

Users' views of hospital environmental quality: Validation of the Perceived Hospital Environment Quality Indicators (PHEQIs)

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ABSTRACT

Environmental Quality Perception (EQP) is an important construct used to help to understand the relationship between people and the hospital environment. From a patient-centered care perspective, it is important that hospital design take into account the patients' (and other users') point of view. This paper presents the adaptation and validation of a measure of hospital EQP, the Perceived Hospital Environment Quality Indicators (PHEQIs; Fornara, Bonaiuto, & Bonnes, 2006), and seeks to confirm the factor structure of this construct in a different cultural context. Three scales, two focusing on physical environments and one evaluating the social environment, were completed by 562 users of four orthopedic units in Portuguese hospitals, two older and two recently built or renovated. To assess criterion validity, hospital physical environments were also objectively evaluated by two architects. Using a confirmatory factor analysis the three validation procedures produced acceptable fit indices in the final measurement models. Overall reliability values were satisfactory, as was the evidence for criterion validity. PHEQIs scales and factors correlated with global evaluation of the environment, supporting concurrent criterion validity; and predictive criterion validity was demonstrated given that users of older and newer hospitals differed significantly on the perception of quality of hospital EQP, and that high congruence between users' and experts' evaluations was found. Discriminant construct validity was supported, and some difficulties in showing convergent validity are discussed in terms of item formulation adequacy. Implications for research and practice are described.

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It is inescapable: the appearance of healthcare facilities matters to users (Devlin, 2010; Gesler, Bell, Curtis, Hubbard, & Francis, 2004). After decades of research on the healthcare physical environment it is hard to ignore the fact that it has an impact on users' outcomes (e.g., Ulrich et al., 2008). However, despite the significant advances in the science of medicine, or perhaps because of them, hospitals, with their life-saving equipment, procedures, and technologies, are often perceived as sterile, intimidating institutions (Ulrich & Gilpin, 2003), and environmental qualities of buildings that could promote the health process have been largely neglected (Dilani, 2001). Finally, the premise that a healthcare facility be designed as a "curing machine" for medical conditions, rather than as an environment to promote wellness for the individual is being challenged (Arneill & Devlin, 2002), and a new generation of hospitals seem to be adopting this revised perspective. In a society where the understanding of health has expanded to encompass

a holistic notion of physical, psychological, and social well-being, rather than a constrained idea of a disease-free body, it is not surprising that hospitals are changing in both form and function (Gesler et al., 2004). How should the hospital environment look to produce judgments that it is humanistic and of high quality? In this paper the basic dimensions that individuals use to represent the hospital environment have been investigated, through the adaptation and validation of a measure of hospital environmental quality perception. In the next section arguments that explain the value of such measure will be presented.

1. Fostering hospital environmental quality from the users' point of view: some practical considerations

To measure and understand how patients, family, and staff evaluate the hospital physical environment may be useful for architects, administrators, and researchers of healthcare environments.

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The effort to conceive hospitals as facilities that benefit their users can be seen as part of the broader context of implementing a model of patient-centered care. The Planetree model, founded in 1978, is one of the pioneers in patient-centered approaches in hospitals and has been dedicated to the transformation of the healthcare experience for patients and their families (Arneill & Frasca-Beaulieu, 2003). The Planetree philosophy encourages patients to become educated participants in choices regarding their care by fostering patients' access to information, promoting positive staff–patient interaction, and involving both patients and their families in the healing process (Schweitzer, Gilpin, & Frampton, 2004). An important component of this philosophy is the creation of an aesthetic, comfortable, soothing, and home-like environment conducive to well-being (Casparia, Erikssonb, & Naden, 2006; Martin et al., 1998), the benefits of which have already been confirmed through research (e.g., Devlin, 1995). The movement toward humanizing healthcare settings is also taking place in Europe (e.g., Dilani, 2001; Gesler et al., 2004). For instance, the recent Private Finance Initiative program of hospital building in the UK has been accompanied by a vigorous debate over what constitutes good hospital design for different stakeholders (Gesler et al., 2004). Accordingly, the need to investigate the perceptions and attitudes of users (i.e., patients and staff) of the healthcare built environments and to provide them the opportunity to participate in the design process is being emphasized (e.g., Douglas & Douglas, 2004; Gesler et al., 2004). Many hospital designs have been based primarily on expert discourses that emphasize efficiency in terms of costs and clinical functionality; that is, only the visions of administrators, architects, construction engineers, policy-makers, and politicians were taken into account (Gesler et al., 2004). However, it seems intuitive that a “user-centered design” (Gifford, 2002), aimed at planning and designing spaces that fit with the needs and preferences of current and potential users, must take into account what such users think. In this context, a measure that assesses users' perceptions of hospital environmental quality is valuable as a tool for architects and designers in order to 1) inform future environmental interventions, by capitalizing on what users wish to see in the environment, or to 2) determine the success of a hospital design planned to be user-centered, ensuring that it satisfies users' needs.

Despite the call for stronger empirical evidence showing the influence of design attributes on hospital users' well-being (e.g., Devlin & Arneill, 2003; Dijkstra, Pieterse, & Pruyn, 2006; Ulrich et al., 2008; Zimring & Bosch, 2008), one can already talk about the healthcare research framework of “Evidence-Based Design” (EBD). EBD was defined as “a deliberate attempt to base design decisions on the best available research findings” (Hamilton, 2003, p.19). That is, EBD is based not only on designers' technical knowledge and requirements, but also on the information available about what is better for users (Fornara & Andrade, *in press*). Therefore, we believe that the process of monitoring the reactions of users toward different design solutions might be facilitated by the availability of a practical and relevant self-report measure on hospital environmental quality perception. The implementation of research-based solutions should be complemented by the assessment of the perceptions of the users of the targeted hospital care unit (e.g., Watkins & Keller, 2008).

Most of all, it is important to give voice to the stakeholders very often forgotten. Although there still may be some skepticism from healthcare architects and planners regarding the benefit of input from clinicians and patients in the design process (Hignett & Lu, 2008), there is an additional reason to involve the hospital users: people appreciate participating and benefit from it (Horelli, 2006; Kaplan & Kaplan, 2009). When hospital and nursing administrators listen to nurses, recognize their contribution, and allow them to

participate in decision making about their physical work environment, the result can be an increase in job satisfaction and a decrease in staff stress (Applebaum, Fowler, Fiedler, Osinubi, & Robson, 2010). For example, Becker, Sweeney, and Parsons (2008) acknowledged that the involvement of staff in the design process might influence outcomes in terms of job satisfaction. With regard to patients, Devlin and Arneill (2003) have argued how crucial it is for patients to have control over their healthcare environment. In this sense, the gesture of asking (and using) patients' views might increase patient satisfaction.

A reliable and valid measure on hospital environmental quality perception can also be useful for hospitals administrators. In a time when hospitals are actively competing for patients, when patients are becoming increasingly aware of their role as consumers of the healthcare they purchase, and when staff are demanding greater participation in decisions affecting their work (Becker & Poe, 1980), it is important that managers monitor users' perceptions of quality and levels of satisfaction in order to track quality improvements over time. Such data allow managers to compare their facilities to those of other health providers (when the same measures are used), and to recognize and resolve service problems in real-time (Lis, Rodeghier, & Gupta, 2011). With regard to the physical environment, patients are increasingly adopting the perspective of consumerism and consumer facility types in healthcare (e.g., Verderber & Fine, 2000) and are likely to make comparisons with other kinds of venues where comfort is being emphasized, such as airport departure lounges, ski villages, and even Ikea (Curtis, 2000, as cited in Gesler et al., 2004). The equation seems to be simple: the physical environment generates satisfaction with the service (e.g., Swan, Richardson, & Hutton, 2003), as well as with the staff (e.g., Gotlieb, 2002), which are predictors of intention to recommend and to use the hospital again (e.g., Becker et al., 2008; Lee & Yom, 2007; Lis et al., 2011). In fact, organizations such as the Joint Commission on Accreditation of Healthcare Organization (JCAHO) are using patient satisfaction as a quality care indicator (Boudreaux, Mandry, & Wood, 2003). Further, since 2008, US hospitals' comparable data on patient satisfaction collected through a standard survey is available to the public (Hospital Consumer Assessment of Healthcare Providers and Systems, known as HCAHPS: see a discussion in Devlin, 2010), providing an opportunity to directly compare hospital patient satisfaction ratings. These examples illustrate a significant trend to ask people (patients/consumers) to report on their experiences, and a greater emphasis on quality as defined by their perceptions. In an increasingly competitive market, where healthcare consumers have more options for care, hospitals and healthcare organizations must work hard to create environments that encourage repeat visits and increase patient satisfaction (Fottler, Ford, Roberts, Ford, & Spears, 2000).

With regard to staff, a survey found that nurses based their decision to work at a hospital on a variety of factors, including the workspace in wards (CABE, 2004), and Devlin (2010) points out that increasingly modern hospitals and up-to-date facilities will lure the best doctors. As a result, administrators and managers might want to regularly examine the factors that influence the patients' and clinicians' perceptions of quality and satisfaction, as a basis for planning any changes that may be necessary.

Lastly, we propose that a measure of hospital environmental quality perception is important for researchers interested in healthcare quality, environmental psychology, or both. Since its birth, Environmental Psychology has maintained an interest in the study of healthcare environments and its implications for users (e.g., Baker, Davis, & Silvadon, 1960; Ittelson, 1960; Ittelson, Proshansky, & Rivlin, 1970; Osmond, 1957; Sommer, 1969). As a result, a growing body of research has demonstrated that the healthcare physical environment has an impact on patients'

recovery and satisfaction, and on staff performance and stress. Although some deceleration in the publication of research in this area has occurred over the last few years (e.g., Sundstrom, Bell, Busby, & Asmus, 1996), there is a current call for such research, with the advantage that healthcare decision makers are ready to apply it (Zimring & Bosch, 2008). In this context, the understanding of the role of the perceptions of quality in the relationship of patients, family, and staff to the hospital is important.

1.1. The influence of perceptions of the healthcare physical environment on users' health outcomes

A growing body of literature has illustrated the impact of the physical attributes of the hospital on user outcomes, such as recovery, satisfaction, hospital perception, and overall well-being (for a review, see Ulrich et al., 2008). The routes by which the physical environment exerts its influence, both direct and indirect, can be diverse. Besides the direct physiological influence (for example, the microorganisms in a carpeted floor can cause infections), the environment may act through psychological processes evolving from sensory perceptions. These processes can be of a cognitive or an emotional nature (Dijkstra et al., 2006). In this paper the focus is on the cognitive processes that enable the hospital users to judge the hospital environmental quality. Specifically, the present study attempts to adapt and validate a measure of hospital environmental quality perception, namely, the Perceived Hospital Environment Quality Indicators (PHEQIs) (Fornara et al., 2006). However, to demonstrate the important role of perception in outcomes, studies in which the role of perception of the hospital physical environment is documented will be described first.

Swan et al. (2003) investigated the effects of appealing and typical patient rooms in the same hospital on patient evaluations. The patients in the two types of rooms were matched on a number of variables and their services were equivalent (e.g., same physicians, similar housekeeping and food service). The appealing rooms were well-decorated, hotel-like, with wood furniture, decorator art, carpeted floors, crown molding, and ceramic tile baths, whereas the typical rooms were standard wardrooms with typical metal hospital beds, inexpensive family sitting chairs, and no artwork. The typical rooms were slightly smaller and noise levels were higher. Appealing rooms resulted in more positive patient evaluations of the rooms and of the physicians, as well as more favorable patient judgments about food and housekeeping services. In addition, patients in appealing rooms had stronger intentions to use the hospital again, and would recommend the hospital to others than did patients in typical rooms. Through a questionnaire mailed to discharged patients from a large hospital of a major metropolitan area, Gotlieb (2002) found some similar results. He concluded that patients' evaluation of their rooms affected their evaluation of the nurses and their hospital satisfaction.

The study of Leather, Beale, Santos, Watts, and Lee (2003) compared a pre-relocated waiting room (described as "traditional" in design) and the post-relocated waiting room (described as "nouveau") in terms of effects on environmental appraisals, self-reported stress and arousal, satisfaction ratings, and pulse readings. They found that the new waiting area was associated with more positive environmental appraisals, but also with improved mood, an altered physiological state, and greater reported satisfaction.

One can also make reference to the experimental study of Arneill and Devlin (2002). Using photographs of waiting rooms of distinct medical offices, they showed that people can make judgments about the expected comfort as well as the quality of care they think will be delivered by the doctor. Perceived quality of care was greater for waiting rooms that were nicely furnished, well-lighted, contained artwork, and were warm in appearance vs. waiting

rooms that had outdated furnishings, were dark, contained no artwork or poor quality reproductions, and were cold in appearance.

The studies described demonstrate the relevance of the perceptions of patients about the hospital physical environment and show a relationship between these perceptions and evaluation of health professionals and likely care.

Some studies have also shown a relationship between hospital physical environment and staff outcomes (for a review, see Chaudhury, Mahmood, & Valente, 2009). For instance, Shepley, Harris, and White (2008) found that staff members working in single-family rooms of neonatal intensive care units are more satisfied with the physical environment, had higher job satisfaction, and lower stress than did those staff members working in an open-bay unit. Mroczek, Mikitarian, Vieira, and Rotarius (2005) showed that staff believes that certain hospital design features, such as increased natural light, have a positive impact on the quality of their work life.

These kinds of results suggest that users do not ignore the qualities of the hospital physical environment and that those perceived qualities have an influence on their well-being. Ultimately, research has shown the potentialities of the hospital physical environment to be used as a powerful instrument to create and enhance conditions for increased satisfaction and perception of quality of care, as well as to promote healthier work conditions for staff. In this context, it is important to understand the processes by which hospital users evaluate the hospital physical environment, namely the major environmental dimensions involved.

1.2. Measuring hospital environmental quality perception

The construct of *environmental quality perception* (EQP) has strict connections with the cognitive–psychological processes involved in the evaluation of environmental qualities (e.g., Bonnes & Secchiarioli, 1995; Carp & Carp, 1982; Craik & Feimer, 1987; Craik & Zube, 1976), and represents a way to operationalize the relationship between the person and the environment (Horelli, 2006). The construct has been primarily applied to the study of residential environments (e.g., Amerigo & Aragones, 1997; Bonaiuto, Aiello, Perugini, Bonnes, & Ercolani, 1999; Bonaiuto, Fornara, & Bonnes, 2003, 2006; Carp & Carp, 1982) and, as a result, some measures of residential EQP have been developed (e.g., Perceived Residential Environment Quality Indicators – PREQIs – Bonaiuto et al., 1999). In this context, EQP has been conceptualized as the cognitive facet of residential satisfaction and measured through a large set of specific items evaluating single features of the residential environment. In general, whenever the environmental quality of a place has been measured, it is common to focus on its physical and social attributes. For instance, the Perceived Residential Environment Quality Indicators (PREQIs) (Bonaiuto et al., 1999, 2003, 2006) include 11 scales covering specific aspects of spatial, human, functional (Canter, 1983) and contextual evaluative features (Bonnes, Bonaiuto, Aiello, Perugini, & Ercolani, 1997) at a neighborhood level. A short version of PREQIs was recently created through Confirmatory Factor Analysis technique (Fornara, Bonaiuto, & Bonnes, 2010).

EQP has also been applied to the hospital context, taking the form of the Perceived Hospital Environment Quality Indicators (PHEQIs) (Fornara et al., 2006). This instrument aimed at covering the primary design and social attributes that are expected to play a role in the assessment of healthcare environments. PHEQIs were developed in studies carried out in various Italian hospital units (Fornara, 2005; Fornara et al., 2006) through three steps: (i) adaptation of items extracted from existing measures of perceived environmental quality designed for other specific environments (i.e., urban neighborhoods, e.g., Bonaiuto et al., 2003; residences for

the elderly, e.g., Moos & Lemke, 1984); (ii) development of additional items based on six semi-structured in-depth interviews carried out with representatives of hospital users' categories (i.e., patients, staff members, and visitors); (iii) modification of the wording or deletion of items on the basis of a pilot study carried out in a hospital containing renovated and non-renovated care units. The authors used as frameworks both the multiple evaluative dimensions (spatial, human, and functional) demonstrated to be plausible regarding neighborhood perception (Canter, 1983), and the multi-place perspective (Bonnes & Secchiarioli, 1995), which placed emphasis "*on the prevalent multiplace nature of any individual environmental or place experience and thus on the importance of looking at the interplace system of activities in order to fully understand one place's activities, evaluations, and characteristics*" (Bonnes & Bonaiuto, 2002, p. 31).

Accordingly, the instrument published in 2006 contains four scales, three focusing on different physical environments and one evaluating the social environment: (a) spatial–physical aspects of proximal external spaces of the hospital (16 items); (b) spatial–physical aspects of the care unit (21 items); (c) spatial–physical aspects of a specific in-/out-patient (waiting) area (18 items); (d) social–functional aspects of the care unit (18 items). Principal component analyses revealed a total of 12 PHEQIs factors of quality environment perception, namely, upkeep & care, orientation, building aesthetics, and green spaces, which belong to scale (a); spatial–physical comfort, orientation, and quietness, which belong to scale (b); spatial–physical comfort, and views & lighting, which belong to scale (c); and care for social and organizational relationship, and privacy, which belong to scale (d). Although we can say that the practical utility of this instrument is related to the assessment of hospital physical environment qualities, it also focuses on the social and functional aspects of the environment, as EQP measures usually do. For Canter (1983), the experience of any place has physical and social aspects but is itself unitary. Healthcare environments in particular are places where patients' interest is to interact with healthcare professionals; nevertheless, most of the time is spent sharing the space available with other patients, meeting not only their own but also other patients' visitors. Therefore both social and physical components of healthcare environments need to be analyzed.

To the best of our knowledge PHEQIs scales represent one of the few instruments created to measure users' EQP specifically in hospitals. This instrument has been used in research on healthcare environments in different types of Italian care units (e.g., Fornara, 2004, 2005; Fornara, Bonaiuto, & Bonnes, in press; Fornara & Cerina, 2011). However, the scales were developed through an exploratory factor analysis (principal component analysis) and have never been tested with confirmatory factor analysis, which would indicate the adequacy of their structures and if they need further verification. One step toward establishing the basic dimensions with which individuals represent the hospital environmental quality, and the validity and reliability of PHEQIs scales, is to replicate its structure in another cultural context. Thus, the adaptation and validation of these scales using a Portuguese sample was the main purpose of this study. We hypothesized that the principal components obtained by Fornara et al. (2006) represent the factor structure underlying the construct of hospital EQP, therefore those measurement models were explicitly tested using Confirmatory Factor Analyses (CFA). CFA can be used for construct validation and scale refinement (MacCallum & Austin, 2000). In sum, the objective was to test the factorial structures of PHEQIs scales, to verify their construct and criterion validity, and to reflect on the conceptual and practical implications of hospital EQP.

Underlying this research approach and the present study in particular is the assumption that the differences in the quality

perception among hospital environments are mainly due to the physical differences between them (e.g., Schelleken, 1979). Despite the many studies that have found disagreement between architects (considered experts that can make objective evaluations) and laypersons in their assessment of physical settings (e.g., Gifford, Hine, Muller-Clemm, Reynolds, & Shaw, 2000; Gifford, Hine, Muller-Clemm, & Shaw, 2002), Fornara et al. (2006) found a fairly good congruence between expert and lay evaluations with regard to the hospital environment. Specifically, the results showed that, in general, users' perception of environmental quality (measured by PHEQIs scales) improves when hospital humanization (obtained on the basis of the evaluation of two architects through an "expert" grid) increases. Accordingly, in the study presented here, hospitals that varied in terms of several environmental attributes were evaluated by architects. This evaluation was considered objective and was used as a criterion to evaluate PHEQIs' validity. In particular, two older and two newer hospitals were selected and evaluated by users, through PHEQIs scales, and by architects, though an observation grid. Hospital buildings of different ages were used to test the relationship between objective evaluation and levels of EQP when age varied.

2. Objectives and hypothesis

The main objective of the present study was to adapt and validate the Perceived Hospital Environment Quality Indicators (PHEQIs). In order to pursue this objective, the factor structure, the internal reliability, and the validity of PHEQIs scales were examined.

Specifically, it is hypothesized that the original factor structures of PHEQIs scales would be replicated, as evidence for factorial validity; that PHEQIs factors show good internal consistency, as evidence for scales' reliability; and that PHEQIs show convergent and discriminant validity, as evidence for construct validity. It is also hypothesized that PHEQIs correlate with the users' global evaluation of the environment, as evidence for concurrent validity; and that PHEQIs are sufficiently sensitive to detect differences on EQP among users of hospitals with different physical and spatial conditions, as evidence for predictive validity, both in the spatial–physical scales and in the social–functional scale (in particular, users of older hospitals were expected to report less EQP than were users of newer hospitals). Lastly, it is hypothesized that PHEQIs correlate with the experts' evaluation, as further evidence for predictive validity.

In addition, the objective is to shorten the PHEQIs scales. Hospitals are normally places where people are experiencing stress, and long and repetitive questionnaires can be annoying to some respondents, and potentially increase that feeling. Also, the large number of total items (i.e., 67) can discourage participation, or undermine the quality of collected data. A long questionnaire also limits the possibility of adding further measures in research protocols. Consequently, a shorter version of PHEQIs scales would be more appealing for professional practice and for quicker administration.

3. Method

3.1. Settings/places/hospitals

Four Portuguese hospitals were selected for this study, all with different spatial and physical conditions. In each hospital, only orthopedic units (both in-patient areas and out-patient waiting areas) were selected because PHEQIs were originally developed on the basis of a sample of orthopedic units' users (see Fornara et al., 2006). Beyond language and culture, we thus decided not to

introduce any further change. The care units admit orthopedics and trauma patients. In the in-patient area, patients were hospitalized for a few days (e.g., operation recovery), whereas in the out-patient area patients went only to have a medical consultation.

To choose different orthopedic units two criteria were used: type of hospital (two general hospitals and two orthopedic hospitals) and age of the buildings (two recently built or renovated hospitals, and two older hospitals). The purpose of the first criterion was to differentiate the sample; the second was used to evaluate criterion predictive validity.

Both the orthopedic and the general more recent hospitals had their in-patient and out-patient areas in the same main building, whereas the older hospitals had them in separate buildings. The older hospitals date from the early twentieth century and were sanitariums for tuberculosis patients before being converted into hospitals. One of them still has a predominantly pavilion structure. In relation to the more recent hospitals, one was inaugurated in 2003 and the other is located in a historic building, at one time a maritime fortification, that was undergone many renovations in recent decades.

For simplification, hospitals will be designated as old-general (old G), old-orthopedic (old O), new-general (new G), and new-orthopedic (new O) (see Figs. 1–12).

3.2. Participants

Five hundred and sixty-two hospital users participated in this study, 372 (66.8%) of whom were women. The age of the subjects ranged from 13 to 88 years with a mean age of 48 years and a standard deviation of 16.2 years. The sample was composed of patients ($n = 221$), staff ($n = 165$) and visitors/companions ($n = 193$) that were contacted in the in-patient area ($n = 310$) or in the out-patient (waiting) area ($n = 252$) of one of the four orthopedic units (for characteristics of the sample by hospital area, see Table 1).

3.3. Instruments

In this study two instruments were used: one questionnaire for hospital users (patients, staff, and visitors) and one observation grid for the architects' technical evaluation of the hospital environmental attributes.

3.3.1. Questionnaire for users

The questionnaire for users contained five sections. The first section included the more recent version of the PHEQs scales (Appendix A). In the recent version of the instrument Fornara and



Fig. 2. In-patient area of the old G hospital.

colleagues (e.g., Fornara et al., *in press*) have merged the scales (b) spatial–physical aspects of the care unit, and (c) spatial–physical aspects of a specific in-/out-patient (waiting) area. The decision to merge the scales was due to the substantial overlap of their content in terms of both the wording of items and kind of participant response. As a result, some very similar items were removed (7 items). In addition, 4 new items were added. The new items aimed to increase the content validity of the scales by taking into account what emerged from open responses (provided by patients and staff) included in previous unpublished investigations of the authors. The resulting scale has 36 items and two versions, one referring to the in-patient area, and the other referring to the out-patient waiting area. Moreover, 1 new item was added on the scale (a) spatial–physical aspects of proximal external spaces of the hospital, whereas on the scale (d) 3 items about the functional aspects of the environment were omitted (because they concerned a residual factor) and 1 new item was added. As in the case above, these changes are based both on the results of statistical analyses regarding previous data and on qualitative material collected by the authors from hospital users.

In sum, the recent version of PHEQs contains three scales, two focusing on different physical environments and one evaluating the social environment: (a) spatial–physical aspects of proximal external spaces of the hospital (16 items); (b) spatial–physical aspects of the care unit and specific in-/out-patient (waiting) area (36 items), and (c) social–functional aspects of the care unit (18 items). Items are defined as sentences that express environmental evaluations (e.g., “External hospital area is not very clean”), and responses were made on 5-point Likert-type scales (from 0 “totally



Fig. 1. External space of the old G hospital.

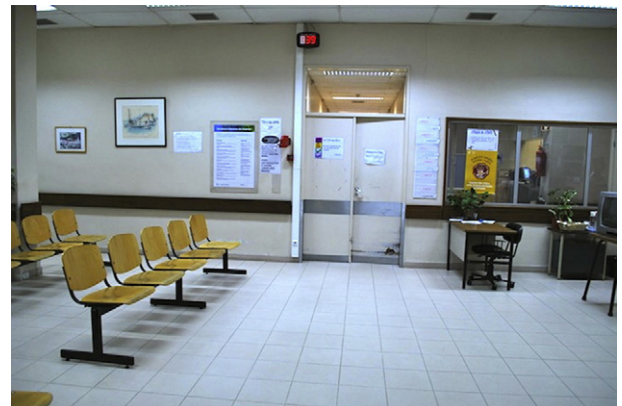


Fig. 3. Out-patient area of the old G hospital.



Fig. 4. External space of the old O hospital.



Fig. 6. Out-patient area of the old O hospital.

disagree" to 4 *"totally agree"*). Each scale contains positive (i.e., indicating the presence of quality) and negative (i.e., indicating the absence of quality) items, in order to control for response set. Scales were translated from Italian to Portuguese, using the translation and back-translation method, and pre-tested for testing clarity of instructions and item wording. For this purpose, 14 participants (6 patients, 4 visitors, and 4 nurses of one of the hospitals were the study was conducted) were asked to qualitatively appraise the instructions and items of the pre-final version of the instrument. As a result, one item from the Social–functional features' scale was divided in two items, namely, *"Staff members are generally not very understanding toward patients"* was divided in *"Nurses are generally not very understanding toward patients"* and *"Operational assistants*

are generally not very understanding toward patients". The first section also included, after each PHEQIs scale, three 10-point items to measure environmental global evaluation, e.g., *"In general, how do you evaluate the environment quality of the hospital external space?"*. These three questions (global evaluations of external space, care unit and in-/out-patient area, and social–functional environment) were developed in order to test the criterion concurrent validity of PHEQIs scales.

The questionnaire also included questions to measure satisfaction with the care unit, well-being, familiarity with the hospital and with hospitals in general, and socio-demographics.

3.3.2. Experts' observation grid¹

The four orthopedic units were technically evaluated with respect to various design attributes that cover the same issues as the PHEQIs scales concerning spatial–physical aspects, through an observation grid (adapted from Fornara et al., 2006), except as regards the quietness dimension. Items were rated from 0 to 4 with the categories of *inadequate*, *minimal*, *satisfactory*, *good*, and *excellent*.

The observation was done by two independent judges with a theoretical background in architectural design issues, in order to test the criterion predictive validity of PHEQIs. Interjudge agreement was moderate ($r(276) = .66, p < .05$). A different approach to view this level of agreement is to count the number of items to which the two architects gave the same rating ($n = 142, 51.3\%$), in which the ratings were off by one ($n = 117, 42.2\%$), and in which the ratings were off by more than one ($n = 18, 6.5\%$).

3.4. Procedure

Permission for the study was obtained from the orthopedic care units' directors and the data were collected between October and December 2009. Participants were contacted by a trained researcher in the in-patient or out-patient (waiting) area of each orthopedic care unit, and were informed of the nature and purpose of the study. Confidentiality was assured. Persons who agreed to participate in the study filled out the questionnaire with reference to the hospital area where they were at the moment. When patients did not have the physical capability to read or to answer the questionnaire alone, data were collected through an interview.



Fig. 5. In-patient area of the old O hospital.

¹ More information about the experts' observation grid can be requested from the Corresponding author.



Fig. 7. External space of the new G hospital.

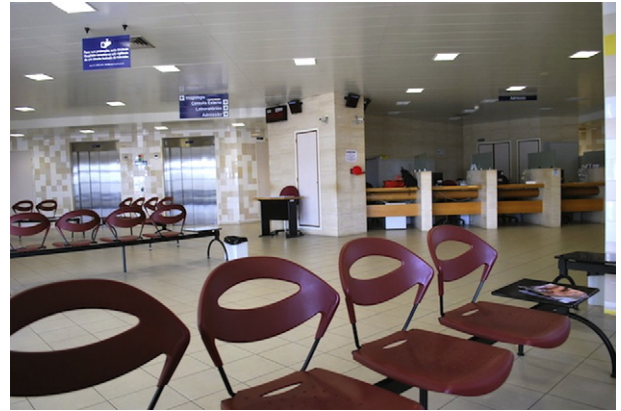


Fig. 9. Out-patient area of the new G hospital.

3.5. Data analysis

First, in order to confirm the differences between the two older and the two newer hospitals regarding the “objective” evaluation, a mean between the two architects’ evaluations of each hospital was computed.

Then, running the AMOS 17 software (SPSS Inc, Chicago, IL), Confirmatory Factor Analyses were performed to validate each PHEQIs scale, allowing the factors to be correlated. The model was first developed on the total sample, and then confirmed on a randomly selected half part of it (test sample, $n = 281$). To evaluate the global adjustment quality of the model we considered *CFI* and *GFI* above .90, *PCFI* and *PGFI* above .60, χ^2/df around 2, and *RMSEA* below .05 with non-significant p as indicating the good adjustment of the model (e.g., Schumacker & Lomax, 1996).

For each scale, a step-by-step iterative procedure was followed (similar to the one used by Fornara et al., 2010 for creating the abbreviated form of the Perceived Residential Environment Quality Indicators – PREQIs), starting from the analysis of the initial solution including all the items. Both conceptual and statistical criteria led to the emergent factorial solutions. The model refinement was made taking into account the significance and the magnitude of items’ factorial loadings (values equal or above .50 were considered acceptable), and through the modification indices by Lagrange Multipliers (LM) (the paths and correlations with $LM > 11$ ($p < .001$) were considered indicators of significant variation on the model quality). Every time two items shared a high proportion of measure error, one of them was eliminated. Conceptually, we tried to keep the same factorial



Fig. 8. In-patient area of the new G hospital.



Fig. 10. External space of the new O hospital.



Fig. 11. In-patient area of the new O hospital.

structure. At the same time, if possible, items measuring an identical aspect were avoided, for example, one positively and one negatively worded.

Construct reliability was evaluated by the calculation of the composite reliability (Fornell & Laker, 1981) and of the inter-item correlations. Construct validity was evaluated through factorial validity, convergent validity (estimated by average variance extracted – AVE; Hair, Anderson, Tatham, & Black, 1998; and by the statistical significance at $p < .001$ of the observable variables' loadings on the respective latent factor), and discriminant validity (evident when the factors have greater AVE than the variance they share with the other factors, expressed by their respectively squared correlations; see Fornell & Laker, 1981). We considered values equal or above .70 as acceptable for composite reliability; and values equal or above .50 for AVE (which indicates that the factors explain more than 50 percent of the variance in its items).

As there are no other measures of hospital EQP to compare with PHEQs, concurrent criterion validity was analyzed through the correlations between each scale and the users' global evaluation of that attribute of the environment. Predictive criterion validity was examined using a one-way ANOVA (post-hoc comparisons were run using the Scheffé's Test) to assess the significance of differences between EQP means among the users of different hospitals. In addition, correlations between experts' and users' evaluations of the environment were also tested. To proceed with this analysis,



Fig. 12. Out-patient area of the new O hospital.

Table 1
Characteristics of the study participants ($N = 562$).

	Old G hospital			Old O hospital			New G hospital			New O hospital		
	Patients	Staff	Visitors	Patients	Staff	Visitors	Patients	Staff	Visitors	Patients	Staff	Visitors
<i>In-patient area</i>												
<i>n</i>	41	29	28	25	26	28	19	22	22	25	19	22
<i>Age</i>	60.9 (17.9)	37.3 (11.3)	49.9 (17.9)	55.3 (15.2)	39.5 (13.26)	50.75 (17.24)	64.6 (14.1)	36.55 (11.8)	47.7 (15.9)	57.1 (15.7)	38.6 (12.5)	44.5 (16.1)
<i>M (SD)</i>												
<i>Gender frequency n (%)</i>												
Women	25 (61.0)	19 (65.5)	16 (57.1)	15 (60.0)	20 (76.9)	17 (60.7)	9 (47.4)	19 (86.4)	14 (63.6)	14 (56.0)	17 (89.5)	15 (68.2)
<i>Education n (%)</i>												
Not literate	3 (7.3)	0 (0)	0 (0)	1 (4)	0 (0)	0 (0)	3 (15.8)	0 (0)	1 (4.5)	0 (0)	0 (0)	0 (0)
4 years of school	20 (48.8)	2 (6.9)	2 (7.1)	8 (32)	3 (11.5)	2 (7.7)	13 (68.4)	1 (4.5)	4 (18.2)	14 (56)	2 (10.5)	3 (13.6)
6–9 years of school	9 (22)	5 (17.2)	8 (28.5)	4 (16)	4 (15.4)	6 (23)	1 (5.3)	3 (13.6)	3 (13.6)	5 (20)	1 (5.3)	10 (45.5)
12 years of school	5 (12.2)	3 (10.3)	9 (32.1)	5 (20)	1 (3.8)	10 (38.5)	1 (5.3)	4 (18.2)	8 (36.4)	4 (16)	1 (5.3)	5 (22.7)
M.A and PhD degrees	4 (9.8)	19 (65.5)	9 (32.2)	7 (28)	18 (69.2)	8 (30.8)	1 (5.3)	14 (63.6)	6 (27.3)	2 (8)	15 (78.9)	4 (18.2)
<i>Out-patient area</i>												
<i>n</i>	34	11	29	32	13	18	17	14	12	26	11	32
<i>Age</i>	52.2 (14.7)	40.6 (11.8)	49.0 (13.5)	46.8 (16.7)	42.2 (10.7)	44.4 (14.8)	53.3 (20.4)	43.64 (15.11)	42.08 (11.6)	49.4 (16.4)	37.7 (7.0)	44.4 (14.7)
<i>M (DP)</i>												
<i>Gender frequency n (%)</i>												
Women	21 (61.8)	8 (72.7)	18 (62.1)	20 (35.5)	10 (76.9)	13 (72.2)	13 (76.5)	14 (100.0)	6 (50.0)	15 (57.7)	9 (81.8)	22 (68.8)
<i>Education n (%)</i>												
Not literate	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (11.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
4 years of school	10 (29.4)	1 (9.1)	1 (3.4)	4 (13.3)	0 (0)	1 (5.6)	4 (23.5)	3 (21.4)	3 (27.3)	5 (19.2)	0 (0)	4 (12.9)
6–9 years of school	7 (20.6)	2 (18.2)	15 (51.7)	10 (33.3)	2 (15.4)	4 (22.3)	7 (41.1)	1 (7.1)	3 (27.3)	2 (7.7)	0 (0)	1 (3.2)
12 years of school	10 (29.4)	4 (36.4)	4 (13.8)	11 (36.7)	5 (38.5)	7 (38.9)	2 (11.8)	5 (35.7)	3 (27.3)	16 (61.6)	7 (63.7)	19 (61.3)
M.A and PhD degrees	7 (20.9)	4 (36.4)	9 (33.2)	4 (16.7)	6 (46.2)	6 (33.3)	2 (11.8)	5 (35.7)	2 (18.2)	3 (11.5)	4 (36.4)	7 (22.6)

each hospital was considered as a case, and the means of the users' and of the two experts' evaluations were correlated through Spearman's Rho correlations.

Items' sensibility was evaluated by analyzing the skewness and the kurtosis coefficients. We considered skewness values above 3, and kurtosis values above 10 (in absolute value) to have sensibility problems and significant deviation from normality (e.g., Kline, 1998).

4. Results

4.1. Experts' evaluation

The experts' objective evaluations regarding the hospitals' external space area, care unit's out-patient area, and care unit's in-patient area are higher for the two newer hospitals than for the two older hospitals (Fig. 13). This pattern is more pronounced for the in-patient than for the out-patient areas.

4.2. Validation of PHEQIs scales

The skewness and kurtosis estimates for PHEQIs items are all acceptable, indicating that responses are normally distributed.

4.2.1. Scale 1: external spaces

Confirmatory Factor Analysis of the four-factor structure of this scale indicated that the original model has a poor adjustment to the study sample (Table 1). To achieve a better fit, 4 items were removed. The modified model has a better adjustment to the sample data than does the original model, even if that adjustment cannot be considered very good, because CFI, RMSEA and χ^2/df values are still slightly distant from the recommended values. The correlations between the different environmental dimensions range from very low (between the factors "orientation" and "green spaces", $r = .10$, n.s.) to very high (between "upkeep & care" and "orientation", $r = .75$, $p < .001$). Although this strong correlation between "upkeep & care" and "orientation" factors suggests that these dimensions are highly related, the analysis supported a modified model keeping these factors separated. The four-factor modified model was compared with a three-factor model combining "upkeep & care" and "orientation" factors ($\chi^2/df = 5.106$, CFI = .846, GFI = .927, RMSEA = .086; p (rmsea $\leq .05$) $< .001$). The Chi-square difference test indicated that the four-factor model has significantly better fit than does the three-factor model ($\Delta\chi^2_{(3)} = 34.92$, $p < .001$). Moreover, the content of factors also supports treating them as separate constructs, since they reflect different conceptual dimensions. Because the interest is to keep the

original structure, and the four-factor model has better adjustment quality, we decided to retain the four-factor model.

The modified model is more parsimonious than the original model and has an acceptable global adjustment even in the test sample. Considering the overall results and, in particular, the improvement of the global adjustment of the model, the reliability and validity of the modified model composed by 12 items were analyzed.

Subscales scores were calculated by taking the mean of the contributing items. Composite reliability is above the optimum level of .70 for the composite reliability for "building aesthetics" factor (.74) and slightly below .70 for "upkeep & care" (.64), "orientation" (.65) and "green spaces" factors (.65). In addition, the mean of inter-item correlations is acceptable ($M_C = .36$; $M_O = .32$; $M_{GS} = .39$; $M_{BA} = .48$; $M_{total} = .19$). In general, these values are appropriate and indicate construct reliability.

All factor loadings connecting the items with the latent variables are significant and above .50, providing evidence of convergent validity. However, AVE for "building aesthetics", "upkeep & care", "orientation", and "green spaces" factors are .48, .37, .33 and .38, respectively, giving the opposite evidence. Regarding discriminant validity, factors' AVE exceed the variance shared between them, except "upkeep & care" and "orientation", with a correlation of .75 ($r^2 = .75^2 = .56$).

Positive and significant correlations between users' global evaluation of the external space and the total scale show evidence for concurrent criterion validity ($r = .60$, $p < .01$). Looking at the separate factors, "upkeep & care" had the strongest correlation ($r = .54$, $p < .01$), followed by "building aesthetics" ($r = .41$, $p < .01$) and "orientation" ($r = .36$, $p < .01$). The smallest correlation was with "green spaces" ($r = .26$, $p < .01$).

Finally, predictive criterion validity has been shown because a series of ANOVAs revealed that the scale of External spaces, as well as its subscales, significantly differentiate between users of the four hospitals ($F_{External\ space\ total\ scale(3558)} = 18.652$, $p < .001$, $\eta^2 = .09$; $F_{upkeep\ \&\ care(3558)} = 49.892$, $p < .001$, $\eta^2 = .21$; $F_{orientation(3558)} = 29.459$, $p < .001$, $\eta^2 = .14$; $F_{green\ spaces(3558)} = 9967$, $p < .001$, $\eta^2 = .05$; $F_{building\ aesthetics(3558)} = 40.657$, $p < .001$, $\eta^2 = .18$) (Table 2). A Scheffé's Test was conducted to determine which specific groups were different regarding the total scale. As expected, the users of the two newer hospitals reported higher scores of external space EQP ($M_{NG} = 2.30$; $M_{NO} = 2.33$) than did the users of the two older hospitals ($M_{OG} = 1.94$; $M_{OO} = 1.89$).

Correlations between experts' and users' evaluations regarding the external space ($r = .80$, n.s.) and, in particular, to "upkeep & care" ($r = .80$, n.s.), "orientation" ($r = .80$, n.s.), "green spaces" ($r = .63$, n.s.) and "building aesthetics" ($r = .80$, n.s.) factors are all positive and high, giving further evidence to predictive criterion validity.

4.2.2. Scale 2: Care unit & In-/Out-patient (waiting) area

Confirmatory factor analysis of the four-factor structure of this scale indicated that the original model has a poor adjustment to the study sample (Table 1). To achieve a better fit, 21 items were removed. We should stress that with the elimination of these items the "quietness" factor kept only 2 of its original 4 items, both regarding the noise that users hear from the outside, one positively and one negatively worded. However, in the whole "quietness" factor, only these two items had acceptable factor loadings. The correlations between the factors range from .37 ($p < .001$), between "spatial-physical comfort" and "quietness", and .55 ($p < .001$), between "spatial-physical comfort" and "views & lighting", which are appropriate values. The modified model has a better adjustment to the sample data and is more parsimonious than is the original model. In addition, the modified model also has an acceptable

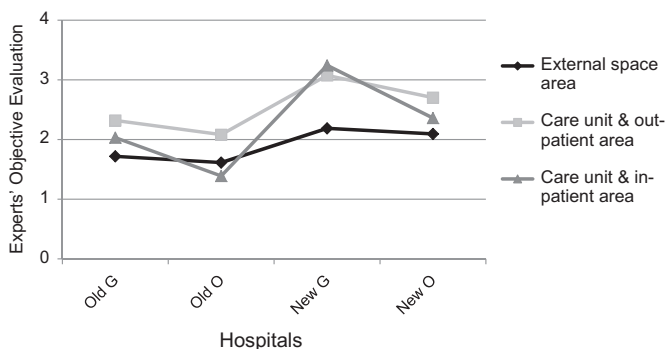


Fig. 13. Mean scores of architects' evaluation of the hospital areas design quality ($n = 2$). Note: Old G – old and general hospital; Old O – old and orthopedic hospital; New G – new and general hospital; New O – new and orthopedic hospital.

Table 2
Goodness-of-fit indices for original and modified models.

	Adjustment indices					Parsimony indices		
	χ^2/df	CFI	GFI	RMSEA	p (rmsea $\leq .05$)	AIC	BCC	MECVI
Scale 1								
Original model (total sample)	5.474	.791	.887	.089	.000	612.409	614.784	1.096
Modified model (total sample)	4.697	.870	.935	.081	.000	285.433	286.856	.511
Modified model (test sample)	2.953	.870	.922	.084	.000	201.751	204.672	.731
Scale 2								
Original model (total sample)	4.839	.698	.733	.083	.000	3001.203	3012.218	5.369
Modified model (total sample)	3.708	.915	.926	.069	.000	383.483	385.597	.687
Modified model (test sample)	2.439	.915	.911	.072	.003	276.861	281.224	1.004
Scale 3								
Original model (total sample)	5.562	.775	.867	.090	.000	726.316	728.636	1.299
Modified model (total sample)	4.587	.922	.954	.080	.000	157.257	157.947	.282
Modified model (test sample)	2.181	.950	.955	.065	.134	94.697	96.104	.343

global adjustment in the test sample. Considering the results and, in particular, the improvement of the global adjustment of the model, the reliability and validity of the modified model composed by 15 items were analyzed.

The composite reliability of this scale is above .70 for “spatial–physical comfort” (.84) and “orientation” (.77) factors, and below .70 for “views & lighting” (.68) and “quietness” (.66) factors. Further, the mean of inter-item correlations is acceptable ($M_{SPC} = .45$; $M_O = .35$; $M_Q = .39$; $M_{VL} = .51$; $M_{total} = .28$). In general, these values are appropriate and indicate construct reliability.

All factor loadings connecting the items with the latent variables are significant and above .50, indicating convergent validity. However, AVE values are respectively .47, .46, .40 and .52 for “spatial–physical comfort”, “orientation”, “views & lighting” and “quietness” factors. Thus, except for “quietness”, these values are slightly distant from the recommended value. Regarding discriminant validity, in all cases factors’ AVE are higher than the variance shared between them.

Concurrent criterion validity and predictive criterion validity were tested using in-patient ($n = 310$) and out-patient ($n = 252$) samples separately.

Regarding care unit and in-patient area, positive and significant correlations between the total scale and users’ global evaluation ($r = .66$, $p < .01$) show evidence for concurrent criterion validity. Looking at the separate factors, “spatial–physical comfort” had the strongest correlation ($r = .60$, $p < .01$), followed by “orientation” ($r = .51$, $p < .01$). The smallest correlations were with “views & lighting” ($r = .35$, $p < .01$) and “quietness” ($r = .28$, $p < .01$).

Regarding care unit and out-patient area, we also found evidence for concurrent criterion validity, since correlation between the total scale and users’ global evaluation ($r = .62$, $p < .01$) is positive and significant. With respect to the separate factors, “spatial–physical comfort” had the strongest correlation ($r = .60$, $p < .01$), followed by “orientation” ($r = .51$, $p < .01$). The smallest correlations were with “views & lighting” ($r = .37$, $p < .01$) and “quietness” ($r = .15$, $p < .01$). All correlations between subscales and global evaluation are positive and significant.

Finally, a series of ANOVAs showed that the total scale and its subscales differentiate between users of the 4 hospitals, both for users in in-patient area ($F_{\text{Care Unit \& In-patient area' scale}}(3306) = 23.716$, $p < .001$, $\eta^2 = .19$; $F_{\text{spatial-physical comfort}}(3306) = 37.715$, $p < .001$, $\eta^2 = .27$; $F_{\text{orientation}}(3306) = 8518$, $p < .001$, $\eta^2 = .08$; $F_{\text{quietness}}(3306) = 13.263$, $p < .001$, $\eta^2 = .12$; $F_{\text{views \& lighting}}(3306) = 10.135$, $p < .001$, $\eta^2 = .09$) (Table 3), and in out-patient area ($F_{\text{Care Unit \& Out-patient area' scale}}(3251) = 35.165$, $p < .001$, $\eta^2 = .30$; $F_{\text{spatial-physical comfort}}(3251) = 40.805$, $p < .001$, $\eta^2 = .33$; $F_{\text{orientation}}(3251) = 4469$, $p < .01$, $\eta^2 = .05$; $F_{\text{quietness}}(3251) = 5276$, $p < .01$, $\eta^2 = .06$; $F_{\text{views \& lighting}}(3251) = 30.375$, $p < .001$, $\eta^2 = .27$) (Table 4). A Scheffé’s Test was conducted to determine which specific groups were different regarding the total scale. As expected, the users of the two newer hospitals reported significantly higher scores of EQP of the care unit and in-patient area ($M_{NG} = 3.05$; $M_{NO} = 2.84$) than did the users of the two older hospitals ($M_{OG} = 2.41$; $M_{OO} = 2.16$). The same significant difference appeared as regards EQP of the care unit and out-patient areas (i.e., $M_{NG} = 2.95$ and $M_{NO} = 2.71$ vs. $M_{OG} = 2.05$ and $M_{OO} = 1.93$). These results show evidence for predictive criterion validity.

In addition, the correlation between experts’ and users’ evaluations of the in-patient area quality ($r = 1.00$, $p < .01$) and, in particular, of “spatial–physical comfort” ($r = .80$, n.s.), “orientation” ($r = 1.00$, $p < .01$) and “views & lighting” ($r = .60$, n.s.) are all positive and high. The same result emerged regarding the correlation between experts’ and users’ evaluations regarding the out-patient areas ($r = 1.00$, $p < .001$) and, in particular, to “spatial–physical comfort” ($r = .80$, n.s.), “orientation” ($r = 1.00$, $p < .001$) and “views & lighting” ($r = 1.00$, $p < .01$). These results give additional support to predictive criterion validity.

4.2.3. Scale 3: Social–functional features

Confirmatory factor analysis of the two factor structure of this scale indicated that the original model had a poor adjustment to the study sample (Table 1). To achieve a better fit, 8 items were removed. The correlation between “Care for social and organizational relationship” and for “privacy” factors is moderate-high in the modified model ($r = .63$, $p < .001$) but less than it was in the

Table 3
External space scale: means, standard deviations and post-hoc comparisons (Scheffé Test, $\alpha = .05$).

	Old G hospital ($n = 173$)	Old O hospital ($n = 144$)	New G hospital ($n = 107$)	New O hospital ($n = 138$)	Total
Upkeep & care	2.17 ^a (.89)	1.97 ^a (.82)	3.17 ^c (.81)	2.71 ^b (.90)	2.44 (.97)
Orientation	1.76 ^a (.87)	1.98 ^a (.82)	2.70 ^b (.92)	2.41 ^b (1.02)	2.15 (.97)
Green spaces	1.77 ^c (1.15)	1.66 ^{bc} (.95)	1.37 ^{ab} (1.00)	1.18 ^a (.98)	1.52 (1.57)
Building aesthetics	2.05 ^a (.99)	1.92 ^a (.98)	1.93 ^a (1.12)	3.01 ^b (.76)	2.23 (1.07)
Total scale	1.94 ^a (.67)	1.89 ^a (.58)	2.30 ^b (.69)	2.33 ^b (.59)	2.09 (.66)

Note. Means in the same row that have different subscripts differ significantly ($p < .05$).

Table 4In-patient area scale: means, standard deviations and post-hoc comparisons (Scheffé Test, $\alpha = .05$).

	Old G hospital (n = 98)	Old O hospital (n = 80)	New G hospital (n = 63)	New O hospital (n = 69)	Total (n = 310)
Spatial–physical comfort	2.40 ^b (.88)	1.67 ^a (.92)	3.12 ^c (.69)	2.69 ^b (.85)	2.42 (.99)
Orientation	2.50 ^{ab} (.98)	2.10 ^a (.95)	2.84 ^b (.89)	2.74 ^b (1.02)	2.52 (1.00)
Quietness	2.20 ^a (1.43)	2.82 ^b (1.10)	3.40 ^c (.89)	2.82 ^b (1.19)	2.74 (1.26)
Views & lighting	2.45 ^a (.96)	2.80 ^{ab} (1.09)	2.97 ^{bc} (.86)	3.28 ^c (.99)	2.83 (1.03)
Total scale	2.41 ^a (.74)	2.16 ^a (.68)	3.05 ^b (.58)	2.84 ^b (.78)	2.57 (.78)

Note. Means in the same row that have different subscripts differ significantly ($p < .05$).

original model ($r = .71$, $p < .001$). Overall, the modified model has a better adjustment to the sample data and is more parsimonious than was the original model. Additionally, the modified model also has a good global adjustment in the test sample. Considering the results and, in particular, the improvement of the global adjustment of the model, the reliability and validity of the modified model composed by 9 items were analyzed.

The composite reliability of the scale is above .70 both for “care for social and organizational relationship” (.85) and for “privacy” (.77) factors and also the mean of inter-item correlations is acceptable ($M_{CSOR} = .37$; $M_p = .40$; $r_{total} = .31$). In general, these values are appropriate and indicate construct reliability.

All factor loadings connecting the items with the latent variables are significant and above .50, providing evidence for good convergent validity. Further, AVE is .49 and .53 for the “care for social and organizational relationship” and “privacy” factors, respectively, which gives it additional support.

Regarding discriminant validity, the factors’ AVEs are higher than the variance they share ($r^2 = .63^2 = .40$), showing evidence for discriminant validity.

Positive and significant correlations between the total scale and users’ global evaluation of the social–functional features ($r = .56$, $p < .01$) show evidence for concurrent criterion validity. Looking at the separate factors, “care for social and organizational relationship” had the strongest correlation ($r = .50$, $p < .01$), followed by privacy ($r = .37$, $p < .01$).

Finally, predictive criterion validity has been shown because a series of ANOVAs demonstrated that both the total scale, and subscales differentiate between the users of the 4 hospitals ($F_{\text{Social–functional features’ scale}(3558)} = 12.702$, $p < .001$, $\eta^2 = .06$; $F_{\text{care for social and organizational relationship}(3, 558)} = 15.104$, $p < .001$, $\eta^2 = .08$; $F_{\text{privacy}(3558)} = 4.274$, $p < .01$, $\eta^2 = .02$) (Tables 5 and 6). A Scheffé’s Test was conducted to determine which specific groups were different regarding the total scale. As expected, the users of the two newer hospitals reported higher scores of EQP of the social–functional features ($M_{NG} = 2.93$; $M_{NO} = 2.76$) than did the users of the two older hospitals ($M_{OG} = 2.39$; $M_{OO} = 2.47$).

These results also show evidence for the congruence between the physical and social environment evaluation. However, comparing these means with the means of the scales regarding the physical attributes of the environment, the differences between hospital users are not remarkable.

For all the scales, the re-specification of the original model led to the elimination of a high number of items. From the initial 67 items included in PHEQIs scales, the modified scales retained only 36,

representing a 46% reduction in the number of items. Thus, this reduction process simultaneously served the objective of reducing the scales, as was one of our objectives.

5. Discussion

Anyone thinking about being in a hospital, as an employee, patient, or visitor, can list without difficulty some of the characteristics of the environment associated with good quality. Those characteristics would not be the same (or have the same importance) for everyone because they would vary depending on the role, the needs, the interests, the expectations, the physical condition, the gender, or the age of the person, etc. However, across users, the relevance of some environmental dimensions is shared, such as comfort, natural light, and privacy (e.g., Evans & McCoy, 1998). For that reason, these characteristics might be included on all users’ checklist of hospital environmental quality evaluation.

Hospitals are changing toward providing a more user-centered service to reflect the needs and expectations of users. Architects, designers, and planners can take advantage of a measure that gives users’ feedback about the quality of the hospital environment. Further, hospital administrators may be interested in monitoring users’ appraisals of a healthcare component (the physical environment) that has a significant influence on patients’ overall satisfaction and well-being. Researchers are being called to increase the knowledge about the impact of healthcare physical environment attributes on users’ outcomes, and to understand the role of appraisals of the physical environment on users’ hospital experience. For these reasons, systematic empirical research of the components of hospital environmental quality perception (EQP) is needed and, as such, requires a validated measure.

The main goal of this paper was to present the adaptation and validation of a hospital EQP measure developed in Italy (PHEQIs; Fornara et al., 2006), and to test the structure of the multidimensional construct of hospital EQP. To do so, a Portuguese sample of users from four different hospitals was used. The items of the three PHEQIs scales were submitted to a confirmatory factorial analysis and the adequacy of the measurement models was tested.

The analysis produced the replication of the scales’ factorial structures and final measurement models had good, or at least acceptable, fit indices, both in total as in test samples. Further, though some composite reliability values are lower than .70, internal consistency proved to be acceptable for all the scales, considering that the final versions of the scales include many fewer items. For the External space scale, composite reliability ranged

Table 5Out-patient area scale: means, standard deviations and post-hoc comparisons (Scheffé Test, $\alpha = .05$).

	Old G hospital (n = 75)	Old O hospital (n = 64)	New G hospital (n = 44)	New O hospital (n = 69)	Total (n = 252)
Spatial–physical comfort	1.67 ^a (.81)	1.56 ^a (.86)	3.06 ^c (.67)	2.45 ^b (.86)	2.10 (.99)
Orientation	2.49 ^{ab} (.83)	2.25 ^a (.94)	2.84 ^b (1.05)	2.70 ^{ab} (.93)	2.55 (.95)
Quietness	2.67 ^a (.99)	2.87 ^a (.95)	3.41 ^b (.85)	2.97 ^{ab} (1.10)	2.94 (1.02)
Views & lighting	1.84 ^a (1.00)	1.62 ^a (1.01)	2.57 ^b (1.02)	3.05 ^b (.87)	2.24 (1.13)
Total scale	2.05 ^a (.59)	1.93 ^a (.61)	2.95 ^b (.70)	2.71 ^b (.66)	2.36 (.75)

Note. Means in the same row that have different subscripts differ significantly ($p < .05$).

Table 6Social–functional features scale: means, standard deviations and post-hoc comparisons (Scheffé Test, $\alpha = .05$).

	Old G hospital (n = 173)	Old O hospital (n = 144)	New G hospital (n = 107)	New O hospital (n = 138)	Total (n = 562)
Privacy	2.45 ^{ab} (1.05)	2.23 ^a (1.10)	2.66 ^b (.99)	2.27 ^a (1.07)	2.39 (1.07)
Care for social and organizational relationship	2.44 ^a (.85)	2.56 ^a (.89)	2.99 ^b (.78)	2.95 ^b (.82)	2.70 (.87)
Total scale	2.39 ^a (.79)	2.47 ^a (.88)	2.93 ^b (.76)	2.76 ^b (.81)	2.60 (.84)

Note. Means in the same row that have different subscripts differ significantly ($p < .05$).

from .64 to .74; for the Care unit & In-/Out-patient area scale, the values ranged from .66 to .84; and for the Social–functional features scale, the values ranged from .77 to .85.

Once item validity and reliability have been assessed, the next step was to evaluate construct-level validity. Results supported discriminant validity; for all scales it was shown that the variance extracted for each factor was greater than the variance shared between them. The only exception was due to the strong correlation between “upkeep & care” and “orientation” factors of the External space scale ($r = .75$, $p < .001$). It is plausible that this correlation might be related to a bi-directional influence between these two dimensions. For instance, users may tend to converge in their evaluations related to upkeep and care and orientation, as if a well-maintained environment would facilitate way-finding or an environment that allows easy orientation was perceived as better maintained. This result needs confirmation with other samples.

On the other hand, some difficulty in showing convergent validity was found. For a construct to possess convergent validity, the majority of the variance in its items (i.e., more than 50%) should be accounted for by the underlying construct rather than by measurement error (Fornell & Laker, 1981), and this was assessed by the average variance extracted. Low AVE was found for some factors, namely the “upkeep & care”, “orientation”, and “green spaces” factors of the External space scale; and for the “spatial–physical comfort”, “orientation”, and “views & lighting” factors of the Care unit & In-/Out-patient area scale. We attribute these results mainly to some of the characteristics of the items defined to tap each of the dimensions. First, an uneven number of positively and negatively worded very similar items along the scales might have confused the respondent. In addition, the formulation of some of the negatively worded items can make them difficult to answer using a Likert-type scale from “totally disagree” (0) to “totally agree” (4). This is the case of items such as “External hospital area is not very clean” from the factor “upkeep & care” of the External space scale, and “The view from the windows has little interest” from the factor “views & lighting” of the scale Care unit & In-/Out-patient area. Mistakenly, some people might tend to rate 0 instead of 4 when they agreed with the sentences, or the opposite. Negatively worded items are employed primarily to attenuate response pattern bias, however some studies have found they can reduce the validity of item responses (Hinkin, 1995). Examining the factor loadings of individual items, it had not been found that negatively worded items had lower loading than positively ones. In any case, the formulation of these items should be revised in order to make them clearer. For instance, the formulation “External hospital area is unclean” and “From the windows the view is uninteresting” should solve this question.

Second, some dimension's domain might not be fully represented by its items. This is obviously the case of the factor “quietness” that, although has a good AVE value (.52), its composite reliability is slightly lower than .70 (.68). This dimension has only two items, both addressing the noise that come from the outside (one positively and other negatively worded), which means that the dimension does not capture users' perceptions of the noise inside the care unit, which is much more common.

A third issue that might explain the low convergent validity is that some of the items can have double meanings. Even if part of them were deleted during the model's re-specification process, others are still integrated in the final scales. For instance, the “green spaces” scale includes the item “In the external hospital area there is a lack of well-kept green spaces”. This item mixes the ideas of the external hospital area having or not enough green spaces, and the idea of those green spaces being well-kept or not. In general, double-barreled items should be split into two single idea statements; items should be simple, clear, and as straightforward as possible (see DeCoster, 2000). Therefore, these issues need to be reexamined in future studies in order to ensure respondents will similarly interpret the items, and that they properly will capture the conceptual domain of each dimension. These refinements possibly will improve construct convergent validity.

An important step in validating PHEQIs was to correlate it with a measure of the same construct (alternatively, the global evaluation of the environment was used) and to compare it with a valid criterion (as the objective evaluation of the environment). All scales and its factors correlated with the global evaluation of the environment, providing evidence for concurrent criterion validity of PHEQIs. Also as predicted, the construct predictive validity was supported by the finding that users in newer hospitals have higher scores on the EQP scales than do users in older hospitals, which indicates that PHEQIs scales are sensitive to detect different spatial and physical conditions. Moreover, high congruence between users' and experts' evaluations was verified. It should be noted that, despite the fact that all the results of these correlations are in the expected direction, the limited number of hospitals lowers the power of the test, and in some cases the correlations were not statistically significant. On the whole, these results suggest that “objectively” good hospital environments improve users' EQP as measured by PHEQIs.

Throughout the refinement procedure of each scale we were forced to eliminate a very large number of items. Consequently, this procedure also served the objective of reducing the number of items in the scales. This was particularly clear regarding the “spatial–physical comfort” dimension of the Care unit & In-/Out-patient area scale. This factor originally included 19 items, which related to a very broad array of aspects (e.g., furniture; walls, floors, ceilings; colors; cleanliness; temperature; humidity; air; seats; and windows). The modified model kept only 6 of those items, regarding furniture; walls, floors, ceilings, and seats. This result suggests that this conceptual domain of the construct was being measured with many items and that some of them eventually should be measuring distinct characteristics of EQP. As a consequence, the conceptual dimensionality of care unit and in-/out-patient area EQP might need some further investigation, particularly the content validity of “spatial–physical comfort”. In any case, specifying latent variables with a large number of indicators poses numerous problems and certainly results in misleading fit index values (Little, Cunningham, Shahar, & Widaman, 2002), which happened in our analysis.

This study was a second step toward the development of a culture-general hospital EQP measure. PHEQIs have been used in different types of Italian care units, and in this study evidence has

been found supporting the reliability and the validity of the PHEQs scales in a different cultural context. Confirmatory factor analysis is considered to be a more advanced method than exploratory factor analysis to address the factor structure in instrument development (Bagozzi, Yi, & Phillips, 1991). Nevertheless, results confirmed the factor structure of the PHEQs scales, indicating that hospital EQP can be measured through ten environmental dimensions related to external spaces, in-/out-patient area, and social–functional features. Additionally, it seems that these shorter and easier-to-use versions of the scales are still able to capture the core dimensions of the hospital quality environment. As previously mentioned, some items still need adjustments and the factorial structure of the EQP of the Care unit & In-/Out-patient area scale might need further validation in other samples. However, taking the overall results into account, the PHEQs have the potential to become a widely used and valued measure in the field.

We have argued that PHEQs may be useful for healthcare designers, administrators, and researchers. From a research perspective, several directions and research questions can be identified and tested with PHEQs. For example, when the objective quality of the hospital environment varies, does the perception of the quality of the physical environment (external spaces, and in-/out-patient area) and the perception of the quality of the social–functional environment vary to the same degree? Which aspects of the physical and social environment may lead to better well-being and satisfaction among users? Which objective attributes of the environment are more likely to produce an increase in EQP? Equally interestingly would be to investigate the differences among patients, staff, and visitors. Some studies have found that staff tends to make more negative evaluations of the hospital physical environment than do patients and visitors (Devlin, 1995, 2010), which would be interesting to understand. In fact, it is important to note that PHEQs scales, particularly the Care unit & In-/Out-patient area, and the Social–functional features scales, ask the respondents to assess the environment that is designed for patients (e.g., waiting area), or to assess the environment from the point of view of the patients (e.g., “*In this care unit doctors are generally not very understanding toward patients*”). Staff would possess sufficient knowledge to assess the environmental quality of the waiting area of the care unit where they work, or to give their impression of the quality of care they deliver. In fact, Mroczek et al. (2005) found that 70% ($n = 722$) of the staff of a medical center believed that home-like patient rooms have a positive impact (somewhat positive, positive, or very positive) on the quality of their work life. The authors explain that the home-like appearance of the patient rooms may comfort patients and family and also make them more comfortable, which in turn may make nurses’ job easier. In spite of this, it should be kept in mind that through PHEQs what one can obtain is a subjective evaluation of users about the “patient-centeredness” of the hospital environment. For example, in the current version of PHEQs staff members do not directly assess their own physical and social work environment (e.g., nursing station, restroom). Future research should investigate the convenience of developing an additional PHEQs scale where health professionals can evaluate their own environment.

PHEQs are not only useful in field studies, but have been also applied in experimental studies (Andrade, Lima, Devlin, & Bonaiuto, in preparation). To our knowledge, PHEQs are also being used to inform hospital administrators and healthcare designers. For example, the research group CIRPA (Center of Interuniversity Research on Environmental Psychology) used this set of instruments when involved in the design of the Concourse for the New Pediatric Hospital Meyer of Florence, which is a leading structure at the national level (see Bonnes, Fornara, & Bonaiuto, 2008) as well as in a specific collaboration with the group of designers from the

TESIS center of the University of Florence (Del Nord, 2006). In Portugal PHEQs have been used in academic work intended to give information to hospital administrators about users’ perceptions of the hospital environment and the relation of those perceptions with other relevant outcomes, and also in a pre–post study related to the move of a hospital to a new building. It is expected that these and other studies will bring interesting results and influence better healthcare designs.

Despite the positive results of this study, PHEQs must be applied and validated in more cultural contexts in order to further confirm its reliability. Hopefully these scales can provide an opportunity to invigorate interest in the investigation, evaluation, and improvement of health care environments.

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Appendix. PHEQs scales’ items

EXTERNAL SPACE SCALE

Upkeep & care

(External hospital area) is not very clean

(External hospital area) is well-kept

(In the external hospital area) paths and sidewalks are in good condition

Many hospital buildings are in poor condition^d

Hospital entrance is welcoming^d

Orientation

In this hospital it is easy to find care units and services you are looking for

(In the external hospital area) there are plenty of signposts to find your way^d

(In the external hospital area) it is difficult to find your way around

(In the external hospital area) signposting is unclear

Green spaces

(In the external hospital area) there are nice trees^d

(In the external hospital area) there are green spaces where you can relax or meet people

(In the external hospital area) there is a lack of well-kept green spaces

(In the external hospital area) there is a lack of green spaces with benches to sit^b

Building aesthetics

From the outside, hospital buildings are nice

From the outside, the colors of the hospital buildings are unpleasant

From the outside, the shapes of the hospital buildings are unpleasant

CARE UNIT & IN-/OUT-PATIENT SCALE

Spatial–physical comfort

(In this in-patient/waiting area) furnishings are in poor condition

(In this in-patient/waiting area) furnishings are in good condition

(In this in-patient/waiting area) the quality of furnishings is good

(In this in-patient/waiting area) furnishings are unpleasant^d

(In this in-patient/waiting area) walls, floors and ceilings are in poor condition

(In this in-patient/waiting area) walls, floors and ceilings have nice colors

(In this in-patient/waiting area) walls, floors and ceilings are well-kept^d

(In this in-patient/waiting area) walls, floors and ceilings are unpleasant^d

This care unit’s entrance is welcoming^d

It (the in-patient/waiting area) is clean^d

(In this in-patient/waiting area) windows are dirty^d

(In this in-patient/waiting area) seats are uncomfortable

(In this in-patient room/waiting area) the number of beds/the number of places to sit (chairs/sofas) is appropriate^{b d}

(continued on next page)

Appendix (continued)

CARE UNIT & IN-/OUT-PATIENT SCALE
(In this in-patient/waiting area) temperature is inadequate (too hot or too cold) ^d
(In this in-patient/waiting area) the air exchange from outside is adequate ^d
(In this in-patient/waiting area) air humidity is adequate (neither too wet nor too dry) ^d
(In this in-patient/waiting area) the air is unbreathable ^d
In this care unit there is a lack of well-equipped waiting or lounge rooms/This waiting area is well-equipped (chairs, tables, TV, newspapers, magazines, etc.) ^{b,d}
Orientation
It is easy to recognize the entrance of this care unit
(In this care unit) there are few signposts to help find your way around
(In this care unit) there are few signposts to help find your way around
(In this care unit) it is difficult to find your way around ^d
(In this care unit) information points are badly located ^d
(In this care unit) you can easily find information points
(This in-patient/waiting area) is clearly defined ^{b,d}
Quietness
(In this care unit) there is enough quietness ^d
(In this care unit) you can hear dins and screams ^d
(In this care unit) there is not much noise ^c
(In this care unit) it is too chaotic ^c
Views & lighting
This in-patient/waiting area is large enough ^d
(In this in-patient/waiting area) the intensity of artificial lighting is satisfactory ^d
(This in-patient/waiting area) does not get enough sunlight
This in-patient/waiting area has large windows ^d
(In this in-patient/waiting area) you can see green spaces from the windows ^d
(This in-patient/waiting area) needs more windows
(In this in-patient/waiting area) the view from the windows has little interest ^b
SOCIAL–FUNCTIONAL FEATURES SCALE
Care for social and organizational relationship
(In this care unit) people receive a nice welcome from staff
(In this care unit) doctors are generally not very understanding toward patients
(In this care unit) nurses are generally not very understanding toward patients ^a
(In this care unit) operational assistants are generally not very understanding toward patients ^a
(In this care unit) medical visits are satisfactory for patients ^d
(In this care unit) doctors generally provide poor information on medical examinations, therapies and interventions ^d
(In this care unit) there is a good cooperative atmosphere among staff members ^d
This care unit is poorly organized
(In this care unit) it is clear who you must ask for information ^d
(In this care unit) there are too many strict rules which limit people's freedom
Privacy
(In this care unit) you feel watched
(In this care unit) people are generally nonintrusive ^d
This care unit is often too crowded
(In this care unit) people gossip too much
(In this care unit) people can create their own personal space ^d
(In this care unit) you can talk to staff about delicate issues without being overheard by others ^d
It is easy for patients to identify the name, surname and function of the staff members ^b

^a Items resultant from the item "(In this care unit) staff members are generally not very understanding toward patients".

^b New items in the recent version.

^c Items that were slightly modified in the recent version.

^d Item was removed during CFA.

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