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## IMPACTS OF DAYLIGHT ON IMPROVING HEALING QUALITY IN PATIENT ROOMS: CASE OF SHORSH HOSPITAL IN SULAIMANI CITY

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### ABSTRACT

Nature provides important design solutions whether in architecture or other sciences and arts. Biophilia is an innate human desire to be connected to nature and biophilic architecture is bringing nature to indoor environments. The positive effects of biophilia are especially interesting in healthcare facilities due to extreme stress elements in those spaces. The architecture of hospitals can affect the health and well-being of patients and staff. Therefore, the main purpose of the present research is to understand the relationship between a patient's health and their physical environment, which specifically addresses using natural light as a biophilic technique in the patients' rooms. Most patients' restrooms were built without windows and depend on artificial lighting. This paper, impacts of daylight is investigated through a detailed questionnaire which handed to 155 patients of Shorsh Hospital randomly of both gender aged between (18-40 years old), they were asked to indicate their opinions about lighting conditions in their rooms and its impacts on their health and recovery. According to the findings, using the biophilic technique (natural light) specifically inside hospital rooms support physical and psychological wellbeing and accelerates the healing of the patient. Therefore, architects and designers should try to bring daylight into hospitals to upgrade the qualities of these environments skillfully.

**Disciplinary:** Architectural Science (Daylight in Buildings).

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## 1. INTRODUCTION

As indoor environments are affected by several elements, humans being directly affected by indoor environments. Well-designed indoor environments make people feel comfortable and more active. The elements start from the structure and form of the building, and complete with color, light, furnishings, and other details. One of the most important elements that affect indoor environments is light. Architects can develop their designs for interior environments by understanding the importance

of light (Dalke et al., 2006).

In these days, biophilic design is being regarded as a harmonious approach for dealing with workplace stress, student performance, patient healing, and other familiar challenges to health and overall well-being. The high standard biophilic design is a design that powerfully reduces stress and anxiety inside the build environments and improves the physical health of the users – can be attained by providing a useful connection with nature, without requiring trendy industry alliances of architecture. As the practice of biophilic design needs applying different design strategies, Kellert & Calabrese (2015) introduce a guide or framework of biophilic design strategies and classified nature experiences into three categories that include 24 biophilic attributes. One of the biophilic patterns applying in buildings is daylight.

Light is a part of the electromagnetic spectrum that is in contact with retinal receptor cells. Human eyes receive and transmit them to the brain. Receiving range based on the characteristics of the environment (Jiang et al., 2017). Having light as an integral part of the universe of creation, we cannot imagine life on earth without lighting. A human being is Bioclimatic Creatures, has a strong dependence on the light. Any disruption in receiving desirable illumination can cause different consequences for humans. Lighting is always an inseparable part of the human environment; around 80-85% of our communications with the outside world are performed by visual senses (Almusaed & Almssad, 2006).

Lighting quality in an environment requires the integration of three important factors, including human needs, factors related to architecture, and economic-environmental considerations. Human needs mainly include the ability and ease of vision, the ability to communicate with the environment, aesthetics, health, and comfort. Providing appropriate quantity and quality, light for a deep perception is an environmental factor. Ming et al. (2011) shown that the improvement in brightness intensity has increased 5% of human performances in their environments, which can be attributed to improved visual acuity, biological effects of brightness, and psychological effects.

Human activities affected by the intensity, type of source, color, direction, and method of light distribution in different environments by affecting his behaviors, morale, efficiency, and effectiveness. Among these, the role of natural light as the most complete and most desirable light is undeniable.

Patients are among those who normally spend more than one hour in a closed environment without having the opportunity to enjoy natural light. The darker the hospital, the more staying time of patients, which leads to depression and anxiety. And most of the healthcare spaces depend on artificial light which causes serious damage to the eye retina. In this case, our eyes protect themselves with the continuous blinking mechanism. Dalke et al. (2006) shown that the lamps and other artificial light are more tedious than normal light. Incomplete or undesirable lighting, in addition to the effects of the lens on the visual system, can include effects on the mental, neuropsychological, and physiological effects of the patients. Too much exposure to artificial lights has many harmful effects include eye fatigue, headache, visual impairment, and an increase in accidents due to lack of light or glare and sight (Knez, 1995). Therefore, in terms of meeting patient health, safety, and ergonomics needs, hospitals require achieving all the components of optimal daylighting

This study examines the impacts of daylight in improving the health of patients in hospitals. Exposure to light during the hours of the day has a significant impact on the physical and mental health of individuals. Increasing efficiency, reducing harmful accidents, increased mental capacity, increased satisfaction, and more pleasures are Advantages of using natural lighting in the patient rooms. Daylight, in addition to preventing patient's tiredness, improves their morale and satisfaction. The installation of windows that are sufficiently luminous can make the healing environment pleasant and comfortable and add to the health and wellbeing of people. Also, desirable illumination can improve satisfaction, comfort, alertness, mood, and quality of working in workplaces.

## **2. LITERATURE REVIEW**

### **2.1 BIOPHILIC ARCHITECTURE**

In architecture, biophilia refers to a concept that imitates the conditions of a natural environment. Almusaed (2011) said it is the integration of nature within urban spaces to make buildings alive, It aims to re-establish the link between the individual and nature in our daily living and working spaces. Biophilic design is the answer to the human need to be connected to nature and aims to reestablish this link in the built environment. In other words, biophilic design is the theory, science and practice aimed at creating buildings inspired by nature and maintaining a connection to nature in the environments in which we live and work every day (Kellert & Calabrese, 2015). Daylighting is one of the most important patterns of biophilic architecture.

### **2.2 SPECTRAL CHARACTERISTICS OF DAYLIGHT**

The light is part of electromagnetic waves, which is received in contact with human retina receptor cells, then the signal is transmitted to the brain. Physiologically, for a healthy person, light waves are within the range of 400-700 nm in the color spectrum. Daylight is a form of energy radiation from the sun. It is an important part of our daily lives that vary according to where we are, the time of day and the season. This light ray will be reflected or absorbed by an object and surface that it will reach. (Knez, 1995).

In the old days, people often use sunlight and spend themselves outdoors but nowadays humans spend most of their time in an indoor environment that filled with artificial light. Daylight was the main source of lighting for a building until 1940 when artificial light was discovered (Yin et al., 2018). However, despite its significant improvements, an increase in electric power consumption, health, and environmental danger, is a result of reviving the use of natural light as the main source of indoor lighting. Daylight is a renewable natural resource that its contribution does not require any technological transformation.

### **2.3 DAYLIGHT, HUMAN BODY, AND HEALTH**

Since the eye remains the main gateway to the waves of the light spectrum, the daylight is as vital as air and water for human beings. our brain has a biological clock, which needs daylight to adjust itself. A lack of natural light has dangerous consequences. In the morning, light appears mostly in green-blue tones, while it is rather reddish in the afternoon. Brains are perfectly regulated on this natural cycle. When the eyes register a blue-green light, the brain "knows" that it is morning (Locke & Latham, 1990).

The use of daylight in indoor environments improves the health of occupants. "People who are more exposed to natural light are physically more active, their sleep quality and quantity are much better also have a higher quality of life than others," (Shishegar & Boubekri, 2016). They also indicated that exposure to light, especially during the day and in the morning, will have a positive effect on the health of people as a result of their impacts on mood, metabolism and level of consciousness.

Another important benefit of daylighting is reducing CO<sub>2</sub> level which causes many health issues, artificial light in workplaces increasing CO<sub>2</sub> by consuming energy. Other studies report indoor energy consumption of 30% is attributed to consumption for artificial lighting (Parise & Martirano, 2013). The use of natural light represents a substantial saving in consumption that leads to a significant decrease in CO<sub>2</sub>. Optimum use of daylight in buildings also contributes to the more rational use of heating and air-conditioning systems that consume energy and acoustically distracting.

Daylight can also help to improve the posture of the body (the position of the body) and prevent light-related skeletal disorders. Light can push or delay the biological rhythm by altering the balance of the body's hormones. This agent can affect the sleepiness or alertness of individuals. The quantity and quality of lighting influence the mental health and performance of individuals. Therefore, allowing entering sunlight to indoors is essential for providing better health physically and psychologically (Shishegar & Boubekri, 2016). Table 1 demonstrates the multiple benefits of having natural light in the buildings.

**Table 1:** Natural light benefits for human health (Shishegar & Boubekri, 2016).

Physically		Psychologically	
Improve	Decrease	Improve	Decrease
Vitamin D	Cancer Possibility	Mood	Depression
Visual System	Abnormal Bone Formation	Mental Performance	Stress
Circadian Rhythms		Alertness	Sadness
Sleep Quality		Brain activity	Violent behavior

## 2.4 DAYLIGHT IN HOSPITAL

Healthcare centers are built aims to treat patients and improving human well-being. The interior design of the therapeutic space is an integral part of the design quality of the environment. Research shows that Therapeutic environments need high flexibility, security, intimacy, and relaxation as these spaces that lead to anxiety and panic in users, Lack of attention to physical design and interior design in therapeutic areas causes users dissatisfaction (Ryan et al., 2014). Figures 1, it is important to provide factors that needed for healthy hospital environments. Hospital lighting is an essential environmental factor in providing users with the right healing conditions (Kellert & Calabrese, 2015).

It is essential to have the optimum amount of light in the design of therapeutic settings to identify important areas such as reception and nursing stations. Make it easier and faster to find paths, reduce workforce, stress and confusion, and waste of time.

The amount of light, whether natural or artificial, is represented by the level of illumination; (Kradić et al., 2013). The luminance is expressed in lux. When the sky is cloudy, an intensity of about 1000 lux is measured outside. The light intensity measured on a sunny day exceeds 10,000 lux.

Far below the levels of illumination necessary to accomplish quality-healing environments, the optimum amount of light you need depends on the type of activity you do. Besides the amount, the placement of windows in hospital rooms should be considered according to sun orientation to avoid direct exposure that leads to depression and eye pressure (Ulrich et al., 2004).



**(a):** Most modern Healthcare spaces Controlled by technology lead to Stress and anxiety.



**(b):** Healthcare spaces with view to nature and daylight provide more healing quality.

**Figure 1:** Comparison of healthcare with architectural environment design (after Kellert & Calabrese (2015)).

## 2.5 IMPACT OF DAYLIGHT ON PATIENT'S HEALTH AND RECOVERY

The benefits of daylight in health centers include brightness, reduced heating costs, as well as better physical and mental health for staff and its patients. The patient wants a quality environment, he needs to be under the supervision of the medical staff and able to see them. In terms of access, clear signs, visual clues, and navigation make it vital for visitors and patients to enter the hospital for the first time because they are anxious and distracted. Patients want access to the world outside the hospital. It has many effects on the human body and psyche and mental and physical health. It will also have a decisive role in improving the disease (Hauge, 2015).

Aripin (2007) demonstrated the positive outcome of natural lighting on patients' health and recovery process in addition to its benefits on hospital staff and the environment of the hospitals. Aripin (2007) focused on physical aspects that affect daylighting designs of wards, including building orientation which is an important criterion to create sustainable healing environments, window design which physically psychologically and mentally affect patient and hospital staff, Access to view which accelerate the process of recovery from the illness which psychologically aids the patients. Visual comfort should satisfying patients to achieve sustainable hospitals, artificial lighting, natural light design with the help of artificial lighting should be pursuing to provide a comfortable environment for patients, color is another physical aspect that should be considered to sustain hospitals that affect the patient's perception the environment.

McSweeney et al. (2019) investigate the impact of indoor exposure to sunlight on psychological stress makers in hospitals, under two conditions, one with sufficient natural light and another with

covered windows. Change in physiological stress measured through heart rate variability HRV and a survey of how participants feel their exposure to natural light. The results concluded that indoor natural exposure can provide relief from stress resulting from the parasympathetic activity.

Totaforti (2018) focused on the impacts of windows in designing hospitals. The study showed the evidence that views of natural landscapes reduce post-operation hospital stay by 8%, Serotonin hormone can be boosted by daylights which lower the pain perception by 22%. The study concluded that too much exposure to artificial light in a patient room cause psychological and physical problems, like headaches, eye pressure, fatigue, depression.

Proper lighting in the hospital environment improves the body's biological cycle, transparency and visual clarity in the environment, reducing occupational errors, reducing hospital stay, and reducing pain. Reducing the feeling of depression, increasing the positive feeling in the hospital environment (Ming et al., 2011).

### 3. METHODOLOGY

To understand the impact of lighting on human health and wellbeing in hospitals in the term of recovery of patients during their hospital staying time, a survey is used as a method for data collection. Participants were day-patients from different rooms of Shorsh Hospital in Sulaiman. Patients' staying time was from 08:00 am to 5:00 pm. Participant's ages were between 18-40 years with the mean age 30 years old. Participants were told that the study is about the impact of daylighting in their rooms on healing and recovery. Out of 155 questionnaires that were randomly distributed, 120 were returned (48 female and 72 male). The questionnaire includes questions regarding their restrooms lighting conditions, duration of current light level exposure, and impact of that condition on their health, recovery, and psychological health throughout the day. A qualitative approach was used to demonstrate the significant relationship between the patient's perception and lighting design used inside hospital spaces. The Statistical Package for Social Sciences (SPSS) software program was used to analyze data.

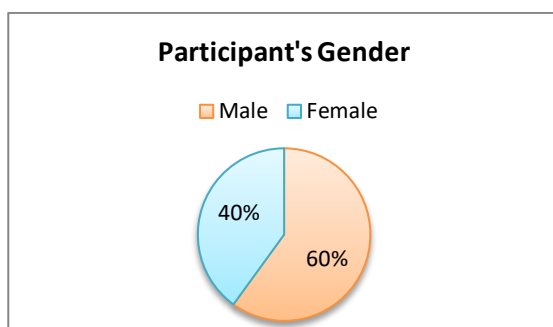


Figure 2: Participants gender

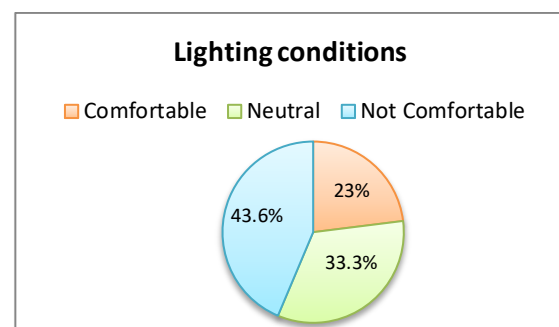
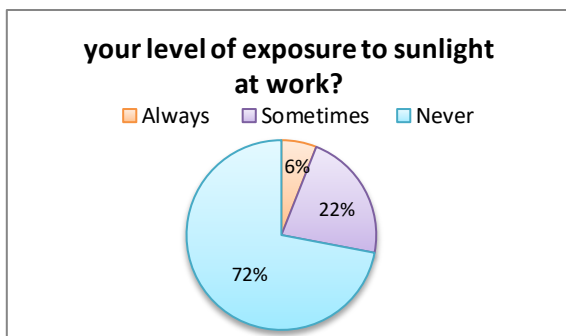


Figure 3: Hospital lighting conditions

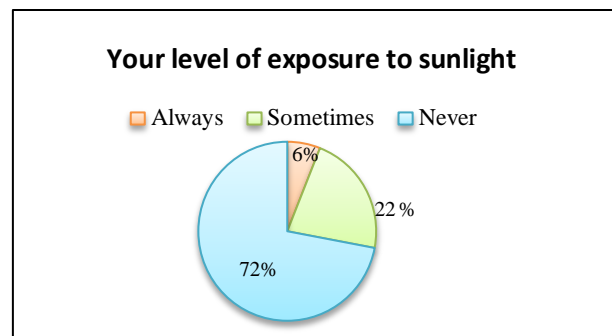
### 4. RESULTS AND DISCUSSION

According to a questionnaire question (How is the lighting condition in your room), illustrated in Figure 2 that most of the patients were not satisfying with the indoor lighting condition out of 120 participants, 52 thought that it's not comfortable and 40 patients rated neutral, only 28 (23%) were comfortable with it. So the lighting conditions in that hospital need improvements due to the survey answers. Most respondents do not feel comfortable with the hospital lightings, Figure 3.

One of the questionnaire questions is for investigating types of lighting that mainly used for illuminating patient's rooms. According to the answers, we found that rooms in Shorsh Hospital do not depend on natural daylighting. Only 21% rated that the main source of indoor illumination is daylight, 47% stated that their rooms use artificial light. And some rooms depend on both natural and artificial light, (Figure 3). The amount of patient's exposure to sunlight during their recovery time was recorded, while many researchers concluded that daily exposure is necessary for human being both physically and mentally, but the most patients in Shorsh hospital as we see in Figure 4 have lack of sunlight exposure, as 72% of respondents said never expose to sunlight daily. Only 6% of them have a chance to always expose to the sun. this finding is quite aligned with the finding of Raanaas et al. (2012) which they investigate the lighting condition on 'lung' and 'heart' patients at the rehabilitation center.

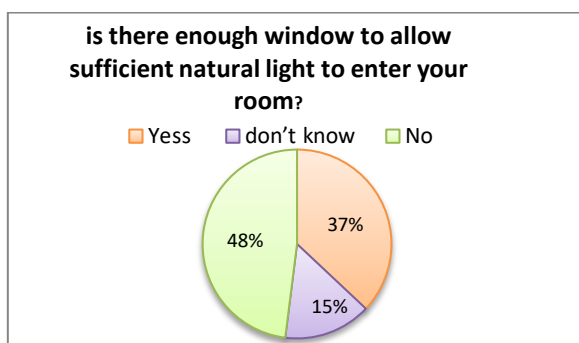


**Figure 4:** Main source of lighting.

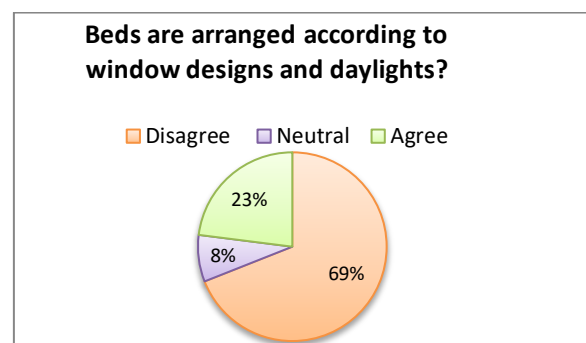


**Figure 5:** Amount of patient's sunlight exposure

The sunlight entering indoor environments through the window opening, the most important factor to let maximum natural light enter and spread its benefits is window designs (Kradić et al., 2013). Another question was "do you think that there is enough window to allow sufficient natural light to enter your room?" 48% said "No" while 15% doesn't have enough windows (Figure 6).



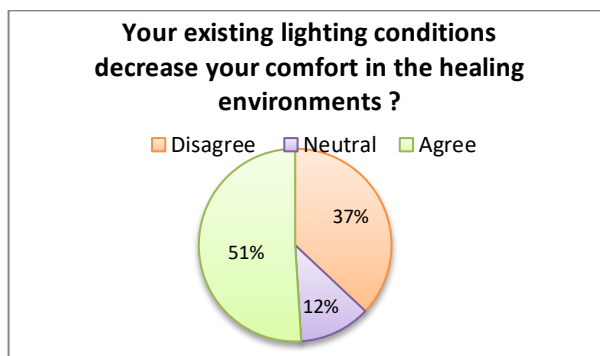
**Figure 6:** Does your room have enough windows?



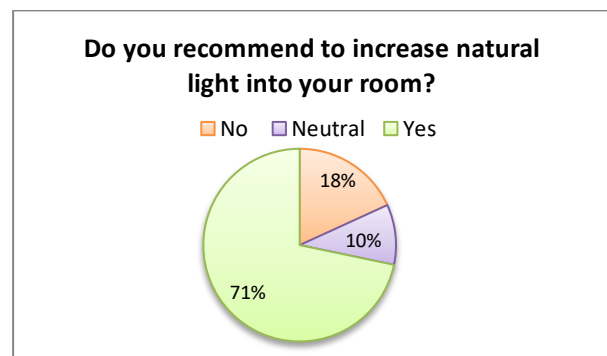
**Figure 7:** Arrangements according to sunlight

Beside maximizing the windows and adding skylights, Ming et al. (2011) demonstrated to make full use of daylight inside healing areas by arranging furniture according to the sunlight, as surgical and medical process requiring more accuracy and light near windows. In this survey (Figure 7). most participants 69% of the respondents were disagree that furniture in their recovery rooms arranged according to sunlight. It indicates that the design conditions according to natural lighting are poor in this hospital in Sulaimani city and need improvement in terms of using daylights.

The questionnaire intends to investigate whether there is a correlation between patients health and recovery with their lighting conditions, there is a strong correlation between exposing to natural lighting and increasing healing process in hospitals, as in the 2nd questions most of them were not comfortable with their lighting condition and according to 47% of them the main source of lighting were artificial lighting. here in the question about their wellbeing (Figure 8) 51% associated poor healing environments to the poor lighting conditions and lack of daylights, while 37% of the respondent wont distracted by the lighting conditions and believed that natural lighting don't increase their satisfactions in their bedrooms. So majority of the respondents supported the idea that natural light affect hospital spaces positively and 71% of them recommended to have more natural light inside their rooms, while 18% of those participant that do not associate lighting with their healing process did not recommend increasing natural light (Figure 9).



**Figure 8:** Effects of lighting on patient's performances



**Figure 9:** Patient's preferences for natural light

The results of this questionnaire indicate a relationship between the patient room's daylight and healing quality. Patients in rooms with enough Windows not only had more light exposure but also increase their comforts and satisfactions to the hospital environments. After analyzing the survey we can conclude that lighting conditions in most of the rooms of Shorsh Hospital are poor as %43 of the patients were not comfortable with it. Figure 8, 51% believed that their existing lighting conditions decrease their healing perception. So the hospital needs lighting design improvement. Building design should be so that more sunlight allowed entering the buildings of healthcare as it affects patients' perception in the healing environments and improves the space quality, as the goal of all healthcare facilities is to increase patients' health and recovery from illness.

Many techniques can be done to maximize natural light, one of them is expanding windows and arranging restroom beds so that patients get enough light, but none of them achieved in these hospital rooms. Besides increasing sunlight amount window in hospitals let outdoor views and other roles that were not taken into account in this paper .views have psychological effects for humans while daylight has physiological benefits. Future investigations s may be able to uncover the various benefits of views of windows.

#### 4. CONCLUSION

This study investigated and analyzed the roles of daylight on increasing healing quality and patient's satisfaction in healthcare spaces. Biophilic design, use of natural elements/resources in an indoor environments. Use of natural light and avoid immersing interiors in artificial light is an



important pattern of biophilic design. The result of this study show that architects and designers should be concerned with the effects of natural factors on the design of healing spaces to provide comfortable hospital environment for patients and accelerate healing. Proper design of the daylight system besides contribution to minimizing environmental impacts, also promotion the creation of a healthy and comfortable environment for the occupants.

Too much exposure to artificial light in the patient room cause psychological and physical problems, like headaches, eye pressure, fatigue, depression .while, Sunshine is the healthiest, cheapest light source and one of the most important sources of light energy supply. Using natural light in the patient room avoids disappointment and frustration. It is also an effective approach to create comfort and increase self-confidence throughout the day. It also provides better mental satisfaction and comfort.

Daylight directly improves the health and productivity of individuals.it is said to be the source of mobility and motivation. Those who stay in a natural light environment will significantly improve their health, happiness, and comfort which are the results of faster patient recovery. Therefore providing daylight to the patient's room should be considered as a priority in the architecture and design of the healing spaces. More researches are required to investigate building techniques that optimizing the benefits of natural light in buildings.

## 5. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

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