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Assessing the Comparative Spatial Variances in the Effects of Urban Built Environments, City Risking Behaviors, and Air Pollutants on Breast and Prostate Cancer

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ABSTRACT

Cancer is a serious public health dilemma. According to the World Health Organization (WHO), cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths in 2020, or nearly one in six deaths. Therefore, research on effectively preventing and managing cancer is continuously needed in various fields in order to improve people's quality of life and safety. This study aims to explore the spatial distribution of incidences of breast cancer and prostate cancer that occurred in Korea from 2009 to 2013 with the use of the Geographic Information System (GIS). This research also examined the association between prostate cancer, breast cancer, air pollutants (CO, NO_2, PM_{10}, SO_2), urban health-risk behaviors (smoking, drinking, and obesity), and the built environment of industrial, commercial, residential, and green areas. The main results showed that cancer incidence rates were highly clustered in specific regions and the regional differences in cancer incidence rates significantly depended on the cancer type. Concentrations of air pollutants also vary by region and tend to be high in certain regions. Air pollution is likely to play a mediating role in the relationship between the built environment and cancer incidences rather than the built environment directly affecting cancer incidences. These findings suggest that it is necessary to examine spatial and regional characteristics in building cancer prevention strategies and policies. This also emphasizes the need for interdisciplinary research for cancer prevention, not only in the medical field, but also in public health, urban planning, and environmental fields.

Introduction

In the face of impending challenges to public health and concerns that loom over the foreseeable future, humanity possesses the inherent capability to shape forthcoming circumstances. This inherent capacity serves as the catalyst for the establishment of novel societies and innovative solutions to persisting predicaments. One of the pressing concerns within the domain of public health pertains to the formidable menace of cancer. The deleterious impact of cancer, characterized by anguish and compromised bodily functions, exerts a grave toll on human well-being. Given that the quintessence of a fulfilling existence hinges upon robust health and a life of substance, numerous nations across the globe vigilantly oversee and manage vital health indicators within the spheres of public health and medical administration. As underscored by the WHO, cancer stands out as a prominent contributor to global mortality, accounting for a staggering approximate of 10 million deaths in the year 2020, corresponding to nearly one-sixth of total mortalities. This reality holds true, particularly in the context of South Korea, where the exponential surge in national income and improvements in quality of life due to rapid economic progress have augmented concerns regarding health. Evidencing this concern, the Korea

Disease Control and Prevention Agency (KDCPA) has meticulously amassed data pertaining to health behaviors, medical checkups, vaccinations, and healthcare utilization through comprehensive surveys conducted under the banner of the Korea Community Health Surveys (KCHS) since the year 2008. The culmination of these data-driven endeavors accentuates cancer's steadfast grip on mortality charts, reigning as the foremost cause of death over a span exceeding three decades. This realization culminated in the formulation of the National Cancer Control Plan (NCCP), a strategic initiative aimed at methodically addressing and managing cancer incidences. Reflected in the statistical annals provided by the National Statistical Office (NSO), the annual tally of cancer cases in Korea ascended from 196,046 in 2009 to 227,188 in 2013. This trajectory of escalating cancer incidences underscores the exigency of comprehensive research and intervention. A recent statistical exposition, '*Statistics on Causes of Death in 2021*', based on data gleaned by Statistics Korea in 2022, reveals a sobering statistic—more than a quarter of the Korean populace succumbs to the scourge of cancer. Given this contextual backdrop, it becomes imperative to meticulously investigate the determinants steering cancer's prevalence within the Korean demesne.

This study embarks on an exploration of the intricate interplay between urban and natural environments and their contributory role in shaping cancer incidence patterns. Genetic factors, inherently complex and personalized, alongside the environmental milieu within which individuals reside, collectively orchestrate the landscape of cancer's occurrence. While the manipulation of genetic predispositions remains a formidable challenge, the realm of environmental interventions promises a pathway for targeted cancer prevention, buttressed by judicious urban policies.

Focusing specifically on the urban milieu, the concept of built environments assumes paramount significance. Encompassing the fabric of human-made spaces that accommodate a gamut of activities, ranging from habitation to recreation, built environments encompass a spectrum of entities such as infrastructure, industrial precincts, thoroughfares, verdant expanses, and recreational havens. A historical trajectory spanning back to the 19th century bears testimony to the unsavory conditions that burgeoned within densely populated industrial locales, instigating the prevalence of diseases and epidemics. A conscious pivot towards residential spaces detached from industrial epicenters heralded a seminal turning point, engendering notable improvements in public health. Nonetheless, the evolution of built environments in the 20th century took a divergent trajectory, veering towards aesthetics and economic considerations, and distancing itself from the nexus with public health. This paradigm shift manifested in the proliferation of sprawling suburban designs, engendering reliance on automobiles and inadvertently catalyzing the proliferation of air pollutants. The conscious intent underlying the establishment of built environments, each replete with latent potential, has the power to significantly influence the discourse of national public health. Notably, environments that prioritize expansive, verdant, and pedestrian-friendly spaces hold promise in fostering healthier lifestyles.

However, the irony that pervades the realm of built environments lies in its dual impact—while conceived with the intent of ameliorating human lives, it paradoxically impinges upon the natural environment, thereby indirectly compromising human well-being. Instances abound wherein built environments harboring transportation nodes and congestion inadvertently expose individuals to pernicious air pollutants, thereby precipitating an insidious rise in preventable cancers. This unsettling trend underscores the compelling need to unravel the intricate relationship between the built environment and the genesis of cancer.

Within the purview of South Korea, the specter of air pollution has cast its ominous shadow since the aftermath of World War II. The nation contends with recurrent episodes of noxious yellow dust storms and an upsurge in airborne contaminants, attributed in part to the scarcity of green spaces within the built environment and the industrial hubs emanating from neighboring China. Legislative efforts such as the '*1978 Environmental Preservation Act*' and the '*1990 Air Quality Preservation Act*', formulated to curtail the onslaught of air pollutants by advocating for low-sulfur fuel and the eradication of solid fuels, have been set in motion.

However, these well-intentioned endeavors have been marred by their inadequacy in navigating the complex terrain of environmental governance. The dominance of growth-oriented economic policies, prioritizing economic and industrial progress over the broader imperatives of health and environment, has posed a formidable hurdle in the effective enforcement of environmental laws. This fissure between intent and implementation amplifies the predicament and accentuates the gravity of the challenge. Moreover, the predicament is further compounded by the nuanced interplay of built environments, geographical location, and cancer incidence. Cancer prevalence exhibits a profound variability contingent upon cancer type and geographic expanse. Diverse human-made structures and natural terrains render each locale distinct, engendering disparate cancer incidence rates. The intricate weave of built environments within each city or neighborhood introduces a tapestry of proportionate diversity, thereby necessitating caution against extrapolation from one region to another markedly dissimilar locale.

The imperative of robust research thus necessitates a multidimensional exploration across diverse geographic domains, accounting for the idiosyncratic interplay of built environments and natural surroundings unique to each locale. This study embarks on a systematic inquiry aimed at unraveling the intricate associations between air pollutants, land use dynamics within built environments, and cancer incidence rates. By peering into the intricate web of causation, the study seeks to discern the nuanced nuances wherein specific air pollutants and land use patterns intersect with various cancer types, thus illuminating pathways for targeted interventions and policy formulation.

Literature Review

All paragraphs, Extensive inquiry has been devoted to investigating the intricate interplay between specific cancer types, the built environment, and air pollution within the context of South Korea. Noteworthy among these endeavors, Jang et al. (2021) meticulously examined the interrelationship between socioeconomic factors, thyroid cancer screening, thyroid dysfunction, smoking, and thyroid cancer incidences spanning the years 1999 to 2015. The outcomes of their study revealed pronounced regional differentials, with elevated incidences of thyroid cancer observed in the southwestern regions and comparably lower rates in the northeastern territories. In a distinct vein, Shah et al. (2014) delved into an underexplored domain, scrutinizing the spatial dynamics underlying colorectal cancer incidences within Kuala Lumpur. Their investigations illuminated that individuals aged 60 to 69 years accounted for a considerable proportion of colorectal cancer cases, with male individuals predominantly bearing the burden of diagnosis.

Venturing into the domain of lung cancer, Hwang et al. (2007) embarked on an exploration into the influence of air pollution on lung cancer prevalence within South Korea. Their findings defied conventional wisdom by refuting a direct association between lung cancer risks in males and the presence of particulate matter (PM_{10}), thereby challenging the presupposition of an invariably negative influence exerted by air pollutants on lung cancer. Albeit a substantial body of research has dissected the intricate relationship between air pollution and cancer, Kim et al. (2007) took an alternate trajectory by investigating the nexus between breast cancer incidence and light-polluted urban areas. Their investigation unveiled Gwangju City as a hotspot for breast cancer, boasting incidence rates nearly twice that of rural Jeollanam-do areas. This unique perspective underscores the multifaceted influences that potentially intersect in shaping cancer patterns.

Drawing parallels to the observations of Hwang et al. (2007), research conducted by Biggeri et al. (1996) in Italy echoed a similar sentiment, challenging conventional assumptions regarding air pollution's unequivocal link to lung cancer. Their meticulous analysis of lung cancer incidence rates in Trieste debunked the statistically significant association between lung cancer and air pollution from shipyards, offering a nuanced perspective that resists generalizations.

The exploration of cancer patterns extended beyond lung cancer, with Yoo et al. (2021) delving into the regional concentration of liver and gallbladder cancer incidences in South Korea. Their investigations spotlighted distinctive spatial clusters, with liver cancer exhibiting a concentration in the southeastern and southwestern domains, and gallbladder cancer assuming a similar disposition in the southeastern realm. Interestingly, these findings echoed the regional trends identified by Jang et al. (2021), thereby alluding to shared geographic concentrations of diverse cancer types. Notably, Yoo et al. (2021) discerned a correlation between liver cancer and factors such as high household income, marital status, and hepatitis B, while gallbladder cancer incidence exhibited links with high household income and proximity to river bodies.

The intricate interplay between socioeconomic attributes and cancer incidence patterns was a focal point of Chun's investigation (2016), wherein the urban environment's influence on cancer-related mortality was dissected through the lens of Geographic Information Systems (GIS) and geographically weighted regression models. In striking contrast to the findings of Yoo et al. (2021), Chun (2016) underscored the profound impact of socioeconomic characteristics on cancer-related mortality, with poverty emerging as a potent influencer. However, these divergent viewpoints are reconciled by the assertions of Wray and Minaker (2019), who championed the significant role of the built environment as a determinant of human health. Their exhaustive systematic review illuminated the profound influence of transportation, land use, and housing in shaping cancer incidences, thereby bridging the gap between the built environment and cancer outcomes.

Xie et al. (2022) ventured into the Chinese landscape, investigating the correlation between the built environment, characterized by land-use intensity and green coverage ratio, and the prevalence of Women's Lung Cancer. Their findings revealed pronounced regional disparities, with Heilongjiang, Liaoning, and Inner Mongolia grappling with elevated incidence rates, while Tibet, Xinjiang, and Hainan exhibited comparably lower rates. This nuanced exploration underscores the unique configuration of built environments across geographical regions and its potential implications for cancer outcomes.

Lee and Kim (2019) harnessed spatial statistical techniques to scrutinize the connection between built environments and liver and thyroid cancer incidences. Their observations revealed a compelling correlation between diminished green areas within urban landscapes and elevated liver and thyroid cancer incidences. These findings find resonance in the spatial concentrations highlighted by Jang et al. (2021) in their study of thyroid cancer.

Illustrating the convergence of insights from various research streams, Figure 1 furnishes a comprehensive conceptual framework that underscores the necessity of simultaneously considering air pollutants and the built environment in the pursuit of a holistic understanding of cancer incidence patterns. Within this landscape, a discernible research gap emerges—a dearth of studies that dissect distinct cancer types' individual associations with air pollutants. This study's overarching goal is to fill this void by meticulously examining the spatial distribution and regional differentials characterizing the occurrence of breast cancer and prostate cancer, utilizing cancer statistical data published at the local government level by the National Cancer Center (NCC) in 2016.

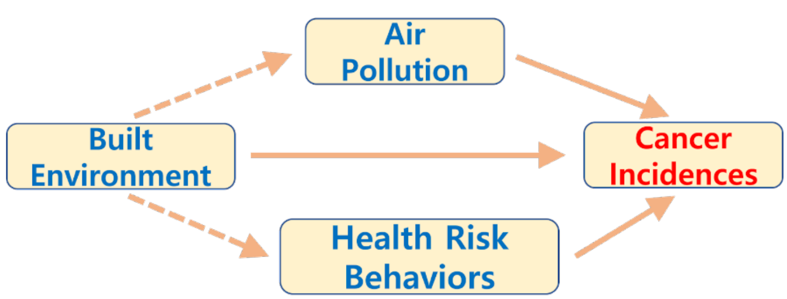

Figure 1. Conceptual Framework

Based on the provided conceptual framework, this research endeavors to provide concrete findings that offer insights into viable strategies and policies for cancer prevention. While the connection between air pollution and cancer incidences is widely acknowledged, it's important to recognize that air pollution itself is influenced by the built environment, which in turn could impact cancer rates. In addition, while health risk behaviors impact cancer, built environments influence these risky behaviors, ultimately blurring the variables causing cancer. This study aims to assess the combined effects of both the built environment, health risk behaviors, and air pollution on cancer incidences. To achieve this, we intend to control either air pollution or built environment variables in our analysis. By doing so, we can isolate and understand the specific influence of air pollution on cancer incidences when the built environment and behaviors are held constant, and vice versa. This approach will enable us to disentangle the intricate relationship between air pollutants, behaviors, the built environment, and cancer incidences.

Our investigation holds implications not only for the realm of public health and medicine but also extends its reach to urban planning and environmental considerations. Employing a spatial analysis methodology utilizing GIS techniques, we seek to provide practical and effective land use policy strategies for cancer prevention at the local level. By scrutinizing the spatial relationship between cancer incidences and pertinent measures, our study aims to uncover consistent and stable patterns across different geographic areas, thus contributing to informed policy decisions.

Methodology and Materials

The primary objective of this study is to delve into the intricate interplay between cancer incidences and the built environment, while accounting for the potential influence of air pollutants on cancer rates. The analytical framework employed to explore this nexus revolves around multivariate regression analysis. Notably, Prentice and Gloeckler (1978) harnessed regression analysis to study grouped survival data associated with breast cancer, whereas Takahashi et al. (2001) delved into the correlation between cancer incidence rates and water fluoride using regression analysis based on the IARC (WHO) data. These studies leveraged regression analysis to discern significant associations among an array of variables, reflecting the utility of this methodological approach. A spectrum of software tools, including R, Python, SAS, MATLAB, and SPSS, are commonly employed for regression analysis. In this context, our study availed the Statistical Package for the Social Sciences (SPSS) due to its user-friendly interface, tailored for novice users, and its adeptness in handling extensive and intricate datasets—a characteristic particularly relevant to our research. SPSS, lauded for its suitability in the social sciences, furnishes a robust platform to analyze complex data and is well-equipped to address the challenge of missing data, frequently encountered in cancer research. The software's diagnostic tools, encompassing residual plots and goodness-of-fit tests, empower researchers to scrutinize the quality and appropriateness of regression models. This empirical inquiry endeavors to discern the extent to which air pollution and the built environment contribute to cancer incidences.

Beyond this, our research ventures into the spatial dimensions of cancer incidences, cognizant of the crucial spatial components embedded within data encompassing cancer rates, air pollutants, and the built environment. To address this spatial facet, we used the GIS, a powerful computational framework adept at processing, scrutinizing, and modeling spatially referenced information. Noteworthy is the pioneering work of Brewer (2006), who introduced GIS as a valuable tool for visualizing cancer data, thereby laying the foundation for our study's spatial exploration. Drawing inspiration from Mosavi-Jarrahi et al. (2007), our research embarked on a journey to identify clusters of childhood cancer within the inner city of Tehran, employing spatial cluster tools within the GIS framework. This approach enables us to unravel geographical concentrations of cancer types and high-pollution areas, lending a visual dimension to our analysis. With its ability to capture, manage, and analyze vast volumes of geospatial information—commonly referred to as Big Data—GIS emerges as the most fitting avenue to dissect intricate relationships across the diverse geographical tapestry of South Korea.

South Korea's demographic and geographical context sets a unique stage for our study. Boasting a population of 51.71 million in 2019, with a population density of 515 individuals per square kilometer, South Korea stands out as a pertinent arena for examining cancer incidences in relation to the built environment and air pollutants. Our study capitalizes on secondary data, a readily accessible, cost-effective, and time-efficient resource provided by various national agencies in Korea, lending credence to our comparative endeavors. The foundational dataset for our study emanates from the Korean Statistical Information Systems (KOSIS), drawing from the expansive repository of the National Cancer Center (NCC) in Korea. These data underpin our investigation into prostate and breast cancer, two prevalent malignancies. Given the preponderance of elderly individuals in rural areas, we adopted age-standardized incidence rates to avert potential errors stemming from uneven age distribution. This comprehensive dataset, supplemented by land use and behavior data from KOSIS and air pollution data from 'Air Korea', empowers our analysis of PM10, SO2, CO, and NO2, and their interplay with cancer incidences.

A noteworthy aspect of our study is the integration of GIS for spatial analysis. Spatial information files sourced from the National Spatial Data Infrastructure Portal (NSDIP) were harnessed to visualize the distribution of cancer incidences and air pollutants across the South Korean landscape. By merging these datasets through GIS's 'Table Join function' and subsequent classification, we aim to unveil spatial patterns and concentrations that inform our understanding of this intricate relationship.

Results and Discussion

Descriptive Statistics Analysis

Table 1 shows the descriptive statistical analysis of cancer incidences by cancer type. Looking at the average cancer incidence rates by cancer type, breast cancer (22.889) was relatively high, and prostate cancer (11.006) was relatively low. Regarding land use characteristics, the average residential area in cities across the country was 13.103%. Other commercial, industrial, and green areas were 1.694%, 5.378%, 64.146, respectively. The average concentration of PM_{10} in Korea was 45.561 μg/m3. This concentration level was more than double WHO's recommended PM_{10} annual average of 20 μg/m3 which indicates that Korea's particulate matter contamination was a serious health hazard. Furthermore, the average concentrations of CO, NO_2, and SO_2 were 0.4762, 0.020, and 0.0043 ppm, respectively. NO_2 concentrations were similar to 0.021 ppm, while SO_2 concentrations were lower than 0.019 ppm which are the WHO standards for ideal air conditions.

Table 1. Descriptive Statistical Analysis

	Unit	Mean	Std. Dev	Min.	Max.
Prostate cancer	#/100,000 persons	11.006	2.229	5.700	20.100
Breast cancer	#/100,000 persons	22.889	4.675	11.300	34.200
Residential area	%	13.103	11.951	0.4663	57.643
Commercial area	%	1.694	1.855	0.0694	9.837
Industrial area	%	5.378	9.219	0.000	54.269
Green area	%	64.146	84.075	0.000	411.284
Smoking	%	24.799	2.502	17.500	32.400

Drinking	%	57.828	4.946	36.200	66.500
Obesity	%	23.337	2.899	14.500	32.800
CO	ppm	0.476	0.095	0.000	0.686
NO_2	ppm	0.020	0.007	0.000	0.037
PM_{10}	$\mu g/m^3$	45.561	6.832	0.000	62.661
SO_2	ppm	0.004	0.001	0.000	0.008

Spatial Analysis of Cancer Incidences

Figure 2–3 shows the nationwide spatial distribution of cancer incidences per 100,000 people from 2009 to 2013. As a result of examining the spatial distribution by cancer type through GIS, it was concluded that cancer incidence rates were highly clustered in specific regions. In addition, the regional differences in cancer incidence rates were significantly different depending on the cancer type. Looking at the type of cancer, both prostate and breast cancer occurs widely in areas around Seoul metropolitan areas and northern areas. These main results suggest that those regional characteristics can influence the incidences of cancer. Policies for cancer prevention should be established not only at the national level but also at local levels through policies and interventions that consider regional characteristics. Therefore, it is necessary to examine the relationship between cancer incidences and regional characteristics, including natural and artificial factors.

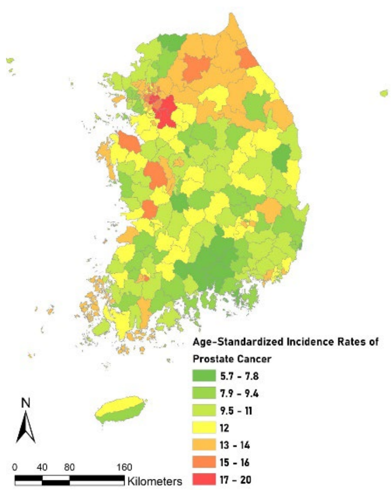

Figure 2. Spatial distribution of prostate cancer incidence

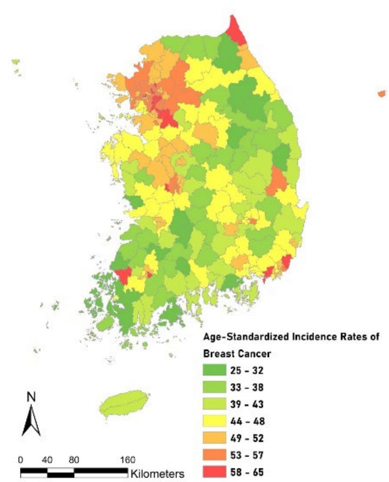

Figure 3. Spatial distribution of breast cancer incidence

Spatial Analysis of Air Pollutants

Figures 4 through 7 provide an encompassing overview of the spatial distribution of air pollutants across the nation. The depicted maps underscore the distinctiveness in regions marked by elevated air pollution concentrations, a disparity that holds true for each specific type of air pollutant. Evidently, these visualizations unveil discernible clusters of air pollution concentrations that are specific to particular areas. Of notable significance

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is the observation that the concentrations of PM_{10} and NO_2 register notably higher levels within the Seoul Metropolitan area compared to other regions. This distinct regional variation is indicative of the multifaceted nature of air pollution, wherein the causative factors behind its occurrence differ regionally, contingent upon the specific type of air pollutant under consideration. shows the nationwide spatial distribution of cancer incidences per 100,000 people from 2009 to 2013.

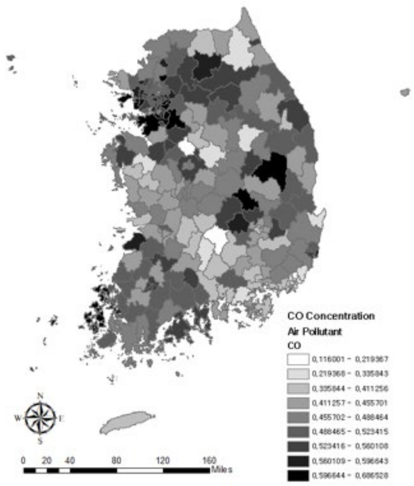

Figure 4. Spatial distribution of CO concentration

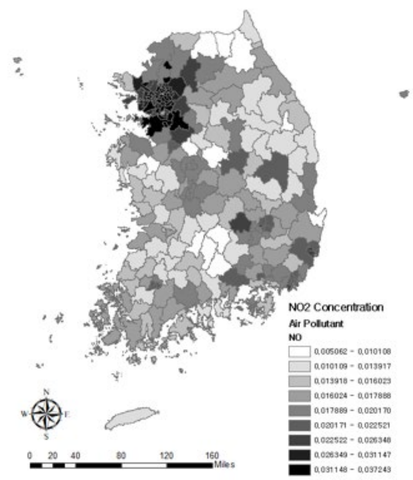

Figure 5. Spatial distribution of NO_2 concentration

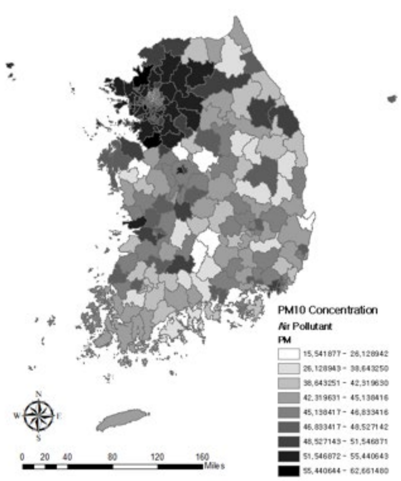

Figure 6. Spatial distribution of PM_{10} concentration

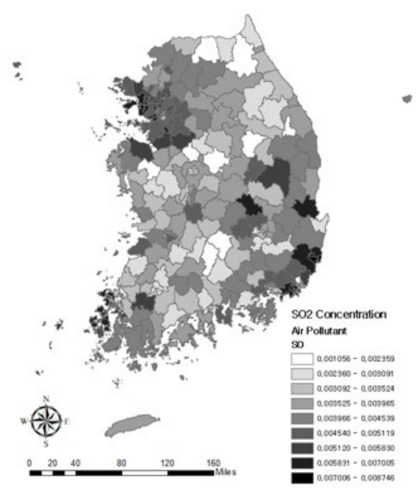

Figure 7. Spatial distribution of SO_2 concentration

Regression Analysis

The outcomes of the regression analysis are laid out in Table 2, elucidating the interconnectedness among cancer incidences, behaviors, air pollution, and the built environment's land use composition. In a counterintuitive turn, the findings defy initial expectations, showcasing that the influence of the built environment on cancer incidences pales in comparison to the impact of air pollution on such occurrences.

Remarkably, the study's revelations unveil an unexpected narrative. Contrary to the assumption that greater prevalence of green spaces would correspondingly yield reduced cancer incidences defies validation, with no demonstrable impact on cancer rates across prostate and breast cancer. Nevertheless, the intricate relationship between land use and cancer incidences manifests its complexities, particularly in the context of industrial areas. Specifically, residential and commercial areas exhibit a discernible influence on hepatocellular cancer incidences. Notably, regions characterized by higher residential areas and commercial areas appear to be non-associated with both cancers. Commercial zones often house entertainment establishments such as bars, restaurants, and liquor vendors, potentially exposing individuals to substances detrimental to health. However, in the urban context, there is no significance. Industrial areas seem to have a slight positive association with breast cancer but a negative association with prostate cancer. Consequently, the nuances of land use underscore the need for tailored approaches rather than generalized assumptions—land use policies aimed at curbing cancer incidences should be intricately informed by the distinctive attributes of residential and commercial zones.

Therefore, land use policies for reducing cancer incidences need to be established by focusing on exclusive characteristics of residential and commercial areas instead of focusing on existing general perceptions that industrial areas increase cancer incidences and green areas decrease cancer incidences.

Significant statistical outcomes emerged across all cancer incidences concerning each of the air pollutants under scrutiny. Notably, a distinct correlation was unveiled between elevated NO_2 concentrations and heightened breast and prostate cancer incidences, underscoring the importance of delving deeper into the origins of NO_2 and formulating pertinent policies and interventions. This imperative extends beyond the medical sphere, necessitating robust research efforts within the environmental domain. CO's abundance, however, decreased breast cancer and an abundance of SO_2 decreased prostate cancer. This nuanced array of findings accentuates the variability in the impact of air pollutants across distinct cancer types.

Distinct health risk behaviors exhibited diverse associations with the two cancer types under examination. Notably, the act of smoking exhibited an inverse correlation with prostate cancer incidence, implying a mitigating effect on its occurrence. Intriguingly, a heightened prevalence of alcohol consumption within specific urban regions corresponded to elevated incidences of both breast and prostate cancer. This variance suggests that the underlying sources and contributors of air pollutants and behaviors differ based on the specific type of pollutant being considered. Consequently, a comprehensive exploration into the origins of each air pollutant and behavior assumes paramount importance in the realm of environmental research. In essence, the study underscores the need for a multifaceted and comprehensive approach to curbing cancer incidences, one that transcends the traditional boundaries of medical intervention.

Table 2. Result of Regression Analysis

	Breast cancer			**Prostate cancer**		
	Coef.	**t-value**	**Sig.**	**Coef.**	**t-value**	**Sig.**
Constant	11.861^{**}	3.568	0.000	10.001^{**}	4.832	0.000
Residential area	0.042	0.908	0.365	-0.013	-0.458	0.647
Commercial area	0.175	0.722	0.471	0.043	0.285	0.776
Industrial area	0.064^{*}	2.132	0.034	-0.040^{*}	-2.143	0.033
Green area	0.002	0.511	0.610	0.004	1.614	0.108
CO	-9.642^{**}	-3.342	0.001	1.966	1.093	0.276
NO_2	371.86^{**}	7.552	0.000	120.17^{**}	3.912	0.000
PM_{10}	-0.007	-0.175	0.861	-0.020	-0.791	0.430
SO_2	-71.607	-0.318	0.360	-432.10^{**}	-3.079	0.002

Smoking	-0.141	-1.584	0.115	-0.218**	-3.915	0.000
Drinking	0.252**	4.731	0.000	0.083*	2.509	0.013
Obesity	-0.129	-1.634	0.104	0.045	0.916	0.360
N		246			246	
R-Squared		0.584			0.288	
Adjusted R-Squared		0.564			0.255	

** $p < 0.01$ * $p < 0.05$

Conclusion

Inherent to the human condition, susceptibility to illnesses and ailments has been an enduring aspect. Thereby, the enhancement of human well-being and the cultivation of a life marked by prosperity and contentment remain paramount pursuits. Yet, despite concerted endeavors, cancer perseveres as the leading cause of mortality in Korea, imposing a grave toll on human health and the overall quality of life. Globally, nations have marshaled diverse initiatives to forestall cancer and mitigate its incidence. Korea, in particular, has ushered in a series of policies and interventions aimed at cancer prevention, necessitating an ongoing exploration into effective management strategies across a spectrum of disciplines. This study navigates the spatial dimension intrinsic to cancer incidences, unveiling geographical nuances in the concentration of malignancies. By harnessing Geographic Information System (GIS) technology, this investigation probes into the spatial distribution of diverse cancer types prevalent in Korea between 2009 and 2013. Through meticulous analysis, the interplay between cancer incidences, the built environment, behaviors, and air pollutants emerges into focus. Noteworthy findings are as follows: Foremost, a distinct clustering of cancer incidence rates within specific regions manifests, with the regional variability intricately tied to the specific type of cancer under scrutiny. Simultaneously, concentrations of air pollutants exhibit regional disparities, displaying elevated levels in select areas. It becomes evident that air pollution diversifies spatially and regionally across different types of pollutants. This revelation underscores the exigency of calibrating cancer prevention strategies to the unique spatial and regional characteristics inherent to different locales.

Moreover, the study underscores the imperative of interdisciplinary synergy in the realm of cancer prevention. The purview of research must extend beyond the confines of the medical realm, encompassing public health, urban planning, and the environmental domain. The intricate dynamics among the built environment, behaviors, air pollution, and cancer incidences necessitate a holistic approach, woven from various disciplines' insights and expertise. Furthermore, the study posits air pollution and behaviors' role as a mediating agent in the nexus between the built environment and cancer incidences. Rather than a direct influence of the built environment on cancer rates, it emerges that air pollution operates as an intermediary player. This underscores the urgency of future research to disentangle the causal relationship between the built environment and air pollution, pivotal in mitigating cancer incidences attributed to air pollution.

The preeminence of nitrogen dioxide (NO_2) assumes prominence within the purview of air pollutants, emerging as a potent influencer across all cancer types. Emissions stemming from vehicular combustion and industrial activities constitute primary sources of NO_2. The study advocates for robust policy measures, such as incentives for electric vehicles and localized strategies like controlled burning practices, that holistically target the reduction of NO_2 emissions.

It is imperative to acknowledge the research's limitations. The omission of individual behavioral characteristics, with potential substantial influence on cancer incidences, represents a constraint. The adjusted R-squared values, ranging from 0.255 to 0.564, underscore the multivariable nature of cancer causation. This study cannot account for the entirety of cancer determinants, as myriad factors contribute to diagnosis occurrences. Data constraints, spanning the years 2009 to 2013, underscore the necessity for more recent and comprehensive datasets. Despite this, the study's conclusions, rooted in the intrinsic characteristics of air pollutants and the built environment, hold strategic value for local government policymaking.

Ultimately, this study's merit lies in its holistic exploration of the intricate interrelation between cancer incidences, the built environment, and air pollutants within a unified framework. This contribution not only guides policymakers but also furnishes urban planners with insights to inform judicious decisions for effective cancer prevention.

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