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The effect of hospital design on indoor daylight quality in children section in King Abdullah University Hospital, Jordan

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ABSTRACT

The purpose of this study is to evaluate and analyze the indoor daylight quality in Pediatrics Ward in King Abdullah University Hospital (KAUH). It conducts an investigative analyses associated with an evaluative approach for the daylight situation in patient rooms in the children sections in KAUH. A multi-method approach was undertaken including on-site measurements, and building simulation software (RADIANCE) to develop a framework for lighting design in Pediatrics Ward.

Daylight conditions were assessed in the hospital site to investigate light quality. A patient room from the Pediatrics Ward in wing A in the hospital was selected. The study considered the following variables: the differences in daylight environments (illuminance, luminance level, and daylight factor), and the physical environment properties of patient rooms in the hospital.

The study found that the indoor daylight performance in terms of illuminance, luminance level and daylight factor in patients rooms are higher than the recommended values by CIBSE. Therefore, attention must be paid to the effect of the surface characteristics, reflectance values of room surfaces, and the physical properties of glazing materials on daylight quality in the hospital. In addition, sun-shading elements must be provided in patients' rooms, to avoid excessive glare and to guarantee a good level of visual comfort for patients and staff.

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1. Introduction

The goal of the healing environments is to provide non-institutional surroundings and a sense of calmness for patients, staff, and visitors. Daylighting is one of many adopted strategies to create these environments (Edwards & Torcellini, 2002). In addition, human preferences in building design are based on occupants' satisfaction with their indoor environments. Views and daylight through windows in buildings are recognized as an important factor in increasing the Indoor Environment Quality (IEQ) (Choi, 2005; Prakash, 2005).

Hospital environments present special challenges continuously during the running time of the hospitals. Several studies that are related to healthcare design showed a gradual dissatisfaction from hospital environment, such as comfort, lighting, IAQ, temperature, humidity, and noise.

However, there is a lack of studies in Jordan that deal with architectural efforts to address the indoor daylight quality in hospitals. In fact, Jordan needs intensive research to address healthcare facility problems such as lighting in patient rooms, daylight level, and other necessary conditions for patients' satisfaction.

This study attempts to cover research shortage in this field. By evaluating and analyzing the daylight environments (illuminance, luminance level, and daylight factor) in Pediatrics Ward in KAUH in Jordan through different methods of inquiry, in order to determine whether the current quality meets the recommended values for a patient rooms or not.

1.1. Daylight and views in hospitals

Reported benefits of natural light in hospitals and assisted-living communities are advantageous for lighting and heating costs as well they improve physiological and psychological states for both patients and staff (Edwards & Torcellini, 2002). Exposure to natural sunlight has been associated with improvement in mood, reduced mortality among patients with cancer, and reduced length of hospitalization for patients who have experienced myocardial infarction (Walch et al., 2005).

Recommended lighting levels for patient rooms are 200–220 lux while ensuring at least four types of lights – general, reading, examination and night lighting (Phiri, 2003), see Table 1.

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Table 1
Recommendations for a patient room (illuminance at floor level) (CIBSE, 2002).

	Maintained illuminance (lux)	Limiting glare rating	Minimum color rendering (Ra)
General lighting	100	19	80
Reading lighting	300	19	80
Simple examinations	300	19	80

Recent studies correlated the relationship of medication errors to lighting levels. As lighting intensity approaches 1500 lux, the incidence of medication errors dramatically decreases. Poor lighting and lack of daylight are linked to depression, increased need for pain medication, medication errors, and order entry errors (Dickerman & Barach, 2005; Joseph, 2006). Adequate and appropriate exposure to light is critical for the health and well-being of patients as well as staff in healthcare settings (Joseph, 2006).

The importance of natural sunlight to healing has been explored in a number of studies (Schweitzer, Gilpin, & Frampton, 2004). Much of the research suggests that access to sunlight has positive effects on patient outcomes and patient and staff satisfaction (Nelson, West, & Goodman, 2005). Studies have shown that daylight can reduce the mental and physical strain of patients, doctors, and nurses (Edwards & Torcellini, 2002), and reduces depression among patients with seasonal affective disorder and bipolar depression (Joseph, 2006; Nelson et al., 2005). It minimizes pain, shorten hospital stays, and improves the ability to perform visual tasks. It also has positive effect on sleep and circadian rhythms among patients, and eases pain and agitation in those suffering from dementia (Joseph, 2006), and thus, supports the healing process.

Furthermore, exposure to light is useful for vitamin D metabolism in the human bodies. Light exposure also is used as a treatment for neonatal hyperbilirubinaemia (Joseph, 2006). It is also beneficial in reducing lighting and heating costs (Edwards & Torcellini, 2002).

According to a study conducted at the Department of Neuropsychiatric Sciences at the University of Milan, bipolar patients assigned to rooms with more sunlight had a mean 3.67-day shorter hospital stay than patients with the same diagnosis in rooms with little or no sunlight (Nelson et al., 2005).

Studies examining the effects of natural sunlight on the recovery of patients with refractory, bipolar, and SAD have demonstrated a decreased length of stay (LOS) among patients exposed to increased light intensity (Walch et al., 2005).

Exposure to natural light or artificial high-intensity light has been associated with reduced depression for pregnant women, reduced mortality from ovarian, breast, and colon cancer, as well as reduced hospital mortality and LOS in patients experiencing myocardial infarction (Walch et al., 2005).

The European norm for the lighting of indoor workplaces defines nearly 50 different healthcare premises, all with their own, often widely differing, lighting requirements. For example, the required level of maintained illuminance varies from 5 lux for night lighting (observation lighting) in maternity wards to 5000 lux in the pathology laboratory. It is even higher in the operating theaters it reaches between 10,000 and 100,000 lux (Nelson et al., 2005).

Table 2
Geographic and weather information for King Abdullah University Hospital (Jordan Meteorology Department, 2009).

Irbid, Alt: 618, Latit: 32.54°, Long: 35.85°				
Temperature	Min. temp	Avr. temp	Max. temp	Sun hour
January	4.9	9	13	5.4
February	5.4	9.8	14.1	6.1
March	7.4	12.2	17	7.1
April	10.7	16.4	22.1	8.3
May	14.2	20.7	27	10.2
June	17.5	23.7	30	11.9
July	19.3	25.2	31.1	11.9
August	19.7	25.6	31.4	11.2
September	18.2	24	29.8	10.2
October	15.2	21	26.7	8.5
November	10.1	15.5	20.7	7
December	6.4	10.7	15	5.4

Exposure to bright light affects the natural clock of patients and employees in hospitals. In certain illnesses, the biological regulatory system (circadian rhythms) plays an important role in maintaining the well-being of the individual. For example, Alzheimer's patients who are exposed to bright lights during the day have improved circadian rhythms and are less prone to depression (Edwards & Torcellini, 2002).

In their study in Alaska, Roseman & Booker (1995) found that 58% of all medication errors among hospital workers occurred during the first quarter of the year when daylight hours were less (Rashid & Zimring, 2008).

Ne'eman states that patients are eager for natural light in the patient room; he interviewed occupants in four types of buildings: houses, schools, offices and hospitals, around London, England. A total of 375 responses have been examined, Fig. 1, (Choi, 2005).

1.2. King Abdullah University Hospital (KAUH)

KAUH is built within the Jordan University of Science and Technology (JUST) campus which is located in the northern part of Jordan at the highway linking Jordan to Syria. It is about 70 km north of Amman and 15 km east of Irbid.

The hospital consists of 15 story high-rise building, in which all hospital beds are located, and three stories of low-rise buildings in which outpatient clinics, diagnostic and other services are located, with overall area of 95,583 m^2. It has also a double story car parking with area of 9000 m^2. It has a capacity of 683 beds, which can be increased, to 800 beds in emergency conditions (Fig. 2, Table 2).

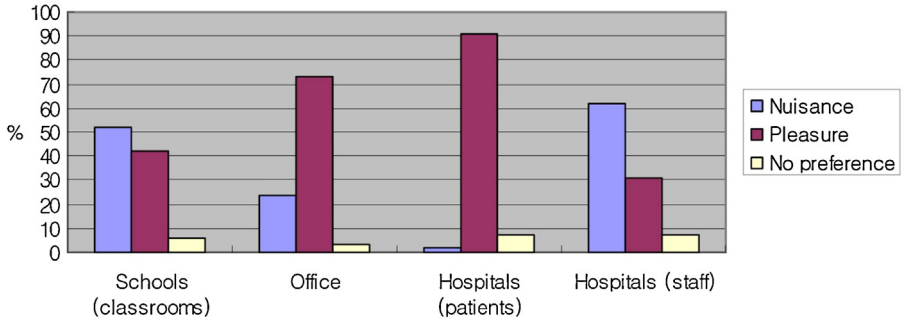

Fig. 1. Preferences of sunshine inside building as a pleasure or a nuisance (Choi, 2005).

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