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Evaluating Indoor Environmental Quality of a Wellness Center Through Objective, Subjective and Architectural Criteria

Bir Sağlıklı Yaşam Merkezinin İç Mekan Fiziksel Çevre Kalitesinin Nesnel, Öznel ve Mimari Kriterler Çerçevesinde İncelenmesi

Abubaker Hassan Ali ALKABASHİ, Papatya Nur DÖKMECİ YÖRÜKOĞLU

ABSTRACT

Designing a good indoor environment is necessary for its health effects on the users. Therefore, the assessment of indoor environmental quality (IEQ) should include analysis of objective measures and architectural assessment as well as users' comfort evaluations. In this research, a wellness center in Ankara, Turkey is chosen as a case space. In order to assess its indoor environmental quality, acoustical, lighting, thermal and humidity measurements on indoor environment, questionnaires on user experience and architectural assessment of the chosen case space is presented. The findings obtained from the measurements and questionnaires are presented in detail. In addition, the relationship between objective and subjective data is statistically tested. Moreover, overall architectural assessment and material type and usage analysis are also included. Special spaces such as, exercise and treatment rooms in the case space are focused specifically for in depth function and activity related analyses. In addition, demographical and space usage data are also statistically tested with considering the importance and physical perception ratings of the IEQ parameters. Obtained results show that, age, frequency of visit and purpose of visit are the factors that affect the subjective evaluation of the IEQ parameters. Furthermore, the measured objective data are compared to international standards, where incompliances are found in the acoustic and lighting conditions of the case wellness center.

Keywords: *Environmental perception; indoor environmental quality; wellness center.*

ÖZ

Kabul edilebilir bir iç mekan kalitesinin tasarlanması, mekanda bulunan kullanıcıların üzerindeki sağlık etkileri nedeniyle çok önemlidir. Kapalı alan kalitesinin değerlendirilmesi dört temel parametre ile gerçekleştirilmektedir. Bu parametreler, iç mekan hava kalitesi, ısıl konfor, aydınlatma seviyesi ve akustik konfor olarak örneklenebilir. Bu araştırmada üç temel metot kullanılarak analizler sağlanmıştır. Bunlar, kapalı bir alanda bulunan çevre koşullarının kalitesini yerinde ölçümleme, öznel kullanıcı değerlendirmeleri ve seçilen alanının mimari analizi olarak belirlenmiş ve alan çalışması için bir sağlıklı yaşam merkezi seçilmiştir. Nesnel veriler uluslararası standartlarla karşılaştırılmış ve detaylı sunulmuştur. Araştırmanın bulguları istatistik testler ile desteklenmiş ve yapılan üç farklı analizin arasında birçok korelasyon ve ilişki saptanmıştır. Analizlere ek olarak, egzersiz ve tedavi odaları fonksiyon ve aktivite odaklı olarak detaylı irdelenmiş ve karşılaştırmalı olarak değerlendirilmiştir. İlk korelasyon, egzersiz odası için aydınlatma parametresinin nesnel ve öznel verileri arasında kurulmuştur. Ayrıca, katılımcıların demografik ve alan kullanımı verileri ile farklı alanlardaki öznel fiziksel algılama ve önem değerlendirmesi arasında korelasyonlar saptanmıştır. Son olarak, ANOVA testi ve ortalama analizlerinin karşılaştırılması sonucunda, egzersiz odaları, tedavi odalarından çok daha gürültülü, daha aydınlık, daha serin ve daha nemli bulunmuştur.

Anahtar sözcükler: *Fiziksel çevre algısı; iç mekan fiziksel çevre kalitesi; sağlıklı yaşam merkezi.*

Department of Interior Architecture, Çankaya University Faculty of Architecture, Ankara, Turkey

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Correspondence: Papatya Nur DÖKMECİ YÖRÜKOĞLU. **e-mail:** papatya@cankaya.edu.tr

Introduction

In previous studies regarding indoor environmental quality (IEQ), the main attention was focused solely on the prevention of harsh effects using a methodology that treats each factor in an isolated manner, meaning the selection of the thermal, sound, air or lighting quality and treating each separately (Bluyssen, 2013). Nevertheless, the indoor environment and related subjects are included in Vitruvius architectural books in ancient history, around 100 BC, and it recognizes the subject as one of the most important issues that has always concerned designers (Hobday, 2011). Therefore, the main interest becomes realizing the significance of the indoor environment, especially the aspects that are concerned with occupants' health and environmental changes (Alhorr et al., 2016). It is essential to achieve the healthiest indoor environment for occupants. However, the relation between the components of indoor environmental quality (IEQ) was not studied until the early 20th century in order to achieve an overall comfort for the occupants (Bluyssen, 2013).

Recently, engineers concerned with the subject have realized that the relation between the four components of IEQ, namely air quality, lighting quality, thermal comfort and acoustic comfort, should not start by setting standards based on numeric data, but rather start by focusing on the occupants who will use the enclosed environment (Bluyssen, 2013). The more control the occupant has over the IEQ in the space, the more comfortable the indoor experience becomes Moreover, the comfort in any indoor space is not limited to the four components of IEQ. People spend approximately 90% of their daily time in indoor environments. Therefore, the ability of the occupant to function efficiently by providing adequate space and resting zones also contributes to the overall comfort. Therefore, the architecture and usage of the space characteristics of an indoor environment should also be addressed as part of all indoor environmental studies that focus on the occupants' perspective.

It is also necessary to study the side effects resulting from unhealthy IEQ in order to create the knowledge about the weight of the contribution of each component in the overall comfort of the indoor space (Chung et al., 2011). The side effects can include short-term and long-term negative effects on the occupants' health. For instance, inadequate lighting in a space may cause the occupants to develop optic deficiencies, as well as lung, ear or skin diseases that might be caused for frequent users of buildings that do not satisfy the IEQ minimum qualities, which is a phenomenon known as 'sick building syndrome' (SBS) (Apte et al., 2000).

Time spent in residential and working environments accounts for nearly 88% of individuals' daily time (Chung et al., 2011). In the literature, there are many studies on the IEQ of residential and work spaces; however, there are no significant studies that concentrate on the IEQ of other indoor environments. Studying recreation oriented spaces in particular detail and in accordance with IEQ requirements is necessary for the design of better indoor environments. This research concentrates on objective, subjective and architectural evaluations of case wellness centres in Ankara, Turkey.

To establish the relation between interior architectural design and IEQ of a wellness centre, it is important to understand the definition of wellness in general. The term itself may mean several things depending on people's perspectives. For instance, wellness that is focused on exercise, diet and nutrition will eventually target the physical aspect of the term, while if it is focused on the mind and mental health, the term describes the spiritual aspect. Moreover, from a corporate perspective, the spa, healthcare and insurance providers may use the term for the specific benefit of their products and objectives (Benson, 2013). However, in interior design, no specific wellness definition has been related to the field, as it requires further understanding to establish the relation. Therefore, the focus on interior architecture is to provide the best indoor environment for the occupants in order to achieve wellness, which is better understood as a process rather than a measurable component. Therefore, the effect of the surrounding environment, architectural characteristics, space usage, psychological and physiological factors are all related to the overall quality of the space and indoor environment regarding users' points of view. Before presenting the case study, it is important to review the recent studies and standards regarding IEQ parameters in detail.

Indoor Environmental Quality Parameters

IEQ assessment includes many sub factors such as external of environmental conditions, building assemblies, the mechanical and electrical services of buildings and the functions of the occupants in the space (Raimondo, 2012). The various sub factors become incorporated through the environmental design as part of the aesthetic qualities of the spatial design. Hawkes (207) comments on the interactions of the IEQ components with the building design as, "the interaction of light, air and sound with the form and materiality of architectural space is the very essence in the architectural imagination." Another philosophy about the relation between the building design and occupants' sensual attributes is adopted by Pallasmaa (2005), who considers that "architecture is the art of reconciliation between ourselves and the world, and this mediation takes place through the senses".

Nevertheless, indoor environmental quality (IEQ) components do not take psychological factors, age or diseases into account due to the difficulty in measuring such parameters. Therefore, the main measurement of IEQ depends on the air, acoustic, thermal and lighting qualities as major components, which could determine, to a great extent, the overall IEQ of any space (Bluyssen, 2013). There are many factors that affect indoor environmental quality, such as temperature, humidity, air flow, pollutants, noise level in the space, as well as lighting levels and the type that depends on the functionality needed for the space. Here, the IEQ concept is very broad, thereby it is a necessity to group it under larger families, such as thermal, visual and acoustic comfort, in addition to indoor air quality (Almeida et al., 2015).

Lighting Quality

Type of lighting plays a major role in the architectural experience and psychological perception of the overall indoor environment. Vision is the primary sense through which we experience architecture, and light is the medium that reveals space, form, texture and colour (Bluyssen, 2013). Lighting quality and lighting characteristics have more input into the interior architecture and overall indoor environment of a space due to their impacts on the visual attributes of the overall spatial experience. In addition, energy consumption of lighting appliances is one of the most important factors to be considered as part of the overall building design. Artificial lighting that works with electrical power uses approximately 40% of the total energy in any commercial building and recently there has been a preference adopted by architects and designers to employ natural sunlight as part of the green building strategy. This strategy has also had a positive impact on occupants' overall comfort (O'Connor et al., 1997). Therefore, more focus becomes necessary on window sizes and brightness of the wall finishes, which depends on the amount of sunlight required and the functionality of the designed space. Studies have also proved that offices with less sunlight lead to occupant depression, stress and tension. Therefore, there is a lux level specified for each space in order to support its comfort and empower its functionality. Because this study is mainly concerned about a health care facility, Table 1 shows the minimum lux levels (illumination) required in different areas in a health care facility to act as a guideline for this research from two different references: the LARA: 1998 guidelines and the related Turkish standards: TS EN 12464 1:2013.

Table 1. Minimum Lux levels of healthcare facilities in different spaces as specified in LARA regulation and Turkish Standard

Area	Minimum Illumination (Lux)	
	LARA	TS EN 12464-1
Corridors Day	215	100
Corridors Night	110	50
Critical Care (ICU) General – Full room	215	300
Critical Care (ICU) Examination - Fixed	1615	1000
Emergency General – Full room	540	500
Emergency Examination - Fixed	1615	1000
Examination & Treatment Rooms	540	500
Hand wash areas	225	200
Nursing Stations – General	225	300
Nursing Stations – Desk	540	500
Nursing Stations - Medical	810	1000
Physical Therapy Treatment	225	300
Stairways	215	100
Toilets	225	200
Operating Room	1615	1000

Acoustic Quality

Many studies in the literature show that noise and temperature are the main parameters that have the majority of the weights in determining the satisfaction of the occupants in indoor spaces. Therefore, indoor spaces with noise problems significantly affect occupant productivity at work or their living experiences in their homes (Huang et al., 2012) and therefore, their overall acoustic comfort level. According to the Institute of Scientific Information (ISI), the maximum outdoor and indoor noise level in residential areas should not exceed 45 dB, which is the same standard level used in healthcare facilities in Turkey (Koçyiğit, 2012). One related study in healthcare facilities shows that the noise levels of the tested buildings exceed the local and international standards by 5 dB, which may have adverse effects in the long term (Kocyigit, 2012). It has also been found that offices with acoustic comfort issues have reduced productivity rates in comparison to those with acceptable acoustic comfort and privacy levels (Alhorr et al., 2016). Employees with acoustically private offices were found to be more productive, open to interaction with their colleagues, more focused in their jobs, and happier with their work environment (ASID, 2004). Moreover, it was found that noise has adverse effects on health, including increased stress and heart disease (ASHA, 2015). In addition, other health and well-being issues may be caused by the uncomfortable noise levels in a building, including stress, sleep disturbance, hypertension that can even lead to cardiac attacks and sudden death (Evan & Johnson, 2000). The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE, 2010) identified the most common noise sources that affect a building to include outdoor noises, noise from neighbouring spaces, office equipment noises, airborne sounds and noises from adjacent facilities. Therefore, noise control and acoustic comfort should be the prior design criteria of a building (Andersen, 2009).

Thermal Quality

Thermal quality and comfort level may vary from one person to another depending on their gender, ethnicity, age and body preferred climate as the human body is in continuous adaptation to the surrounding environment and temperature (Quang, 2013). Thermal comfort and influencing factors are divided into two main categories (Katafygiotou & Serghides, 2015):

- Environmental factors: including air temperature, radiant temperature, relative humidity and air velocity; and
- Human factors: including body metabolism and clothing.

Similarly, thermal comfort varies from one climatic region to another in which cultural background plays a major role (Lovins, 1992). This mainly depends on the adaptation of people to their indoor environment, which has two influential factors, namely physical adaptation and physiological adaptation (Nikolopoulou & Steemers, 2003).

Air Quality and Humidity

Indoor air quality and related problems are important to raise awareness in building design and long-term usage (Levin, 1995). In order to determine acceptable indoor air quality, ASHRAE (2010) has set several criteria and guidelines. The most important two criteria are as follows:

- The minimum ventilation rate for any space should be 8 Ls^{-1}. This standard keeps the CO_2 levels in the space steady at 870 ppm, assuming that each person generates 0.31 $Lmin^{-1}$, while the minimum ventilation rate increases for office spaces to 10 Ls^{-1} (Apte et al., 2000).
- There should be no dangerous contaminant concentrations, in accordance with the authorities' regulations. Moreover, indoor air quality (IAQ) is acceptable if a minimum of 80% of the occupants of the space are not dissatisfied or have no health issues resulting from the IAQ (Almeida et al., 2015).

Furthermore, humans are always surrounded with water vapour as part of the atmospheric air. The humidity level that is required to achieve an optimal thermal comfort should be between 40 to 70 percent in any space (Spengler & Chen, 2000). The humidity level varies in indoor spaces depending on the functions. For instance, the humidity in industrial spaces is higher than the humidity in offices or houses due to the heat generated from machines, which increases the evaporation of water or moisture from the human body, resulting in discomfort (Harrison, 2002).

Methodology and Findings

The importance of this research emerges from the following:

- There has been very little focus on indoor environmental quality parameters, indoor air quality, thermal quality, acoustic quality, lighting quality and their overall integration into the evaluation process.
- There has been a lack of indoor environmental quality research in healthcare facilities and especially in wellness centres.
- There has been a lack of IEQ studies in wellness centres that incorporate users' perspectives and correlate them to objective measurements.

This research has adopted three evaluation methods in order to ensure a full assessment of the IEQ in the case space. Two different function spaces, exercise rooms shown in Figure 1 and treatment rooms shown in Figure 2 and the materials used in the interior finishes of the wellness centre were considered as part of the architectural analysis. The objective data collection method is performed through measurements of the considered IEQ parameters, while the subjective data collection method focused on the results of 95 questionnaires completed by the case space users in order to collect data on the physical perception towards the IEQ parameters. The measure-

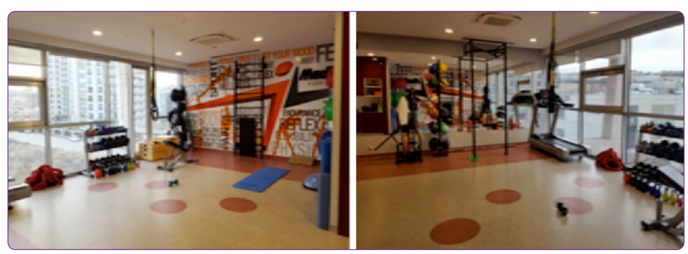

Figure 1. Exercise rooms in the case wellness space.

Figure 2. Treatment rooms in the case wellness space.

ments and questionnaires were applied together simultaneously in order to produce comparable datasets.

Thermal, lighting, acoustic and humidity related levels in the exercise and treatment areas of the wellness centre are measured according to the techniques stated in the related standards (TS ISO 1996 2 and TS EN 12464 1:2013) and the relationship between the objective measurements and the subjective evaluations are statistically tested. In addition, the results are compared with international standards related to similar facilities. Finally, possible design solutions or implications in the case space to increase the quality assessment of IEQ are discussed. The analysis and findings include four main sections:

- Architectural analysis of the case spaces in the wellness centre regarding material usage, area distribution and functions;
- Objective IEQ measurements;
- Subjective IEQ perception in the case spaces; and
- Statistical analyses between objective and subjective data.

Architectural Analysis

The case space is two-stories high with a rectangular plan and a grid allocation system, as shown in Figures 3 and 4. The overall space is divided according to main and supporting activities. The primary facilities are the treatment rooms and the exercise rooms, while the supporting facilities are the reception areas, corridors, toilets, waiting room and kitchen. The total area of the case space is 464.2 square meters, with 303 square meters for the first floor and 161.2 square meters for the second floor. In studying the materials used in the different spaces of the case space, the wall material was categorized as two types: painted gypsum board used in the majority of the areas and glass facades used on the west side in the exercise rooms. The main advantage of using glass facades is that they allow natural light to pass through the exercise space, increasing illuminance levels thereby taking advantage of natural light-related health benefits. Suspended gypsum ceilings were in all the areas of the case space. The treatment rooms, reception and waiting room had wood laminate flooring, and PVC linoleum flooring was used in the exercise rooms.

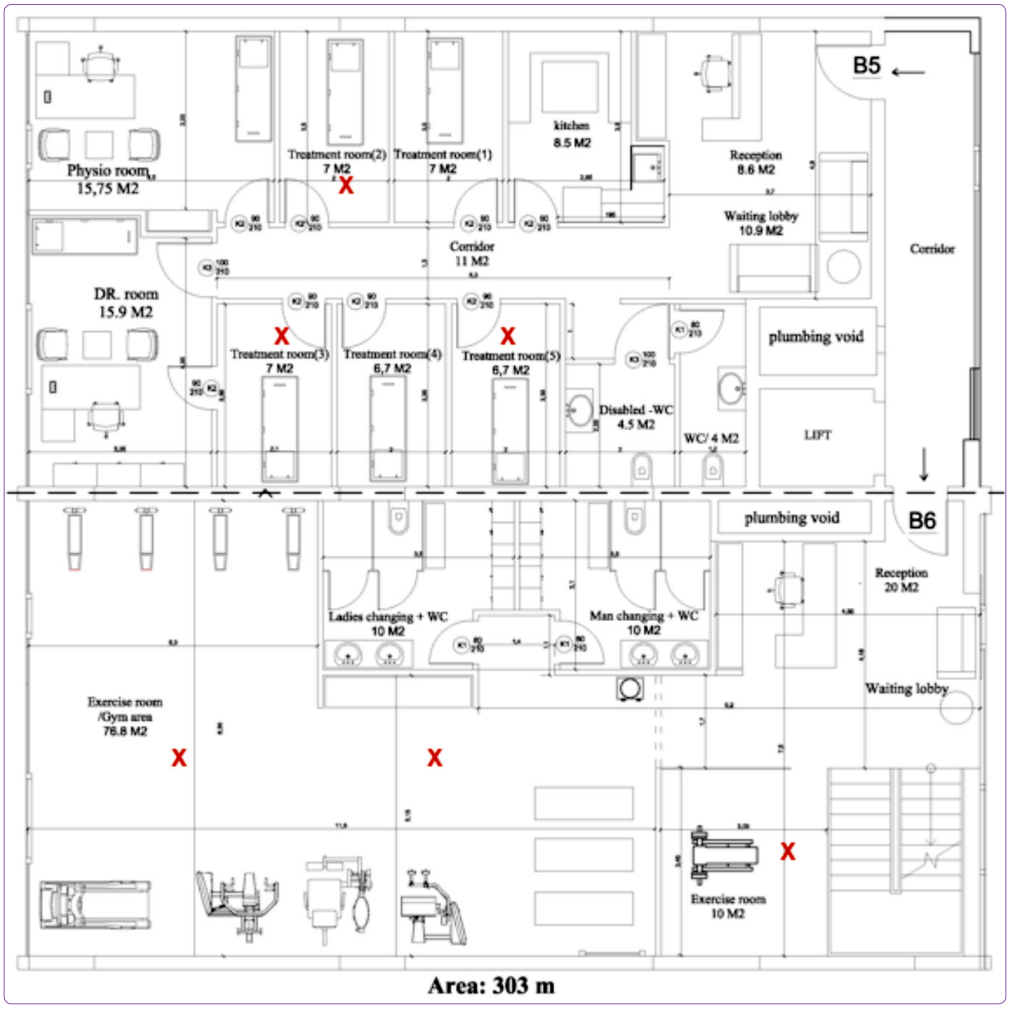

Figure 3. First floor plane of the case space showing treatment and exercise rooms.

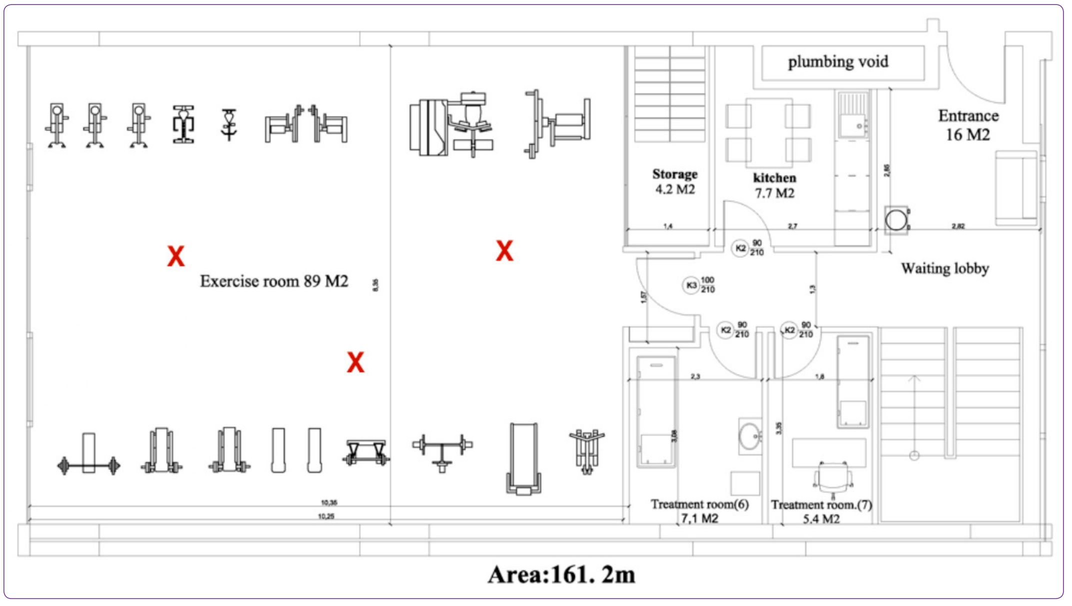

Figure 4. Second floor plane of the case space showing treatment and exercise rooms.

Measurement Findings

Measurements of temperature, humidity, sound level and illuminance were taken using the CEM DT8820 environmental meter on 6 different days under two weather conditions: sunny and cloudy in April of 2017. The sound pressure level meter was located 150 cm above ground level and 100 cm away from every reflective surface. The exercise rooms on first and second floor were illuminated with natural light and LED spotlights (D: 15cm, 18 watt). The treatment rooms were illuminated only with LED spotlights (D: 15cm, 18watt). The measurements were taken during four main time periods: in the (T1) morning between 8:00 and 11:00, at (T2) noon between 11:00 and 14:00, in the (T3) afternoon between 14:00and 17:00, and in the (T4) evening between 17:00 and 20:00. Table 2 shows the minimum, maximum and average readings for all the IEQ parameters in the treatment and exercise rooms.

The maximum illuminance value was measured during the noon period in the exercise rooms with the large glass facade, while the lowest illuminance value was measured in the morning period in the enclosed inner areas to be as low as 74 lux. Moreover, the sound level measurements reached a maximum of 92.5 dBA, which was measured in the morning period in the exercise room on the first floor next to the sound speakers in the exercise room of the first floor, while the lowest sound level was measured in treatment rooms during the afternoon. In addition, the maximum humidity values were measured in the treatment rooms in the morning, while the maximum values for the temperature values were also measured in the same space

Table 2. Maximum, minimum and average measured values of indoor environmental parameters in the case spaces on different time periods

Space Type	Value	Sound Pressure Level (dBA)	Illuminance (Lux)	Temperature (°C)	Relative Humidity (%)
Treatment	Minimum	33 (T3)	206 (T1)	20.8 (T1)	29.4 (T3)
Rooms	Maximum	51.4 (T1)	313 (T1)	26.6 (T2)	39.8 (T1)
(First Floor)	Average*	43.4	259.1	23.8	32.5
Exercise	Minimum	36.3 (T4)	74 (T1)	18.9 (T1)	26 (T3)
Rooms	Maximum	92.5 (T1)	1578 (T3)	24.5 (T3)	31.6 (T1)
(First Floor)	Average*	56.1	536.8	22.5	29
Exercise	Minimum	34.6 (T2)	172 (T4)	18.9 (T1)	26.3 (T3)
Rooms	Maximum	47.4 (T3)	1973 (T2)	25.5 (T3)	30.7 (T1)
(Second Floor)	Average*	41	1033.8	22.7	28.6

* Measurement values of different measurement points in different measurement times are averaged.
T1: Morning measurement time; T2: Noon measurement time; T3: Afternoon measurement time; T4: Evening measurement time.

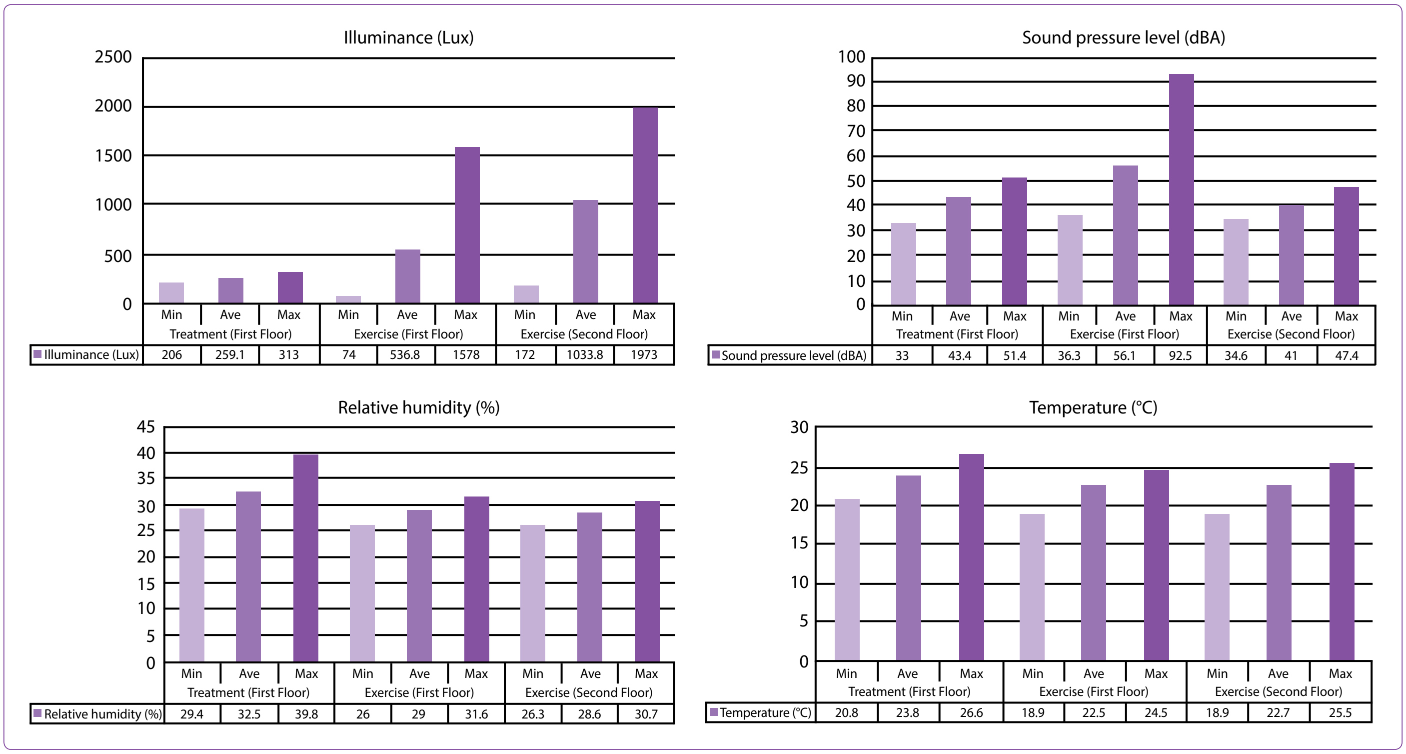

Figure 5. Maximum, minimum and average measured values of indoor environmental parameters in the case spaces.

in the afternoon. Figure 5 illustrates the maximum, minimum and average measured values of the indoor environmental parameters in the case spaces and Table 3 shows the mean values for the studied IEQ parameters in the treatment and exercise areas according to the different time periods. Figure 6, on the other hand, shows the mean IEQ parameter values in the treatment and exercise rooms during different time periods.

Questionnaire Findings

Ninety-five (95) participants were asked to evaluate the indoor environmental quality according to their physical perception in exercise and treatment rooms separately. 55% of the participant group was male and 45% female. In addition, 60% of the participant group were aged 18 30 years, 23% 31 44 years of age and 17% 45 60 years. Furthermore, 65% of the participants indicated that they spent at least 1 2 hours in the Centre during each visit and 47% of the participants indicated that they visit the Centre 2 3 times per week. The evaluation was performed on an even bipolar 6 point scale, using semantic differential analysis for each of the five parameters in every considered area, as follows:

- Acoustic quality – 6 point scale between the semantic pair; Quiet/Noisy
- Lighting quality – 6 point scale between the semantic pair; Bright/Dull
- Thermal quality – 6 point scale between the semantic pair; Hot/Cold

Table 3. Mean IEQ parameter values in treatment and exercise rooms at different time periods

Time	Space Type	SPL (dBA)	STD (dBA)	E (Lux)	STD (Lux)	T (°C)	STD (°C)	RH (%)	STD (%)
Morning (T1)	Treatment	46.3	25 for treat.	273.8		21.2		36.6	
	Exercise	54.0		628.6		19.2		31.2	
Noon (T2)	Treatment	40.7	55 for exerc.	242.4	Min. 300	23.9	15-30	32.3	<60
	Exercise	48.6		931.4		23.6		29.6	
Afternoon (T3)	Treatment	42.4		246.4		24.8		29.9	
	Exercise	53.2		1043.3		24.6		26.7	
Evening (T4)	Treatment	44.1		273.6		25.2		31.1	
	Exercise	44.3		338.9		22.9		28.0	

* Treatment rooms that are located in first floor and exercise rooms that are located in first and second floor. STD: Related standard value.

Figure 6. Mean IEQ parameter values in treatment and exercise rooms at different time periods.

- Indoor air quality – 6 point scale between the semantic pair; Fresh/Stale
- Humidity condition – 6 point scale between the semantic pair; Humid/Dry

As presented in Figure 7, the results for the physical perception of IEQ parameters indicate a score of 2.2 for the acoustic quality ratings in the exercise room, which is in the range of (2) quiet to (3) slightly quiet. Secondly, the lighting quality was evaluated as being close to bright with a mean score of 1.9. On the other hand, the thermal quality was perceived as being between (2) hot and (3) slightly hot with a mean score of 2.5. A mean score of 1.5 was found for the indoor air quality, which was perceived as being between (1) very fresh and (2) fresh. Finally, the humidity conditions were evaluated as moderate, that is, rated as being close to (3) slightly humid with a mean score of 3.2.

The physical perception ratings of the IEQ parameters in the treatment rooms are shown in Figure 8, with comparisons to the exercise room mean scores. The results show that the treatment rooms were evaluated to be quieter when compared to the exercise rooms with a mean score of 1.9 for the acoustic parameter. The lighting perception also shows a difference with ratings with a slightly bright range in the answer scale with a 2.2 mean score. The thermal quality was perceived as being from hot (2) to slightly

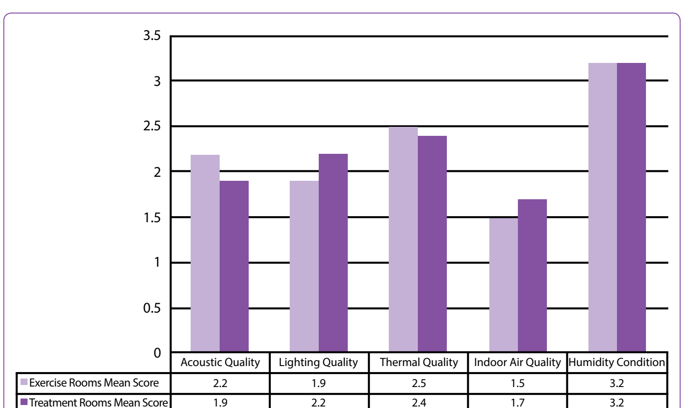

Figure 7. Physical perception rating scores for IEQ parameters in the case spaces.

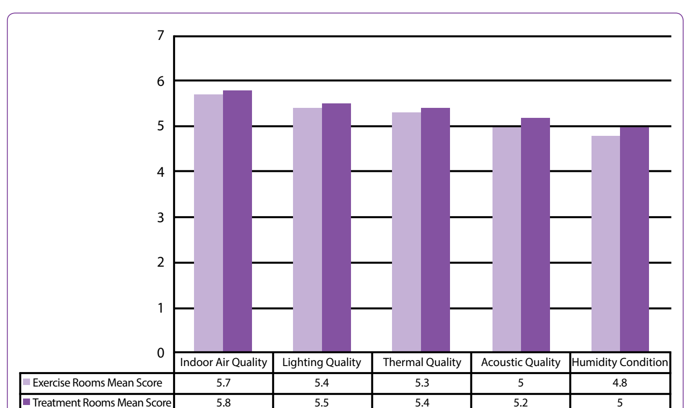

Figure 8. Importance rating scores of IEQ parameters in the case spaces.

hot (3) with a mean score of 2.4, giving a very similar rating to the exercise rooms. Indoor air quality had a mean score of 1.7, which lays this parameter as rating between very fresh (1) and fresh (2). Finally, the humidity condition was evaluated with a mean score of 3.2, equal to the exercise room means.

The participants were asked to rate the importance of the indoor environmental quality in the exercise and treatment rooms on a 6 point unipolar scale. The results of the importance ratings are shown in Figure 10 for both space types. Indoor air quality was the most important parameter, while the humidity condition was rated as the least important parameter. The importance mean scores showed the second most important parameter to be lighting quality followed by thermal and acoustical quality. Although the differences of the mean scores among some parameters were very small, it is valuable to further investigate this evaluation from the users' points of view.

Results and Discussion

Correlation and Variation Analyses

In correlating the demographics and space usage data with the subjective evaluation of the users, a one way ANOVA statistical analysis was carried out, as shown in Table 4. Several important correlations are established between the demographics and space usage data and the subjective measurements of the physical perception of the IEQ parameters and their importance:

- A statistically significant relationship was found between age and importance given to thermal quality in the treatment rooms (Significance = 0.023 at $p<0.05$).
- A statistically significant relationship was found between frequency of visits and importance of indoor air quality in the treatment rooms (Significance = 0.001 at $p<0.05$).
- A statistically significant relationship was found between the purpose of visit and thermal physical perception in the exercise rooms (Significance = 0.016 at $p<0.05$).

Relationship between Measurement and Questionnaire Results

After testing the relationship between the measurement and questionnaire findings of the IEQ parameters, the only significant difference was found in the lighting parameter of the exercise room (0.013, $p<0.05$). The lack of correlations between the other parameters may be due to the lack of the relationship between the two datasets or the insufficient information provided by the data to establish any correlations.

ANOVA and means comparison tests were performed to analyse the objective data collected by measurements in the treatment and exercise rooms of the wellness centre. The first parameter tested was on the acoustical parameters with the ANOVA testing significance being calculated as 0.000 ($p < 0.001$) indicating variation in means between the two datasets. The same procedure was applied for the acoustic quality subjective data, which yielded similar results. The mean of the acoustic objective measurement in the treatment rooms was 42.6 dBA, while the value in the exercise room was 50.6. The subjective assessment shows a mean of 1.9 for the treatment rooms versus 2.2 for the exercise rooms. These results confirm that the acoustic levels in the exercise rooms were significantly higher than in the treatment rooms at a significance level of 0.001.

The second parameter tested was the lighting quality measurements and questionnaire data from which a significant difference was obtained ($p<0.000$). The means of the measurements were 252.4 lux and 855 lux for the treatment and exercise rooms, respectively. For the subjective evaluation of the users, the means were respectively 2.2 and 1.9 for the treatment and exercise rooms. Both means and the ANOVA testing confirm that the exercise rooms were significantly brighter than the treatment rooms.

The third parameter tested was the thermal quality with the significance calculated as $p<0.000$, highlighting a significant mean difference between the two data sets. Measurement mean scores that are reported as 23.9°C and 23.2°C for the treatment and exercise rooms, explain the mean difference indicated by the ANOVA testing. The

Table 4. ANOVA correlation findings between subjective assessment results and demographics and space usage data

Demographical and space usage data	Subjective assessment of IEQ parameter	One-Way ANOVA sig. ($p<0.05$)
Age	Physical perception of humidity condition in the treatment rooms	0.017
	Importance of thermal quality in the treatment rooms	0.023
Frequency of visit	Physical perception of acoustical quality in the exercise rooms	0.032
	Importance of indoor air quality in the treatment rooms	0.001
Purpose of visit	Physical perception of thermal quality in the treatment rooms	0.037
	Physical perception of thermal quality in the exercise rooms	0.016

findings are also confirmed by the subjective assessment means of 2.4 and 2.5 respectively for the treatment and exercise rooms. These results confirm that both measurements and subjective ratings show significant variance.

The final parameter tested was the humidity condition, with significance being again calculated to be 0.000. The measurement means showed a 32% humidity level in the treatment rooms, while the exercise rooms had a mean of 28.6%. Finally, the subjective ratings are respectively 3.20 and 3.18 for the treatment and exercise rooms, showing a very small variation for the mean score. Statistical tests confirm that the treatment rooms were significantly more humid than the exercise rooms.

Discussion

In order to understand the current situation in the case space, the measurement values collected from the case space were compared with the international standards on healthcare facilities. The subjective ratings were also reviewed along with the objective measurements in order to understand the issues that can be highlighted from the performed analysis and work towards possible future studies.

The materials used in the case space were considered to be suitable for their functionality and activities planned in each space type. The glass facades in the exercise rooms supported natural light during the day time, which adds to the benefits of providing better lighting quality. Moreover, the PVC linoleum flooring was also suitable for the fitness areas with its durable and hygienic outer finish. However, there is no evidence from the architectural survey and analysis that the ceiling types support the acoustic requirements of a healthcare facility (CISCA, 2010), which is discussed further in this part. The laminated wood flooring in the treatment rooms were also found suitable for cleaning and disinfection criteria in addition to the thermal advantages when compared to ceramic tiles or natural stone flooring applications.

Based on the objective measurements, the lighting quality fluctuates from 1,973 lux in the exercise rooms near the glass facade during the day time to as low as 74 lux in the inner parts of the exercise rooms. According to the standards for health care facilities, general lighting in healthcare facilities should have a minimum of 100 foot candles, which is equivalent to 1,076 lux for the illuminance (E) level. Task lighting should be between 150 and 200 foot candles (1,614 to 2,153 lux) (Michigan Dept. of Community Health, 2007). However, according to the Turkish standards (TS EN 12464 1:2013), the minimum illuminance level for exercise and treatment rooms is 300 lux. Based on these results, the lighting quality in the case study wellness centre does not meet the international standards for either the exercise rooms or the treatment rooms, and the Turkish standards for the treatment rooms. In addition, illuminance levels of 215 lux, 225 lux and 540 lux for the corridor (general lighting), exercise rooms, and treatment rooms, respectively, do not meet international lighting comfort requirements (LARA, 1998).

The acoustic quality in the treatment centre is measured by sound pressure level (SPL) readings from different parts of the facility. The data shows an average measure that ranges from 40.68 dBA to 54.02 dBA. International standards for healthcare facilities and the World Health Organization recommend as maximum of 35 dBA during the day (CISCA, 2010). Related Turkish regulations on noise level limits in treatment and resting rooms in healthcare facilities is 25 dBA and in exercise rooms in sports facilities, it is 55 dBA (Turkish Ministry of Environment and Forestry, 2010). According to these limits, treatment room noise levels are well above, and exercise room noise levels are on the border when compared to the values of the Turkish regulations. Ceiling types and the materials used in the facility play a major role in determining the acoustic quality of the space. Therefore, the architectural analysis did not include the use of any specific acoustic ceiling, which could be a suitable solution to decrease comparatively high dBA levels in the case spaces by providing hygienic and durable sound absorbing material applications.

For the thermal comfort in healthcare environments, the British Standards recommend that temperature (T) should range between 15°C and 30°C, while humidity should not exceed 60% (Lomas & Giridharan, 2012). According to the measured values of temperature in the treatment and exercise rooms, the minimum value was recorded as 18.9°C and the maximum value was recorded as 26.6°C, which falls within the standard range. Furthermore, the relative humidity (RH) reached a maximum of 39.8%, not exceeding the 60% limit as stated in the literature.

The results of the questionnaire show that 87.37% of the wellness centre visitors would spend at least one hour in the facility and some would spend even more time, and 80% would visit the facility at least twice a week. Therefore, the indoor environment of the facility could have an influential impact on the visitors' health and wellbeing. The physical perception results showed the air quality as being the best-perceived parameter of the IEQ parameters, followed by the lighting quality, acoustic quality and thermal quality, considering the exercise and treatment areas of the facility. Due to lack of equipment, the measurement of the indoor air quality was not accomplished. This can be discussed as one of the drawbacks of this study.

Conclusion

Wellness centres are one of the most popular facilities related to well-being and treatment, yet no specific standards have been created for these special environments. In this study, a comprehensive analysis approach was planned and applied to understand the relationship between objective, subjective and architectural data to evaluate the case of a wellness centre in Ankara, Turkey. The conclusions of this study are as follows:

- The measurements in the wellness centre showed that temperatures ranged between 18.9°C and 26.6°C and the relative humidity reached a maximum of 39.8%, which was found to be suitable according to standards.
- Acoustic and lighting measurements in the wellness centre were not found to be within the acceptable limits as per the IEQ requirements and space functionality in related standards.
- Older users of the case space were more sensitive towards humidity and perceived the treatment rooms to be more humid when compared to the exercise rooms.
- Lighting was one of the most dominating factors and when compared to other indoor environmental parameters, the lighting parameter was found rto be significantly correlated with the objective measurements.
- Correlations were found between the demographic and space usage data of the participants, and the subjective physical perception and importance assessment of the IEQ parameters in different spaces.
- After performing the ANOVA tests and means comparison, it was found that the areas within the case space varied in their indoor environmental quality, as the exercise rooms were found to be significantly noisier, brighter, cooler and less humid than the treatment rooms.

As a note for future research on the related subject, additional indoor air quality parameters on VOC, CO and CO2 levels can be reported and similar relations can be tested. Future work could also include comparisons of different wellness centres with varying architectural characteristics, such as material finishes, facade orientation, window opening sizes and materials. In addition, seasonal changes could be studied to understand their effects on indoor environmental parameters and their perceptions by users.

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