International Journal of Innovative Research and Scientific Studies, 8(2) 2025, pages: 2033-2046

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Unraveling the nexus: Socioeconomic and environmental determinants of chronic diseases and health challenges in Saudi Arabia

Sania Khan

Department of Human Resource Management, College of Business Administration, Prince Sattam Bin Abdulaziz University, Al Kharj 11942, Saudi Arabia

(*Email: sa.khan@psau.edu.sa*)

Abstract

Saudi Arabia is facing substantial public health challenges, especially in its urban areas, where chronic diseases like diabetes, cardiovascular diseases, and obesity are becoming more prevalent. This research investigates the intricate relationships between socioeconomic and environmental factors that contribute to these health issues and influence the evolution of health policies in the country. Data were collected from 348 urban Saudi citizens to analyze the impact of these factors on the rising rates of chronic diseases. Using quantitative analysis with SPSS and structural equation modeling (AMOS), the research aimed to identify the key drivers of health disparities and evaluate how these factors are currently addressed in public health policy. The study identified climate change and extreme weather, as well as a lack of greenery, as key predictors of chronic disease prevalence, followed by hereditary and genetic factors. Enhancing health education, promoting cultural and social norm shifts, and developing sustainable urban infrastructure could significantly contribute to reducing chronic diseases. Furthermore, the study assessed the effectiveness of existing health policies and provided recommendations for sustainable and integrated strategies to reduce health risks. The findings offer crucial insights for developing more equitable health systems, ultimately improving health outcomes for diverse populations across Saudi Arabia. This supports the enhancement of healthcare quality in line with Saudi Vision 2030 and aligns with Sustainable Development Goal 3 (SDG 3).

Keywords: Chronic diseases, Health challenges, Non-communicable diseases (NCDs), Saudi public health, Sustainable Development Goal 3 (SDG 3), Socioeconomic factors, Environmental issues.

DOI: 10.53894/ijirss.v8i2.5594
Funding: The authors extend their appreciation to Prince Sattam Bin Abdulaziz University for funding this research work through the project number (PSAU/2024/02/31703).
History: Received: 27 January 2025/**Revised:** 12 March 2025/**Accepted:** 18 March 2025/**Published:** 21 March 2025

Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.
Transparency: The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Institutional Review Board Statement: Not applicable.
Publisher: Innovative Research Publishing

1. Introduction

Modernization, lifestyle changes, dietary shifts, rapid population shifts, environmental pollution, economic changes, demographic changes, and widespread urbanization have all coincided with Saudi Arabia's enormous economic growth in recent decades. According to Alshaikh, et al. [1], Saudi Arabia faces the risk of a rise in the prevalence of lifestyle-related diseases despite its economic success, much like many other nations with high economic standards. Also, Katzmarzyk, et al. [2] argued that predominantly, the sedentary lifestyle raises the risk of non-communicable diseases and early mortality. Urban centers, as hubs of population growth and economic activity, are disproportionately affected. Significant public health issues have also arisen as a result of these developments, most notably the rising incidence of chronic conditions like diabetes, heart disease, and respiratory disorders. Understanding and resolving the multifaceted determinants that contribute to these health issues has become a top priority for public health authorities and urban planners as the country continues on its path of urban growth. Even though the burden of chronic diseases has been shown in previous studies, little is known about how socioeconomic, environmental, and healthcare dynamics in Saudi Arabia interact with specific factors of urbanization. This disparity restricts the capacity to create efficient, situation-specific solutions to address the problem.

Most research studies consider chronic illnesses separately, emphasizing either specific environmental influences or biological elements. Only a few studies take an integrated, holistic approach that accounts for how community behavior, healthcare infrastructure, and urban architecture interact. This study seeks to address these gaps by exploring chronic disease determinants in a comprehensive, context-specific manner. Through the integration of multidisciplinary viewpoints, this study makes a unique contribution to the improvement of chronic illness and health policy in urban Saudi Arabia. By bridging the gap between urban planning and public health, it proposes innovative solutions that are both sustainable and culturally relevant. Additionally, the study advances knowledge on chronic disease prevention in Middle Eastern contexts, contributing to global public health literature. The findings will inform policymakers, urban planners, and healthcare professionals in Saudi Arabia, providing a roadmap for developing healthier urban environments.

A thorough examination of existing and proposed health-related policies and initiatives designed to achieve the Saudi Vision 2030 targets can enhance policymaking processes and decision-making. This study primarily aims to investigate the relationship among the socioeconomic and environmental factors that contribute to chronic diseases and health challenges and highlights critical areas for shaping health policies and enhancing innovative strategies to encourage a healthy lifestyle. The study recommends highlighting how technology is revolutionizing healthcare, including the application of data-driven healthcare solutions, telemedicine, and health monitoring applications to increase accessibility and effectiveness. It emphasizes how important it is for the government, healthcare providers, and the community to work together across multiple sectors in order to address the escalating root causes of chronic diseases, support early detection, and encourage preventative measures. Through an analysis of the achievements and obstacles of public health reform in Saudi Arabia's cities, this research presents practical suggestions for improving health outcomes and increasing the country's healthy life expectancy. Achieving the country's Vision 2030 objectives and addressing chronic diseases in Saudi Arabia's urban areas are both vital health imperatives.

2. Theoretical Background and Hypotheses Formulation

2.1. Social Factors

2.1.1. Education and Health Literacy

According to Tang [3] education and health literacy are critical factors in managing chronic diseases and overcoming health challenges. Individuals with lower education levels often face difficulties understanding medical information, increasing the risk of medication errors and hospital admissions. Research suggests an inverse relationship between education and the prevalence of chronic diseases and health challenges (PCDHC), as higher educational attainment serves as a protective factor against these conditions [4]. Improved education enhances health outcomes by fostering better literacy, expanding job opportunities, and promoting healthier behaviors. Conversely, limited access to quality education constrains career prospects and socioeconomic mobility, ultimately contributing to poorer long-term health outcomes [5]. Therefore, it is hypothesized:

H_{1}: Education and health literacy have a negative relationship with the prevalence of chronic diseases and health challenges.

2.1.2. Urbanization and Lifestyle Changes

Neighborhood environments play a crucial role in healthcare access, with marginalized communities often facing limited healthcare facilities and transportation barriers, worsening health disparities [3]. According to Alhejely, et al. [6] in Saudi Arabia, rapid urbanization has led to significant lifestyle changes, particularly in cities such as Riyadh and Jeddah. Increased consumption of high-calorie, processed foods and sedentary behavior contribute to the rising prevalence of obesity and related chronic diseases. Physical inactivity, a major risk factor for non-communicable diseases (NCDs), remains a significant public health concern, with 94.9% of Saudi adults reporting low levels of physical activity Mahmood, et al. [7]. Research indicates that perceived accessibility to recreational facilities mediates the relationship between the actual availability of such facilities and physical activity levels, emphasizing the role of urban planning in promoting exercise Zhang, et al. [8]. The research study of Andrade, et al. [9] observed that access to free or low-cost recreational facilities has been shown to increase physical activity, with individuals 42% more likely to meet the American Heart Association's exercise recommendations. Notably, regional disparities in chronic disease prevalence are evident in Saudi Arabia, with higher rates observed in Alzahrani, et al. [10].

Sleep disorders, particularly chronic insomnia, further lead to these health challenges. Prevalence rates vary across studies, with chronic insomnia disorder (CID) affecting 5.5% to 6.7% of adults in Europe, while one study reported a significantly higher prevalence of 23.2%, with higher rates in females (25.2%) than males (21.1%) [11, 12]. The studies also stated that sleep deprivation is strongly associated with chronic conditions, including cardiovascular diseases (e.g., hypertension, myocardial infarction), metabolic disorders (e.g., type 2 diabetes, obesity), and mental health issues (e.g., depression, anxiety) [13, 14]. Prolonged sleep deprivation heightens stress responses, increases arterial pressure, and contributes to hypertension and other cardiovascular diseases [15]. Individuals with chronic insomnia have a 31% higher risk of developing cardiovascular diseases [16]. Additionally, sleep disturbances such as obstructive sleep apnea are linked to heightened sympathetic activity and systemic inflammation, further elevating hypertension and cardiovascular risks [17]. According to Chmura, et al. [18] and Souza, et al. [19] from a metabolic perspective, inadequate sleep impairs insulin sensitivity, thereby increasing the risk of type 2 diabetes by disrupting glucose metabolism. Short sleep duration has also been associated with insulin resistance, underscoring the importance of proper sleep hygiene for metabolic health [20]. Therefore, it is hypothesized:

$H_{2:}$ Urbanization and lifestyle changes have a positive relationship with the prevalence of chronic diseases and health challenges.

2.1.3. Cultural and Social Norms

Tobacco use remains a significant contributor to chronic respiratory and cardiovascular diseases in Saudi Arabia, with smoking being a major risk factor for conditions such as chronic obstructive lung disease (COLD) and cardiovascular disease (CVD). The prevalence of smoking is estimated at 28.05%, with 22.7% of men actively smoking [21]. Additionally, second-hand smoke exposure affects 67.3% of non-smokers, leading to respiratory symptoms and increasing their risk of chronic illnesses [22]. Effective public health strategies, including tobacco control measures, targeted health campaigns, and multisectoral collaborations, are essential in reducing tobacco use and related health burdens [22]. Furthermore, implementing cessation programs and improving access to treatment could significantly lower tobacco consumption and the prevalence of chronic diseases [23, 24].

Physical inactivity and sedentary behavior (SB) further worsen chronic disease risks in Saudi Arabia. A scientific review found that 80% to 90% of younger individuals fail to meet the recommended 60 minutes of daily moderate-to-vigorous physical activity (PA), while 50% to 80% engage in over two hours of screen time per day Evenson, et al. [25]. Among adults, 50% to 95% report insufficient physical activity, with 50% engaging in more than five hours of sedentary behavior daily. Regional disparities indicate that the northern and central regions have the highest inactivity rates, while individuals in the southern region are more physically active Al-Zalabani, et al. [26]. These trends highlight the urgent need for national PA promotion programs, workplace wellness initiatives, and urban planning strategies that encourage active lifestyles.

Social connections also play a critical role in shaping health outcomes, particularly in relation to chronic diseases. Strong social networks provide access to health resources and reinforce positive behaviors, mitigating the effects of socioeconomic disadvantages. Conversely, weak social ties contribute to isolation, increasing the risks of mental health disorders and mortality McCoy, et al. [27] and Venkat Raghav [5]. Supportive networks offering emotional, financial, and resource assistance can enhance resilience against chronic illnesses and improve overall well-being. Therefore, it is hypothesized:

$H_{3:}$ A strong cultural and social norm will have a negative relationship with the prevalence of chronic diseases and health challenges.

2.1.4. Hereditary and Genetical Factors

In Saudi Arabia, consanguineous marriages significantly contribute to the high rates of hereditary diseases, especially autosomal recessive disorders, which in turn increase the prevalence of chronic conditions such as diabetes. Additionally, lifestyle factors aggravate these health challenges Albanghali [28]; Alharbi, et al. [29], and Bakry, et al. [30]. Hence, it is assumed that the combined impact of consanguineous marriages and lifestyle factors contributes to the rising burden of chronic diseases in Saudi Arabia, necessitating targeted health interventions and policy changes to address these associated risk factors. Therefore, it is hypothesized:

$H_{4:}$ Hereditary and genetic factors will have a positive relationship with the prevalence of chronic diseases and health challenges.

2.2. Economic Factors

2.2.1. Income Inequalities

Socioeconomic status (SES) is a crucial determinant of healthcare access and lifestyle choices, significantly shaping overall health outcomes. Factors such as income, education, and social support influence the ability to obtain quality healthcare and engage in healthy behaviors, thereby contributing to disparities in health outcomes Al-Khatib [31]; McCoy, et al. [27]; Venkat Raghav [5] and Tang [3]. Higher-income levels are generally linked to improved health outcomes, while lower income is associated with an increased risk of chronic diseases and mental health issues due to restricted access to healthcare services [5]. Moreover, financial barriers including inadequate insurance and high healthcare costs further limit access for low-income populations Al-Hanawi and Keetile [32] and Tang [3].

Based on these observations, the research hypothesis is that lower socioeconomic status is associated with a higher prevalence of chronic diseases and related health challenges, primarily due to limited access to healthcare and significant financial obstacles. Therefore, it is hypothesized:

$H_{5:}$ Income inequalities will have a positive relationship with the prevalence of chronic diseases and health challenges.

2.2.2. Limited Healthcare Access & High Cost

Regional variations in infrastructure and socioeconomic factors significantly impact healthcare access for chronic disease patients, particularly those with diabetes and hypertension, in Saudi Arabia. Urban centers like Riyadh offer more extensive healthcare coverage, whereas rural regions often contend with limited access to specialized care and extended travel distances, which negatively affect disease management [33, 34]. Although some studies indicate that rural residents report fewer unmet healthcare needs, persistent service inequities result in uneven care, delayed diagnoses, and inadequate follow-up, further deteriorating health outcomes [35-38].

Based on these observations, one research hypothesis is that regional disparities in healthcare infrastructure and socioeconomic status contribute to poorer management and outcomes of chronic diseases in rural Saudi Arabia compared to urban areas. Therefore, it is hypothesized:

$H_{6:}$ Limited healthcare access and high cost will have a positive relationship with the prevalence of chronic diseases and health challenges.

2.2.3. Unemployment and Occupational Health Risk

Low-income populations encounter a range of financial, physical, and psychological barriers that often delay care and lead to poorer health outcomes, including a growing mistrust of healthcare systems (Murata and Kondo [39]). Conversely, employment has been shown to enhance overall health, whereas unemployment and job insecurity tend to increase stress, limit healthcare access, and contribute to a cycle of deteriorating health (Venkat Raghav [5]). Building on these observations, it is hypothesized that individuals with chronic diseases within low-income groups are at an increased risk for adverse health outcomes due to the combined effects of socioeconomic challenges and restricted access to timely and effective healthcare. Therefore, it is hypothesized:

$H_{7:}$ Unemployment and occupational health risk will have a positive relationship with the prevalence of chronic diseases and health challenges.

2.3. Environmental Factors

Saudi Arabia's extreme heat and arid climate significantly impact health, particularly in relation to diabetes and hypertension, by worsening issues such as obesity and physical inactivity Al-Sumaih, et al. [40].

2.3.1. Air Pollution

Air pollution significantly contributes to the burden of noncommunicable diseases, accounting for an estimated 9 million deaths globally due to environmental pollution with ambient air pollution alone responsible for 4.2 million deaths Rajagopalan, et al. [41]. Vulnerable populations are at an increased risk due to higher exposure levels compounded by inadequate sanitation Vidal, et al. [42]. Moreover, exposure to particulate matter specifically PM2.5 and ultrafine particles has been linked to increased cardiovascular risk. This occurs through mechanisms such as oxidative stress, inflammation, atherosclerosis, and myocardial injury, ultimately leading to conditions like heart disease, stroke, and arrhythmias Abdul-Rahman, et al. [43]. Based on these observations, it is assumed that chronic exposure to ambient particulate matter is a key determinant in the development and aggravation of chronic cardiovascular diseases, particularly among populations with limited access to adequate sanitation, through pathways involving sustained oxidative stress and systemic inflammation. Therefore, it is hypothesized:

$H_{8:}$ Air pollution will have a positive relationship with the prevalence of chronic diseases and health challenges.

2.3.2. Urban Design and Infrastructure

Recent years have seen rapid advancements in urban design and infrastructure in Saudi Arabian cities, driven by modernization efforts and the Vision 2030 initiatives of Alqahtany and Aravindakshan [44]. Major cities such as Riyadh, Jeddah, and Dammam have received substantial investments in transportation networks, mixed-use developments, and smart city technologies aimed at enhancing livability and urban mobility in Almatar [45]. However, challenges persist; urban sprawl and heavy car dependency continue to worsen congestion and pollution while limiting open spaces necessary for recreational activities, walking, and other forms of physical exercise [46]. Initiatives like the Riyadh Green program have begun addressing these issues by enhancing walkability and public spaces, with the broader goal of improving sustainability and quality of life. Therefore, it is hypothesized:

$H_{9:}$ Urban design and improved infrastructure will have a negative relationship with the prevalence of chronic diseases and health challenges.

2.3.3. Climate Change and Extreme Weather

Extreme heat in desert regions presents significant obstacles for managing chronic conditions like hypertension and diabetes. Elevated temperatures can increase dehydration, impair thermoregulation, and complicate medication adherence Moreira [47]. Individuals with these conditions often struggle with effective heat dissipation, leading to heightened cardiovascular risks and increased mortality, particularly among vulnerable populations Kadi [48]. Moreover, extreme heat can intensify medication side effects, reduce drug stability, and discourage consistent use, further challenging chronic disease management Brunk [49] and Kadi [48]. The inability to engage in outdoor activities due to excessive heat also promotes sedentary lifestyles, contributing to obesity, insulin resistance, and high blood pressure, which further aggravates the risks associated with diabetes and hypertension Al-Sumaih, et al. [40]. Therefore, it is hypothesized:

$H_{10:}$ Climate change and extreme weather will have a positive relationship with the prevalence of chronic diseases and health challenges.

2.3.4. Lack of Greenery

The scarcity of green spaces in Saudi Arabia is linked to an increased risk of chronic diseases such as cardiovascular disease, obesity, and diabetes. Limited greenery reduces opportunities for physical activity and heightens exposure to air pollution and heat stress, thereby worsening these health challenges Al-Hanawi and Keetile [32]. Moreover, communities with restricted access to green areas often exhibit higher rates of these conditions Vidal, et al. [42]. Consequently, integrating more greenery into urban planning may mitigate these risks. Therefore, it is hypothesized:

$H_{11:}$ Lack of greenery will have a positive relationship with the prevalence of chronic diseases and health challenges.

This research aims to identify the primary socioeconomic and environmental determinants of chronic diseases in Saudi Arabia's urban centers. Enhanced understanding of the role of community engagement and cultural factors in the prevalence of chronic diseases. The study attempts to develop evidence-based recommendations for urban planning, public health policies, and healthcare strategies to mitigate chronic disease risks. Based on the theoretical perspectives, the hypothesized model of socioeconomic and environmental constructs prevalent in chronic diseases and health challenges is presented as shown in Figure 1.

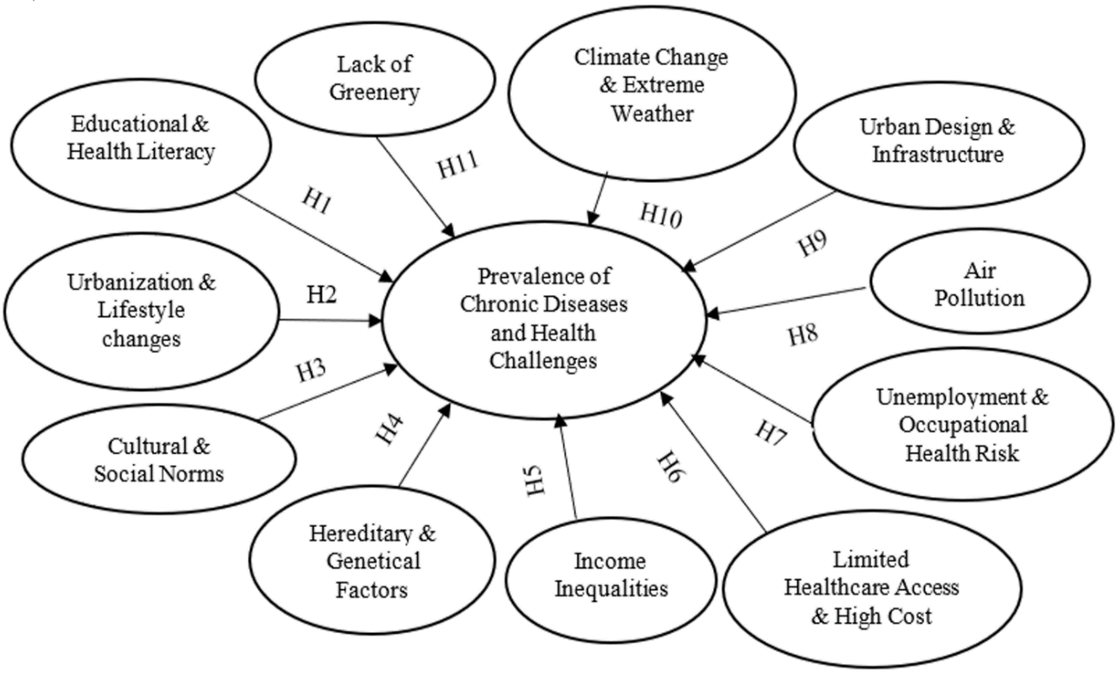

Figure 1.
Hypothesized model

The constructs that are identified under socioeconomic and environmental dimensions are presented in Table 1.

Table 1.
Category and Constructs of Socioeconomic and Environment Prevalence to Chronic Diseases

S. No	Category	Constructs	References
1	Social	Education & Health Literacy (EHL)	[3-5]
		Urbanization & Lifestyle Changes (ULC)	[3, 6-8, 10-20]
		Cultural & Social Norms (CSN)	[21-27]
		Hereditary & Genetical Factors (HGF)	[28-30, 50]
2	Economic	Income Inequalities (IIE)	[3, 5, 27, 31, 32]
		Limited Healthcare Access & High Cost (LHAHC)	[12, 33-38]
		Unemployment & Occupational Health Risk (UEOHR)	[5, 39]
3	Environment	Air Pollution (AP)	[42, 43]
		Urban Design & Infrastructure (UDI)	[44]
		Climate Change & Extreme Weather (CCEW)	[40, 47-49]
		Lack of Greenery (LG)	[32, 42]

3. Methodology

3.1. Data Collection

A structured survey questionnaire was employed in a cross-sectional quantitative study and gathered data from 348 patients diagnosed with chronic diseases. The data collection took place between November 2024 and January 2025 across three major urban cities in Saudi Arabia: Riyadh, Dammam, and Jeddah. The survey participants represented diverse socioeconomic backgrounds and environmental conditions, ensuring a comprehensive understanding of the factors influencing chronic disease prevalence. Before initiating data collection, the study's objectives were clearly communicated to the participants.

Additionally, the measurement procedures were thoroughly explained to ensure their full understanding. Once the participants comprehended both the purpose and methodology of the study, they were given the choice to voluntarily participate in the survey. Those who agreed to take part were requested to complete a questionnaire designed to capture their socioeconomic and environmental characteristics.

3.2. Measurement Items of Socioeconomic and Environmental Predictors

Many variables can be examined to determine socioeconomic status and environmental conditions of the individuals. However, in this study, eleven parameters under socioeconomic and environmental conditions were considered. The measurement items of the study were developed specific for this study based on the vital and repeated dimensions mentioned in the literature. Under social aspect, four constructs namely education and health literacy [3-5] urbanization and lifestyle changes [3, 6-8, 10-20] cultural and social norms [21-27] and hereditary and genetical factors Albanghali [28] Alharbi, et al. [29] and Alslamah [50] were identified as potential predictors. In the economic construct, income inequalities Al-Khatib [31]; McCoy, et al. [27]; Venkat Raghav [5]; Tang [3] and Al-Hanawi and Keetile [32]; limited healthcare access and high cost [12, 33-36, 38].

Unemployment and occupational health risk Murata and Kondo [39] Venkat Raghav [5] were significant predictors; and air pollution Vidal, et al. [42] and Abdul-Rahman, et al. [43]; urban design and infrastructure Alqahtany and Aravindakshan [44] climate change and extreme weather [40, 47-49] Lack of greenery Al-Hanawi and Keetile [32] andVidal, et al. [42] are considered as potential predictors under environment construct.

3.3. Research Methods

Regression analysis, confirmatory factor analysis (CFA), and structural equation modeling (SEM) were employed in this study to identify the key pathways among the variables included in the model.

3.4. Structural Equation Modeling Method

Structural equation modeling combines factor analysis and regression analysis to examine relationships between latent constructs and observable variables, as well as their interconnections. SEM integrates both exploratory and confirmatory analysis, making it a preferred technique for researchers due to its ability to estimate multiple interrelated dependencies within a single analysis. Overall, SEM serves as a powerful tool for scholars to explore complex study designs, validate theories, and assess measurement validity. Its numerous advantages make it widely adopted across various fields, including social sciences, psychology, business, and education.

3.5. Confirmatory Factor Analysis

In behavioral sciences, medical education, and social sciences, CFA is used to explore the underlying structure of complex constructs. It allows researchers to evaluate the validity of measurement constructs, ensuring they measure what they intend to, and assess the reliability of the scale.

3.6. Regression Analysis

Regression analysis assumes that dependency is reflected through the mean, also known as the regression function, which defines the relationship between the response variable's mean and the predictors. Various metrics can be used to assess model fit, such as R-squared, which quantifies the proportion of the total variance in the dependent variable explained by the independent variable.

4. Data Analysis and Results

Also, the demographic data analysis presented in Table 2 revealed that males, comprising 62.07% of the population, exhibit a higher susceptibility to chronic diseases compared to females, particularly within the age group of 46 to 60 years. In terms of educational qualifications, the majority hold either a master's degree (36.78%) or a bachelor's degree (33.33%), and 55.17% are employed.

Additionally, a significant portion of the urban population is affected by metabolic and endocrine disorders (24.71%), followed by cardiovascular diseases (14.65%) and cancer (13.22%).

Table 2.
Demographic characteristics of respondents.

Description	Item	Frequency	Percent (%)
1. Gender			
	Male	216	62.07
	Female	132	37.93
2. Age			
	18-30	38	10.92
	31-45	96	27.59
	46-60	164	47.13
	61 and above	50	14.37
3. Education			
	Schooling	44	12.64
	Vocational	32	9.2
	Bachelor	116	33.33
	Master	128	36.78
	Ph.D.	28	8.05
4. Employment Status			
	Student	18	5.17
	Employed	192	55.17
	Unemployed	88	25.29
	Retired	50	14.37
5. Suffering Disease			
	Cardiovascular	51	14.65
	Metabolic & Endocrine	86	24.71
	Respiratory	38	10.92
	Cancer	46	13.22
	Neurological Disorder	24	6.90
	Musculoskeletal Disorder	22	6.32
	Digestive Disorder	21	6.03
	Kidney Disease	19	5.46
	Mental Health Disorder	26	7.47
	Autoimmune Disorder	15	4.31

4.1. Descriptive Statistics

The mean values ranged from 3.55 to 4.09, while the standard deviation (SD) values varied between 0.602 and 0.766. As shown in Table 3, the correlation values among all eleven latent constructs are significant. Table 4 presents the exploratory and confirmatory analysis results, along with the internal consistency of the variables. Additionally, Table 5 further defines the discriminant validity (DV) of each construct, with the Average Variance Extracted (AVE) values exceeding the inter-correlation thresholds, as supported by previous studies by Hussain, et al. [51] and Jameel, et al. [52].

Table 3.
Correlation analysis

S. No	Factors	1	2	3	4	5	6	7	8	9	10	11
1	EHL	-										
2	ULC	0.443**	-									
3	CSN	0.213**	0.343**	-								
4	HGF	0.235**	0.441**	0.375**	-							
5	IIE	-0.235**	-0.326**	-0.268*	-0.235*	-						
6	LHAHC	-0.235**	-0.237*	-0.153*	-0.138*	-0.582**	-					
7	UEOHR	-0.431**	-0.329**	-0.189*	-0.132*	-0.498**	-0.546**	-				
8	AP	-0.487**	-0.483**	-0.236*	-0.210*	-0.243*	-0.312*	-0.133*	-			
9	UDI	0.363**	-0.437**	0.436**	-0.138*	-0.184*	-0.447**	-0.248*	-0.535**	-		
10	CCEW	0.136*	-0.382*	0.326*	-0.135*	-0.213*	-0.267*	-0.112*	-0.528**	-0.439**	-	
11	LG	0.286*	-0.536**	-0.113*	-0.183*	-0.144*	-0.141*	-0.183*	-0.683***	-0.321*	-0.484**	-

Note: Significance of Correlations: ***p < 0.001; ** p < 0.01; * p < 0.05

Table 4.
CFA measurement model

Latent Factor	Items	EFA	CFA	α
EQ	EL1	0.737	0.694	0.949
	EL2	0.78	0.781	
ULS	ULS1	0.841	0.891	0.822
	ULS2	0.865	0.938	
	ULS3	0.833	0.752	
CSN	CSN1	0.823	0.886	0.842
	CSN2	0.835	0.714	
HGF	HGF1	0.737	0.756	0.914
	HGF2	0.795	0.947	
	HGF3	0.78	0.638	
II	II1	0.731	0.743	0.868
	II2	0.735	0.599	
	II3	0.789	0.809	
LHAHC	LHAHC1	0.736	0.769	0.935
	LHAHC2	0.844	0.867	
UOHR	UOHR1	0.813	0.863	0.875
	UOHR2	0.843	0.835	
	UOHR3	0.809	0.892	
AP	AP1	0.753	0.746	0.813
	AP2	0.802	0.824	
UDI	UDI1	0.832	0.703	0.824
	UDI2	0.821	0.724	
	UDI3	0.842	0.822	
CCEW	CCEW1	0.775	0.745	0.841
	CCEW2	0.813	0.908	
	CCEW3	0.775	0.611	
LG	LG1	0.786	0.743	0.952
	LG2	0.868	0.753	
	LG3	0.834	0.785	

Table 5.
Analysis of validity and reliability.

Factors	CR	AVE	1	2	3	4	5	6	7	8	9	10	11
EHL	0.940	0.665	**0.815**										
ULC	0.895	0.624	0.438***	**0.789**									
CSN	0.933	0.677	0.432***	0.334***	**0.822**								
HGF	0.864	0.620	0.361***	0.472***	0.389***	**0.787**							
IIE	0.822	0.732	0.442**	0.634***	0.453**	0.535**	**0.855**						
LHAHC	0.932	0.725	0.485**	0.703***	0.523***	0.463**	0.463**	**0.851**					
UEOHR	0.934	0.872	0.532***	0.442**	0.623***	0.426**	0.425**	0.444**	**0.933**				
AP	0.832	0.759	0.463**	0.462**	0.372**	0.473**	0.327**	0.446**	0.374**	**0.871**			
UDI	0.842	0.783	0.661***	0.443**	0.456**	0.429**	0.356*	0.424**	0.462 **	0.634***	**0.884**		
CCEW	0.813	0.729	0.483**	0.438**	0.437**	0.343*	0.349*	0.353*	0.467**	0.563**	0.533**	**0.853**	
LG	0.942	0.863	0.561***	0.433**	0.457**	0.436**	0.347*	0.459**	0.532***	0.573**	0.366*	0.464**	**0.928**

Note: Significance of correlation: *** p<0.001; ** p<0.01; * p<0.05; CR: Composite Reliability; AVE: Average Variance Extracted; Bold values are the squared root of AVE showing discriminant validity

4.2. Confirmatory Factor Analysis

The logical model in the current study was evaluated using CFA. As mentioned by Jeong, et al. [53], the study examines the model by assessing discriminant validity, convergent validity (CV), and content validity. Establishing item validity is one of the most challenging aspects of measurement techniques Joshi, et al. [54] and Jameel, et al. [55]. Convergent validity measures the extent to which a construct is correlated with other items within the hypothesized model. Concurrent validity was determined by assessing average variance extracted (AVE), standardized factor loadings, reliability test values, and construct reliability (CR) Hussain, et al. [51]. Cronbach's alpha reliability is a widely used statistical method for evaluating item reliability Gefen, et al. [56] and Jameel, et al. [52] and indicates internal consistency among the items of a latent variable. Construct reliability (CR) assesses whether results are dependable and consistent. Additionally, the internal consistency of the model was confirmed by evaluating CR, DV, and CV for all factors to ensure greater validity of the research model and data (see Table 5).

As shown in Table 5, the CR values for each factor ranged from 0.813 to 0.942, exceeding the recommended threshold (CR > 0.7). Similarly, the AVE values for each construct ranged from 0.620 to 0.872, surpassing the minimum required benchmark of 0.50 [57].

4.3. Hypothesis Testing

The proposed research framework was empirically analyzed using SPSS and AMOS. Structural equation modeling was employed to test each hypothesis as illustrated in Figure 1. Additionally, multiple fit indices were used to validate the model, including the chi-square test (X^2), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Incremental Fit Index (IFI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA) Morgeson III, et al. [58]. For an acceptable model fit, the values of IFI, TLI, and CFI should exceed 0.90 Jöreskog and Sörbom [59], while RMSEA and SRMR should not exceed 0.08 McNeish [60]. Furthermore, the X^2/df value must be less than 3 for an adequate model fit Hussain, et al. [51]. The fit analysis is shown in Table 6.

Table 6.
Model fit statistics.

Fit indices	Model Value	Reference value
χ^2/df	2.182	<5.00
CFI	0.946	>0.90
IF	0.963	>0.90
TLI	0.926	>0.90
Standardized RMR	0.054	<0.05
RMSEA	0.052	<0.10

Hypotheses H1 to H11 were validated using regression weights (β) and t-tests, as presented in Table 6. H1 proposed a significant negative relationship between EHL and PCDHC, which was supported (β = -0.243, t = 8.204, p < 0.01). H2 suggested that ULC is significantly associated with PCDHC, and the results confirmed this relationship (β = 0.463, t = 9.652, p < 0.01). H3 anticipated a significant connection between CSN and PCDHC, and the findings supported this (β = -0.324, t = 9.837, p < 0.01). H4 examined the link between HGF and PCDHC, which was found to be significant (β = 0.633, t = 9.572, p < 0.001). H5 suggested that IIE positively influences PCDHC, and the results confirmed a significant relationship (β = 0.253, t = 8.322, p < 0.05). H6 established a positive and significant relationship between LHAHC and PCDHC (β = 0.423, t = 8.587, p < 0.01). H7 found that UEOHR is positively related to PCDHC (β = 0.342, t = 7.657, p < 0.01). H8 showed a strong positive relationship between AP and PCDHC (β = 0.673, t = 9.783, p < 0.001). H9 indicated a negative correlation between UDI and PCDHC (β = -0.167, t = 8.154, p < 0.05). H10 revealed that CCEW is positively associated with PCDHC (β = 0.763, t = 10.214, p < 0.001). H11 confirmed that LG has a positive relationship with PCDHC (β = 0.752, t = 9.772, p < 0.001). The hypothesis results are shown in Table 7.

Table 7.
Regression coefficients (β) for hypotheses testing.

Hypothesis	Path			β Estimate	SE	T
H1	EHL	→	PCDHC	-0.243	0.052	8.204**
H2	ULC	→	PCDHC	0.463	0.046	9.652**
H3	CSN	→	PCDHC	-0.324	0.042	9.837**
H4	HGF	→	PCDHC	0.633	0.036	9.572***
H5	IIE	→	PCDHC	0.253	0.068	8.322*
H6	LHAHC	→	PCDHC	0.423	0.042	8.587**
H7	UEOHR	→	PCDHC	0.342	0.037	7.657**
H8	AP	→	PCDHC	0.673	0.026	9.783***
H9	UDI	→	PCDHC	-0.167	0.035	8.154*
H10	CCEW	→	PCDHC	0.763	0.016	10.214***
H11	LG	→	PCDHC	0.752	0.018	9.772***

Note: *** p < 0.001; ** p<0.01; * p<0.05. SE: Standard error.

Furthermore, the study's findings are supported by t-statistic values, which exceed the 1.96 cutoff threshold, reinforcing the validity of the results of Kanwel, et al. [61]. Therefore, the data provides strong support for hypotheses H1 to H11.

5. Discussion

The findings of this study provide strong empirical evidence for the various factors influencing the prevalence of chronic diseases and health challenges. Each of the tested hypotheses was supported, indicating significant relationships between socioeconomic and environmental determinants with respect to health outcomes.

Education and health literacy have a significant negative relationship with the prevalence of chronic diseases and health challenges. This hypothesis was confirmed, suggesting that higher levels of education and health awareness contribute to better disease prevention and management. This aligns with existing literature indicating that individuals with better health literacy are more likely to engage in preventive health behaviors and seek timely medical intervention. Urbanization and lifestyle changes revealed a significant positive association with chronic disease prevalence. This finding supports previous studies by Mahmood, et al. [7]; Alzahrani, et al. [10], and Zeliger [14] that have linked rapid urbanization and lifestyle transitions, such as sedentary behavior and unhealthy diets, to increased risks of chronic conditions like obesity, diabetes, and cardiovascular diseases. The influence of cultural and social norms was also supported by the results. The negative relationship suggests that traditional health-supportive norms may serve as protective factors against chronic diseases, reinforcing the importance of community-based health promotion strategies. The impact of hereditary and genetic factors showed the strongest association with chronic disease prevalence. This result underscores the critical role of genetic predisposition in determining an individual's susceptibility to chronic conditions, highlighting the need for targeted genetic screening and personalized medical approaches.

The income inequalities confirmed a significant positive relationship with chronic disease prevalence. Economic disparities often limit access to healthcare, nutritious food, and preventive services, worsening health inequities. The impact of limited healthcare access and high costs, with results indicating a strong positive correlation. This finding highlights the importance of improving healthcare affordability and availability to mitigate the burden of chronic diseases, particularly in underserved communities, and supports the research findings of previous studies by Alfaqeeh, et al. [33] Kattan [34] and Hulen, et al. [38]. Unemployment and occupational health risks significantly contribute to chronic disease prevalence. This aligns with research indicating that job insecurity and workplace hazards increase stress levels and exposure to unhealthy environments, leading to adverse health outcomes. The findings are also consistent with Murata and Kondo [39] and Venkat Raghav [5].

It was observed that there is a strong positive association between air pollution and chronic disease prevalence. This is consistent with global evidence linking air pollution to respiratory and cardiovascular diseases, reinforcing the need for environmental regulations and pollution control measures. Urban design and infrastructure have a negative relationship with chronic disease prevalence. Well-planned urban environments with walkable spaces, recreational areas, and accessible healthcare facilities can promote healthier lifestyles and reduce disease risks. The study has confirmed a significant positive relationship between climate change, extreme weather events, and chronic disease prevalence. This finding emphasizes the increasing health risks posed by climate variability, including heat-related illnesses, vector-borne diseases, and food insecurity, and supports the previous studies by Moreira [47]. The study revealed that a lack of greenery is positively associated with chronic disease prevalence. Green spaces are essential for mental and physical well-being, reducing stress, encouraging physical activity, and improving air quality.

The findings of this study highlight the complex interplay of socioeconomic and environmental determinants in influencing chronic disease prevalence. Based on these insights, a multifaceted approach is recommended, incorporating policy-level interventions, community engagement, and healthcare system improvements.

The study recommends that early education on nutrition, exercise, and preventive healthcare can foster lifelong healthy habits. It suggests initiating workshops and campaigns to improve public awareness about disease prevention, early symptoms, and available healthcare services. Additionally, it advocates for the development of mobile health applications and online platforms to provide accessible health information, particularly for underserved populations. To promote a healthy urban lifestyle, it is essential to implement walkable city designs, bicycle lanes, and green spaces to encourage physical activity and counter sedentary lifestyles. The study also calls for the introduction of policies to limit unhealthy food marketing and subsidize healthier food options. Furthermore, it emphasizes the enforcement of policies that reduce work-related stress, promote flexible working hours, and integrate wellness programs in workplaces. Encouraging traditional health-supportive practices by implementing culturally appropriate interventions, such as herbal medicine and community-based physical activities, that align with scientific health recommendations is also recommended. Finally, it suggests developing treatment plans based on genetic predisposition and lifestyle factors to improve disease management.

Ensuring affordable healthcare for low-income populations through government-subsidized programs can also reduce health risks. It is recommended to enhance unemployment benefits, disability support, and job training programs to mitigate the health impact of economic instability. Strengthening policies to reduce hazardous exposures in work environments and incentivizing employers to provide mental health services, ergonomic workspaces, and preventive health screenings is essential. Enforcing stricter emission controls on industries and vehicular pollution is necessary. Promoting the expansion of tree planting initiatives and urban forestry is encouraged to improve air quality. Though cooling shelters and public advisories to prevent heat-related illnesses are commonly seen in Makkah and Madinah areas, it is recommended to establish such initiatives across other urban areas. Developing cities with accessible healthcare facilities, parks, and pollution-free transportation options is also a sustainable initiative. The government must implement policies to mandate a minimum percentage of green space in city planning and support local gardening initiatives that provide access to fresh produce and promote social cohesion.

6. Limitations

There are certain limitations in this research. Firstly, as the study is cross-sectional in nature, it would only provide a snapshot of the relationship between socioeconomic and environmental factors and chronic diseases, rather than establishing causality. The study may face challenges in obtaining comprehensive, reliable, and up-to-date data on socioeconomic and environmental factors, especially from rural or remote regions. Therefore, the findings may not be fully generalizable across all regions of Saudi Arabia due to cultural, geographic, or demographic differences. Additionally, the study may focus on specific cities or population subgroups that may not reflect the broader national context. There may be challenges in accurately measuring environmental and socioeconomic factors, such as the quality of air, water, or living conditions, which could influence chronic diseases but are difficult to quantify. The research might not fully capture the social and cultural determinants affecting health, such as traditional medicine use, social stigmas, or variations in health-seeking behaviors, which could skew the results. Overall health outcomes may be impacted by regional differences in public health policies, insurance coverage, and healthcare access, making it difficult to evaluate consistent effects.

7. Conclusion

The study investigated a holistic approach integrating socioeconomic and environmental factors to examine their influence on chronic disease prevalence. It provided a detailed understanding of the complex dynamics among the multifaceted aspects and their influence on each other. Consequently, it has deepened knowledge of the current urban lifestyle and other behavioral aspects. The findings revealed a significant relationship between the variables, supporting all the proposed hypotheses in the structural equation modeling analysis that were confirmed. The results made a significant impact by bridging the research gap between current practices and the proposed sustainable practices. Additionally, the study's outcome highlights the need for enhancing sustainable and integrated strategies to reduce health risks. The research suggests implementing sustainable policies that address both socioeconomic and environmental determinants to create healthier communities and reduce long-term healthcare burdens. Implementing these strategies also requires a coordinated effort among government, healthcare institutions, community organizations, and individuals to achieve lasting health improvements. By examining the socioeconomic and environmental factors contributing to chronic diseases, this study offers valuable insights for enhancing public health policies, supporting Saudi Vision 2030's objective of improving healthcare quality and accessibility, and aligning with Sustainable Development Goal 3 (SDG 3).

References

[1] M. K. Alshaikh, F. T. Filippidis, H. A. Al-Omar, S. Rawaf, A. Majeed, and A.-M. Salmasi, "The ticking time bomb in lifestyle-related diseases among women in the gulf cooperation council countries; review of systematic reviews," *BMC Public Health,* vol. 17, pp. 1-17, 2017.

[2] P. T. Katzmarzyk, C. Friedenreich, E. J. Shiroma, and I.-M. Lee, "Physical inactivity and non-communicable disease burden in low-income, middle-income and high-income countries," *British Journal of Sports Medicine,* vol. 56, no. 2, pp. 101-106, 2022. https://doi.org/10.1136/bjsports-2020-103640

[3] L. Tang, "The impact of inequality in socioeconomic status on healthcare services utilization," *Journal of Education, Humanities and Social Sciences,* vol. 28, 2024.

[4] Al-Hanawi, "Socioeconomic determinants and inequalities in the prevalence of non-communicable diseases in Saudi Arabia," *International Journal for Equity in Health,* vol. 20, pp. 1-13, 2021.

[5] P. S. Venkat Raghav, "The Role of Socioeconomic Factors in Shaping Health Outcomes among Vulnerable Populations.," *South Eastern European Journal of Public Health,* vol. XXV S1, pp. 1422–1432, 2024.

[6] M. M. M. Alhejely *et al.*, "Influence of lifestyle changes on cardiovascular diseases in Saudi Arabia: A systematic literature review," *Cureus,* vol. 15, no. 6, 2023.

[7] A. Mahmood, N. Elwakeel, A. S. Khaled, Q. Mehedi, P. Claudiu, and C. Gosselin, "Prevalence and Risk Factors of Obesity in Saudi Arabia," *International Journal of Clinical Inventions and Medical Sciences (IJCIMS),* vol. 6, no. 2, pp. 74-85, 2024.

[8] S. Zhang, L. Ran, X. Fan, Y. Zhang, and H. Guo, "Perceived built environment as a mediator linking objective built environment and leisure-time physical activity in Chinese cities," *Scientific Reports,* vol. 14, no. 1, p. 17091, 2024.

[9] L. Andrade *et al.*, "The associations between access to recreational facilities and adherence to the American heart association's physical activity guidelines in US adults," *Frontiers in Public Health,* vol. 9, p. 660624, 2021.

[10] M. S. Alzahrani, Y. S. Alharthi, J. K. Aljamal, A. A. Alarfaj, V. Vennu, and M. D. Noweir, "National and regional rates of chronic diseases and all-cause mortality in Saudi Arabia—Analysis of the 2018 household health survey data," *International Journal of Environmental Research and Public Health,* vol. 20, no. 7, p. 5254, 2023.

[11] S. L. Appleton, A. C. Reynolds, T. K. Gill, Y. A. Melaku, and R. J. Adams, "Insomnia prevalence varies with symptom criteria used with implications for epidemiological studies: role of anthropometrics, sleep habit, and comorbidities," *Nature and Science of Sleep,* pp. 775-790, 2022. https://doi.org/10.2147/nss.s359437

[12] F.-X. Chalet *et al.*, "Epidemiology and burden of chronic insomnia disorder in Europe: An analysis of the 2020 national health and wellness survey," *Journal of Medical Economics,* vol. 27, no. 1, pp. 1308-1319, 2024.

[13] D. A. Hansen, B. C. Satterfield, M. E. Layton, and H. P. Van Dongen, "Sleep deprivation and sleep-onset insomnia are associated with blunted physiological reactivity to stressors," *Military Medicine,* vol. 186, no. Supplement_1, pp. 246-252, 2021. https://doi.org/10.1093/milmed/usaa464

[14] H. I. Zeliger, "Sleep deprivation," *Oxidative Stress,* pp. 137-141, 2023.

[15] K. Whale and R. Gooberman Hill, "The importance of sleep for people with chronic pain: Current insights and evidence," *Journal of Bone and Mineral Research Plus,* vol. 6, no. 7, p. e10658, 2022. https://doi.org/10.1002/jbm4.10658/v1/decision1

[16] M. Aamir *et al.*, "Incidence of adverse cardiovascular events in patients with insomnia: A systematic review and meta-analysis of real-world data," *Journal of the American College of Cardiology,* vol. 81, no. 8_Supplement, pp. 1680-1680, 2023.

[17] J. Gmitrzuk *et al.*, "Effects of sleep and insomnia on cardiovascular disease-literature review," *Quality in Sport,* vol. 17, pp. 53050-53050, 2024. https://doi.org/10.12775/qs.2024.17.53050

[18] A. Chmura, K. Skowrońska, A. Karaś, P. Baciur, and F. Białas, "The influence of sleep disturbances on the development of insulin resistance-a literature review," *Journal of Education, Health and Sport,* vol. 12, no. 8, pp. 518-522, 2022.

[19] J. F. T. Souza, M. Monico-Neto, S. Tufik, and H. K. M. Antunes, "Sleep debt and insulin resistance: What's worse, sleep deprivation or sleep restriction?," *Sleep Science,* vol. 17, no. 03, pp. e272-e280, 2024.

[20] T. Singh *et al.*, "Does insufficient sleep increase the risk of developing insulin resistance: A systematic review," *Cureus,* vol. 14, no. 3, 2022.

[21] H. AlNujaidi, ALAnsary, N., AlShawan, D., AlSaif, A., Ali, U., Muhammad, M. H., Albagmi, F., Bah, S., Althumiri, N. A., & BinDhim, N., "Prevalence of smoking and its associated health effect among Saudis: A Nationwide study " 2023.

[22] M. Madkhali *et al.*, "Association between second-hand smoke exposure and respiratory symptoms among the general population of non-smoker adults in saudi arabia: A cross-sectional study," *Cureus,* vol. 15, no. 11, 2023.

[23] K. Aljerian *et al.*, "Prevalence of substance use among students in health colleges in Saudi Arabia: A cross-sectional study," *Cureus,* vol. 16, no. 10, 2024.

[24] M. Alrabah, I. Gamaleddin, and F. Allohidan, "International approaches to tobacco-use cessation programs and policy for adolescents and young adults in Saudi Arabia," *Current Addiction Reports,* vol. 5, pp. 65-71, 2018.

[25] K. R. Evenson *et al.*, "Scoping review of population-based physical activity and sedentary behavior in Saudi Arabia," *Journal of Physical Activity and Health,* vol. 20, no. 6, pp. 471-486, 2023. https://doi.org/10.1123/jpah.2022-0537

[26] A. H. Al-Zalabani, N. A. Al-Hamdan, and A. A. Saeed, "The prevalence of physical activity and its socioeconomic correlates in Kingdom of Saudi Arabia: A cross-sectional population-based national survey," *Journal of Taibah University Medical Sciences,* vol. 10, no. 2, pp. 208-215, 2015. https://doi.org/10.1016/j.jtumed.2014.11.001

[27] C. A. McCoy, E. Johnston, and C. Hogan, "The impact of socioeconomic status on health practices via health lifestyles: Results of qualitative interviews with Americans from diverse socioeconomic backgrounds," *Social Science & Medicine,* vol. 344, p. 116618, 2024.

[28] M. A. Albanghali, "Prevalence of consanguineous marriage among Saudi citizens of Albaha, a cross-sectional study," *International Journal of Environmental Research and Public Health,* vol. 20, no. 4, p. 3767, 2023.

[29] S. M. Alharbi *et al.*, "Common chronic conditions in pediatric primary care," *Int J Community Med Public Health,* vol. 9, p. 3911, 2022.

[30] H. Bakry, R. A. Alaiban, A. A. Alkhyyat, B. H. Alshamrani, R. N. Naitah, and F. Almoayad, "Predictors of consanguinity marriage decision in Saudi Arabia: a pilot study," in *Healthcare*, 2023, vol. 11, no. 13: MDPI, p. 1925.

[31] I. Al-Khatib, Mahmoud, A. E. D., & Ndiaye, M., "Access to healthcare—a prominent challenge in public health," *IgMin Research,* vol. 2, no. 7, pp. 276–289, 2024.

[32] M. K. Al-Hanawi and M. Keetile, "Socio-economic and demographic correlates of non-communicable disease risk factors among adults in Saudi Arabia," *Frontiers in Medicine,* vol. 8, p. 605912, 2021. https://doi.org/10.3389/fmed.2021.605912

[33] G. Alfaqeeh, E. J. Cook, G. Randhawa, and N. Ali, "Access and utilisation of primary health care services comparing urban and rural areas of Riyadh Providence, Kingdom of Saudi Arabia," *BMC Health Services Research,* vol. 17, pp. 1-13, 2017.

[34] W. Kattan, "The state of primary healthcare centers in Saudi Arabia: A regional analysis for 2022," *Plos One,* vol. 19, no. 9, p. e0301918, 2024.

[35] M. Alattas, S. Gordon, L. L. Sabin, F. El-Jardali, and V. J. Wirtz, "Equity and unmet need of non-communicable diseases services in Saudi Arabia using a national household survey (2019)," *BMC Health Services Research,* vol. 24, no. 1, p. 346, 2024.

[36] M. B. Baker *et al.*, "Overcoming barriers: A comprehensive review of chronic pain management and accessibility challenges in rural America," in *Healthcare*, 2024, vol. 12, no. 17, p. 1765.

[37] C. M. Franco, J. G. Lima, and L. Giovanella, "Primary healthcare in rural areas: Access, organization, and health workforce in an integrative literature review," *Cadernos de Saúde Pública,* vol. 37, p. e00310520, 2021.

[38] E. Hulen, S. Ono, S. T. Edwards, T. L. Pleasant, T. I. Lovejoy, and D. Coultas, "Temporal access barriers among rural-residing veterans with multiple chronic conditions," *Practicing Anthropology,* vol. 46, no. 1, pp. 4-8, 2024.

[39] C. Murata and K. Kondo, "Access to healthcare and health disparities," *Social determinants of health in non-communicable diseases: Case studies from Japan,* pp. 199-206, 2020.

[40] I. Al-Sumaih, B. Johnston, M. Donnelly, and C. O'Neill, "The relationship between obesity, diabetes, hypertension and vitamin D deficiency among Saudi Arabians aged 15 and over: Results from the Saudi health interview survey," *BMC Endocrine Disorders,* vol. 20, pp. 1-9, 2020.

[41] S. Rajagopalan, S. G. Al-Kindi, and R. D. Brook, "Air pollution and cardiovascular disease: JACC state-of-the-art review," *Journal of the American College of Cardiology,* vol. 72, no. 17, pp. 2054-2070, 2018.

[42] D. G. Vidal, G. M. Oliveira, M. Pontes, R. L. Maia, and M. P. Ferraz, "The influence of social and economic environment on health," in One health: Elsevier, 2022, pp. 205-229.

[43] T. Abdul-Rahman *et al.*, "The impact of air quality on cardiovascular health: a state of the art review," *Current Problems in Cardiology,* vol. 49, no. 2, p. 102174, 2024.

[44] A. Alqahtany and S. Aravindakshan, "Urbanization in Saudi Arabia and sustainability challenges of cities and heritage sites: Heuristical insights," *Journal of Cultural Heritage Management and Sustainable Development,* vol. 12, no. 4, pp. 408-425, 2022.

[45] K. M. Almatar, "Investigating the new public transportation system in Riyadh city," *Journal of Urban Planning and Development,* vol. 150, no. 1, p. 05023051, 2024. https://doi.org/10.1061/jupddm.upeng-4331

[46] M. H. Bahaydar, "Urban sprawl and its negative effects on Jeddah," Ball State University, 2013.

[47] R. P. Moreira, Da Silva, C. B. C., De Sousa, T. C., Leitão, F. L. B. F., Morais, H. C. C., De Oliveira, A. S. S., Duarte-Clíments, G., Gómez, M. B. S., Cavalcante, T. F., & Costa, A. C. , "The influence of climate, atmospheric pollution, and natural disasters on cardiovascular diseases and diabetes mellitus in drylands: A scoping review," *Public Health Reviews* vol. 45, pp. 1-11, 2024.

[48] H. O. Kadi, Mohamed, H. K., & Taha, H. K. , "Urgent notification of high temperature induced mortality of patients with diabetes and hypertension in hodeidah governorate " *Yemen University Journal,* vol. 2, no. 8, pp. 1–3, 2023.
[49] D. Brunk, "Diabetic patients unaware of heat's effect," *Family Practice News,* vol. 40, no. 12, p. 28, 2010.
[50] T. Alslamah, "Prevalence of various non-communicable diseases (NCDs) and NCD 2 risks factors among Saudi population-analysis from SHIS 2013," *Pak. J. Med. Health Sci,* vol. 16, pp. 710-715, 2022.
[51] A. Hussain, M. Asif, A. Jameel, and J. Hwang, "Measuring OPD patient satisfaction with different service delivery aspects at public hospitals in Pakistan," *International Journal of Environmental Research and Public Health,* vol. 16, no. 13, p. 2340, 2019.
[52] A. Jameel *et al.*, "Improving patient behavioral consent through different service quality dimensions: Assessing the mediating role of patient satisfaction," *International Journal of Environmental Research and Public Health,* vol. 16, no. 23, p. 4736, 2019. https://doi.org/10.3390/ijerph16234736
[53] Y. Jeong, S.-K. Kim, and J.-G. Yu, "Determinants of behavioral intentions in the context of sport tourism with the aim of sustaining sporting destinations," *Sustainability,* vol. 11, no. 11, p. 3073, 2019.
[54] V. D. Joshi, R. Malhotra, J. Lim, T. Ostbye, and M. Wong, "Validity and reliability of the expectations regarding aging (ERA-12) instrument among middle-aged Singaporeans," *Ann Acad Med Singapore,* vol. 39, no. 2, pp. 394-398, 2010. https://doi.org/10.47102/annals-acadmedsg.v39n5p394
[55] A. Jameel, M. Asif, A. Hussain, J. Hwang, N. Sahito, and M. H. Bukhari, "Assessing the moderating effect of corruption on the e-government and trust relationship: An evidence of an emerging economy," *Sustainability,* vol. 11, no. 23, p. 6540, 2019.
[56] D. Gefen, D. Straub, and M.-C. Boudreau, "Structural equation modeling and regression: Guidelines for research practice," *Communications of the Association for Information Systems,* vol. 4, no. 1, p. 7, 2000.
[57] C. Fornell and D. F. Larcker, "Evaluating structural equation models with unobservable variables and measurement error," *Journal of Marketing Research,* vol. 18, no. 1, pp. 39-50, 1981.
[58] F. V. Morgeson III, D. VanAmburg, and S. Mithas, "Misplaced trust? Exploring the structure of the e-government-citizen trust relationship," *Journal of Public Administration Research and Theory,* vol. 21, no. 2, pp. 257-283, 2011.
[59] K. G. Jöreskog and D. Sörbom, "Recent developments in structural equation modeling," *Journal of Marketing Research,* vol. 19, no. 4, pp. 404-416, 1982.
[60] D. McNeish, "Thanks coefficient alpha, we'll take it from here," *Psychological methods,* vol. 23, no. 3, p. 412, 2018.
[61] S. Kanwel, Z. Lingqiang, M. Asif, J. Hwang, A. Hussain, and A. Jameel, "The influence of destination image on tourist loyalty and intention to visit: Testing a multiple mediation approach," *Sustainability,* vol. 11, no. 22, p. 6401, 2019.