spaces may influence behavioral responses, cognitive attention, and risk perception, reinforcing the need for evidence-based governance and regulatory interventions (Li et al., 2025; Stavrinou et al., 2016; Wilson & Casper, 2016).

Methodologically, the field remains dominated by quantitative approaches, including surveys, spatial analyses, and GIS-based assessments. However, emerging technologies such as eye-tracking systems, virtual reality simulations, and digital twin platforms are creating new opportunities for understanding advertising exposure and its behavioral consequences with greater precision (Schmälzle et al., 2023; Eddine, Mulatti, and Biondi, 2024; Yu et al., 2024). These developments suggest a gradual transition toward more data-driven and predictive research frameworks.

Despite these advances, important gaps remain. Research continues to be concentrated in high-income countries, while evidence from developing regions remains limited (Adjoian, Dannefer, and Farley, 2019; Puspikawati et al., 2021). Furthermore, the sustainability, social equity, and governance dimensions are comparatively underexplored compared with health-related exposure studies. Addressing these gaps will be essential for developing a more globally representative understanding of outdoor advertising and its implications.

Overall, this review demonstrates that outdoor advertising should be understood as a multidisciplinary issue situated at the intersection of public health, environmental management, urban governance, and sustainability. Strengthening evidence-based regulation, expanding research in underrepresented regions, and integrating advanced analytical technologies will be critical for supporting healthier, safer, and more sustainable urban environments in the future.

6. AUTHOR CONTRIBUTIONS

Conceptualization, B.I.T. and A.M.; methodology, B.I.T. and A.D.L.; literature search and data collection, B.I.T.; study selection and data extraction, B.I.T. and A.D.L.; quality assessment and validation, B.I.T. and A.M.; formal analysis and synthesis, B.I.T.; writing—original draft preparation, B.I.T.; writing—review and editing, A.M. and A.D.L.; supervision, A.M. All authors have read and agreed to the published version of the manuscript.

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8. INSTITUTIONAL REVIEW BOARD STATEMENT

Not applicable. This study is a systematic review and does not involve human participants or animals.

9. INFORMED CONSENT STATEMENT

Not applicable. This study does not involve human participants.

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11. CONFLICT OF INTEREST

The authors declare no conflicts of interest regarding this study.

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