Planning for Urban Sustainability Through Residents' Wellbeing:

The Effects of Nature Interactions, Social Capital, and Demographics

by

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ABSTRACT

Promoting human wellbeing is a core tenet of human development and sustainability research and practice. The COVID-19 pandemic provided a unique opportunity to examine drivers of distinct aspects of wellbeing in an urban setting. Understanding how nature interactions impact human wellbeing is pertinent during the pandemic given the abrupt changes in lifestyle and anxiety experienced by many people. Through a quantitative analysis of 2021 survey data in metropolitan Phoenix, Arizona, I explored how distinct nature recreation activities, along with nature satisfaction and social capital in their neighborhoods, affected residents' wellbeing during the COVID-19 pandemic.

To conceptualize wellbeing holistically, I employed a tripartite model of health encompassing subjective wellbeing, physical health, and mental health. Data from the 2021 Phoenix Area Social Survey were analyzed coupled with geospatial environmental factors that linked to survey respondents. With linear and logistic regression models, I examined how different types of nature recreation, along with local environmental and social factors, influence Phoenix residents' life satisfaction, common health diagnoses, and depression and anxiety.

Results indicate that perceived social and environmental attributes of neighborhoods and proximity to desert preserves had a more significant impact on subjective wellbeing than nature recreation. Age and park visitation largely influenced physical health, while socio-demographic factors had the largest impact on mental health. Changes in nature recreation during the COVID-19 pandemic did not significantly impact

any dimension of wellbeing among the survey sample. This research demonstrates that distinct aspects of wellbeing have different drivers, and multiple environmental and social features should be considered when designing happy and healthy communities. Additionally, the design and management of human–environment dynamics at the local level can improve residents' subjective wellbeing. Research should continue investigating trends and drivers of human wellbeing to support sustainability goals into the future in order to promote wellbeing in urban communities.

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I would like to acknowledge all the work my advisor Kelli has done for me, and thank her for being an amazing mentor and guiding me through the last two years. She taught me how to effectively develop and undertake social science research, and inspired my newfound interest in social survey research. She helped me hone my academic writing skills and poster-making skills. And finally, she made me and my research feel seen and appreciated in such a large university. I would also like to recognize the help and guidance I received from my committee members, Jose-Benito and Deirdre, throughout this process. With their expertise, I was able to expand my knowledge into the fields of health and urban planning, and think critically about the ways in which who we are and where we live influences our wellbeing.

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INTRODUCTION

As urban areas grow in population and size, residents are experiencing higher levels of stress due to a lack of proximity to natural spaces (Cazalis et al., 2023; Soga & Gaston, 2016). Complex social and environmental interactions uniquely impact urban residents' health, quality of life, and life satisfaction (Lederbogen et al., 2011; Mitchell & Popham, 2007; Mouratidis, 2021; Vlahov et al., 2007). The COVID-19 pandemic added layers of stress to urban residents as they faced isolation and increased concerns over their health and wellbeing (Campion et al., 2020; Gupta et al., 2021; Nigg et al., 2021).

With over half the global population, and 83% of the US population, living in urban areas (The World Bank, 2023), improved methods are needed to address health and wellbeing in urban contexts. Urban residents have a higher risk of stress-related mental health problems compared to rural residents (Lederbogen et al., 2011; Peen et al., 2010). In urban regions, greenspaces such as public parks and private yards are a pathway to improved health and wellbeing for city residents in search of a human–nature connection (Dawwas & Dyson, 2021; Jato-Espino et al., 2022; Khalilnezhad et al., 2021; Lehberger et al., 2021; Maas et al., 2009). Urban residents dissatisfied with options for connecting with nature around them or who experience a loss of nature interactions for other reasons show a decrease in life satisfaction (Soga & Gaston, 2016). Conversely, residents with increased exposure to greenspaces have higher reported happiness and wellbeing (Carrus et al., 2015; Nisbet & Zelenski, 2011). In particular, research has established the importance of human–nature interactions for decreasing stress and providing mental relief (Berman et al., 2008; Kaplan, 1995; Korpela et al., 2017; Spano et al., 2020).

In an effort to improve resilience during public health crises and generally improve human wellbeing in urban centers, studies of how nature interactions in residential spaces influence multiple dimensions of health and wellbeing are crucial (Banks & Xu, 2020; Egerer et al., 2022; Lee et al., 2020; Theodorou et al., 2021). While studies have shown the benefits of nature interactions and nature satisfaction, they tend to focus on isolated dimensions of wellbeing, like mental health, and specific demographics, such as the elderly or infirm. This study aims to provide a comparative analysis of how neighborhood features and nature recreation impact multiple dimensions of wellbeing for urban residents.

Through a quantitative analysis of social survey and environmental data from the Phoenix, Arizona metropolitan area, I explored how nature interactions, such as gardening and park visitation, affected residents' wellbeing during the COVID-19 pandemic. Specifically, I ask: How do diverse forms of urban nature recreation, local neighborhood conditions, and socio-demographic factors affect different dimensions of wellbeing? By breaking down wellbeing into three dimensions—subjective wellbeing, physical health, and mental health—I captured a holistic view of the distinct factors affecting these dimensions of wellbeing. I employed regression models to examine the impact of various types of human–nature interactions on all three dimensions of wellbeing, as well as the role of local environmental satisfaction and social capital. With the robust survey data, I controlled for many socioeconomic factors, including race/ethnicity, gender, age, and home ownership. This comprehensive effort to better

understand how neighborhoods, and urban recreational spaces contribute to wellbeing has implications for urban planning, sustainability science, and global health.

REVIEW OF LITERATURE

Wellbeing

Wellbeing is difficult to define and measure due to its complex nature (Dodge et al., 2012; Huber et al., 2011; Jadad & O'Grady, 2008). Health and wellbeing broadly incorporate multiple dimensions such as physical, mental, emotional, spiritual, and social (Adler & Seligman, 2016; Dobewall et al., 2018). The World Health Organization (WHO) defines health as "a state of complete physical, mental and social well-being" (World Health Organization, 2021, p. 3), which has been contested by health scholars because of the seemingly unattainable nature of "complete" health (Huber et al., 2011; Jadad & O'Grady, 2008). The WHO further defines wellbeing as "a positive state experienced by individuals and societies" including "quality of life" (World Health Organization, 2021, p. 10). The Centers for Disease Control and Prevention (CDC) highlights the importance of living conditions on perceived or subjective wellbeing, broadly encompassing life satisfaction and a wide range of feelings (*Well-Being Concepts | HRQOL | CDC*, 2018). Further definitions of wellbeing incorporate socioeconomic levels and capacity, and even include aspects of the communities and environments in which someone lives (Adler & Seligman, 2016; Placa et al., 2013). Overall, wellbeing

incorporates both objective and subjective measures, such as physical or mental health diagnoses, along with self-reported evaluations such as life satisfaction (Dodge et al., 2012; Lehberger et al., 2021).

A tripartite model of wellbeing acknowledges its multidimensional nature by emphasizing subjective wellbeing, physical health, and mental health (Dodge et al., 2012; Placa et al., 2013). Other studied dimensions of health include social and spiritual health, along with ideas like people's function, purpose, and personal growth (Adler & Seligman, 2016; Gallop Inc, 2017; World Health Organization, 2021). Subjective wellbeing, defined as how much a person's current life compares to their ideal life, is one of the most broadly used terms and includes positive and negative affect (feelings) and cognitive beliefs (thoughts) (Adler & Seligman, 2016; Diener et al., 2018; Lehberger et al., 2021). A common and reliable measure of subjective wellbeing is global life satisfaction (Diener et al., 1985). Such measures of subjective wellbeing are a departure from physical health and socioeconomic measures, making it more reflective of how an individual feels or perceives their own life, rather than an external perspective or objective measurement (Angner, 2010; Diener et al., 2018).

Beyond subjective wellbeing, health encompasses physical symptoms typically diagnosed by a medical professional as specific diseases or ailments (Cross et al., 2018). In the US, for instance, 60% of adults have been diagnosed with at least one chronic disease like cardiovascular disease, with leading causes being a lack of physical activity, substance abuse, and poor nutrition (*Chronic Diseases in America | CDC*, 2022). Cardiovascular disease, a common diagnosis in the US, is the leading cause of death for

adults (CDC, 2023). A leading cause of cardiovascular disease is high blood pressure or hypertension, which almost half of US adults are diagnosed with (CDC, 2023; Fuchs & Whelton, 2020). Around 16% of US adults have been diagnosed with diabetes, another risk factor for cardiovascular disease and the eighth leading cause of death (CDC, 2023). Obesity, which affects around 42% of US adults, is also linked with cardiovascular disease and type-2 diabetes, all of which disproportionally impact people of color and those of lower socioeconomic status (CDC, 2022). Asthma, which affects 8% of US adults (CDC, 2023), is unevenly distributed among socio-demographic groups and is exacerbated by air pollution, especially through residential exposures in urban areas (Grineski et al., 2007).

Mental health problems such as anxiety and depression are also widespread in the US. In a survey conducted by the CDC in the spring of 2021, almost a third of US adults reported symptoms of an anxiety or depressive disorder (*Mental Health - Household Pulse Survey - COVID-19*, 2023). Specifically, around a quarter of US adults reported symptoms for a generalized anxiety disorder, and a fifth reported symptoms of a depressive disorder. The prevalence and severity of mental health disorders varies by gender, age, and ethnicity; specifically, adults aged 18-25, women, and Indigenous and mixed-race individuals report the highest prevalence and severity compared with older adults, men, and other racial and ethnic groups (National Institute of Mental Health, n.d.). Furthermore, mental and physical health are linked—for instance, people with higher stress levels are more likely to develop cardiovascular diseases, and people with

symptoms of anxiety and depression may report lower perceived physical health or symptoms (Robson & Gray, 2007; Steptoe & Kivimäki, 2012).

Nature Interactions

Nature interactions, defined here as any experience a person has with an element of the natural world including plants, animals, and ecosystems broadly (Hartig et al., 2014), are known to have an overall positive effect on many aspects of human wellbeing (Shanahan et al., 2016; Stock et al., 2021; White et al., 2021). In urban settings, these interactions can occur in public parks, preserves, or other greenspaces, as well as private gardens and yards. Different dimensions of wellbeing are affected by nature interactions through a variety of pathways, including increased physical activity, reduced stress, and stronger social ties (Hartig et al., 2014).

Negative interactions, resulting in harm and fear of certain wildlife or vegetation, can result in altered behavior in response to these perceived risks (Larson et al., 2023). Additionally, perceptions of some wildlife or broader aspects of nature as undesirable or a "nuisance," such as pollen resulting in allergies, also impact wellbeing (Hartig et al., 2014). However, literature generally supports the benefits of nature interactions to the improvement of a myriad of physical and mental health conditions such as anxiety, depression, cardiovascular disease, diabetes, and obesity (Frumkin et al., 2017). Ultimately, a combination of built amenities and natural features in parks, along with

visitor perceptions, are important for promoting physical and social activities and linking them to varied health outcomes (Kent & Thompson, 2014; Veitch et al., 2021).

For many people globally, leisure activities changed during the COVID-19 pandemic, especially in the context of stay-at-home policies that limited movement and encouraged people to look for new activities at home or in new public venues (Cannon et al., 2021; Engels et al., 2021; Marques et al., 2021; K. F. Morse et al., 2021; Shen et al., 2022). Gardening and visiting parks positively affected wellbeing during the pandemic in terms of providing places for exercise, safe spaces to gather, and restorative benefits from nature (Bell-Williams et al., 2021; Dawwas & Dyson, 2021; Vogel et al., 2022). Many people intentionally increased their time spent outdoors—through activities like gardening or visiting parks—in order to improve their wellbeing during this stressful time (O'Brien & Forster, 2020; Theodorou et al., 2021; Vogel et al., 2022). Due to the increased screen time associated with quarantining and working from home, people sought nearby nature in parks and gardens as an escape (Doughty et al., 2022; Marsh et al., 2021). Climatic seasonality of locations (Gupta et al., 2021) as well as the enforcement and then easing of stay-at-home orders contributed to location-specific shifts in activities (Engels et al., 2021; J. W. Morse et al., 2020; K. F. Morse et al., 2021).

Especially in suburban areas in the US, gardens and yards provide a space for nature interactions. People who identify as gardeners, or those who participate in cultivation activities generally, are better prepared to deal with stressors than people who do not garden (Lehberger et al., 2021; Shen et al., 2022; Sia et al., 2022; Theodorou et al., 2021). Social health can also be boosted by gardening, through the social aspects

associated with community gardens (Koay & Dillon, 2020; McGuire et al., 2022). However, for some, gardening and yard work can negatively impact life satisfaction by increasing stress through pressures to conform to social rules and norms about yard appearance (Locke et al., 2018; Robbins, 2012). In the US, there is often pressure to perpetuate conventional turf lawns and avoid alternative yards, which can be perceived as "messy" or "disordered" (Larson et al., 2016; Nassauer et al., 2009).

Beyond gardening, other recreation activities such as hiking, jogging, or walking in parks can increase or maintain moderate to high levels of physical activity and improve overall physical health (Hughey et al., 2021; Kaczynski et al., 2008). However, frequency and duration of park visitation, along with park size, influences the level of impact on physical health. Specifically, more time spent in parks, especially larger parks with longer trails, is associated with fewer physical health problems (Martin et al., 2020; Shanahan et al., 2016; Turrell et al., 2021).

Satisfaction with parks and park accessibility, along with residential proximity to parks, increases park usage and levels of physical activity (Cohen et al., 2007; Turrell et al., 2021; W. Wu et al., 2020). Public parks also improve wellbeing through increased community satisfaction and visitor appreciation of parks in urban areas (Larson et al., 2016; Pfeiffer et al., 2020). Further, the ultimate effects of parks on human wellbeing may depend on their recreational facilities and other amenities as well as perceptions of these qualities (Humpel et al., 2002; Kaczynski et al., 2008; McCormack et al., 2010). Additionally, perceived safety of the parks or trails is important for use, and varies with neighborhood characteristics such as socioeconomic status and amount of services

(Mouratidis, 2020b; Wilson et al., 2004; Yang & Xiang, 2021). Perceptions of safety or danger can be mediated by type and amount of vegetation, with dense vegetation frequently being viewed as more dangerous because of the threat of concealment, and thus less preferred for park landscaping (Lis & Iwankowski, 2021).

People may be motivated to visit parks and greenspaces that they perceive as "natural" or "wild" because they find it more tranquil and restorative (Aasetre et al., 2016; Wyles et al., 2019). Theories suggest that exposure to nature (such as time spent in vegetated parks or natural areas) affects mental health through psychological restoration, relieving mental fatigue, and shifting toward a more positive emotional state (Berman et al., 2008; Kaplan, 1995; Korpela et al., 2017; Spano et al., 2020). Increased time engaging with nature improves feelings of connectedness, which has implications for conservation and sustainability (Martin et al., 2020; Mayer & Frantz, 2004).

Neighborhood Dynamics

Neighborhoods, which can be defined as specific geographic areas with a significance to residents, provide spaces for living, community engagement and bonding, access to services, and recreation (Talen, 2018; Weiss et al., 2007). More than just a development boundary, a neighborhood gives personal context to daily life and a collective identity to bring residents together (Talen, 2018). Often defined objectively as census tracts or subdivision development areas, neighborhoods are also subjectively delineated by residents, which can have implications for wellbeing and neighborhood

satisfaction (Pfeiffer et al., 2020). Due the effects of these neighborhood environments on human wellbeing, scholars increasingly consider local-to-regional landscapes a public health resource (Kingsley et al., 2021; Zhang et al., 2021). Since neighborhood landscapes are the most common interface between humans and nature, it is there that social and ecological components come together to affect wellbeing (Opdam et al., 2018). In fact, landscape sustainability has been defined as the ability of landscape features to enhance human wellbeing (Larson et al., 2020; J. Wu, 2013), which can be shaped by both objective and subjective features of urban and residential landscapes (Pfeiffer et al., 2020).

Perceived and objective evaluations of landscape features in the urban context are known to impact wellbeing (Andrade et al., 2021; J. Wu, 2013). Subjective evaluations of neighborhood environmental features such as quality of vegetation or parks tends to be more influential for wellbeing than objective measures; specifically, satisfaction with the local environment drives subjective wellbeing for residents (Larson et al., 2019; Mouratidis, 2020b; Pfeiffer et al., 2020). Additionally, satisfaction with different landscapes depends on personal perceived values, such as aesthetic or recreational, and perceptions of built neighborhood features do not always correspond with objective measures (Larson et al., 2009, 2016; Nassauer et al., 2021). For example, the presence and accessibility of parks in a neighborhood does not necessarily mean residents will use that greenspace—matching park amenities to location-specific desires is important to encourage local use (Larson et al., 2022; Pfeiffer et al., 2020; Rigolon, 2016).

Further, opinions on neighborhood safety are associated with the types of vegetation and open space, and dependent on individual perceptions (Nassauer et al., 2021). Spaces like vacant lots with weeds, unmown grass, or other undesirable vegetation decrease neighborhood satisfaction due to perceived lack of care, even though they objectively increase the amount of vegetation (Nassauer et al., 2021). Geographical context can also impact perceptions of vegetation, with residents of more arid environments showing preferences toward xeric landscaping in yards (Larson et al., 2009). Thus, understanding how local perceptions and public appreciation influence assessments of neighborhood environments can also shape how landscapes impact wellbeing.

As alluded to above, objective measures of local environments also play an important role in residents' wellbeing. Vegetation density and tree cover, for example, has been linked to neighborhood satisfaction and other aspects of wellbeing through increased happiness and lower stress, thereby reducing mental health problems and improving subjective wellbeing. Residents of neighborhoods with higher vegetation densities typically report higher physical and mental health, which is also linked to decreases in the prevalence of cardiovascular disease (de Vries et al., 2013; Pereira et al., 2012). Vegetation type generally, and tree cover specifically, can vary by neighborhood in urban areas, as can residential landscape preferences (Andrade et al., 2021; McDonald et al., 2021; Wheeler et al., 2020).

The variation and kind of vegetation can also change how people use a residential greenspace—certain types of plants or trees may encourage (by increasing shade) or

discourage (by decreasing visibility) physical activities (Pereira et al., 2012; Yang & Xiang, 2021). Certain vegetation may also harbor, or be perceived to harbor, unfavorable wildlife like scorpion or snakes (Larson et al., 2009). Pests such as mosquitoes, which are also vectors for dangerous diseases, may be associated with type and density of vegetation as well as neighborhood income levels (Landau & van Leeuwen, 2012; Rhodes et al., 2022). However, mosquito counts do not always match residents' perceptions of mosquito exposure, with people viewing greenspaces with dense and "messy" vegetation as a higher risk of exposure, again highlighting the importance of both objective and subjective measurements (Brown et al., 2021).

Differences in urban vegetation can impact factors such as air quality, temperature, and flooding, meaning exposure to environmental risks and the associated health ailments is neighborhood dependent (Grineski et al., 2007; Harlan et al., 2006). Additionally, studies found that the characteristics of the built environment affected COVID-19 infection rates in urban areas—greener areas and more spacious housing were associated with lower rates of infection and fewer cumulative cases (Schmiege et al., 2023). Improvements to green urban planning, and planning focused on the wellbeing of residents, could be instrumental in decreasing social and health inequities in communities.

Neighborhood social capital, which refers to the networks of association and trust within communities and the benefits a person derives from them, is a product of residential composition and neighborhood activities (Alaimo et al., 2010; Duh-Leong et al., 2021; Larsen et al., 2004). Social capital can be a proxy for social determinants of

health, which are the social components of a person's life (Duh-Leong et al., 2021). Participation in social activities generally is associated with higher subjective wellbeing and better physical health (Baker et al., 2005); in urban neighborhoods especially, social capital and reported health are positively associated (Mohnen et al., 2011). Neighborhood park satisfaction is also linked to higher social capital (Pfeiffer et al., 2020) and greener neighborhoods have been shown to reduce feelings of loneliness and social isolation (Maas et al., 2009). Connection to community and nature can be fostered by green infrastructure by providing spaces to gather and interact, which is important in increasingly dense urban areas (Kent & Thompson, 2014). Thus, neighborhoods that provide satisfactory locations for social gathering promote the health and wellbeing of residents.

Sociodemographic Factors

Wellbeing is closely tied to socio-demographics (Mouratidis, 2020a; Tan et al., 2020; Wadsworth & Pendergast, 2021). For example, physical health diagnoses such as cardiovascular disease and diabetes typically increase with age (*Promoting Health for Older Adults | CDC*, 2022). Perceived socioeconomic status can have substantial impacts on subjective wellbeing as well as physical and mental health, even when controlling for objective measures of wellbeing (Präg et al., 2016; Tan et al., 2020). Moreover, a person's satisfaction with their house and neighborhood is directly linked to their life satisfaction (Mouratidis, 2020a), and factors such as size of house, location, housing market pressures, and length of time in the house can affect subjective wellbeing

(Herbers & Mulder, 2017; Zhan et al., 2022). Additionally, perceived ill health, both physical and mental, tends to be statistically greater for people with a lower socioeconomic status, due to factors such as increased daily stress, emotional exhaustion, and frustration (González et al., 2016).

Neighborhood characteristics, and their influence on health and wellbeing, vary by socioeconomic composition of neighborhoods (Mouratidis, 2020b). The wellbeing benefits of urban greenspaces are tied to socioeconomic status and these are often inequitably distributed (Hu & Ye, 2020; Präg et al., 2016; Tan et al., 2020). The socioeconomic composition of a neighborhood can influence factors such as amount of greenery and walkability, which in turn are associated with differing impacts on wellbeing (Duncan et al., 2012; Li et al., 2016). Additionally, people with gardens or yards typically have higher incomes than those who do not, the privilege of which has been shown to increase wellbeing on its own (Hu & Ye, 2020; Lehberger et al., 2021; Shen et al., 2022; Tan et al., 2020; White et al., 2021).

Sustainability is a global initiative with large-scale goals, but finding ways to focus the lens on individuals in local contexts is imperative for making actionable changes. Specifically, one of the major goals of sustainable development is improving human wellbeing (*Sustainable Development Goals - Health*, n.d.). Pathways to improved wellbeing are not going to lie solely at the global or city scale, when most everyday experiences of urban residents are at the neighborhood level. Thus, drawing from this disparate literature, interventions for dimensions of wellbeing could lie in nature interactions facilitated by

urban neighborhood dynamics. Furthermore, considering the multidimensionality of wellbeing, along with both social and environmental neighborhood features, makes this research unique.

Additionally, studying wellbeing in the temporal context of the COVID-19 pandemic is important for understanding how global events influence individual wellbeing, especially in urban areas. A general reported drop in wellbeing during the pandemic (Campion et al., 2020; Gupta et al., 2021; Nigg et al., 2021) reveals the need to investigate ways to prepare for any future pandemics or similar widespread disasters (Banks & Xu, 2020; Lee et al., 2020). People experienced the pandemic differently depending on local environmental conditions, rules, and culture, thus studying responses across geographically and culturally diverse areas is important to have a more comprehensive view.

METHOD

Study Area

The Phoenix metropolitan area is the fastest growing urban area in the US and is currently the fifth largest city in the country (*Phoenix Tops the Nation in Population Growth for the Fifth Year in a Row*, 2021). The Phoenix area lies in a valley surrounded by mountain ranges. Situated within the Sonoran Desert of the American Southwest, the region has a warm, semi-arid climate with an average of 7.11 inches of precipitation annually (US Department of Commerce, 2021). With both summer and winter rainy

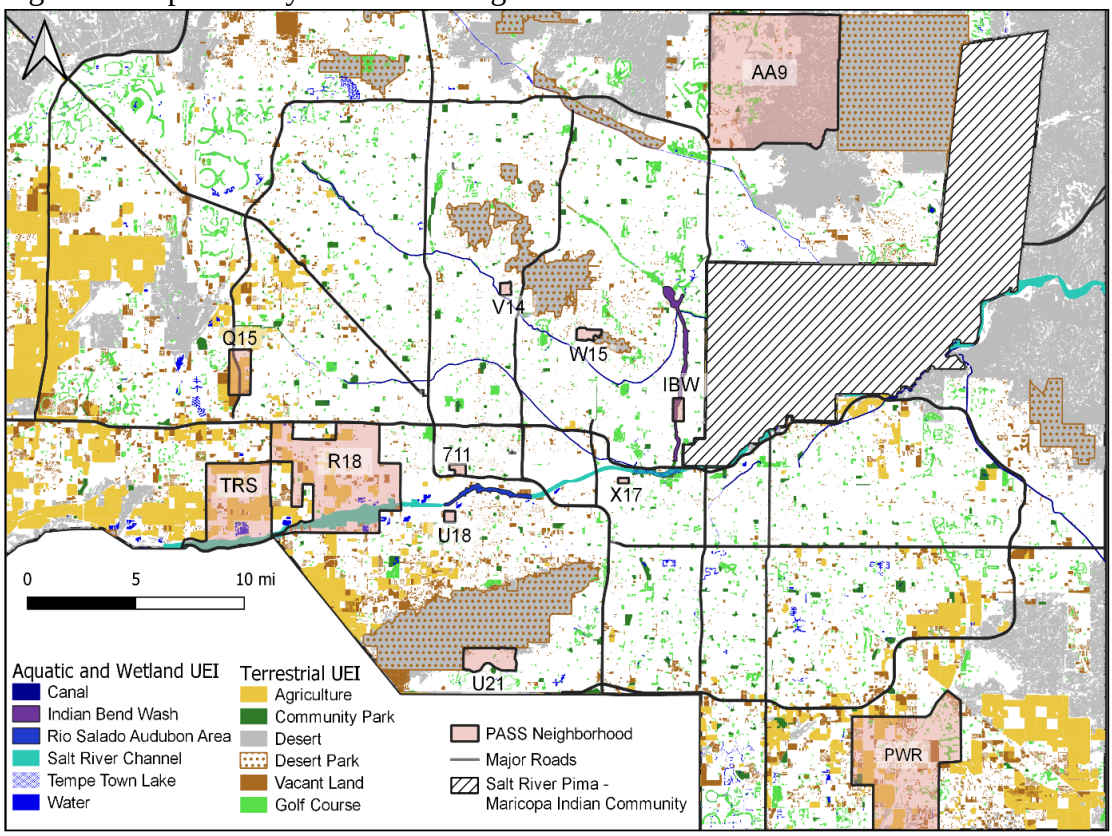
seasons, the Sonoran Desert is a very biodiverse ecosystem with many unique plants and animals. In 2021, temperatures ranged from a low of 36°F (2°C) in January up to a high of 118°F (48°C) in June, with a total of 104 days above 100°F (38°C). With triple-digit temps common through June, July, August, and September, most outdoor living and recreation happens during the mild winter months.

Several large desert preserves within the metropolitan area punctuate the urban landscape, covering more than 41,000 acres of land and over 200 miles of trails. South Mountain Preserve, for example, is the largest municipal park in the country, totaling more than 16,000 acres (*Parks and Recreation Desert Parks and Mountain Preserves*, n.d.). Additionally, more developed parks include small neighborhood parks with fields and sports facilities, playgrounds, and picnic areas. Many parks and residential areas also have water features, including built lakes, canals, and portions of the Salt River channel (Figure 1).

Spring is typically a busy time for park visitation in the Phoenix area as the weather is very pleasant, and during the beginning of the COVID-19 pandemic in spring of 2020, park visits increased (Alam, 2020). At this time, executive orders from the governor mandated that outdoor spaces be kept open for recreation. In March of 2020, some parks restricted access to indoor facilities and eliminated programming, but most outdoor spaces remained open (Alam, 2020). The Phoenix area had surge of cases in the summer, reaching about 20,000 in July, but then numbers fell in the fall (CDC, 2020). By October of 2020, the city of Phoenix reopened playgrounds, park bathrooms, and picnic areas (Fifield, 2020). Cases began surging again in November of 2020, peaking around

50,000 in January of 2021, and then falling to around 10,000 by March of 2021 (CDC, 2020). The survey this research is based on was implemented in the spring of 2021, after the state government told businesses they could resume operations as normal (Arizona Office of Tourism, 2021), and after vaccines had been released.

Figure 1. Map of Study Area with Neighborhoods Marked.



Map created by Jeffrey Brown (Larson et al., 2021).

Survey Implementation

My analysis employs data from the Phoenix Area Social Survey (PASS), a survey that has been conducted every five years since 2001 (Larson et al., 2021). The household survey targets diverse neighborhoods across metropolitan Phoenix to understand residents' values, perceptions, attitudes, and behaviors relating to urban environmental issues, as well as different aspects of residents' wellbeing. Using a stratified random sampling approach, the twelve surveyed neighborhoods include low-to-high income areas distributed across core urban, suburban, and fringe neighborhoods, including those with a large portion of Hispanic residents. Due to this sampling method, the results cannot be generalized to the larger population.

The survey involved a five-wave mailing, beginning on May 10, 2021, and included three full packets and two informational postcards. The initial mailing, a postcard with information about the survey along with a unique URL link to the web version (offered in English and Spanish), was followed by a full packet of the 20-page printed survey with a preaddressed return envelope and $5 cash pre-incentive. Households with Hispanic last names were sent a packet in English as well as Spanish, and any household could request the Spanish-language version. Neighborhoods with fewer than forty returned questionnaires were sent an additional reminder postcard. Residents who completed questionnaires were awarded a $25 Visa gift card. The survey had a total response rate of 35.6% (n=509), although response rates varied greatly by neighborhood (Larson et al., 2021). Further survey results are discussed below.

Variables

Dependent Variables for Tripartite Wellbeing

Using a tripartite model of wellbeing, the dependent variables aim to capture a holistic view by including subjective wellbeing, physical health, and mental health. Subjective wellbeing is measured with reported life satisfaction (Diener et al., 1985), an established measure of human wellbeing that has high internal consistency and high correlation with other established wellbeing scales. PASS included a suite of five statements from the Life Satisfaction Scale, evaluated on a five-point response scale ranging from “strongly disagree” (1) to “strongly agree” (5). Example statements include: “The conditions of my life are excellent” and “My life is close to ideal” (Table 1). To create a subjective wellbeing scale variable, I averaged the responses to the five statements (Cronbach’s alpha = 0.896).

Table 1. Descriptive Statistics: Subjective Wellbeing and Physical and Mental Health.

Measurement	Mean / Frequency (%)	Standard Deviation	Valid N
Subjective Wellbeing			
Life satisfaction (alpha=0.896)[1]	3.71	0.934	497
My life is close to ideal	3.65	1.077	497
Conditions of my life are excellent	3.75	1.103	497
I am satisfied with my life	3.93	1.028	496
I have important things I want	3.97	1.048	497
I would change almost nothing	3.23	1.286	496
Physical Health Problems			
Physical health diagnoses[2]	1.02	1.148	497
Asthma	14.9%	N.A.	490
Obesity	18.2%	N.A.	491
Diabetes	12.0%	N.A.	495
High blood pressure	28.8%	N.A.	495
Mental Health Problems			
Depression or anxiety: yes[3]	25.9%	N.A.	490

[1] Life satisfaction scale ranged from 1 to 5 and represents the average of five statements from Diener et al., 1985. Higher numbers indicate higher wellbeing

[2] Count of four common medical diagnoses in the US. Higher numbers indicate more diagnoses, range 0-4. All diagnoses were binary yes/no, with yes=1.

[3] Binary variable with 1 representing a diagnosis of depression or anxiety.

Survey respondents answered physical and mental health questions by indicating if a medical professional had diagnosed them with any of five health problems common in the US: asthma, obesity, diabetes, high blood pressure, and depression or anxiety (Table1). The physical health variable is a count of the four physical diseases (asthma, obesity, diabetes, and high blood pressure), while the mental health variable indicates a yes or no response to depression or anxiety.

Explanatory Variables: Local Neighborhood Factors

Local neighborhood characteristics in this analysis encompass residents' judgments about the social and physical environments of their neighborhoods, including respectively a measure of social capital and local environmental satisfaction (Table 2). Both social capital and neighborhood satisfaction were measured using a five-point response scale across multiple statements, which were each averaged to form a reliable composite variable. Social capital, or the social bond between neighbors, was measured using three questions (Larsen et al., 2004) on a scale ranging from "strongly disagree" (1) to "strongly agree" (5), with statements such as "I live in a close-knit neighborhood" and "I can trust my neighbors." I averaged the responses for all statements to create the social capital scale variable (Cronbach's alpha = 0.724). Local environmental satisfaction was measured using six statements that asked respondents about their satisfaction with the number and quality of parks and preserves, the presence of water features, and the number of trees and birds in their neighborhood, with the response scale ranging from "very dissatisfied" (1) to "very satisfied (5). I averaged the responses for the questions to create the local nature satisfaction scale variable (Cronbach's alpha = 0.836).

Table 2. Descriptive Statistics: Social Capital and Nature Satisfaction in Neighborhoods.

Features	Mean	Standard Deviation	Valid N
Social capital (alpha=0.724)[1]	3.48	0.935	503
Close-knit neighborhood	2.99	1.254	502
Neighbors get along	3.76	1.115	502
Trust neighbors	3.69	1.112	503
Local nature satisfaction (alpha=0.836)[2]	3.46	0.879	503
Number of trees	3.45	1.288	501
Amount of neighborhood parks & open spaces	3.61	1.222	503
Quality of parks & open spaces	3.59	1.219	501
Variety of birds	3.61	1.110	502
Amount of desert parks & preserves	3.61	1.080	499
Presence of streams, rivers, and other water	2.87	1.187	502

[1] Composite scale adapted from Larsen et al., 2004. Higher numbers are higher social capital. Range 1=disagree strongly, 5=agree strongly.
[2] Composite scale calculated from average of six questions. Range 1=very dissatisfied, 5=very satisfied.

Due to the focus on neighborhood characteristics broadly and parks specifically, I incorporated distance to desert preserves and distance to local parks along with vegetation density (NDVI) in the analysis as objective measures of local environmental characteristics (Table 3). For ease of analysis, I transformed the distance variables to reflect respondents who were proximal to desert preserves and neighborhood parks. Proximal to a neighborhood park was calculated as the address being within one kilometer of a park, about the time it would take an average adult to walk the distance in ten minutes (Figure 3) (Rigolon, 2016). Based on the distribution of results (Figure 4), proximal to a desert preserve was calculated as the address being located within five kilometers to a preserve, which equates to around a ten-minute drive. The NDVI, collected in 2018 and calculated within a one-kilometer area around each address, reveals the quantity of vegetation using remote sensing.

Table 3. Descriptive Statistics: Geospatial Variables for Respondent Addresses.

Variable	Mean/ Frequency	Standard Deviation	Min	Max	Valid N
NDVI[1]	0.222	0.049	0.121	0.370	503
Nearest neighborhood park (km)	0.717	0.635	0.016	3.656	510
Nearest desert park (km)	5.391	4.552	0.045	15.964	509
Proximal to local park[2]	76.4%	N.A.	N.A.	N.A.	505
Proximal to desert preserve[3]	44.8%	N.A.	N.A.	N.A.	509

[1] Calculated within 1km of surveyed address in 2018

[2] Binary variable with 1 representing an address within 1km of a local park (Rigolon, 2016).

[3] Binary variable with 1 representing an address within 5km of a desert preserve based on the distribution of results.

Figure 2. Histogram of Vegetation Density for Surveyed Addresses with Normal Distribution.

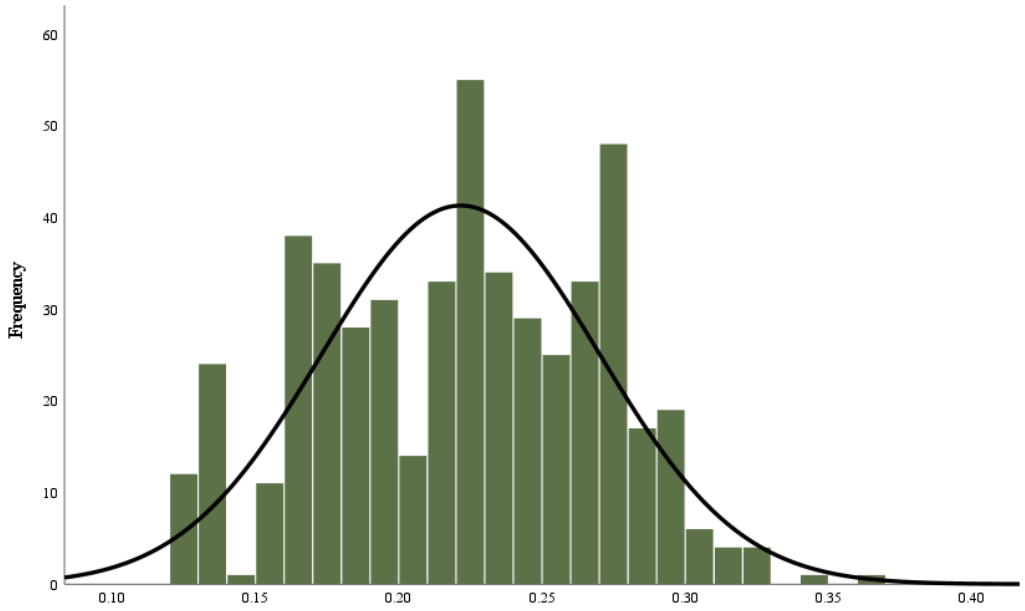


Figure 3. Histogram of Distance (km) to Neighborhood Parks from Survey Addresses.

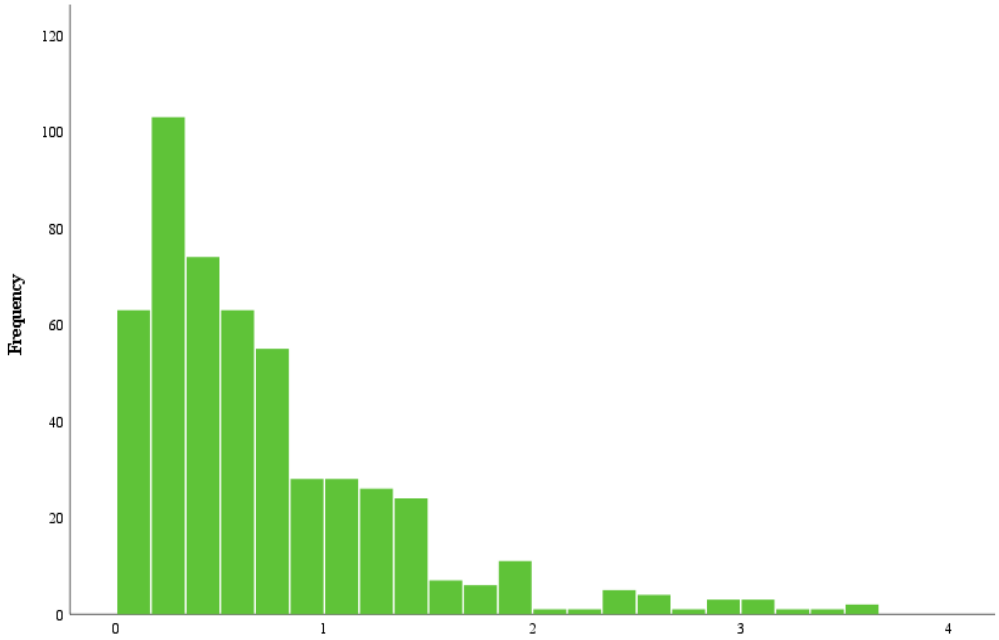
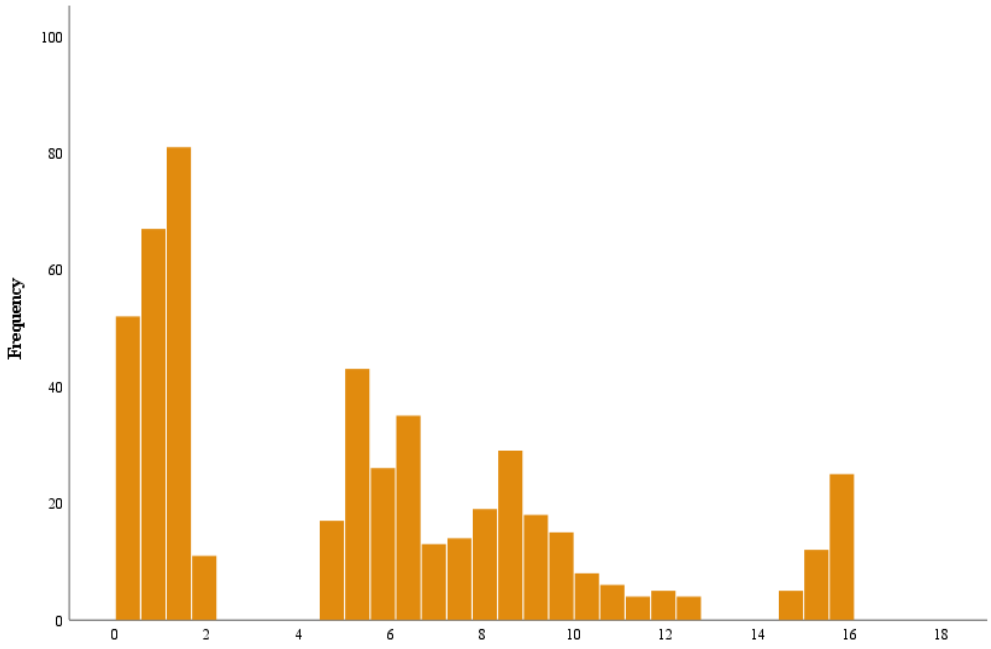


Figure 4. Histogram of Distance (km) to Desert Preserves from Survey Addresses.



Explanatory Variables: Nature Activities

Because of the time period this survey was conducted, I grouped nature activities into general and COVID-specific activities based on different survey questions that address both gardening and park visitation (Table 4). Gardening activities were evaluated using five questions that asked survey respondents if they added trees, desert plants, food-bearing plants, or plants for rainwater control in the past five years, or added or maintained plants that attract birds. A response of "yes" (1) to any activity was added together to create a count inclusive of all gardening activities, i.e., the number of these gardening activities completed by the respondent in the last five years. The frequency of park visitation was measured by four statements on a five-point ordinal scale ranging from "never" (1) to "at least once a week or more" (5). The statements asked about visiting different types of parks within the last year, including desert preserves, neighborhood parks, and streams, ponds, or lakes within or beyond the metropolitan area. I averaged the responses to the four statements to create a parks visitation frequency scale variable (Cronbach's alpha = 0.786).

Questions specific to the COVID-19 pandemic asked participants to report changes in three activities—gardening, hiking, or visiting parks—compared to the previous year. Two separate questions asked about changes at the outset of the pandemic in spring of 2020, in addition to more recently in spring of 2021 after the rollout of vaccinations. The multivariate models include the 2021 changes, since they temporally align with the timing of respondents' reporting on their health and subjective wellbeing. Each COVID-related nature activity from the survey (gardening, hiking, and visiting

parks) was measured on a five-point ordinal scale from “a lot less time” (1) to “a lot more time” (5). The 2021 variables were recoded into binary variables for analysis, with 1 indicating an increase in each activity and 0 indicating a decrease or no change (Table 4).

Table 4. Descriptive statistics: nature recreation activity frequencies during the COVID-19 pandemic and generally

Activities	Mean/ Frequency	Standard Deviation	Valid N
General Nature Recreation			
Gardening activities[1]	1.92	1.462	502
Planted trees	56.2%	N.A.	413
Added desert plants	58.2%	N.A.	419
Added plants that grow food	36.1%	N.A.	418
Added plants to capture and absorb rainwater	22.2%	N.A.	432
Planted or maintained plants to attract birds	48.3%	N.A.	499
Parks visitation frequency (alpha=0.786)[2]	2.62	0.943	506
Desert parks or open spaces in Valley	3.09	1.334	505
Neighborhood parks in Valley	3.03	1.319	504
Streams/ponds/lakes in Valley	2.36	1.216	501
Streams/ponds/lakes beyond Valley	1.98	0.916	503
COVID Nature Recreation			
Increased gardening or landscaping in 2021[3]	23.2%	N.A.	499
Increased hiking in 2021[2]	20.9%	N.A.	494
Increased spending time in parks in 2021[2]	23.5%	N.A.	498

[1] Count of five questions, range 0-5. All questions were binary yes/no, with yes=1.
[2] Composite scale calculated from average of four questions with higher numbers indicating more frequent visitation, range 1=never visit, 5=visit at least once a week.
[3] Binary variable calculated from a 5-point scale, 0=decreased or no change, 1=increased.

Socio-demographic Factors

Because PASS is a large-scale longitudinal survey, it aims to collect as much socio-demographic information about respondents as possible. This analysis included basic demographic information such as age, education level, household income, gender identity, and race/ethnic identity (Table 5). Additionally, due to the focus on

neighborhood characteristics and nature activities, I also included housing type. The mean household income of survey respondents was around $100,000, and many respondents had earned a bachelor's degree or higher (Table 5). Sixty percent of respondents were women, and 75.5% lived in single-family residences. The median age was 56 years. The racial/ethnic group most represented in the survey was white at 64.3%, and the next largest group was Latinx/Hispanic at 18.2% of respondents. Of the survey respondents, 76.4% lived within 1 kilometer of a neighborhood park, and 44.8% lived within 5 kilometers of a desert preserve (Table 4; Figure 1). Because the survey sample is not representative of the whole metropolitan area population, the results are not generalizable.

Table 5. Descriptive statistics: socio-demographic characteristics of respondents

Demographic	Mean (Median)/ Frequency (%)	Standard Deviation	Range	Valid N
Age	54.28 (56.0)	17.381	18-100	491
Education level[1]	5.31 (6.0)[1]	1.591	1-7	497
Household income[2]	5.87 (5.0)[2]	3.336	1-11	483
Gender: Women[3]	60.6%	N.A.	N.A.	495
Race/ethnicity: Latinx[4]	18.2%	N.A.	N.A.	495
Race/ethnicity: White[4]	64.3%	N.A.	N.A.	495
Housing Type: Single family residence	75.5%	N.A.	N.A.	497

[1] 5=vocational school, 6=bachelor's degree.

[2] 5=$80k-$100k, 6=$100k-$120k.

[3] Binary variable. Includes all who selected female along with four people who reported nonbinary or other gender

[4] Respondents could select more than one race/ethnicity, but only 9 individuals selected both Latinx and White.

Analyses

Using SPSS statistical software, I conducted two linear and one logistic regression to analyze the factors explaining the three distinct wellbeing measures. I identified and compared the factors influencing subjective wellbeing and physical health variables with generalized linear regression models. Because the dependent variable for mental health was a binary variable, I used logistic regression to examine the factors influencing mental health. Missing values were excluded from the analysis. To simplify the analysis, I standardized NDVI (Figure 2) using Z-scores. All models were checked for collinearity, and had a VIF below two. Statistical significance was at the $p<0.05$ level, and any marginal significance indicates values at the $p<0.10$ level.

RESULTS

The Dependent Variables: Wellbeing

Survey respondents generally felt somewhat satisfied with their lives, with an average of 3.71 on a 5-point life satisfaction scale (Table 1). The statements “I am satisfied with my life” and “I have important things I want” were the highest scored statements (3.93 and 3.97, respectively) and “I would change almost nothing” was the lowest scored (3.23). For physical health problems, respondents reported, on average, one diagnosis by a medical professional. Hypertension had the highest frequency (28.8% of respondents), followed by obesity (18.2%) and asthma (14.9%), and finally diabetes with the lowest frequency (12%). Across race, respondents who identified as Black had the

highest reported rates of obesity and hypertension, while respondents who identified as Native American had the highest rates for asthma and diabetes. A quarter of survey respondents reported a diagnosis of depression or anxiety, with Black respondents reporting the highest rates of any race.

Explanatory Factors: Subjective Wellbeing

My explanatory variables best explained subjective wellbeing, with 31.8% of the variation in life satisfaction explained by four significant variables ($p<0.001$; Table 6). Perceptions of local social and environmental characteristics best predicted life satisfaction. Specifically, respondents who reported higher social capital reported higher life satisfaction. The next most influential factor (based on standard Beta values) was satisfaction with the natural environment in their neighborhoods. Proximity to desert preserves was another strong predictor of life satisfaction, with households located nearer to preserves reporting higher subjective wellbeing. Residents with higher income levels also reported higher life satisfaction, but no other socio-demographic factors had significant effects in these models.

The frequency of visiting parks ($p=0.053$) and increased gardening during COVID ($p=0.094$) were both marginally significant predictors of life satisfaction, with lower magnitude effects on life satisfaction based on standard Beta values than any of the more significant variables. Specifically, while people who reported more frequent park visits reported higher life satisfaction, those who increased gardening had a lower subjective wellbeing. No other nature activities had a significant impact on life

satisfaction, including increased park visitation and hiking during COVID, nor did vegetation density or proximity to a neighborhood park.

Table 6. Model Results: Subjective Wellbeing. R^2=0.318

Explanatory Variables	Std. Beta	t	Sig.
(Constant)		3.942	0.000
Local Environment			
Social capital	0.241	5.360	0.000
Local nature satisfaction	0.199	4.461	0.000
Proximal to desert preserve	0.167	3.519	0.000
Vegetation density	0.067	1.441	0.150
Proximal to local park	-0.055	-1.188	0.236
Nature Activities			
Parks visitation frequency	0.085	1.943	0.053
Increased gardening in 2021	-0.072	-1.679	0.094
Increased park visits in 2021	0.058	1.120	0.263
Gardening activities	0.018	0.396	0.693
Increased hiking in 2021	-0.010	-0.196	0.845
Socio-Demographics			
Income	0.201	3.869	0.000
Ethnicity: Latinx	0.064	1.436	0.152
Housing type: SFR	0.058	1.240	0.215
Gender: Women	0.040	1.001	0.317
Education	0.030	0.657	0.512
Age	0.025	0.541	0.589

Explanatory Factors: Physical Health

Overall, the explanatory variables accounted for 9.2% of the variation in physical health diagnoses. Factors related to visiting and living near parks, as well as some socio-demographic factors, significantly explained the number of physical health diagnoses among the survey sample (Table 7). Residents near desert preserves had fewer diagnoses ($p<0.001$). Similarly, respondents who visited parks more frequently, but not necessarily increased their frequency of visits during the pandemic, had fewer diagnoses than respondents who rarely visited parks ($p=0.031$). Higher levels of education also reduced

physical health problems (p=0.048), while older age increased health problems (p=0.006).

Local nature satisfaction and race/ethnicity were nearly significant in explaining the number of physical health diagnoses. Increased environmental satisfaction in neighborhoods (p=0.064) and identifying as Latinx (p=0.085) were both associated with fewer health diagnoses, although the magnitude of the effect was lower than the more significant variables based on standard Beta values. No other explanatory variables had significant impacts on physical health.

Table 7. Model Results: Physical Health Problems. R^2=0.092

Explanatory Variables	Std. Beta	t	Sig.
(Constant)		4.943	0.000
Local Environment			
Proximal to desert preserve	-0.234	-4.268	0.000
Local nature satisfaction	-0.096	-1.859	0.064
Social capital	-0.040	-0.768	0.443
Proximal to local park	-0.033	-0.620	0.536
Vegetation density	0.027	0.498	0.619
Nature Activities			
General parks visitation	-0.109	-2.159	0.031
Increased park visits in 2021	0.030	0.500	0.618
Increased gardening in 2021	-0.015	-0.312	0.755
Increased hiking in 2021	-0.009	-0.150	0.881
Gardening activities	0.003	0.050	0.960
Socio-Demographics			
Age	0.147	2.778	0.006
Education	-0.105	-1.980	0.048
Ethnicity: Latinx	-0.090	-1.726	0.085
Housing type: SFR	0.055	1.024	0.307
Gender: Women	-0.032	-0.697	0.486
Income	-0.031	-0.519	0.604

Explanatory Factors: Mental Health

Socio-demographic factors best predicted if a survey respondent was likely to report a diagnosis of anxiety or depression (Table 8). For model fit, the pseudo R^2 values ranged from 0.085 for Cox & Snell's method to 0.122 for Nagelkerke's method. Age ($p=0.030$), income ($p=0.024$), and education ($p=0.038$) had the strongest likelihoods of indicating a mental health diagnosis. Specifically, older, wealthier, and more highly educated people had a decreased likelihood of reporting depression or anxiety. Lastly, respondents who identified as Latinx had a decreased likelihood of anxiety or depression ($p=0.021$), when controlling for other socio-demographic factors.

Vegetation density had a marginally significant chance of influencing a mental health diagnosis ($p=0.061$), with a greener environment increasing the likelihood of an anxiety and/or depression diagnosis. No other local environmental characteristics or the nature activities measured in the survey influenced mental health for the survey sample.

Table 8. Model Results: Mental Health Problems. Pseudo R^2=0.122.

Explanatory Variables	B	Exp(B)	Wald	Sig.
(Constant)	2.492	12.086	7.816	0.005
Local Environment				
Vegetation density	0.251	1.285	3.521	0.061
Proximal to local park	0.387	1.473	1.402	0.236
Proximal to desert preserve	0.245	1.278	0.854	0.355
Local nature satisfaction	-0.171	0.843	1.502	0.220
Social capital	-0.213	0.808	2.436	0.119
Nature Activities				
Increased gardening in 2021	0.027	1.027	0.009	0.925
Gardening activities	-0.014	0.986	0.025	0.874
Increased park visits in 2021	-0.051	0.950	0.022	0.881
General parks visitation	-0.082	0.921	0.404	0.525
Increased hiking in 2021	-0.169	0.845	0.224	0.636
Socio-Demographics				
Ethnicity: Latinx	-0.769	0.464	5.360	0.021
Education	-0.164	0.849	4.291	0.038
Income	-0.104	0.901	5.125	0.024
Age	-0.016	0.984	4.712	0.030
Gender: Women	0.356	1.427	2.233	0.135
Housing type: SFR	-0.051	0.950	0.028	0.866

Comparing the Influential Factors on All Three Dimensions of Wellbeing

Life satisfaction, the measurement used for subjective wellbeing, had the best fitting model and predicted about a third of the variation. Comparatively, the models for physical and mental health only predicted around a tenth of the variation each (although the logistic regression model for mental health cannot be directly compared to the linear regression models, the pseudo R^2 values are similar to the value for physical health). Residents' perceptions of local neighborhood dynamics best predicted life satisfaction, especially perceived social capital and satisfaction with the natural environment. Proximity to desert preserves, general parks visitation, and nature satisfaction all

influenced subjective wellbeing and physical health. Income impacted both subjective wellbeing and mental health, while age, education, and ethnicity affected physical and mental health. Increasing nature recreation during COVID had no significant impacts ($p<0.05$) on any of the wellbeing variables, nor did vegetation density, proximity to a local park, gender, or type of residence.

Table 9. Summary of Significant Variables Across All Wellbeing Measures[1].

Explanatory Variables	Subjective Wellbeing Std B	Physical Health Problems Std B	Mental Health Problems Exp(B)
Local Environment			
Proximal to desert preserve	0.167**	-0.234**	
Local nature satisfaction	0.199**	-0.096^	
Social capital	0.241**		
Vegetation density w/in 1km			1.285^
Nature Activities			
General parks visitation	0.085^	-0.109*	
Gardening activities	-0.072^		
Socio-Demographics			
Age		0.147**	0.984*
Income	0.201**		0.901*
Education		-0.105*	0.849*
Ethnicity: Latinx		-0.090^	0.464*

[1]Nonsignificant variables left out: proximal to local park, gardening activities, increased gardening in 2021, increased hiking in 2021, increased park visits in 2021, gender, housing type.

**p<0.001, *p<0.05, ^p<0.10

DISCUSSION

By using a multidimensional model of wellbeing, my research reveals that different social and environmental drivers affect distinct dimensions of wellbeing for residents in Phoenix. In particular, perceptions of the local physical and social environment were most strongly associated with subjective wellbeing, while proximity to parks was most connected with physical health and socio-demographic factors with mental health. These findings suggest that designing neighborhoods for wellbeing means thinking beyond the provisioning of parks to also include spaces for community socializing, which is consistent with other literature (Pfeiffer & Cloutier, 2016).

Moreover, local perceptions need to be accounted for, meaning urban planners should create location-specific designs. Further, this research highlights that diverse groups of people within a neighborhood should be consulted given the emphasis of socio-demographic factors such as age, income, education, and ethnicity on subjective wellbeing and mental health. The variation of perceptions and need to plan for distinct socio-demographic communities across urban areas is similar to findings in other research (Larson et al., 2022; Talen, 2019).

Life satisfaction, a robust measure of subjective wellbeing (Diener et al., 1985), was well-explained by local social and environmental factors as well as income. My research found that social capital was an especially important indicator of subjective wellbeing in these neighborhoods, demonstrating that the social bonds in these communities drove the wellbeing of residents. These findings are consistent with those of

Pfeiffer et al., 2020, further confirming the importance of social capital for subjective wellbeing. Similar to findings in other locations (Doughty et al., 2022; Stock et al., 2021), subjective everyday factors associated with the communities where people live appear more important than outdoor recreation for subjective wellbeing in the context of the COVID-19 pandemic.

The combination of social capital and income impacting life satisfaction could imply the social fabric of a neighborhood is partially driven by socioeconomic status. Consistent with other research on wellbeing in relation to address proximity and park size (Sugiyama et al., 2010; Wood et al., 2017), Phoenix residents living close to large desert preserves reported higher subjective wellbeing. Since neighborhoods nearer to desert preserves tend to be more expensive and have residents of higher socioeconomic status, income is inherently tied to the design of these neighborhoods as well as the life satisfaction of the people living there (W. Wu et al., 2020). Nature recreation, including gardening and hiking, did not impact subjective wellbeing in this study, which is not consistent with other literature (Gupta et al., 2021; K. F. Morse et al., 2021; Shen et al., 2022; Vogel et al., 2022). However, the intensity and duration of the recreation activities was not measured, which is known to influence the wellbeing impact and could have limited the results. Broadly speaking, this research suggests that residents' views on neighborhood features, both social and environmental, drive life satisfaction overall, emphasizing that local planning and implementation is most important for subjective wellbeing (Talen, 2019).

For physical health, parks played an important role in reducing the prevalence of four physical health diagnoses for residents in Phoenix neighborhoods, which resonates with extensive previous work examining the important role of urban parks in increasing physical activity and improving health (Cohen et al., 2007; Hughey et al., 2021; Kaczynski & Henderson, 2007). In this study, parks visitation reduced the number of reported diagnoses for the survey population, likely due to physical activity (Cohen et al., 2007). Proximity to desert preserves did decrease residents' number of health diagnoses, but proximity to neighborhood parks did not. This suggests that park quality and amenities matter for physical health, not just park provisioning, which is increasingly supported by research (Dillen et al., 2012; Ding et al., 2022). Unlike findings from other studies on park usage during the pandemic (Volenec et al., 2021), which found that parks became spaces for exercise when other facilities closed, increased park visitation and hiking during this time had no effect on physical health for the residents surveyed in Phoenix.

Moreover, despite other research finding that nature recreation broadly increased during the COVID-19 pandemic (Dawwas & Dyson, 2021; J. W. Morse et al., 2020), and that this typically had a positive impact on multiple dimensions of wellbeing, my research did not find that to be true. Other research found that geographic particulars impacted recreation during the pandemic (Gupta et al., 2021). Phoenix is a largely suburban city with generally low population density. Perhaps due to the relatively loose local governmental guidelines and regulations, along with a unique arid climate, residents did not seek alternative leisure activities during the pandemic, did not experience lowered

wellbeing, or did not choose to use nature recreation as a coping mechanism for decreased wellbeing.

The likelihood of a diagnosis for anxiety or depression was only related to socio-demographic factors for the residents of these neighborhoods in Phoenix, and, counter to previous studies (Keniger et al., 2013; Marques et al., 2021), not at all impacted by nature recreation or neighborhood characteristics. Identifying as Latinx was associated with better mental health, which is a finding bolstered by research (Barger et al., 2009). This study suggests that a higher socioeconomic status reduces the likelihood of anxiety or depression, consistent with other research connecting socioeconomic status with health (Everson et al., 2002). During the COVID-19 pandemic, people of lower means experienced more economic hardship because they were typically employed in non-remote jobs, leading to unemployment or more stressful working conditions, along with higher exposure to the virus (Khanijahani et al., 2021).

RESEARCH LIMITATIONS AND FUTURE RESEARCH

The survey sample is not representative of the metropolitan Phoenix population because of the stratified sampling method and specifically-targeted neighborhoods. Future research should pursue similar studies in other locations to better understand how diverse residential environments impact wellbeing across multiple dimensions. Further, research should work to understand if the impacts of social capital and local environmental satisfaction hold true for subjective wellbeing beyond the pandemic

context. Inclusion of more robust measures of social health as its own dimension of wellbeing is also a priority for future research. Investigating if the strong connection between mental health and socio-demographic factors, with no impacts found from neighborhood characteristics or nature interactions, extends beyond the geographic and temporal context of this research could lead to improved mental health interventions.

Additional limitations of this research lie in the methods of measuring physical and mental health. By quantifying physical health as a count of only four specific diagnoses, and mental health as a combined option of anxiety and depression, these metrics may not capture the entirety of an individual's physical or mental health. Moreover, the survey questions ask if a medical professional has diagnosed the diseases, but some respondents may have the disease but not received an official diagnosis. Lastly, all health measures were self-reported yes/no questions and did not use recognized survey scales such as the Short Form Health Survey (SF-36), Patient Health Questionnaire (PHQ-9), Depression Anxiety Stress Scale (DASS-21), or Generalized Anxiety Disorder (GAD-7) that measure reported physical and mental health with more nuance and precision. Even with these limitations, my tripartite approach to measuring distinct aspects of wellbeing demonstrated internal validity in identifying significant relationships with particular explanatory variables in this study.

Future research should engage more with environmental justice concerns around the quality of parks and other natural features in underserved urban areas, and ways in which these neighborhoods can be redesigned to promote resident wellbeing. As previously discussed, park provisioning does not always lead to park usage, while park

amenities and perceived overall quality are important (Dillen et al., 2012; Larson et al., 2022; McCormack et al., 2010; Rigolon, 2016). Incorporating visitor information from parks along with larger datasets from fitness wearables and other technology is one method that could strengthen this type of research and reveal new patterns of park usage and associated health metrics (Guo et al., 2022).

As a rapidly-growing, car-centric, and arid urban area, the geographic context of Phoenix is unique. By investigating drivers of wellbeing in such a distinct context, this research highlights the importance of understanding how local factors influence residents, regardless of what research in other contexts supports. Further, the temporal context of the COVID-19 pandemic provides insight into wellbeing during a critical time in history and should be considered when designing spaces for improving local resilience (Doughty et al., 2022; Soga et al., 2021). Because locations experienced the pandemic differently, having a broad understanding of wellbeing during this time adds to the growing body of literature. Because of the comprehensive research design, this study furthers research on the importance of local context for wellbeing dimensions.

CONCLUSION

This comparative research highlights that differing individual, neighborhood, and social factors uniquely influence three different measures of wellbeing: life satisfaction, physical health, and mental health. This implies that designing sustainable landscapes for increased happiness needs to consider these dimensions and more to promote holistic resident wellbeing. This research on residents of select neighborhoods in the Phoenix

metropolitan area demonstrated that satisfaction with both the social and natural environments played an important role in their subjective wellbeing, but more research is needed to understand if the importance of social bonds for subjective wellbeing extends beyond this study's geographic and temporal contexts. Physical health in Phoenix was more dependent on desert preserve proximity and usage. Increased nature recreation during the pandemic had no significant effects on any measures of wellbeing, but residents living in proximity to desert preserves had improved physical health. Additionally, my findings revealed that socio-demographic factors most influenced mental health in Phoenix, even in relation to neighborhood characteristics and nature interactions.

Using a comparative perspective and analyzing multiple influences on different dimensions of wellbeing makes it possible to plan and manage landscapes for improved health. Urban planners aiming to increase wellbeing should use place-based information to successfully design happy and healthy neighborhoods. Specifically, planning for subjective wellbeing should focus on bolstering neighborhood social spaces based on local residential preferences and perceptions, while interventions for physical should target park quality and accessibility. A core tenet of sustainability research and practice is the advancement of wellbeing across the globe, and this research demonstrated that wellbeing is tied to the communities we live in. By implementing targeted local wellbeing interventions, achieving global wellbeing goals is possible.

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