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Health implications of the built environment: lessons for an evidence-based design

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Abstract

The purpose of the built environment had always been focused on protection from external hostilities (wild creatures, worse climatic conditions, etc.) and internal comfort. Recent studies suggest another spectrum regarding the physical and psychological implications of the built environment. As a specialized and crossed disciplinary area of research, the results are less than often conveyed and incorporated in the planning design practice. This research aims to develop a comprehensive base about the implications of built environment for incorporation in future planning and design. The evidence-based design approach was used based on the extraction and analysis of published research from JSTOR, Google Scholar, PubMed, and Scopus through single and combined keyword search, like evidence-based design; architecture and health; impacts of layouts; social capital; healing environment; stress reduction; social support; views of nature; daylighting; urban planning and health etc. The data was analysed for different levels of evidence and only those studies having excellent, good, and fair levels of evidence were included. The results were broadly categorized into two levels, the macro level (urban and regional planning), and the micro level (architectural level). The results of this study may improve the existing as well as future planning and design.

Keywords: impacts of built environment, social capital, view of nature, exposure to natural light, users' friendly design, evidence-based design, design and health.

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1. Introduction

The fact that environment weather natural or man-made affects the physical and psychological health of the inhabitants is now well established (Pinter-Wollman *et al.*, 2018; Handy *et al.*, 2002). Historically the creation of healthy places was one of the main focuses of architecture and planning (Collins, 2020). History shows that during the 19th Century, both professional from planning and public health worked together to resolve the health problems of the industrial city. In the 20th Century, both fields went apart because of the resolved epidemics caused by unhealthy city attributes. In recent years experts are suggesting a connection between these two disciplines. There have been a good number of papers in the support of possible reconciliation. (e.g., The City of New York, 2010; National Heart Foundation of Australia, 2009). A growing body of evidence demonstrates that lower residential densities, singular land uses, limited public transportation system, insufficient health, social service infrastructure, and lesser open spaces for the public are associated with multiple risk factors for non-communicable diseases like obesity, physical inactivity, and worsened mental health (World Health Organization, 2014; Planning Institute of Australia, Australian Local Government Association, & National Heart Foundation of Australia, 2009).

Today's humans spend more than half of their life inside building, about their entire life surrounded by man-made environment. Therefore, for planners and architects, it is of great benefit to consider the implications of their designs on human life and health for the design of a supportive environment. These impacts on human health can broadly be classified into two levels. Firstly, the macro level or regional planning, which includes the neighbourhood, town or city level environment. As we move out of any building, which may be a residence, a building of work, a recreational area or any other facility, we face the macro level, which consists of connectivity networks (streets, roads or paths of movement), transportation mood, land-use patterns, etc. that all impact human health and life in one way or the other. This macro-level environment is a distinct area of study and research generally referred to as urban and regional planning. At the micro level or architectural level, more and more studies focus on the health outcomes of ventilation, natural lighting, natural views, and greenery. Evidence-Based Design (EBD) and the "healing environment" concept focus on the connection between humans and nature and related health outcomes. Even interior design features and safety inside the building are the subjects of EBD and the healing environment. The impacts of the natural environment on humans have been discussed and practiced for decades however, the influence of man-made environment on human life is less discussed and practiced therefore, this study aims to explore this side of the built environment in the light of recent research for future consideration and implementations in the design of the built environment.

2. Methodology

This study adopted a descriptive-analytical method of research based on the exploration, extraction, and analysis of authentic published work in a holistic descriptive format. Database of JSTOR, Google Scholar, PubMed, and Scopus were searched by using keywords such as evidence-based design; health and building type; commuting and health; social capital; built environment; impacts of planning; health and architecture; greenery; daylighting; supportive environment, etc. The selected research was analysed for the evidence level and divided into three levels of evidence excellent, good and fair. Studies based on randomized controlled trials and systematic reviews were considered as excellent level evidence, while case-control and

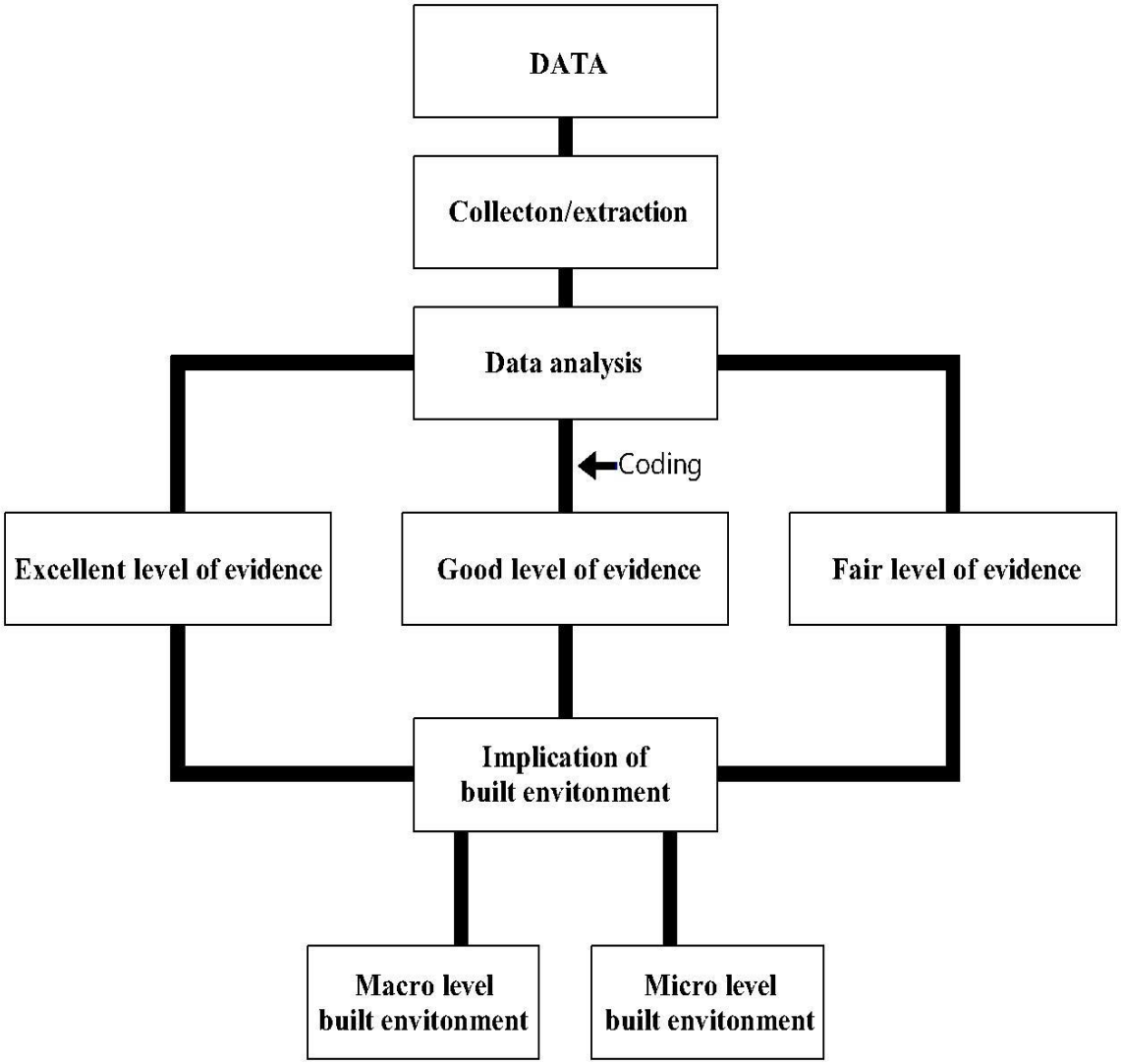
cohort studies were included in a good level of evidence. Finally, studies based on case series, case reports, and expert opinions, were included as fair evidence. Studies having evidence below the mentioned level were not included. The minimum standard for inclusion was a fair level of evidence or above. Studies published in the English language only were included.

Three ways for data collection were used as mentioned below.

- Single keyword search.
- Combination of two or more keywords.
- Through names of authors and researchers, well-known in the field of evidence-based design.

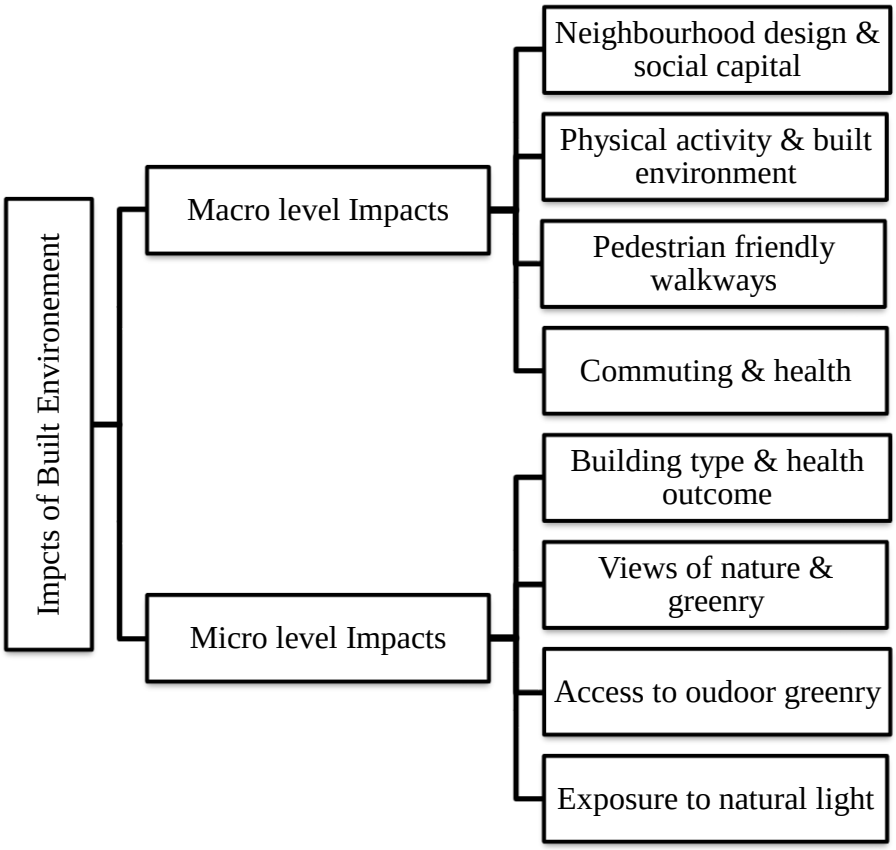
The selected research with evidence levels as mentioned above was then broadly categorized into two levels i.e., macro level and micro level. Further subdivisions in both categories were made for easy understanding of the specific planning or design considerations.

Figure 1: Conceptual framework of the study



3. The impact of built environment at the macro level (regional planning)

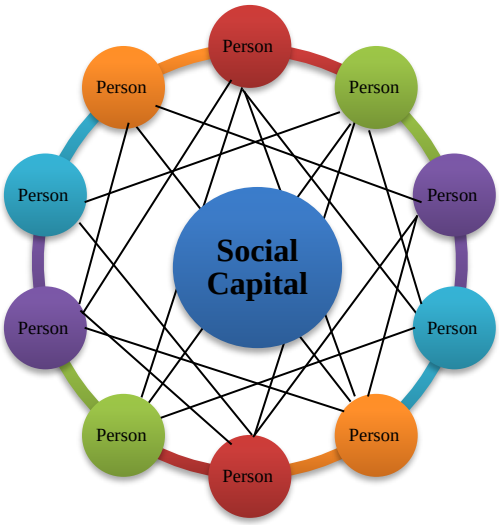
Figure 2: Categorizations of the built environment



3.1. Neighbourhood design and social capital

At the macro level, neighbourhood design plays a vital role in the improvement of human health for instance, providing green spaces to residential communities can increase informal contact and create strong social bonds between neighbours (Alhusban *et al.*, 2019; HAPI, 2014; Towle *et al.*, 2006; Kuo *et al*., 1998). Another study shows strong evidence that many diseases including the common cold, heart attack, stroke, cancer, depression, and premature death are inversely associated with social and family relationships, religion, and membership in other groups. Poor social capital is equal to or worse than elevated blood pressure, smoking, physical inactivity, or obesity, the study added (Putnam, 2000). Suicide, tuberculosis, accidents, schizophrenia, coronary artery disease, alcoholism, and pregnancy complications were reported as the harmful health effects of weak social ties (Lindheim & Syme, 1983). While the street patterns of grid and cul-de-sac are debated from the functional point of view in urban planning, although grid street pattern residents were found with an increased sense of community, neighbourhood friendliness, convenience of shopping and school, it also shows that people prefer circular and dead-end designs over grids (Berman, 1996). However, the grid has the lowest distance from the park and the most visited outside neighbours in the dead zone. Further research shows that to enhance sociability, specifically for children's play and safety, the majority of traffic experts recommend street patterns of the discontinuous type such for instance cul-de-sac and conventional loop patterns. These street designs regularly show decreased accident rates and increased safety levels (Grammenos *et al.*, 2002).

Figure 3: Social capital network of people



3.2. Physical activity and built environment

World Health Organization (WHO) recommends creating physical environments that support physical activity to control noncommunicable diseases (Sallis *et al.*, 2020). A large number of researches with solid evidence reported the health benefits of participating in physical activity on a regular basis (Janssen & LeBlanc, 2010; Warburton *et al.*, 2006) and reduced risk of major chronic diseases, especially heart disease and diabetes of type 2 (Sallis *et al.*, 2020; US Preventive Services Task Force, United States. Office of Disease Prevention, & Health Promotion, 1996). Globally, physical inactivity kills around 3 million people yearly or 8 percent of the total deaths from Non-Communicable Diseases (NCDs) (Beaglehole *et al.*, 2011). Estimates suggest that eliminating physical inactivity would add 0.68 years (0.41-0.95 range) to the life span of individuals (Lee *et al.*, 2012). According to data from 122 countries, one in three adults is physically inactive, which ranges from 17 percent in Southeast Asia to 43 percent in the Americas and Eastern Mediterranean (Hallal *et al.*, 2012). From the above perspective, certain characteristics like street connectivity patterns, residential densities, and land-use mix were found positively associated with transportation and pedestrian recreation (Saelens & Handy, 2008; Sugiyama *et al.*, 2012; Sallis *et al.*, 2012). Research shows that high densities and mixed-used developments increase the activity of pedestrians and cyclist's activity (Berman, 1996; Cervero, 1996). Availability and accessibility of destinations such as local shops, services, transit points, and green spaces have been reported to be potential predictors of pedestrian movements (Sugiyama *et al.*, 2012; Forsyth & Krizek, 2010).

3.3. Pedestrian-friendly walkways

Studies showed that the sidewalk, bustling streets, and pleasant scenery promote walking (Brownson *et al.*, 2001). Another study by Berman (1996) reported that road adjacency, mixed land uses and small plots indicate frequent use of winding sidewalks, while sidewalks separated from streets and human activity are not used. Another study demonstrated that traffic congestion, excessive noise, poor lighting, and lack of public transport could all lead to inactivity in adults of 55 and older (Balfour & Kaplan, 2002). Findings of the research shows

that properly designed walkways improve pedestrian activity and unstructured exercises in the residents.

3.4. Commuting and health

One of the common problems of urbanization today is urban sprawl, which is related to the increased use of automobiles. Research shows that sprawl living is associated with decreased social capital (Putnam, 2000). Raza *et al.* (2021) showed that commuting long distances were associated with higher likelihoods of overweight, disturbed sleep, and physical inactivity. Many studies suggest that the widespread use of cars increases asthma rates. From 1980-95 the rate of asthma doubled in children, coinciding with the period of more cars and urban congestion (Jackson & Kochtitzky, 2001). Their research also reported that when car entries were restricted to the 1996 Olympic Games of Atlanta, subsequently a 22.5% decrease in driving was observed and the hospital admissions record showed a decrease of 41.6% in asthma patients, while other medical events remained the same.

Another research study conducted in southern California showed that expecting mothers exposed to high levels of car exhaust were three times more probable to give birth to a newborn with severe heart problems (Ritz *et al.*, 2002). Automobile emissions were found to be associated with school absences and bronchitis in youngsters and amplified vulnerability to different allergens (Jackson & Kochtitzky, 2001). Commuting long distances by transit or car results in increased absentees and accidents at work (Costal *et al.*, 1988). Research shows that commuting time decreases community involvement and every additional 10 minutes of commute time decreases involvement in community activities by 10% (Putnam, 2000). Road rage commonly known as excessive driving accounts for 56 percent of all fatal car crashes (Frumkin, 2002). This rate was highest in sprawling areas with a predominant reliance on cars and lowest in areas with proper streets and sidewalks (Frumkin, 2002).

4. The impact of built environment at the micro level (The architectural level)

4.1. Building type and health outcomes

Children living in high-rise apartment buildings were found to be less physically active, have behavioural problems and breathing related diseases, while stay-at-home women were found to be neurotic and socially isolated due to the same (Evans *et al.*, 2000; Wells, 2000; Lindheim & Syme,1983). Lindheim and Syme (1983) suggest that children under the age of five and their mothers are most negatively affected by high-rise apartment housing, while younger and older adults may prefer such type.

4.2. View of nature and greenery

Many research studies demonstrated that viewing and experiencing nature reduces stress levels (Ulrich, 1979; Jackson, 2003). Public housing with nearby trees were found associated with decreased levels of domestic violence (Sullivan *et al.*,1996). Windows with views of greenery instead of pavement or bare dirt were found with enhanced cognitive function (Wells, 2000). Ulrich (1984) reported about the faster recovery of patients in a post-operative room looking at greenery through a window compared a patient looking at a brick wall. Leather *et al.* (1998) observed that employees with a natural view report better health, less stress, and higher job

satisfaction. Studies by Keep *et al.* (1980) and Parker and Hodge (1967) show that lack of window is associated with depression, higher level of anxiety, and delirium in the intensive care unit (Ulrich,1984).

4.3. Access to the outdoor greenery

Various studies found that aesthetically pleasing parks with trees, sidewalks, and retail outlets encourages physical activity (Giles-Corti *et al.*, 2003; Giles-Corti & Donovan, 2002). Park access was negatively associated with the development of obesity, and mental health was empirically linked to landscaping and urban parks (Ernstson, 2013). Another study found that residents having increased green spaces adjacent to their dwellings were found to be less affected by traumatic life events than residents with lesser green space, implying that green spaces can decrease stress (Van den Berg *et al.*, 2010). Louv (2005) shows that children who do not have access to urban green spaces suffer from a range of behavioural problems. Timperio *et al.* (2005), found that children who visited parks and recreation more were more active than children who visited fewer parks and recreation areas, and most adults had similar results. Active modes of transport, such as walking and biking, incorporate physical activity into your daily routine and reduce obesity (Giles-Corti *et al.*, 2003; Wolch *et al.*, 2014).

4.4. Exposure to natural light

Many people prefer to work in an environment with a window shown by the results of extensive post-occupancy assessments and office building surveys. According to this study, people generally feel more energetic, refreshed, and better when the sun shines and instead, they feel depressed when it is cold or cloudy. Insufficient sun exposure and low dietary intake are often the cause of clinical vitamin D deficiency (Boubekri, 2008). Older adults, bedridden people, people who live or work in environments with no windows, and people who live or work in high-density areas with limited sun exposure are more expected of vitamin D deficiency (Boubekri, 2004).

Seasonal changes in serum 25(OH)D concentrations (vitamin D) due to sun exposure were found of highest in free-living subjects, regardless of vitamin D dietary supplements, and decreased significantly and proportionally as subjects became less mobile (Webb *et al.*, 1990). Seasonal Affective Disorder (SAD) is another well-known light effect related to the endocrine system. About 10 million Americans suffer from this disease. research have demonstrated a positive relationship between people's susceptibility to SAD and exposure to natural and sunlight. People with SAD report exacerbation of depression when the sky is overcast or when room lighting is reduced at any time of the year (Nayyar & Cochrane, 1996). People suffering from SAD living in northern latitudes have noticed that winter depression worsens as they move more toward the north (Lam *et al.*, 2001).

The amount of light that is thought to treat a variety of conditions, including seasonal affective disorder, combating depression, and providing the amount of light needed for photosynthesis to stimulate the body's release of vitamin D secretion inside the human body, is often several times higher than recommended for lighting levels (Boubekri, 2008). In a psychiatric hospital half of the patients were exposed to sunlight observed that patients in a bright room stayed on average 2.7 days less than patients in a dark room (Beauchemin & Hayes, 1996).

5. Conclusion and recommendations

Based on this research it could be concluded that certain planning and design decisions provide an overarching physical and psychological health outcome. These benefits or otherwise may impact not human health and life but also improve performance and benefits of health in terms of productivity, the lesser occurrence of certain diseases, and even prolonged life span. A small planning and design intervention will improve human health, bring economic benefits, decrease health expenditures, and create a healthy and progressive society. This study could be concluded in the below-mentioned planning and design considerations:

- Planning and design of the neighbourhood not only effects the overall health but also decreases the occurrence of many non-communicable diseases. Therefore, it is essential to consider future developments' elements, patterns, and environments that encourage and support activity, community participation, and enhance safety.
- Urban and regional developments need to consider lesser vehicle dependency, compact planning, and walkable destinations.
- Places at the neighbourhood level need to be designed which may support physical activity and increase social capital.
- Street connectivity, residential densities, land-use mix with pedestrian recreation, transportation, availability, and accessibility to local shops, transit points, services, and green spaces need to be considered for boosting physical activity.
- The presence of adequately designed sidewalks, bustling streets, pleasant scenery, road adjacency, mixed land uses, and small plots may also be assessed for generating physical activity.
- High-rise building designs need to be considered for specific types and age groups of users and are not a general fit for all.
- There is substantial evidence about incorporating green spaces at the building and neighbourhood levels and the related health outcomes.
- Greenery should not be considered a luxury but a health requirement for the residents of the built fabric. Views of greenery and nature may be incorporated for better health performance and reduced stress. While access to outdoor and green spaces if possible may be considered for increased health benefits.

Declaration of conflict of interest

The author(s) declared no potential conflicts of interest(s) with respect to the research, authorship, and/or publication of this article.

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