IS CANCER PREVENTION INFLUENCED BY THE BUILT ENVIRONMENT? A MULTIDISCIPLINARY SCOPING REVIEW

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ABSTRACT

Background: The built environment is a significant determinant of human health. Globally, the growing prevalence of preventable cancers suggests a need to understand how features of the built environment shape exposure to cancer development and distribution within a population.

Methods: We undertook a scoping review of how researchers across disparate fields understand and discuss the built environment in primary and secondary cancer prevention. We focused exclusively on peer-reviewed sources published from research conducted in Australia, Canada, Ireland, New Zealand, the United Kingdom, and the United States from 1990 to 2017.

Results: The review captured 9958 potential results in the academic literature. We scoped this body of results to 268 relevant peer-reviewed journal articles indexed across 14 subject databases. Spatial proximity, transportation, land use and housing are well understood features of the built environment that shape cancer risk.

Conclusions: Built environment features predominantly influence air quality, substance use, diet, physical activity and screening adherence, with impacts on breast, lung, colorectal, and overall cancer risk. The majority of evidence fails to provide direct recommendations for advancing cancer prevention policy and program objectives for municipalities. The expansion of interdisciplinary work in this area would serve to create significant population health impact.

Keywords: cancer, environment, neighborhood, housing, transportation, screening, public health, geography, cities, policy

INTRODUCTION

Environmental and area-level determinants of health have been widely documented in the public health and urban planning literature.[1–6] Public agencies have routinely emphasized the role of the built environment in health, particularly in chronic disease prevention.[7–10] Non-communicable diseases are increasing around the globe, becoming the predominant health concern in developed, transitioning, and developing countries. In 2015, cancer was the second largest cause of death globally with over 8.7 million attributable deaths.[11] Between 2005 and 2015, cancer incidence had increased by 33%, with breast, colorectal, lung, and prostate sites of primary concern in high-income nations.[11] The bulk of these cancers are estimated to be the result of modifiable lifestyle and environmental factors, with up to 45% being solely attributed to these determinants, and potentially over 85% including gene-environment interactions.[12,13]

Cancer is predominantly a disease of highly developed nations, often correlating with patterns of urbanization and wealth creation.[14] Over half of the world's population presently lives in urban areas, and is expected to reach over 90% by 2100.[15,16] Urban life shapes important determinants of health, including access to private, societal and natural resources, distributes exposures to pollutants, and shapes the ethnic and socioeconomic composition of areas.[5,17,18] Previous reviews of urban environments and cancer have found sufficient medical evidence of neighbourhoods influencing disparities in cancer risk and outcomes to warrant further investigation of how the life course, perceptions, workplaces, spatiality, and causal inferences are discussed in medical, social science, policy and natural science disciplines.[19,20] In addition, our review investigates the overlap between medical, natural, and social science sources of literature, filling a major methodological gap in prior reviews that investigated a few subject databases, often from only one field of study.[19,21] Thus, addressing the human built and social environment, particularly in urban areas, as a "cause of causes" for cancer etiology is critical to reducing the burden of disease on developed and developing economies. The purpose of this review is to examine evidence from multiple disciplines to provide a comprehensive synthesis of the literature and concrete

recommendations for built environment and medical professionals to further cancer prevention and control efforts through medical, environmental and social policies.

In this paper, we focus on how researchers from diverse disciplines are discussing the relationships between the built environment and cancer prevention. We adopt a scoping review methodology to provide a representative synthesis of the conceptual research area. We examine evidence from Australia, Canada, Ireland, New Zealand, the United Kingdom, and the United States, providing a relatively homogeneous contextual research frame.[22] Disparate existing results linking cancer risk with built and social factors may be the result of the complexity of human environments with individual and contextual factors intersecting and combining to produce unique variations in cancer risk and outcomes.[23] Corburn's Rational Framework of Urban Place and Health Equity identifies people, process, physical, politics, power, and policy as the key elements that culminate into spatial and social patterns of health risks.[24] The Multi-Level Biologic and Social Integrative Construct is a more detailed representation of the complex system of macro-environmental, individual, and biologic factors that influence cancer etiology.[25] The construct is built on the socio-ecological model of health determinants, and when taken in complement with Corburn's model, we apply these nested contextual approaches to understanding cancer prevention and control.[9,26]

We use these models to structure our scoping review to examine pathways between built environment elements and cancer outcomes, mediated by well-known modifiable risk factors of cancer. We focus exclusively on the primary and secondary levels of prevention in this review, and their subsequent outcomes for risk and severity at diagnosis, thus not exploring impacts on tertiary prevention which includes treatment, survivorship, and morbidity/mortality. These portions of the continuum of cancer prevention may feature in the determination of primary and secondary outcomes, but are not investigated as independent outcomes from the other elements and factors. Built environment elements were selected on an *a priori* basis, informed by previous assessments of urban effects on health.[6,17,27] These elements include spatial proximity (to cancer risks as well as cancer screening services), greenspace, housing, public services, transportation, and urban design. We also noted elements of

social capital and socioeconomic status in relationships between the built environment and cancer as these predominantly affect and are affected by spatial proximity, housing, and transportation conditions.[28–30] Cancers of interest were selected based on incidence rankings for each country of interest from the Global Burden of Cancer 2015 report[11] with adjustments to account for cancers with no significant modifiable risk factors. These cancers include breast, cervical, colorectal, esophagus, kidney, leukemic, liver, lung, neurological, oral, prostate, skin, stomach sites, along with all types overall. Important individual-level risk factors of cancer were selected from guidance published by the Institute of Medicine[31] with a focus on air quality, alcohol use, diet, obesity, physical activity, tobacco use, and ultraviolet radiation exposure. Therefore, we present results of a scoping review using this conceptual structure of how the built environment affects cancer etiology and outcomes.

METHODS

Briefly, a scoping review is a type of synthesis that follows the methodological rigour of a systematic review, while allowing flexibility to investigate the complex relationships between broad topical areas.[32] A scoping review consists of five distinct steps: (1) formation of a research question; (2) planning, testing, validating, and executing a search strategy; (3) relevance assessment of results, and application of inclusion and exclusion criteria; (4) analysis of the included results using thematic or meta-analytic techniques; and (5) reporting of results in an accessible and reproducible format.[33] Scoping reviews do not comprehensively identify all potential literature in a research area. Rather, the method provides a rigorous and transparent representation of links between two disparate fields.[34] A scoping review is a suitable approach to answering research questions that cover multiple fields of knowledge because they provide flexibility to adapt to the results uncovered as part of the review. However, methods described in this paper should allow for reproducibility of our results, as is typical with other systematic approaches to literature reviews.

Our scoping review encapsulates four research traditions: (1) cancer epidemiology and control; (2) urban planning and human geography; (3) sciences and engineering; and (4) public administration and policy. The scoping review methodology adopted in this paper follows established guidance for these types of reviews and,

where applicable, the standards articulated in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[35,36] We elected to conduct a scoping review, rather than a systematic review, to elicit a broad understanding of the research question. Therefore, the review captures *how* built environment exposures and features are operationalized by these various fields in research of cancer prevention, etiology and outcomes. We present the underlying conceptual mechanisms by which features of the built environment are associated with cancer prevention and control in the following sections.

Search Strategy

We searched for peer-reviewed journal articles published in English between January 1990 and May 2017 across 14 subject-specific databases: ABI/IFORM, CINAHL, Cochrane Library, EMBASE, ERIC, ESPM, Google Scholar, HeinOnline, JSTOR, LexisNexis, Medline, Scopus, and Web of Science. We searched for a controlled set of terms in the titles, abstracts and keywords in the index of each database (see Appendix A). The search strategy combines terms that represent the built environment using OR operators, and terms that represent cancer and its risk factors using OR operators. Each grouping of themed statements is then combined with an AND operator. Search terms were adapted to suit the limitations of each database. For example, searching in medical databases often requires the use of a controlled set of terms (ie. MeSH headings), rather than uncontrolled searches of keywords in the titles and abstracts commonly found in social science databases. The search strategy was reviewed by a subject-specific librarian specialized in environment, geography, and planning; and another librarian specialized in bibliometrics. Refer to Appendix A for more information about the search terms and strategy.

Inclusion and Exclusion Criteria

We applied a set of inclusion and exclusion criteria to the potential results captured in the database searches. Articles would be included if they: (1) described a built or social environment feature, exposure, and/or intervention; (2) took place in Australia, Canada, Ireland, New Zealand, United Kingdom, or United States; (3) identified cancer prevention, screening, or a specific etiological factor as the impetus

or outcome of the research; and (4) were peer-reviewed. The geographical limitation was applied to provide a sample of countries with similar political and urban planning systems.[22] Of note, articles were included if they described an element of the social environment, given the built environment's well-understood role in shaping social determinants through land use, transportation, public service and urban design decisions.[28,30,37] This set of inclusion criteria was developed to operationalize the research question throughout the relevance assessment portion of the scoping review. It was applied to the titles, abstracts and full-text of each returned article. Articles were excluded if they did not meet any one of four previously described inclusion criteria. The dominant reason for exclusion of an article was not explicitly declaring a cancer outcome or built environment feature. While the field of environmental design has contributed significantly to improving the local environs of cancer care, treatment, recovery, and hospice facilities[38,39], this form of tertiary prevention is considered out of scope for the purposes of our review.

Data Assessment and Processing

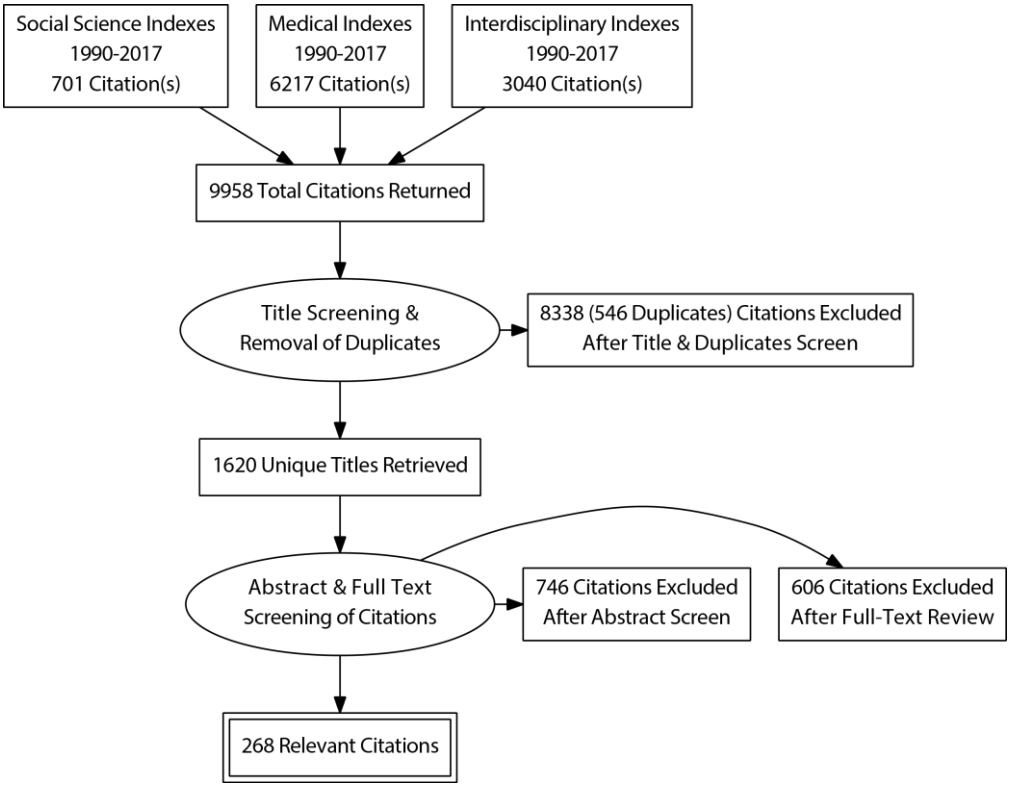
The relevance assessment consisted of executing the search strategy to capture potentially relevant articles. These results were then scanned on their titles for relevance given the inclusion and exclusion criteria. Potentially relevant titles were then assessed based on their abstract. Relevant abstracts were then assessed based on a reading of their full-text before being included in the final scoping review. One reviewer (AW) with expertise in urban planning and environmental assessment processed articles through each stage of the relevance assessment. The other reviewer (LMM) with expertise in public health and planning assessed a randomly generated subset of results at each stage. Disagreements on inclusion/exclusion and classification decisions were resolved by consensus.

The final dataset was processed through a systematic data extraction procedure developed by the reviewers. Data extracted from each article included: bibliographic information; subject database classifications; methodological details; Population, Intervention, Comparators, Outcomes, Timing, Setting (PICOTS) information; evidence quality given study design type; results; implications; and thematic information identified by the reviewers. Data was extracted using tools in Google Forms[40] creating a

record for each article. An article's bibliographic information, and reviewer determined thematic tags were inputted into Zotero[41] for data management purposes. Microsoft Excel[42], R[43], and RawGraphs[44] were used for data cleaning, formatting and analysis.

We present the results of this review in a variety of visual formats. Two of these formats may be novel for cancer research – the alluvial diagram, and network diagram. Alluvial diagrams can be used to represent distributions across categorical variables (Figure 4). Color is used to represent classifications, size is used to communicate proportions, and hierarchy is used to demonstrate weight of each factor within a category.[45] Alluvial diagrams in the context of this literature review can be used to identify broader trends, areas of conceptual saturation, and gaps in research. Network diagrams can be used to illustrate connections between sources in a complex system – in our case, overlap between literature databases (Figure 5). Color is used to demonstrate categories, size is used to demonstrate the proportions within the network, and lines, including their weights, communicate the size of connections between sources.[45,46]

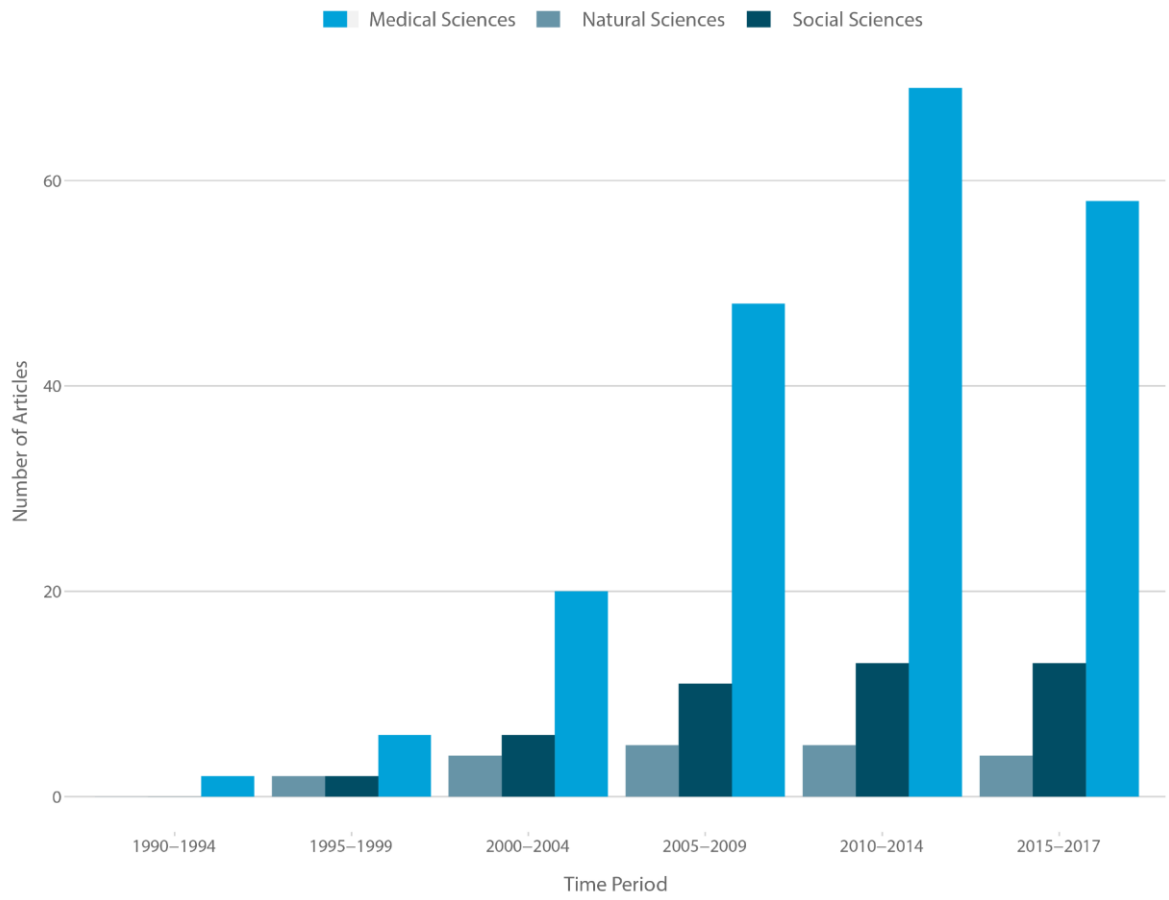
Figure 1. Search results process diagram



RESULTS

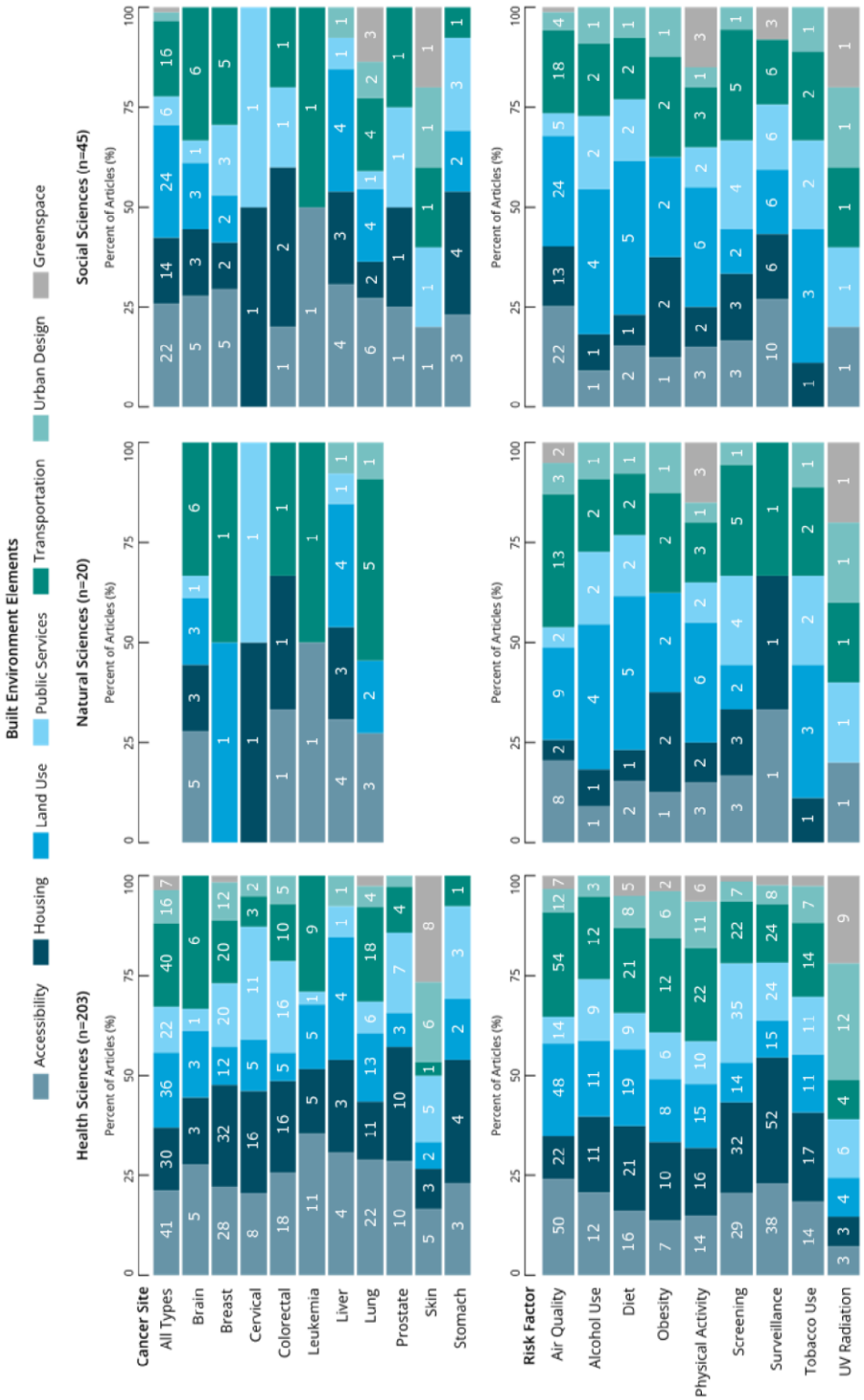
The search yielded 9958 potentially relevant sources. Title scans resulted in 2166 articles to be reviewed by abstract. Prior to abstract review, titles were scanned for duplication, leaving 1620 titles. The abstract review resulted in 874 full-text articles to be reviewed. The full-text of these articles were assessed with the inclusion and exclusion criteria, arriving at the final dataset of 268 peer-reviewed journal articles (Figure 1). Appendix B provides summary tables of these articles. The relevant articles illustrate an interesting shift among various disciplines and their interests in cancer research. From 1990 to 2018, the medical sciences literature has grown exponentially, while the natural and social sciences have seen steady increases in research interest for cancer prevention and control (Figure 2). This shifting trend in publication sources shows the growing interdisciplinary of cancer research and policy.

Figure 2. Distribution of articles by publication year



We have previously reported on a limited subset of the results as part of this scoping review in another paper.[47] Given the size of our final dataset, we present a thematic description of the results and refer the reader to the linked appendices for a description of each article included in the review. Below, we outline how authors in the health, natural, and social sciences interpret and discuss the pathways between the built environment and cancer etiology (Figure 3). Broadly, our *a priori* categorization of the results suggests spatial accessibility, housing, land use, and transportation as thematic areas of interest (Figure 4). An alluvial diagram is deployed in this case to illustrate the proportionality of, and connections between, each built environment element, cancer risk factor, and cancer outcome in the results. Results in the alluvial diagram and reported in the following paragraphs may count a study multiple times to match the number of unique pairings between cancers, risk factors, and built environment elements. We place emphasis on the distribution, rather than specific allocations to each component of the conceptual framing of the results. Overall, the relationship between cancer, cancer risk factors, and urban design and public services (ie. screening and prevention services) remain relatively understudied compared to other built environment elements.

Figure 3. Results by field of study



Health Sciences

Health sciences are predominantly featured in the discussions of the environment's role in shaping cancer etiology (N=203). Of the 203 studies examined, 83% found significant associations between at least one element of the built environment and cancer or cancer risks. There is thus broad evidence across most cancer sites and risk factors of a link to built environment elements, particularly spatial accessibility (n=155), housing (n=133), land use (n=90), and transportation (n=112). Brain (n=18), breast (n=127), colorectal (n=70), leukemic (n=31) and lung cancer (n=75) sites are studied broadly across the field, and mechanisms by which environmental features impact risk of these cancers are typically conceptualized as poor air quality (n=207), diet (n=99), or substance use (n=132).

Natural Sciences

The natural sciences are not featured prominently in the results (N=20). Of the studies examined, 90% had significant associative findings. However, much of the evidence from this domain is of a cross-sectional nature focusing on air quality (n=39). In relation, the role of transportation systems and land uses – ports, railways, truck depots, highways – feature throughout the results from this field of study (n=31). Studies focus predominantly on lung (n=11) and brain (n=18) cancers.

Social Sciences

The social sciences are an expanding area of study within environmental determinants of cancer (N=45). The studies examined in this field found significant associations 80% of the time. Air quality is the predominant risk factor of concern among most studies (n=87), followed by an interest in cancer screening and surveillance practices (n=37). Given these two risk factors, the primary built environment elements of interest within this sphere of practice are related to spatial accessibility (n=49), housing (n=32), land use (n=39), and transportation (n=36).

Figure 4. Distribution of results by features, factors, and outcomes

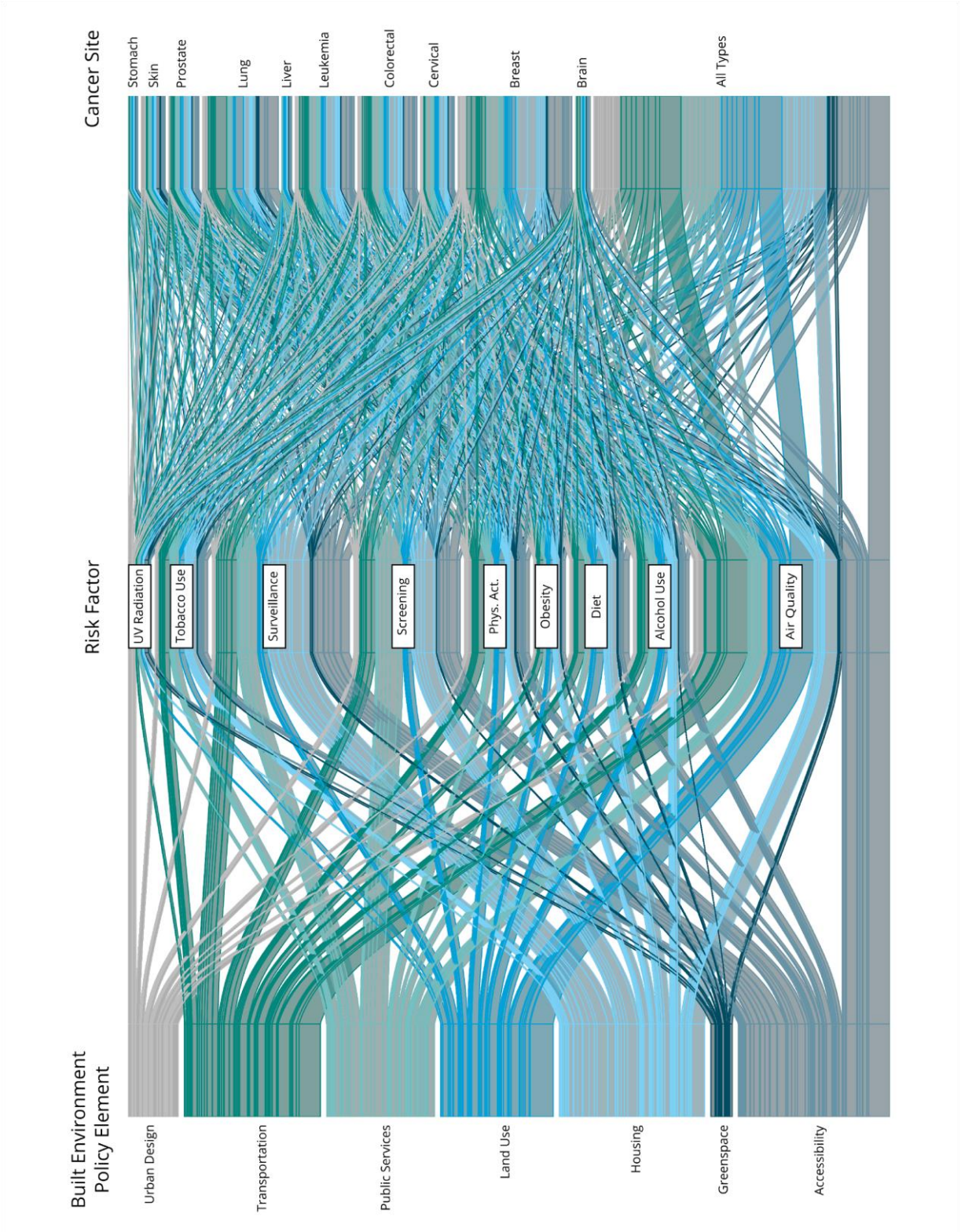
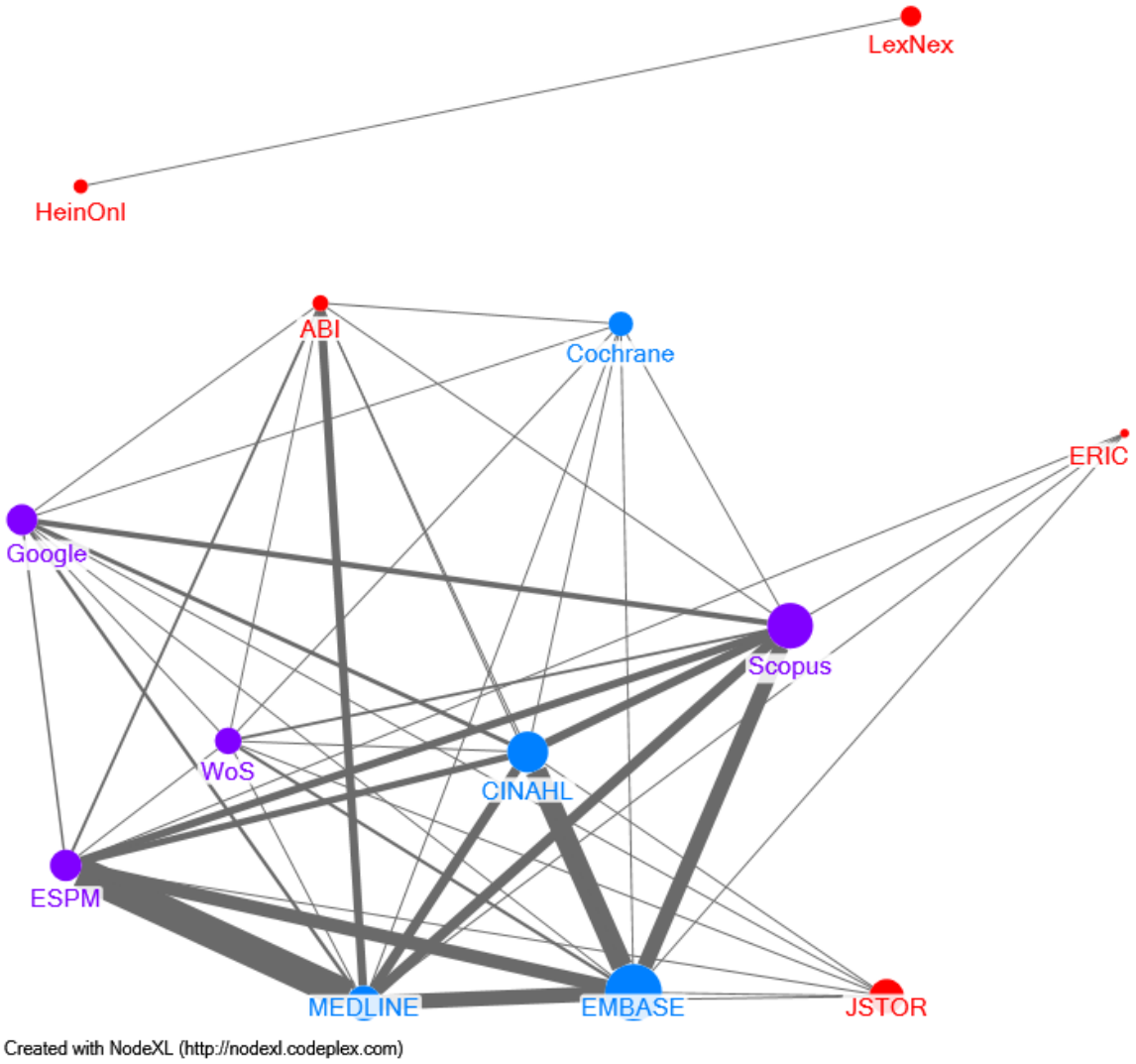


Figure 5. Overlap of results by search database



Results Overlap

As part of the original search process, we noted the duplication in results between databases (Figure 5). A network diagram is deployed to communicate the overlap, and respectively the significance of the relationship, between interdisciplinary (purple), medical (blue), and social science (red) databases. Given that many of the reviews captured in this scoping review primarily used only one database in their search strategy, we sought to investigate the reliability of this practice. We found the overlap between Medline, a primary medical sciences database, and other social science databases – JSTOR, Web of Science, and ABINFORM – was only about 10% of all the results captured in the original search. In addition, LexisNexis and HeinOnline

are isolated from the rest of the network, likely due to their exclusive focus on legal scholarship. Thus, many of the databases in the medical sciences are well-connected to each other with significant overlap in the interdisciplinary databases, and little overlap with the social sciences' databases.

DISCUSSION

The link between environmental exposures and cancer are increasingly being examined, with 60% of relevant studies having been published since 2010. Evidence from our review would suggest cancer prevention and control praxis appears to be crossing disciplinary boundaries. Increasingly, geographers, planners, engineers, and political scientists are interacting with cancer etiology and prevention. They provide new insights to the medical community that could be invaluable in achieving success during implementation of organizational, community, or policy-level changes to the built environment. Medical professionals would benefit from using the expertise of these allied fields to improve population health and wellbeing. The largest built environment elements of interest revolve around the core functions of many communities: spatial accessibility, housing, and transportation. Greenspace, land use, public services, and urban design are other elements that cut across these three larger domains. These elements in turn relate to the risk factors of air quality, screening, and surveillance. Examining these linked pairs of built environment elements and risk factors, breast, colorectal and lung sites emerge as the predominant cancers of interest across the medical, natural, and social sciences – when excluding general investigations of all types of cancer.

Spatial Accessibility

The closer in proximity elements of interest are to each other, the more likely they have an interdependent relationship.[48,49] In the context of cities, proximity can be framed in numerous ways, yet from a health perspective, Penchansky and Thomas[50] provide a useful framing of the variations in meaning for access: availability, accessibility, affordability, acceptability, and accommodativeness. The consideration of accessibility – as a feature of the built environment – reveals how access and proximity to health promoting or demoting resources influence cancer risk. For example, the

centralization of screening services in hospitals and medical clinics in public-transit deficient areas makes these services inaccessible for low-income and transportation-insecure communities.[51–53] The placement of housing in close proximity to noxious uses – manufacturing, refineries, transportation infrastructure – increases the risk of exposure to harmful air pollutants that have been correlated with various cancers.[54–57] Therefore, the spatial and social networks of built environment elements dictates the distribution of cancer risk among various populations.

Housing

The Universal Declaration of Human Rights identifies the right to housing as part of achieving a standard of living suitable to promoting good health and wellbeing.[58] Housing security was a cross-cutting issue in almost all aspects of cancer research. Surveillance of stage at diagnosis, and incidence rates tended to correlate with neighbourhoods that had higher rates of housing insecurity.[59–63] The history of poor land use control in many countries often predicted lower socioeconomic status housing being located in close proximity to polluting industries, major transportation corridors, and health demoting, rather than promoting, amenities.[64–66] The concentration of affordable housing in less-desirable areas leads to disadvantaged populations having lower accessibility to greenspace, healthy food outlets, public services. Furthermore, publicly-provided housing tends to be of a substandard quality, having significant implications for cancer risk.[59] Housing in the context of cancer becomes a source for disparity in the distribution of cancer risks.

Transportation

Transportation is an interrelated element of the built environment to accessibility and housing. Good access to transportation ensures access to high-quality screening services, and was found to be associated with less severe stages of diagnosis for many cancers.[67,68] Transportation infrastructure, like ports, railways, and expressways, are also associated with higher rates of air pollution, and in turn, higher exposure-based risks for lung, colorectal, and nervous-system based cancers.[54,69–71] In summary, these three built environment elements illustrate the majority of the

variation in distribution of risks and cancer diagnoses from preventable social, economic, and environmental conditions.

Limitations

This scoping review may not capture the full extent of the conceptual field and is subject to a few methodological limitations. Firstly, the review excludes evidence not published in English, and evidence not published from research in predominantly English-speaking Western countries. This feature of the review could prove to have a publication bias on the results of the review, as well as discount the value of research occurring in other countries.[72] Secondly, the review may not capture the full extent of the conceptual field given the search strategy was limited to 14 databases. However, our search strategy far exceeds the number of databases used in other reviews.[20,73] Finally, scoping reviews are typically conducted with two independent reviewers.[34] In this case, one reviewer was responsible for the relevance assessment and data coding, while another reviewer performed checks on a random subsample at each stage of the study process. This departure from normalized practice allowed for more efficient use of resources, while still allowing for the judgment of reliability between raters in the relevance assessment and data coding. The authors are not aware of any funding relationships, professional obligations, or perceived conflicts that would bias the results of this review.

CONCLUSIONS

Three key conclusions emerged as important for advancing the cross-disciplinary field of built environment and oncological research. First, although the neighbourhood appears to be a useful analytical unit in many studies of environment-cancer interaction, neighbourhoods themselves are not responsible for many of the observed effects. Second, housing security is a cross-cutting fundamental driver of many cancer risks. Third, land use and transportation policies – current and historic – have broad-ranging impacts on cancer risks and outcomes. Cancer prevention and control practitioners should reflect on these conclusions, in addition to the subsequent recommendations, to identify opportunities for cross-disciplinary communication that

would result in translational impact on cancer prevention and control policy, programming, and practice.

Analytical Units

Neighbourhoods are a unit that can be used to describe the local accessibility context that shapes health. They also provide a useful lens to examine the interdependent issues of housing, transportation, land use, public services, and urban design. While these factors may not have a direct causal link with cancer, they do pattern the effects of other causal factors such as air quality, diet, substance use, or UV exposure. Thus, the study of environmental factors may be viewed as a "cause of causes" – or, at the beginning of a long etiological chain that could lead to a specific cancer outcome.

The Importance of Shelter

Housing security is broadly identified as a built environment determinant of the observed disparities in cancer outcomes across various populations. Authors have routinely found correlations between housing and cancer outcomes, hypothesizing pathway relationships with toxic stress[74], socioeconomic disparities[59,75], segregation[76], and masking the effects of income, cultural, and access to health resources.[60,77–81] Housing has long been recognized as a core determinant of health, with many social and health science fields recognizing the concept of "shelter" as a basic human need.[7] Cancer is no different. Housing security is a clear marker of social standing, and often correlates with other individual and environmental risk factors of cancer.

Land and Transportation Policies

Examining the air quality evidence, among other risk factors, land use policy emerges as an influencer of cancer outcomes. The location of housing near heavy industry, waste management, and transportation facilities exposes populations to harmful pollutants, leading to higher lung and leukemic cancer risks.[54,64,69,70,82] These exposures are also often racialized and stratified by socioeconomic status.[83,84] While many land use decisions are based in historical precedents, current policies and structures can affect patterns of risk across environments. Furthermore, the relationship – and dependencies – between land use and transportation are well-

established in the literature[6,85], and altering either element of the cycle can cause cascading effects across the built environment. Within the broad areas of land use and transportation lie additional concerns regarding the influence of spatial accessibility[64,73], public service distribution[86–88], and urban design[89,90] on cancer risks and outcomes.

Recommendations

Following from the conclusions, we provide three recommendations to advance cancer control, epidemiology, and prevention praxis. These suggestions follow from the recommendations put forth by Gomez[73], Jacobs[59] and Krieger[86] in their respective reviews about cancer, built environments, and social conditions.

Interdisciplinary cancer research. This review's broad and inclusive search strategy yielded a wide range of research across disciplines. Of the research captured, over 20% was found in databases, and written by authors, outside of the medical sciences. When examining the review-type evidence, many authors only searched a limited set of databases, often from only the medical sciences. This narrow approach to the literature immediately limits the types of evidence being made available for use in further research and praxis. Given over 20% of the research was located outside of the medical sciences, it is reasonable to suggest cancer research needs to engage with, and be informed by, research conducted in the natural and social sciences. Valuable contributions of understanding screening behaviours, lifestyles, and production of harmful pollutants can be sourced from fields outside the medical sciences.[91–93] There is a need for new cross-disciplinary 'cancer-environment studies' fields of research and praxis to leverage the capabilities and techniques of the medical, natural and social sciences. Studies of the impacts from food landscapes, active mobility, and non-residential based environments on cancer etiology could be novel areas of future collaborative research.

Longitudinal studies. While much of the evidence remains cross-sectional, further studies similar to the Nurses Cohort in the United States[94,95] are needed to elicit the effects of built environment determinants such as housing, land use, and transportation over the life course. Longitudinal studies of land use and housing effects

would provide more confidence in demonstrating the influence of built environment elements on shaping cancer risk patterns. Given the long latency of cancer outcomes, methods proposed by Hart[94] and Hystad[96] are ideal approaches to eliciting the effects of built environment factors. Further, other analytical units to the neighbourhood need to be deployed in statistical and spatial analyses. Social network-type methods, like those used by Leader and Michael,[87] could be a promising approach to solving the modifiable areal unit problem in surveillance-type research.

Changing the built environment. Cancer control and prevention policy makers should target comprehensive zoning reform that shifts the primary criteria for decisions to the health impacts of various land uses. However, many toxic land uses and their proximity to sensitive uses are well-established in the built environment. Thus, there is a historical challenge of previous uninformed land use decisions to be overcome in many communities. Though many municipalities, and other responsible authorities across Australia, Canada, New Zealand, the United Kingdom, and United States have eminent domain powers that could be leveraged to relocate harmful uses away from housing and school sites, as well as alter the built environment to promote healthier lifestyles.[97] As aptly summarized by Mr. Wortley in the House of Commons debates regarding the United Kingdom's Town Planning Act: "that in all these matters the public health, the interest of generations to come, is the highest of all public interests which can be pleaded."[98] It would be pertinent for both health and planning professionals to remember this core principle when making land use, transportation, and urban design decisions. In addition, medical professionals should consider lending their strong voices to effect meaningful change in the highly politicized arena of promoting healthy and inclusive environments.

In summary, this cross-disciplinary scoping review has found a wide range of evidence suggesting both correlative and causal relationships between built environment elements, risk factors, and cancer outcomes. Engagement across traditional disciplinary boundaries to form a new field of 'cancer-environment studies' – leveraging the study designs of the medical and natural sciences, and the theoretical grounding of the social sciences – could potentially create more impactful and nuanced research.

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Author Contributions

Alexander James David Wray: Data curation, formal analysis, investigation, methodology, software, visualization, writing-original draft, and writing-review and editing

Leia Michelle Minaker: Conceptualization, funding acquisition, formal analysis, methodology, project administration, resources, supervision, validation, writing-original draft, and writing-review and editing

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