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INVESTIGATING THE IMPACT OF HEALING BUILT ENVIRONMENT (HBE) ON PATIENTS' SATISFACTION WITH SPECIAL REFERENCE TO THE EGYPTIAN CONTEXT

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Abstract

The design of healthcare facilities has a significant impact on multiple patients' outcomes, particularly for those undergoing cancer treatment. This paper aims to investigate the Healing Built Environment (HBE) principles and characteristics that influence cancer outpatients' satisfaction in healthcare facilities. The research adapted the Environmental Occupant Health (E-O-H) framework to evaluate the impact of the principles and parameters of healing environments on patients' overall satisfaction by relying primarily on an onsite survey questionnaire. The quantitative data gathered through closed-ended questions of the questionnaire was statistically analyzed using SPSS (version 25). As for the data gathered through open-ended questions of the questionnaire, qualitative analysis was adopted. Furthermore, observational data, field notes and archival sources were used to complement the data gathered from the questionnaires. The combination of quantitative and qualitative data has assisted in getting in-depth feedback on each of the design principles of Healing Built Environment (HBE). The findings of this study confirm that some of demographic and treatment information of the respondents in addition to some parameters within the three key design principles of the E-O-H framework (comfortable environment, well-functioning space and relaxing atmosphere) have a significant influence on cancer outpatients' overall satisfaction.

Keywords: Healing Built Environment (HBE), Cancer Outpatient Satisfaction, Health Outcomes, Chemotherapy Room, Waiting Area, Egyptian Context.

1. INTRODUCTION

The design and functionality of healthcare environments have a significant impact on the patient experience. This is not a recent revelation, the concept of "healing environment" has been documented for over two millennia. (Ghazali and Abbas 2012). However, the creation of healing environments in recent years has received a significant global interest with a focus on creating environments that promote healing alongside medical treatment (Timmermann, Uhrenfeldt, and Birkelund 2015).

Among different diseases, cancer is considered one of the most common causes of death worldwide causing around 10 million deaths in 2020. According to the Global Cancer

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Observatory, Egypt had over 150,000 new cancer cases and nearly 95,000 cancer deaths in 2022. This makes Egypt the Middle East's third-highest cancer-incidence country ("World Health Organization" 2022). Patients classified as high-risk for cancer or those already battling it might face different needs in the physical environment than other patients (Weiland et al. 2015). Accordingly, it is essential to investigate the extent to which the physical environment meets the unique needs of cancer patients across different healthcare facilities.

As a primary treatment option for cancer, chemotherapy can be given either independently or with surgery or radiotherapy, and it is typically given in outpatient setting (Bloom et al. 2015). According to Lamé et al. (2016), cancer is a significant concern, and delivering chemotherapy in the outpatient setting plays a crucial role in cancer care strategies. Unlike a typical outpatient consultation, cancer patient may visit healthcare facility for chemotherapy as often as 100 times in the first year of treatment (Wang and Pukszta 2017); the number of infusions might vary and each visit can last up to six hours, depending on the specific prescription and that often leading to long waiting times for patients patients (Wang and Pukszta 2017; Lamé, Jouini, and Stal-Le Cardinal 2016; Shepley et al. 2012). Since these treatment settings become a regular part of cancer outpatients' lives, they have a unique opportunity to contribute to their treatment experience (Groff et al. 2008). However, there is a lack of international data and limited research is available that investigate patient experiences and needs in such physical environments (Wang and Pukszta 2017; Shepley et al. 2012).

Furthermore, it should be noted that designing healthcare facilities is greatly influenced by social and cultural considerations. According to Gashoot (2022), cultural and religious views can have an impact on health outcomes in the built environment. Shepley et al. (2014) emphasize the importance of considering culturally based spatial behavior in the international healthcare design. Similarly, Winkel et al. (2009) point out that the surrounding sociocultural context can impact how patients and staff experience the physical environment.

Despite such a significance for the sociocultural context in healthcare design, research examining the healing environments and healthcare facilities, particularly in developing countries, remains very limited and insufficient (Shepley and Song 2014). In that sense, this study aims to address these gaps by investigating the impact of Healing Built Environment (HBE) principles and characteristics on cancer outpatients' satisfaction in healthcare facilities in the Egyptian context.

2. LITERATURE REVIEW

To shed light on the HBE and its impact on patients, the following section reviews two main issues. The first is the influence of HBE on patients' outcomes. The second issue is the framework adopted in this research; Environment – Occupant - Health E-O-H framework.

2.1. HBE and its Influence on Patients' Health Outcomes

A growing body of literature reveals the influence of indoor environments on healing. Environmental design parameters for cancer healthcare facilities, such as interior design elements like color, art, lighting, and furnishings, as well as architectural design specifications

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including building design and space planning, play a crucial role in influencing patient health outcomes and enhancing the care delivery process (Shepley et al., 2012; R. S. Ulrich et al., 2010).

Healing, unlike curing, includes the emotional and psychological dimensions of health and serves as the theoretical foundation for healing environments in modern healthcare facilities facilities (Ghazali & Abbas, 2017; Mourshed & Zhao, 2012; R. S. Ulrich et al., 2010). Accordingly, literature considered patient psychological perception as an important outcome beside the direct physical outcomes. For instance, Codinhoto et al. (2009) grouped patient outcomes to psychological, physical and physiological according to the impact of HBE on their mind or body. Zhang et. al (2018) proposed a more comprehensive framework dividing patient outcomes into three categories physical outcome, psychological perception and life experience. They argue that adding life experience to the outcomes will have influence on their physical outcome, psychological perception, and their ongoing perceptions when staying at the healthcare facility.

In addition, according to Jamshidi et. al (2018) patient's experience can be divided into two categories: patient satisfaction and interaction. According to Ulrich et. al (2008) implementing the right design characteristics, can lead to a significant improvement in various patient outcomes such as patient sleep, patient satisfaction, patient privacy, communication with patients and family members and social support. Linder-Pelz (1982) defines patient satisfaction as "positive evaluations of distinct dimensions of health care". Patient satisfaction surveys in healthcare facilities can provide valuable insights into issues that require improvement (Avis et al., 1995). Literature also indicates that satisfaction is linked to various other health outcomes, such as stress (Pati et al., 2016) and length of hospital stay (Borghans et al., 2012). Evaluating the overall indoor environment of healthcare facilities has placed significant emphasis on patient perception and satisfaction as key indicators of performance (Mourshed & Zhao, 2012). Recently, a growing body of research about the physical environment of healthcare facilities has focused on how to maximize patient satisfaction (Alkazemi et al., 2019; Alolayyan & Alfaraj, 2021). The literature has explored wide range of HBE characteristics that play a significant role in influencing patients' satisfaction levels and consequently impact the overall quality of the healing environment within healthcare facilities (MacAllister et al., 2016; Mourshed & Zhao, 2012; Shepley & Song, 2014; R. S. Ulrich et al., 2010). Therefore, aligning with this growing body of research, this study is focusing on patient satisfaction as a key outcome that assess the impact of the healing environment on cancer outpatients.

2.2. Environment–Occupant–Health (E-O-H) Framework

The field of healthcare architecture has witnessed a continuous evolution of theories and frameworks investigating the impact of building design on patient health outcomes. Early contributions include Rubin et al. (1998) who highlighted the suggestive evidence of the HBE influencing clinical outcomes. Kaplan and Kaplan (1989) introduced the theory of restoration that emphasize the positive influence of natural elements on well-being. Additionally, Ulrich (1991, 1997) came with the supportive design theory that highlights the importance of providing healthcare environment with (1) a sense of control; (2) access to social support; (3)

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access to positive distractions in physical surroundings. While these theories have significantly contributed to the field, they are criticized for having their own limitations not capturing the various environmental characteristics that are considered important for patient health outcomes (Devlin et al., 2016). Elf et al. (2017) review supported this notion by highlighting the need for more contemporary theoretical frameworks that capture the environmental characteristics which patients consider important.

By conducting in depth study to link between HBE and patient health outcomes, Zhang et al. (2018) developed the Environment–Occupant–Health E-O-H framework to provide the future research with a holistic framework that has an integrated consideration of the relationship between various environmental characteristics and patient health outcomes (Zhang, Tzortzopoulos, and Kagioglou 2018; Yan et al. 2024). The E-O-H framework functions as a comprehensive assessment tool that combines all the HBE principles and characteristics, enabling a thorough evaluation of healthcare facilities and the impact of such parameters on patient health (Zhang, Tzortzopoulos, and Kagioglou 2018; Yan et al. 2024). The framework outlines three key design principles for healthcare facilities: environmental comfort, well-functioning space, and relaxing atmosphere. Each principle includes various parameters that influence patients' outcomes. Additionally, some of these parameters may have multiple sub-parameters to offer a more detailed approach to the design of healthcare facilities.

The first principle is related to the provision of a "comfortable environment", which is essential for patients' health and wellbeing. There are multiple parameters affecting this principle such as light, air temperature, sound, and air quality (Nimlyat et al., 2022; Zhang et al., 2018). In addition, patients' satisfaction is significantly influenced by the characteristics of indoor environment of the healthcare facility (Croitoru et al., 2013). Various research has studied the parameters of indoor physical environment and their influence on users of healthcare facility (Nimlyat et al., 2022; Wu et al., 2023). Consequently, the need to pay particular attention to these parameters in the design of a healthcare facility cannot be overlooked, as poor environmental quality in a hospital can significantly affect patients' physical and psychological well-being (Nimlyat et al., 2022). However, the majority of the studies focused on an individual parameter (Zhang et al., 2018), such as light (McCunn et al., 2021), thermal environment (Yuan et al., 2022), sound (Walker & Karl, 2019). While these studies provide valuable insights, a more comprehensive understanding can be gained by examining these parameters together.

The second principle focuses on the significance of a "well-functioning healing space" to the patients. According to zhang et al (2018) this principle has three key parameters that focus on functionality and supporting treatment procedures: Furniture, Fixtures, and Equipment (FF&E), flexibility, and patient centered care. Each of these parameters includes multiple sub-parameters that have been identified in literature to have an influence on patient outcomes. For example, a properly designed wayfinding system, a sub parameter of flexibility, has been shown to significantly reduce patients' stress and promote healing (Devlin, 2014; R. S. Ulrich et al., 2010) and it consequently influence their satisfaction (Kaya et al., 2016). Similarly, social support, a sub-parameter of patient-centered care, is identified in the literature to have a significant impact on various health outcomes. The lack of social support can lead to increased

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anxiety, stress, and perceived pain (Andrade et al., 2017; R. Ulrich, 1991). The third principle emphasizes creating "relaxing atmosphere "through parameters such as Interior design and display, and links to nature. Lacking these parameters not necessarily make a severe health problem, but their presence decrease anxiety and stress and of course increase satisfaction (Zhang et al., 2018). Prior research has explored the use of art and nature in enhancing patient healing and satisfaction. For instance, Ulrich's experiments in a healthcare facility demonstrated that patients with window views recovered faster from surgery and required less pain medication compared to those in rooms with bare walls (R. Ulrich, 1984). Additionally, Slater et al. (2017) demonstrated that incorporating art into hospital environments is linked to patients' overall satisfaction and their likelihood to recommend the hospital. This study is adopting E-O-H framework for its inclusivity and holistic nature as mentioned in literature and uses it as an evaluative tool to investigate the impact of HBE characteristics on patient health outcomes, specifically cancer outpatients' satisfaction as justified earlier in this section.

3. METHODOLOGY

3.1. Research Design

The study aims to emphasize the significance of architecture in patient satisfaction as an important health outcome during their healing journey. It aims to investigate the impact of HBE principles/characteristics on cancer outpatients' satisfaction in healthcare facilities in Egypt

The research adapted the Environmental Occupant Health (E-O-H) framework to evaluate the impact of the principles and parameters of healing environments on patients' overall satisfaction. The study relied primarily on an onsite survey questionnaire (Slater et al., 2017) that was based on the 'A Staff and Patient Environment Calibration Toolkit (ASPECT). The number of outpatients involved in the study was 209.

The quantitative data gathered through the closed-ended questions of the questionnaire was statistically analyzed using statistical software IBM SPSS (version 25). As for the data gathered through the open-ended questions of the questionnaire, qualitative content analysis was adopted. Furthermore, observational data, field notes and archival sources were used to complement the data gathered from the questionnaires. The combination of quantitative and qualitative data has assisted in getting in-depth feedback on each of the design principles of Healing Built Environment (HBE).

3.2. Description of the Setting Selected for the Study

This study was carried out at a research and educational hospital. The hospital is located in Cairo, known as the largest and oldest hospital in Egypt and the Middle East (Figures 1,2, and 3). With a capacity of 11 hospitals and 5,500 beds, it serves as a prominent medical institution in the region. Within the hospital, a center of radiation oncology & nuclear medicine operates, comprising 103 beds spread across five floors (Figures 1 and 2). The center features two chemotherapy rooms: one on the ground floor, which was selected for the research, and another one on the second floor, which was inaccessible during the study period. The room selected for the study is close to building's secondary entrance and also beside the waiting area, which is

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used by both chemotherapy and clinic outpatients. To provide a detailed description of both the chemotherapy room and the waiting area, photographs and on-site sketches were used to gain a deeper insight into patient experience (Figures 4,5,6, and 7). The chemotherapy room has a standard two-leaf door and two windows: one large window, which was mostly closed and it has opaque painted glass, and a smaller window that can be opened for ventilation. The room has a ceiling height of approximately five meters and is equipped with two TVs and three air conditioners that have been operated during the site visits. Additionally, it contains 11 chemotherapy chairs and a nurse station with an office and medication refrigerator. The walls were divided horizontally, with ceramic cladding covering the lower part (approximately 1.2 meters high) and the upper part painted in a light grey. The openings, including doors and windows, were painted in a darker shade of grey (Figure 4,5, and 6). For the main waiting area, it has the reception desk in addition to 12 wooden benches that are approximately two meters. the waiting area has also two windows, three air conditioners, five fans -both fans and air conditioners have been operated during site visits- and one television (Figure 4,7). There were additional benches along the sides of the corridor and also an outdoor waiting area to provide more space for patients and their caregivers to wait.

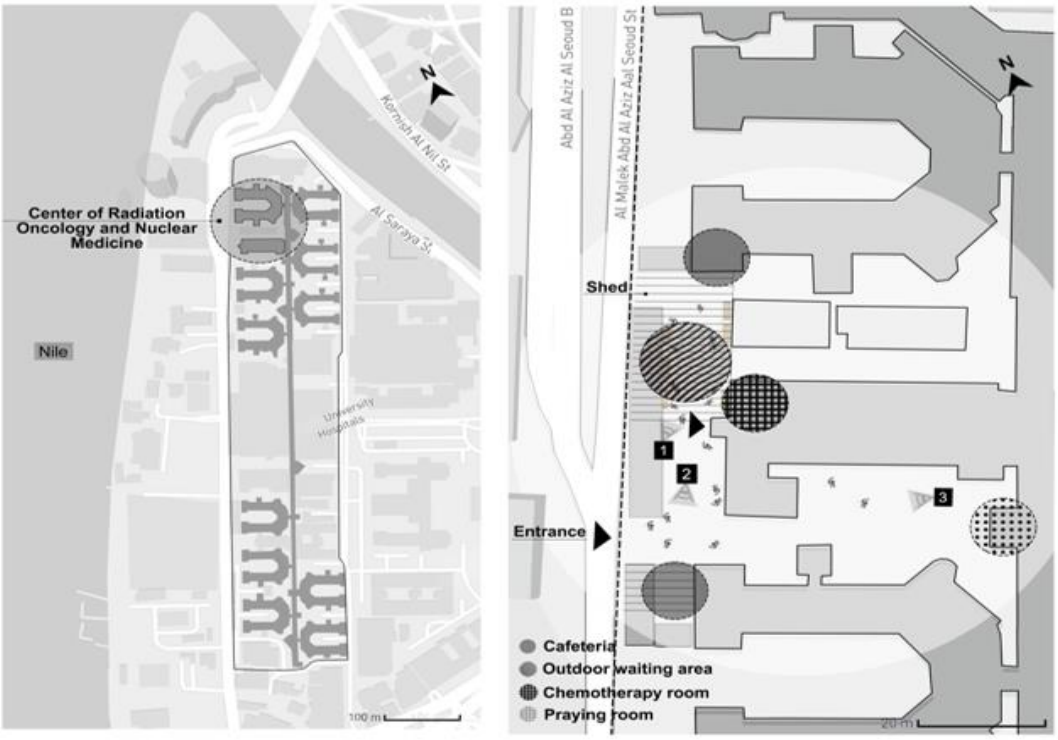

Figure 1: The Layout of the Hospitals, Adapted from Google Maps (2024)

Figure 2: Blow-up for the Center of the Oncology and the Nuclear Medicine, Adapted from Google Maps (2024)

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Figure 3: The Hospital Outdoor Space,

Source: Author

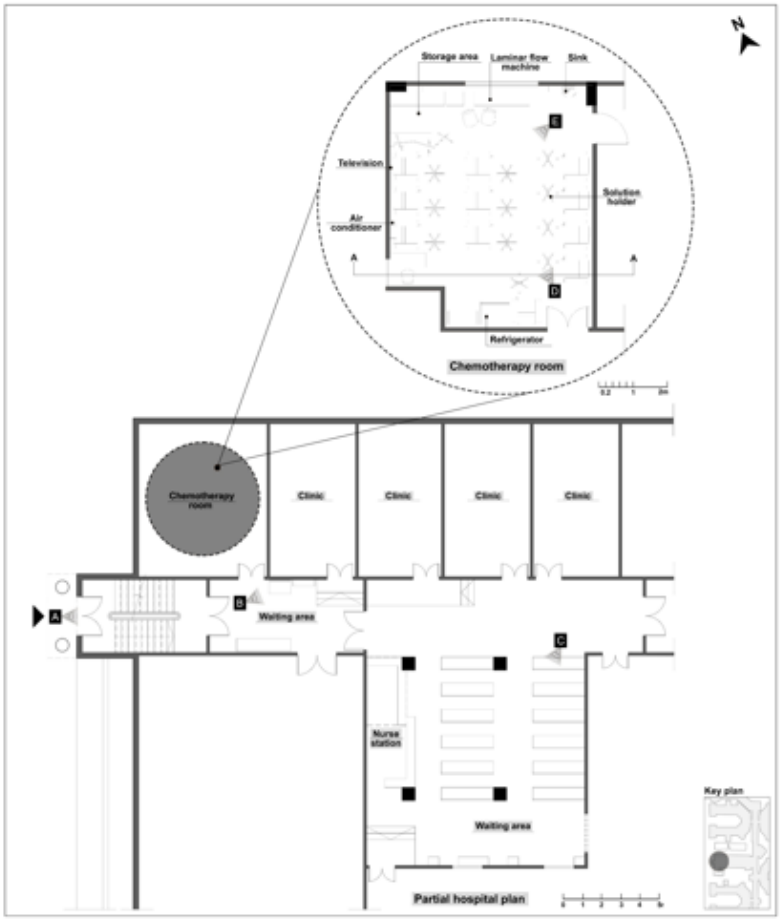

Figure 4: Partial Plans of the Cancer Healthcare Zone Showing the Waiting Area and the Chemotherapy Room

Source: Author (Based on Site Sketches)

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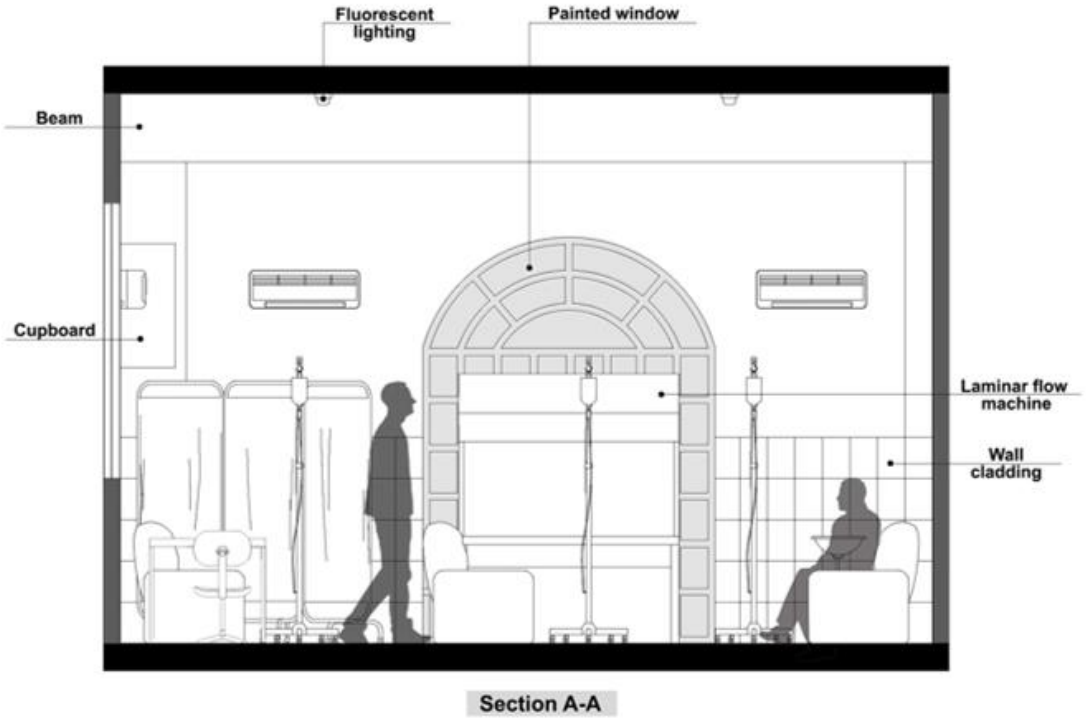

Figure 5: Section in the Chemotherapy Room

Source: Author (Based on Site Sketches)

Figure 6: The Chemotherapy Room

Source: Author.

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Figure 7: Entrance and Waiting Area

Source: Author.

3.3. Data Collection

3.3.1. Data Collection and Procedures

The study was conducted between March 2023 and October 2023. Initially, a pilot study involving 10 patients was conducted in April 2023, in several hospitals to refine the final questionnaire. Based on the pilot study results, certain adjustments were made to shorten the questionnaire. This included merging some questions and eliminating others, as patients expressed fatigue from the lengthy questionnaire.

It should be noted that the task of obtaining consents from hospitals to conduct the research was quite challenging, starting from the difficulty of entering the hospital and meeting with the affairs concerned with the research, to their fear for the privacy of patients and their health, that since they are cancer patients. Eventually, consent from the center of radiation oncology & nuclear medicine in the research and educational hospital, in which the main study was carried out, was granted on June 26, 2023, following a meeting with the head of the oncology department. Subsequently, the main study was conducted between June 26 and September 21 year 2023. It involved 16 visits to the hospital and 209 patients were involved in this stage. While Just 4 copies of the questionnaire were distributed by nurses, the majority were conducted on person due to patients' health conditions. That were exclusively conducted in the chemotherapy room, as patients' families discouraged in person questionnaires elsewhere to avoid causing stress.

These in person questionnaires process spanned 13 visits to the hospital, with the questionnaires being conducted with patients who were able to comfortably participate while receiving chemotherapy treatment. The researcher waited approximately three hours for a new group of patients to enter the room to conduct the in-person questionnaire. These visits occurred from approximately 12 pm to around 5 pm, as chemotherapy sessions typically began after 12 pm following completion of medical tests. Further two observational visits had been conducted

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to physically document the hospital through photographs, videos, field notes and on-site sketches and diagrams.

3.3.2. Sampling Technique

Sampling relied on convenience/purposive sampling, a form of nonprobability sampling, involves selecting individuals from the target population based on specific criteria. These criteria may include factors like easy accessibility, availability at a specific time, or willingness to participate in the study (Amankwah et al., 2019; Emami et al., 2018).

3.3.3. Questionnaire Design

Regarding the questionnaire, which was the primary data collection tool, initially, it was adapted from A Staff and Patient Environment Calibration Tool (ASPECT) Toolkit using some of its established dimensions that suit the context and removing all the parameters that were found to be unavailable in the selected healthcare facility. ASPECT is based on a database of over 600 previous studies. it is a tool with eight sections for evaluating the quality of design in patient environments in healthcare buildings: Privacy, Company and Dignity, Views, Nature and Outdoors, Comfort and Control, Legibility of Place, Interior Appearance, Facilities, and Staff (Ruddock, 2009). It was chosen as it is a reliable tool designed for evaluation of health care environment and it has been applied and tested by different authors (Albernaz, 2024; Amankwah et al., 2019; Ghazali & Abbas, 2017; Oi-Zhen et al., 2015). Subsequently, the questionnaire was structured in accordance with the E-O-H framework. Considering the difficulty of collecting data from patients, the questionnaire items were written in both English and Arabic. The questionnaire was structured into two main sections. The first part encompassed demographic information such as gender, age, educational attainment and occupation, and treatment information such as time since the first visit, frequency of the visits per month, average duration of session and average duration of waiting time. In the second part, respondents evaluated their satisfaction levels with the chemotherapy room and waiting area using a five-point Likert scale ranging from 'very dissatisfied' (1) to 'very satisfied' (5). Additionally, an open-ended question at the end of each part to allow respondents to freely express their opinions for further insight. This section was further divided into three subsections, addressing three main principles of the E-O-H framework mentioned in literature: comfortable environment, well-functioning, and relaxing atmosphere.

The first section concerning environmental comfort includes questions regarding various parameters that influence environmental comfort, such as light, air temperature, sound and air quality in both chemotherapy room and waiting area.

Second section focusing on well-functioning healing space was assessed through several parameters including space planning, way finding, FF&E, privacy, social support, facilities and control. Specific questions delved deeper into each parameter, measuring patient satisfaction for each of them. The questionnaire lastly investigated the third principle the relaxing atmosphere by considering two parameters: interior design and links to nature. Finally, patients were asked to rate their overall satisfaction with the healthcare facility at the end of the questionnaire.

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3.4. Data Analysis

The date from the questionnaires was statistically analyzed using descriptive analysis. The data was analyzed using the statistical software IBM SPSS (Statistical Package for Social Sciences, version 25). The statistical analysis included the percentage and Mean Satisfaction Score (MSS), T-test and ANOVA test were used to investigate differences between means and Pearson correlation test was used to calculate the correlations. The correlational significance value was set at the 0.05 level (2-tailed) (Ellis-Jacobs 2011; Skipper, Guenther, and Nass 1967).

4. RESULTS

4.1 Demographic Information of Respondents

Table 1 shows that among the 209 patients, majority of respondents were females 66% (n=138), while 34% (n=71) were males. Of this proportion, 45% (n=94) of respondents were between 36 and 50 years of age against 32.5% (n=68) of respondents were above 50 years of age. Regarding the educational attainment, 45.5% (n=95) of respondents had secondary education, while 37.3% (n=78) of them had less than primary education, 17.2% (n=36) of the respondents had BSc Degrees and 0% had MSc degrees or higher. The results also revealed that a large number of respondents 68.9% (n=144) are unemployed.

Table 1: The Demographic Characteristics of the Respondents

Patient information		Number	Percentage %
Gender	Male	71	34%
	Female	138	66%
Age	18-25	6	2.90%
	26-35	41	19.60%
	36-50	94	45%
	>50	68	32.50%
Educational attainment	Elementary or below	78	37.30%
	Secondary or high school	95	45.50%
	University	36	17.20%
Occupation	Private sector employee	18	8.60%
	Governmental employee	8	3.80%
	Worker	27	12.90%
	Retiree	12	5.70%
	Unemployed	144	68.90%

4.2 Treatment Information of Respondents

Table 2 shows that respondents were diversified starting from less than 3 months since their first visit till exceeding 2 years. A substantial majority 64.1% (N= 134) reported attending one to 3 visits, while 33.0% (N= 69) had 4 to 6 visits, and a smaller fraction 2.9% (N= 6) underwent 7 to 9 visits monthly. The most common average duration of chemotherapy sessions was one to two hours, constituting 59.8% (N= 125) of responses, with 31.6% (N= 66) opting for sessions lasting less than 1 hour. Additionally, smaller proportions indicated spending more than 4 hours 1.9% (N= 4), while 6.7% (N= 14) reported sessions lasting 3 to 4 hours. Regarding waiting

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times, the majority of patients 48.8% (N= 102) reported wait times of 0 to 30 minutes, while 27.3% (N= 57) endured waits exceeding two hours.

4.3 Overall Patient Satisfaction

4.3.1. Mean of the Overall Patients' Satisfaction

The overall patient satisfaction with all the design principles/characteristics within the healthcare facility yielded a mean score of 3.93 (σ = 0.958) (figure 8), which falls within the range considered satisfactory, as it exceeds the neutral value of 3 on the Likert scale. Analyzing the distribution, the majority of respondents expressed positive opinions, with 42.6% (n=89) reporting 'Satisfied' and 30.1% (n=63) indicating 'Very Satisfied'. A substantial portion of respondents (20.6%, n= 43) adopted a neutral status, suggesting a balanced perspective. Dissatisfaction levels were relatively lower, with 3.8% (n=8) of respondents expressing unsatisfied and 2.9% (n=6) indicating very unsatisfied. These findings highlight an overall positive outlook among respondents regarding the healthcare facility, with a significant proportion reporting satisfaction or high satisfaction.

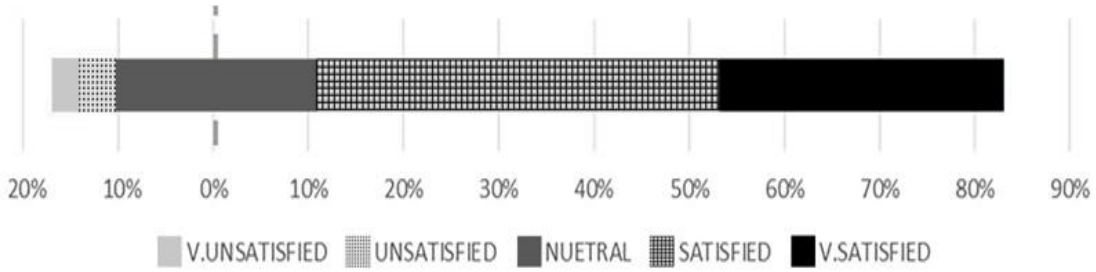

Figure 8: Mean of the Overall Satisfaction

Table 2: Treatment Information of the Respondents

Treatment Information		Number	Percentage %
Time since the first visit	< 3 Months	44	21.1%
	3 - 6 Months	62	29.7%
	7 - 11 Months	36	17.2%
	1 - 2 Years	30	14.4%
	> 2 Years	37	17.7%
Frequency of the visits per month	1-3 visits/month	134	64.1%
	4-6 visits/month	69	33%
	7-9 visits/month	6	2.9%
Average duration of session	< 1 Hour	66	31.6%
	1-2 Hours	125	59.8%
	3-4 Hours	14	6.7%
	> 4 Hours	4	1.9%
Average duration of waiting time	0- 30 Minutes	102	48.8%
	30-60 Minutes	30	14.4%
	> 1 Hour	20	9.6%
	> 2 Hours	57	27.3%

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4.3.2. Correlations of Overall Patient Satisfaction with Demographic and Treatment Information

Table 3 shows that there was no statistically significant correlation between gender (r = -0.114, p = 0.101), age (r = -0.006, p = 0.929), occupation (r = 0.094, p = 0.176), and overall patients' satisfaction. These findings suggest that gender, age, and occupation did not play a significant role in influencing the overall satisfaction levels reported by patients. However, a noteworthy finding emerged in relation to educational attainment, indicating a significant negative correlation (r = -0.434, p = 0.001) between higher educational attainment and decreased overall satisfaction. This suggests that as patients' educational levels increased, their overall satisfaction tended to decline. Additionally, a statistically significant negative correlation (r = -0.163, p = 0.018) between the average duration of waiting time and overall satisfaction. This implies that longer waiting times were associated with a slight reduction in overall satisfaction among patients.

Table 3: The Correlation between Demographics and Treatment Information with Overall Patients' Satisfaction

Demographic Information	Correlation and significance with overall patient satisfaction	
	r value*	p value**
Gender	-0.114	0.101
Age	-0.006	0.929
Educational Attainment	-0.434	**0.001**
Occupation	0.094	0.176
Treatment Information	**Correlation and significance with overall patient satisfaction**	
	r value*	**p value****
Time since the first visit	0.027	0.703
Frequency of the visits per month	0.088	0.207
Average duration of session	0.104	0.136
Average duration of waiting time	-0.163	**0.018**
***Correlation coefficient (r < 0.3 weak, r= 0.3-0.5 medium, r > 0.5 strong)**		
****Significant when (p < 0.05 significant)**		

4.4 Environmental Comfort

4.4.1. Mean of Cancer Outpatients' Satisfaction with Environmental Comfort Parameters

Generally, respondents are more satisfied in the chemotherapy room than in the waiting room. This result might be since the chemotherapy room is a closed/controlled environment or since the respondents are receiving treatments with less waiting stress. Table 4 shows that certain parameters received satisfactory mean scores above 3, reflecting positive evaluations. The thermal environment in the chemotherapy room (M = 4.21, SD= 0.966), the artificial lighting in the chemotherapy room (M= 4.19, SD = 0.809), and the quietness of the chemotherapy room (M = 4.13, SD = 0.797). Additionally, the artificial lighting in the waiting area (M = 3.88, SD = 1.071) and the thermal environment in the waiting area (M = 3.38, SD = 1.250) fall within the satisfactory range. Results show dissatisfaction with the natural daylight and air quality in both spaces and positive distractive sound. This could be due to the non-operability of the painted closed windows.

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4.4.2. Correlation of Overall Patient Satisfaction with Environmental Comfort Parameters

Table 4 shows that there was a significant correlation between overall satisfaction and parameters such as artificial light within the chemotherapy room ($r = 0.249$, $p = 0.000$), the thermal environment in both the chemotherapy room ($r = 0.197$, $p = 0.004$), and the waiting area ($r = 0.259$, $p = 0.000$), as well as the quietness of the chemotherapy room ($r = 0.166$, $p = 0.017$) Respondents' comments emphasized such correlations; for instance, R90, a female patient, reflected upon being satisfied with the thermal comfort in the chemotherapy room mentioning, "feeling cold is quite uncomfortable, but the nursing staff is quick to provide blankets upon request." Additionally, a noteworthy significant correlation was identified between artificial light within the waiting area and overall satisfaction ($r = 0.335$, $p = 0.000$). Although no significant correlation was found between overall satisfaction and air quality, observations and patients' comments suggested otherwise. Specifically, the combination of relying solely on the smaller window for ventilation, as the large window remained closed as mentioned earlier, and a high density of chemotherapy patients in the room, relative to its size, seemed to be aligned with patients' concerns about air quality. For example, a female patient (R40) commented, "There's not enough ventilation because there are too many patients compared to the size of the room." Similarly, a male patient (R193) stated, "If the window had been bigger, the room would have been much better." This is quite aligned with the mean of air quality in the chemotherapy room ($M = 2.61$, $SD = 1.58$) being within the dissatisfaction levels.

These findings shed light on the relationship between specific environmental parameters and patients' overall satisfaction. It indicates that parameters such as artificial light, air temperature, and quietness significantly influence patients' overall satisfaction.

Table 4*:* Mean of Environmental Comfort Parameters and Its Correlation with Overall Patient Satisfaction

Principle	Parameter	Sub-parameter	Mean	SD	Correlation and significance with overall patient satisfaction	
					r value*	p value**
Comfortable environment	Light	Natural daylight in the chemotherapy room	2.41	1.469	0.022	0.755
		Natural daylight in Waiting area	2.34	1.396	-0.014	0.843
		Artificial light in the chemotherapy room	**4.19**	0.810	.249	**0.000**
		Artificial light in the waiting area	**3.88**	1.071	.335	**0.000**
	Temperature	Thermal environment in the chemotherapy room	**4.21**	0.966	.197	**0.004**
		Thermal environment in the waiting area	3.38	1.250	.259	**0.000**
	Sound	The pleasant sounds that act as a positive distraction	2.28	1.351	0.021	0.759
		The quietness of the chemotherapy room	**4.13**	0.797	.166	**0.017**
	Air quality	Air quality in Chemotherapy room	2.61	1.587	-0.003	0.964
		Air quality in the waiting area	2.27	1.399	0.123	0.076

***Correlation coefficient ($r < 0.3$ weak, $r = 0.3$-0.5 medium, $r > 0.5$ strong)**
****Significant when ($p < 0.05$)**

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4.5 Well-Functioning Spaces

4.5.1. Mean of Cancer Outpatients' Satisfaction with Well-Functioning Spaces Parameters.

Table 5 shows that chemotherapy chair comfort showcases a high level of satisfaction, with a mean score of 4.37 (SD =.840). Conversely, the mean score for waiting area chair comfort is 2.72 (SD =1.253), falling below the satisfactory threshold and signaling dissatisfaction among patients.

Additionally, there is a significant negative correlation r=-0.263, p=0.000 between the average duration of waiting time and patient satisfaction with waiting area chair comfort, this suggests that as the waiting time for chemotherapy session increases, patient satisfaction with waiting area chair comfort tends to decrease.

Respondents' comments in the open-ended questions shed light on particular issues related to waiting chairs, emphasizing discomfort and suggesting necessary modifications to the material and design of the chairs. For example, Female patient (R55) stated "The worst thing about the place is the waiting chair" another female patient (R98) commented on the waiting area chair saying "The wooden chair has spacers that make it uncomfortable to sit in.". Another female patient (R125) commented "I brought a pillow with me because the wooden chair is uncomfortable to sit on."

Table 5 also shows a high level of satisfaction with privacy, with a mean score of 3.45 (SD=1.184) and social support among patients with a mean score of 3.46 (SD=1.256). Additionally, all facility parameters like access to drinks/snacks (3.96, SD = 0.929), prayer areas (3.35, SD = 1.471), and toilet quality (3.07, SD = 1.552) received satisfactory mean scores.

Lastly, controlling the temperature yielded a mean score of 3.58 (SD =1.521), and the control over privacy during the session received a mean score of 3.32 (SD =1.357), both falling within the satisfactory range. However, the presence of pleasant sounds as positive distractions scored 2.84 (SD =1.544), and artificial light in the chemotherapy room scored 2.71 (SD =1.446), both falling below the satisfactory threshold. Furthermore, patients expressed dissatisfaction with the control over sunlight and daylight during the session, with a mean score of 1.98 (SD =1.317) and the control over closing and opening the window with a mean score of 1.73 (SD =1.273).

4.5.2. Correlation of Overall Patient Satisfaction with Well-Functioning Space Parameters

Table 5 shows that both of space planning parameters; the position of entrances concerning points of arrival (p = 0.000, r = 0.257) and the circulation distance traveled by patients and visitors (p = 0.001, r = 0.231) demonstrated significant correlations with patient overall satisfaction. Similarly, within wayfinding parameters, accessibility to find a staff member (p = 0.000, r = 0.317) and clarity of entrances and exits (p = 0.000, r = 0.306) showed significant correlations with patient overall satisfaction. These findings are further supported by respondents' comments in the open-ended questions, highlighting challenges they faced with

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navigating the hospital. For instance, several patients expressed frustration with the layout, mentioning the long distances between the entrance and treatment areas, Female (R54)"The place looks like a maze," Female (R123)" I hope we have transportation since it's quite a distance from the outside door to the treatment room door " Female (R167) “I have to walk a long way to get there if I enter from the main entrance, and it is really difficult to get in if there is a crowd”. Additionally, the design made it difficult for some to find their way "Since the places are similar to one another, getting there can be difficult for us”. Additionally, signage aiding direction ($p = 0.045$, $r = 0.140$) and easy access to destinations ($p = 0.006$, $r = 0.190$) also has a significant correlation with patients’ overall satisfaction. The respondents also support these findings. (R13), female, said “Initially I had to ask how to get there, but now I know how to go there.” Another female respondent (R147) confirming this saying “At first, I was confused, but eventually, I got used to the route and found it easier.”

Table 5 also reveals significant correlations between various parameters of the well-functioning space and patients' overall satisfaction. For the ergonomics, results displayed a significant correlation between the satisfaction with chemotherapy chairs comfort ($p = 0.045$, $r = 0.139$) and overall patients’ satisfaction. In addition, in terms of social support, the satisfaction with the place provided for individuals accompanying patients during treatment ($p = 0.001$, $r = 0.223$) demonstrated a significant correlation with overall satisfaction. Within facility-related parameters, the satisfaction with quality-designated places for prayer ($p = 0.013$, $r = 0.171$), available facilities for drinks/snacks ($p = 0.000$, $r = 0.322$) and the quality of toilets ($p = 0.000$, $r = 0.324$) displayed significant correlations with overall satisfaction. Lastly, in terms of control parameters, controlling the temperature in the chemotherapy room ($p = 0.001$, $r = 0.225$) and control over window opening/closing ($p = 0.022$, $r = 0.159$) demonstrated significant correlations with patients’ overall satisfaction.

Table 5*:* Mean of Well-Functioning Parameters and Its Correlation with Overall Patient Satisfaction

Principle	Parameters / Sub parameters		Questions	Mean	SD	Correlation and significance with overall patient satisfaction	
						r value*	p value**
Well-Functioning	FF&E	Ergonomics	Chemotherapy chair comfort	**4.37**	0.840	.139	**0.045**
			Waiting area chair comfort	2.72	1.253	0.107	0.122
		Facilities	The quality of the designated places for prayer	**3.35**	1.471	.171	**0.013**
			The available facilities to patients and their families to have drinks or snacks	**3.96**	0.929	.322	**0.000**
			Quality of toilets for patients and their families	**3.07**	1.552	.324	**0.000**

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	Flexibility	Space planning	Position of the entrances in relation to points of arrival on healthcare facility	**4.05**	0.873	.257	0.000
			The circulation distance travelled by patients and visitors	**3.86**	1.026	.231	**0.001**
		Way finding	Accessibility to find a staff member	**4.30**	0.855	.317	**0.000**
			Clarity of entrances and exits of patients' area	**3.92**	1.023	.306	**0.000**
			Signage that helps in directing users to the needed places in the hospital	2.75	1.437	.140	**0.043**
			Having easy and quick access to your destinations inside the hospital	**3.91**	1.200	.190	**0.006**
	Patient centered care	Privacy	The level of privacy you have during the chemotherapy session	**3.45**	1.184	0.118	0.089
		Social support	The place provided for the person accompanying you to stay during treatment	**3.46**	1.256	.223	**0.001**
		Control	Controlling sunlight and daylight during the session	1.98	1.317	0.047	0.501
			Controlling artificial light in the chemotherapy room	2.71	1.446	0.006	0.930
			Controlling the temperature in the chemotherapy room	**3.58**	1.521	.225	**0.001**
			Controlling pleasant sounds that act as a positive distraction	2.84	1.544	.238	**0.001**
			Controlling privacy during the session	**3.32**	1.357	0.064	0.357
			The control over closing and opening the window	1.73	1.273	.159	**0.022**

***Correlation coefficient (r < 0.3 weak, r= 0.3-0.5 medium, r > 0.5 strong)**
****Significant when (p < 0.05)**

4.6. Relaxing atmosphere

4.6.1. Mean of Patients' Satisfaction with Relaxing Atmosphere Parameters

Table 6 shows that respondents expressed high satisfaction with the interior design parameters, including the colors in the interior space (Mean = 4.18, SD = 0.755), achieving a cozy warm environment (Mean = 4.06, SD = 0.830), design and distribution of furniture within the interior space (Mean = 4.04, SD = 0.860), design and distribution of light fixtures within the interior space (Mean = 3.99, SD = 0.846), and the overall interior design (Mean = 4.11, SD = 0.847). These parameters received satisfactory mean scores, indicating that respondents found them conducive to a relaxing atmosphere. In contrast, the parameters related to links to nature are unsatisfactory. Patient satisfaction with accessibility of windows to the outside view in the chemotherapy room (Mean = 1.36, SD = 0.981) and the overall outside view (Mean = 1.35, SD = 0.960) had mean scores below 3, which suggests a low level of satisfaction. This supports the observation of the small window size in the chemotherapy room, limited outside visibility, and lack of green space outside. These findings suggest a need for improvements in these parameters to enhance the overall relaxing atmosphere within the healthcare facility.

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4.6.2. Correlation of Overall Patient Satisfaction with Relaxing Atmosphere Parameters

Table 6 shows that the patients' satisfaction with the overall interior design of the chemotherapy room demonstrated a significant correlation with patients' overall satisfaction (r = 0.387, p = 0.000), highlighting the importance of interior design in shaping patient satisfaction. Patient satisfaction with achieving a cozy, warm environment also showed a significant correlation with overall satisfaction (r = 0.359, p = 0.000), emphasizing the link between coziness and higher satisfaction levels.

Although no significant statistical correlation between overall patients' satisfaction and links to nature was deduced, the responses revealed its importance to their experience in the healthcare facility. Female (R9) "Some plants or flowers could make the place feel more pleasant ", female (R22) "Adding plants, paintings, and beautiful views will make a difference". Female (R119) "If the hospital had more greenery, it would be very pleasant, like a small garden or just some plants."

The colors of the interior space had a significant correlation with overall satisfaction (r = 0.240, p = 0.000). Respondents' comments in the open-ended questions revealing different recommendations regarding the colors of the interior space. (R79) female commented "I would suggest incorporating more vibrant and colorful colors in the interior space". Contrasting with other respondent opinion (R204), female "It might be a good idea to use white and light colors for a comfy vibe." Significant correlations were observed for the design and distribution of furniture (r = 0.251, p = 0.000) and light fixtures (r = 0.275, p = 0.000). These findings emphasis the importance of creating a well-designed pleasing environment in healthcare settings to enhance overall patient satisfaction and improve the patient experience

Table 6: Mean of Relaxing Atmosphere Parameters and its Correlation with Overall Patient Satisfaction

Principle	Parameter / sub parameter	Questions	Mean	SD	Correlation and significance with overall patient satisfaction	
					r value*	p value**
Relaxing atmosphere	Display / Interior Design	The colors in the interior space	**4.18**	0.755	0.24	**0**
		Achieving a cozy warm environment	**4.06**	0.83	0.359	**0**
		Design and distribution of furniture within the interior space	**4.04**	0.86	0.251	**0**
		Design and distribution of light fixtures within the interior space	**3.99**	0.846	0.275	**0**
		The overall interior design	**4.11**	0.847	0.387	**0**
	Links to Nature	The accessibility of windows in the infusion unit	1.36	0.981	-0.044	0.53
		The overall outside view	1.35	0.96	0.663	1
***Correlation coefficient (r < 0.3 weak, r= 0.3-0.5 medium, r > 0.5 strong)**						
****Significant when (p < 0.05)**						

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5. DISCUSSION

The findings of this study confirm the impact of different HBE characteristics on health outcomes, particularly cancer outpatients' overall satisfaction. More specifically the findings show that there is a significant correlation between cancer outpatient satisfaction and some of demographic information, treatment information and the parameters within the three key design principles within the E-O-H framework: comfortable environment, well-functioning space, and relaxing atmosphere.

The findings of this research confirms that patients' overall satisfaction with the selected healthcare facility report a high satisfactory level. Regarding its correlation with demographic and treatment information, it was found that both educational attainment and waiting time is significantly correlated with overall patients' satisfaction. The study emphasizes the inverse relationship between outpatient overall satisfaction and educational attainment, suggesting that higher educational attainment correlates with lower satisfaction levels. This finding aligns with previous studies that support the same correlation (Desta et al., 2018; Locker & Dunt, 1978; Mahmood & Tayib, 2021). The study also confirms that longer waiting times were correlated with a reduction in overall satisfaction among patients. This finding supports the findings of previous studies all of which demonstrated a negative correlation between waiting time and patients' overall satisfaction (Desta et al., 2018; Kassaw et al., 2020).

The impact of the different parameters of a comfortable environment on patients' satisfaction was emphasized in different studies and accounts. For example, natural light proved to be a major contributor to the physical and visual comfort of human beings and having a crucial impact on individuals psychological and physiological condition (Iyendo Jnr & Alibaba, 2014; Nimlyat et al., 2022) and its ability to reduce perceived stress and pain, ultimately leading to satisfaction (Walch et al., 2005). However, this study did not find a statistically significant correlation between patient satisfaction with natural light and overall patients' satisfaction because it wasn't available, this is shown by respondents' dissatisfaction with the natural daylight, the study found a significant correlation between artificial light and overall patients' satisfaction, which aligns with previous research (Nimlyat et al., 2022). Additionally, the findings of the study that the overall satisfaction of patients has a significant correlation with the design and distribution of artificial light is supporting the literature claiming that artificial light has a positive distracting effect as a decorative feature which influence patient outcomes (Jamshidi et al., 2020).

The study suggested that patient satisfaction with quietness of the chemotherapy room significantly enhances patients' overall satisfaction. This is quite consistent with the literature that noise is identified as a significant stressor for patients and families, leading to dissatisfaction with the healthcare environment (MacAllister et al., 2016; R. S. Ulrich et al., 2008). Another finding of the study is that patient satisfaction with thermal environment and also the control over the temperature is both correlated with overall patient satisfaction. This confirms what is suggested by prior literature about the influence of thermal comfort on patients' satisfaction (Andrade et al., 2017; Yuan et al., 2022).

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Secondly the well-functioning space principle also revealed interesting findings, despite strong negative feedback on the waiting area seats' comfort in open-ended questions, there was no significant correlation between satisfaction with waiting area chair and overall satisfaction. This suggests that waiting area seating, while important, may not have a strong impact on overall satisfaction as other parameters. In contrast, the satisfaction with the chemotherapy chair comfort has a significant correlation with overall patient satisfaction. This finding is in consistency with prior research that demonstrated that comfortable furniture has a strong influence on the psychology of the patient and support the treatment process (Grosenick & Hatmaker, 2000).

Several studies have demonstrated a significant correlation between patient privacy and overall patient satisfaction (Mahmood & Tayib, 2021; Oi-Zhen et al., 2015). Additionally, Bouchard (1993) suggests that cancer patients may have a greater need for privacy than others due to the "private" nature of the treatment and potential physical and psychological risks they face. This aligns with patient comments expressing discomfort socializing with others and that some of the patients would prefer private treatment rooms for ladies. However, the study surprisingly revealed no statistically significant correlation between satisfaction with privacy and overall satisfaction.

Moving to the last principle, relaxing atmosphere, the study found a significant correlation between patient satisfaction with the space designated for their caregivers and their overall satisfaction. This finding is consistent with previous research that highlight the influence of social support on patients' outcomes. For example, the supportive design theory by Ulrich (1991, 1997) that emphasizes the role of social support in promoting patient well-being. Similarly, Siddiqui et al. (2015) claim that the availability of accommodation for patient families has a major influence on patient satisfaction.

The results of this study show that there is a statistically significant correlations between patient overall satisfaction and interior design parameters such as the colors chosen for the interior. These correlations are consistent with both respondents' comments in open-ended questions and also previous studies on the power of color in interior design. Iyendo Jr. and Alibaba (2014), for example, claim that patients feel more relaxed and satisfied in rooms with colorful wallpaper. Their study also pointed out the positive impact of color on healing and stress relief, which in turn increases patients' overall satisfaction. Similarly, Jue and Kwon (2013) argue that colors in interior environments evoke emotional responses, promoting calmness and lowering stress levels, and ultimately influencing individual emotional states. However, this study observed a high mean satisfaction score for the hospital's overall interior design despite the presence of worn furniture, peeling paint, and outdated finishes. This finding appears to contradict existing literature, which suggests that aesthetics and décor influence patient overall satisfaction (Becker, Sweeney, and Parsons 2008) and wellbeing (Slater, Braverman, and Meath 2017).

Respondents' suggestions for incorporating artwork, plants, and natural views in the chemotherapy unit align with the concept of positive distraction from healing environment theory by Ulrich. This theory suggests that viewing natural elements can have a positive

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influence on patient experience (R. S. Ulrich et al. 2008). Additionally, Iyendo Jnr and Alibaba (2014) supports this finding, claiming that both patients and staff feel more relaxed in artistic environments.

6. CONCLUSION

The objective of this study was to investigate the impact of HBE characteristics and principles on health outcomes. The findings of this study confirm the correlation between patients' overall satisfaction, as one of the major health outcomes, and HBE characteristics and principles. It highlights the significant correlation between some of the parameters of a "comfortable environment" such as artificial light, thermal comfort, and quietness of the chemotherapy room and patients' overall satisfaction. Furthermore, it emphasized the importance of various parameters of a "well-functioning space" such as space planning, wayfinding, comfortable chemotherapy chairs, and access to facilities such as toilets and spaces for drinks and snacks and its significant influence on patients' overall satisfaction with the healthcare facility. In addition, it accentuated the importance of most of the interior design elements, which is one of the parameters of a "relaxing environment", to patients' overall satisfaction.

These findings tend to confirm the evidence on the relationship between HBE characteristics/principles and cancer outpatients' health outcomes, particularly in the Egyptian context. In that sense, it is concluded that the proper inclusion of HBE characteristics in the design of Egyptian healthcare facilities could generally assist in promoting health for patients in such settings. More specifically, optimizing environmental comfort could involve incorporating good insulation to decrease noise level, using appropriate artificial lighting, and creating a comfortable thermal environment. Creating a well-functioning space including appropriate layout design for easy wayfinding, comfortable chemotherapy chairs, providing patients with needed facilities, and let them have some control over their surroundings. Furthermore, incorporating parameters that promote a relaxing atmosphere, by considering aesthetics in the design process as identified in the study, can significantly enhance the satisfaction of cancer outpatients undergoing treatment.

As for the limitations, it should be noted that getting consents from hospitals was quite challenging, restricting the research to a single hospital which give insight to only one type of hospitals (public/ educational) Therefore, future research could extend the work conducted in this study by involving other types of hospitals such as private, public and specialized hospitals with a variety of HBE characteristics to enrich the understanding of the integrated effects of diverse HBE characteristics on health outcomes.

Moreover, this study has focused on exploring the perception of patients. Future research could aim to explore the perception of other occupants of healthcare facilities such as medical staff members and caregivers. Furthermore, this study has assessed the impact of HBE characteristics on patients' satisfaction. Future studies are encouraged to focus on other health outcomes such as stress levels and perceived pain. Furthermore, future studies adopting mixed methods or focusing on a qualitative approach could be conducted to offer deeper insight into patients' experiences in healthcare facilities.

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Declaration of Interest

The authors declare no conflict of interest.

Data Availability

The data that support the findings of this study are available from the corresponding author (Omnia Hesham) upon request.

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