

The Impact of the Physical Environment on Intrapartum Maternity Care.
Identification of Eight Crucial Building Spaces

There is widespread concern about the increase in intrapartum intervention rates, in particular as regards caesarean sections, and recent research and discussions have focused on the need for the appropriate use of medically-indicated interventions (Miller et al., 2016; Shaw et al., 2016). Medical interventions during birth have consequences for the health of the mother and child, in both the immediate and long-term (as shown in the latest studies on epigenetics).

In this paper, the authors define intrapartum interventions as all interventions occurring from the onset of labor up to and including the expulsion of the placenta and membranes. Intrapartum interventions include, but are not limited to, the induction of labor, the use of intravenous oxytocin, artificial rupture of the amniotic membranes, epidural anesthesia, electronic fetal health rate monitoring, episiotomy, caesarean section, etc.

The reasons for the **increase in intervention rates are multifactorial** and in many circumstances unexplainable, as evidenced by the variation in rates within and between countries (EURO-PERISTAT, 2013). **The rates may be influenced by the model of care adopted, the relationships between caregivers and the organizational culture, which is made up of many factors including the built environment.**

The activities and relationships among users (a woman in labor, her supporter) and maternity healthcare providers (clinicians and staff) in the labor ward in hospital settings or during home births are contained within walls, and therefore within spaces of

a certain shape, characterized by precise levels of illumination and the objects and equipment they contain.

The knowledge base informing the built environment in healthcare facilities has grown rapidly in recent decades. The research findings demonstrate that the physical environment impacts users' health outcomes and wellbeing, both positively and negatively, in different fields such as mental health care (Connellan et al., 2013), dementia care (Marquardt, Beueter & Motzek, 2014) and pediatric care (Del Nord, 2006), and in different functional units of the hospital such as operating rooms (Joseph, Bayramzadeh, Zamani & Rostenberg, 2017), intensive care units (Denham, Bushehri & Lim, 2018) and wards (Rashid, 2015).

The evidence indicates that well-designed hospitals are safer and promote healing in patients, and are better for staff (Ulrich et al., 2008). The corollary of this is that poorly-designed spaces are less safe, may cause harm or morbidity for users, and may be worse workplaces for staff.

The term *environment* has different meanings in different disciplines and different research fields. In the context of environmental sociology (Catton & Dunlap, 1978), environmental psychology (Bonnes, Bonaiuto & Lee, 2004) and environmental design (Lauria, 2017), the term points to the physical environment and its relationship to a person and their needs and feelings, and to the social relationships among people. The term immediately poses an interdisciplinary and inter-scalar problem that has been accentuated over time by the complexity of the investigated phenomena. This has led to the inclusion in the concept of environment of every area of the anthropized environment and connoting aspects that cannot accurately be defined as physical (technologies, health status, wellness conditions, etc.).

This paper focuses, from an architectural perspective, on the physical environment as the built physical space where women undergo labor and birth. The authors specify the physical environment by using the term “building spaces” (Delany, 2015) which refers to single functional spatial units, their spatial relations (visibility, proximity, accessibility, permeability), and the physical environmental characteristics that define them (dimensions, shape, topology, envelope walls, auditory and lighting environmental surroundings).

This paper reviews the literature to determine whether the architectural factors and design features of the birth environment have an impact on intrapartum interventions, and if so, how this occurs.

Method

A scoping review of the topic was firstly conducted within the Scopus databases, Avery Index to Architectural Periodicals (EBSCO), and SAGE Journals in December 2017. The search strategy included the following keywords: ("Birth Environment" OR "Birth Space" OR "Birth Design" OR "Birth Architecture") OR ("Maternity Environment" OR "Maternity Space" OR "Maternity Design" OR "Maternity Architecture") OR ("Midwifery Space" OR "Midwifery Design" OR "Midwifery Architecture") OR ("Obstetric Environment") AND ("Caesarean Section" OR "Intervention rates" OR "Birth Outcomes"). The search was limited to studies in the English or Italian language.

Initially, 80 studies were found, 12 papers were further screened by title and abstract, and 4 were finally identified as relevant by reading the full text. The inclusion criteria adopted while reading the full text were: (a) the paper must provide a clear

description of the building spaces; and (b) the text must describe whether the physical environment influences intervention rates or birth outcomes.

Numerous articles referring to certain environmental qualities such as home-like, clinical, intimate, private, calm, and related psychological and functional effects were discarded as they did not meet criteria (a), that is they did not provide a clear description of the building spaces, and this acted as important filter. *Home-like* is the term chosen to illustrate the following logic: if the authors specified or explained the spatial quality, for example by saying “‘homelike’ decorative features including soft lighting, colored bedspread, floral curtains, carefully designed wooden furniture, a wooden rocking chair and artwork on the walls” (Bowden, Sheehan & Foureur, 2016, p.74), the paper was included. If instead the term was attributed to a space but the authors did not state which specific element was able to confer this spatial quality, by providing a materially identifiable explanation, the paper was excluded.

The dearth of literature retrieved from the search, the authors’ knowledge of healthcare architecture research, a review of the references of the included articles, and many of the papers that were discarded due to the absence of a direct connection between building spaces and intervention rates, suggested the importance of looking for different kind of impacts, which finally led to the development of a broader perspective.

The search then moved from seeking to understand the direct impacts of the physical environment on birth intervention rates to looking at how the physical characteristics of space might influence people’s behavior, experience or practice. The rationale was that the physical environment of birthplaces has the potential to influence intrapartum interventions both directly (A) and indirectly (B) by influencing women’s and staff’s behaviors, experiences and practices, which act as intermediate impacts. (See Figure 1).

[Place Figure 1 approximately here]

The figure illustrates that the indirect impact (B) is made up of the succession of two direct effects, both supported by the literature. The first effect is confirmed by studies on **social and health care architecture. It is known that in these kinds of buildings the physical environment plays an important role in determining stress levels, behaviors and the care experience, and** sometimes even the healing of patients (Codinhoto, Tzortzopoulos, Kagioglou, Aouad & Cooper, 2008; Nickl-Weller & Nickl, 2013; Peponis, Zimring & Choi, 1990; Ulrich, Berry, Quan & Parish, 2010). The second direct effect has been reported in midwifery and obstetrics where users' behavior, experiences and practices have a direct impact on intrapartum intervention rates because they affect the physiological birth process. It is widely recognized that stress-related factors interfere with the physiological hormonal processes of women in labor (Buckley, 2005; Stenglin & Foureur, 2013) and consequently their experiences. Behaviors such as movement and the ability to adopt upright birth positions can reduce the duration of labor, the risk of caesarean section and the need for epidural anesthesia (Lawrence, Lewis, Hofmeyr, Dowswell & Styles, 2013; Priddis, Dahlen & Schmied, 2012). Moreover, midwives' good practices foster the physiological progress of labor which leads to fewer interventions for women (Iannuzzi, 2016; Simkin & Ancheta, 2011; Walsh, 2012).

In reviewing the literature in light of these considerations, the research identified the physical elements of the birth environment that affect behavior, experience and practice, that is those direct impacts that could function as mediators, namely factors that later influence birth interventions and outcomes.. Consequently the new search strategy incorporated the use of the keywords "behavior", "experience" and "practice" in the search matrix instead of the previous terms related to intervention rates. Database

findings were screened by adopting the same procedures previously illustrated and the following inclusion criteria: the paper must provide a clear description of the building spaces and describe the influence of the physical environment on behavior, experience or practice. Initially, 247 studies were found, 56 papers were then further screened by title and abstract, and 8 were finally identified as relevant by reading the full text. The systematic keyword search was supplemented with additional manual searches of the references given in the included articles and related material identified through the active research network on the topic. A total of 37 studies (30 scientific articles, 3 book chapters, 2 research reports, 1 doctoral thesis and 1 interview) met the criteria and were read and analyzed in depth.

Results

The findings were organized into three tables. Tables 1 and 2 report 32 of the selected studies, and Table 3 the remaining 5. Table 1 shows the main characteristics of the selected studies and the building spaces that emerged as influential. These studies were mostly conducted in Western countries and employed quantitative, qualitative and mixed design research methods. Table 2 illustrates in-depth description of the building spaces mentioned in the previous table and their impacts on behaviors, experiences, practices and interventions. As shown in the last column, the main impacts were on women (28), midwives or staff (8), and less frequently on those supporting women in labor (6).

[Place Table 1 and Table 2 approximately here]

Table 3 outlines elements of building spaces that were shown to have an impact in documents setting out building design principles and recommendations.

The five key architectural publications analyzed were:

- a) “Key design concepts” (Foureur & Hastie, 2008), written in collaboration with the architect Bianca Lepori, considers all the sensory modalities that could have a positive impact on physiological birth processes. The architect’s comparison of home and hospital birth spaces conducted by closely observing how women behaved in each place led to her to develop “Mindbodyspirit architecture” for birth theory (Lepori, 2008) drawing on an experiential approach to design. The framework of the theory can be identified in design principles based on the fact that all individuals experience space with at least three bodies: the moving, the feeling and the dreaming one.
- b) “Birthing Unit Design Guidelines” (Forbes, Foureur, Leap & Homer, 2008), which proposes “optimal birth spaces” derived from a review of the literature, insights from surveys of women and in-depth interviews with midwives and architects in health facility practices.
- c) “Budset Design Principles” (Foureur, Leap, Davis, Forbes & Homer, 2011), developed using a qualitative study including a literature review, interviews with key informants (architects, midwives and researchers), and consultation with an expert panel.
- d) “Evidence-based guide to birth environment design” (Jenkinson, Josey & Kruske, 2014), a report proposing a Birth Space guide based on findings from literature reviews.
- e) “La Casa di Maternità” (Felli & Lauria, 2006), a book presenting guidelines for the design of Maternity Home facilities.

Based on these sources, the physical components included in Table 3 were mostly identified for their performance rather than morphological-descriptive characteristics. The BUDSET Tool (Foureur et al., 2011) was used as a framework to organize and categorize the identified characteristics of the building spaces.

[Place Table 3 approximately here]

Different information can be gleaned from Tables 1, 2 and 3: firstly, they provide some interesting data on the building spaces, they then differentiate between the type of impact these spaces produce, and finally a salutogenic approach emerges in many papers.

The Building Spaces

Tables 1 and 2 show that data on building spaces is limited and lacking in detailed descriptions, including the relative architectural plans. The design principles presented in Table 3 give a detailed description of the building spaces providing important clues for our investigation, although some important design aspects are not covered.

However, despite these limitations, some physical elements are fully demonstrated and recur repeatedly. One example is the presence of a medical bed in the birth room which does not help the physiological process, or a bed that occupies the central space in the room (Bowden et al., 2016; Fahy & Parratt, 2006; Forbes et al., 2008; Foureur et al., 2011; Jenkinson et al., 2014; Lepori, 1994; McCourt, Rayment, Rance & Sandall, 2016; Mondy, Fenwick, Leap & Foureur, 2016; Walsh, 2006), or one that is visible (Hodnett, Stremmler, Weston & McKeever, 2009). Moreover, the bed is seen as being majorly responsible for layout inflexibility, thereby preventing midwives from finding the space to carry out tasks (Hammond, Foureur & Homer, 2014).

The literature included in this review and the architectural knowledge and experience of the authors led to the identification of eight building spaces that require further investigation: 1) *Unit layout configuration*; 2) *Midwives' hub/desk*; 3) *Social room*; 4) *Birth philosophy vectors*; 5) *Configuration of the birth room*; 6) *Dimension and shape of the birth room*; 7) *Filter*; 8) *Sensory elements*.

The relevance of building spaces is based on several factors. Some are currently unsupported by evidence (e.g., the position of the desk), some are found in the literature but their impacts are not proven (e.g., the Unit layout configuration), and others recur repeatedly in papers but lack a clear description of their physical characteristics (e.g., the Filter). Although the building spaces are analyzed and presented individually, some are closely related and interact with each other.

The first three building spaces are related to the unit configuration, i.e., the set of spatial relationships (permeability, accessibility and visibility) between the rooms in a layout. For example, it is crucial to consider the birth room as a set of reciprocal relationships regulated by the distance, dimension, position and connection of the room with respect to other spaces in the layout (corridors, social spaces, storages, midwife desks and hubs).

Unit layout configuration. The first building space that impacts how people live within the environment is the layout configuration. It dictates how the spaces are connected, their permeability, the number of doors between them and the visibility between rooms, and how these elements affect people's movements and how they enter and exit the birth room and move within the unit. People's movements within the unit are governed by different purposes: women need to walk during labor, midwives move between their work hub and the birth room, and the women's supporters may require access to refreshments and to be able to rest in different areas.

In order for women to identify their own place, the architect Bianca Lepori (2008) has underlined the importance of planned pathways, partitions and sequences of spaces, while Longo and Setola (2009) have discussed the importance of space morphology (dimensions and layout) providing several uses for users. Symon, Paul, Butchart, Carr and Dugard (2008b) identified that the perceived spaciousness of the ward layout was directly related to increased user satisfaction and quality of care, and Symon et al. (2008d) showed that the spatial layout enabled staff to perform their duties and promoted interaction among them. Ariadne Labs and MASS (2017) conducted a pioneering study showing how design elements influence clinical decision-making and identified quantitative layout data associated with the caesarean section rates of the analyzed case studies. Some of these design elements depend on the layout configuration. The analysis showed that the maximum distance between the various Labor Delivery Rooms (LDRs) and the average distance of the nurse stations from the birth rooms are positively associated with the number of caesarean sections performed, the greater the distances the higher the cesarean rate. The measure of this last distance is linked to the compactness of the layout and the proximity of the elements within it. In short, it is a configuration problem because the distance decreases if the rooms are grouped into clusters thus assuming a central rather than longitudinal conformation. Even the percentage of the unit circulation area accessible to users, another factor that Ariadne Labs and MASS (2017) suggest could be linked to the extent of medical treatments performed during labor and delivery, is a configuration aspect: it makes a difference to a woman in labor if she is invited to walk along a corridor or can choose from alternative circular routes.

These studies reiterate the importance of the layout but no specific or in-depth studies have been carried out on the most suitable morphology of the layout (e.g., circular or elongated) in relation to the care model, nor on the position that different

rooms should occupy within the layout to facilitate optimal movements for users.

Furthermore, no studies have yet been carried out in LD units on how the careful design of the configuration in the environment allows for greater appropriation by the users who inhabit them (Penn, 2005).

Layout configuration is important not only because it influences movement but also because it affects social interaction among people (Setola & Borgianni, 2016), **a relational aspect of immense importance in labor and birth.**

Intelligibility is the property of a layout that can be understood and therefore easily navigated by people. In the guidelines, the configuration aspect comes into play at the level of the unit's intelligibility with respect to the point of arrival in the hospital (Forbes et al., 2008; Foureur et al., 2011).

[Place Figure 2 approximately here]

Midwives' hub/desk. The strategic position of spaces like the midwives' hub and desk may favor the relationship between women and midwives and among midwives themselves, as well as decrease stress and misconceptions in communication and practice among colleagues. For example, Berridge, Mackintosh and Freeth (2010) talk about how the location of the midwives' hub, in particular as regards its proximity to labor rooms, can affect communication and collaboration among staff. The authors have raised the question, without reaching definitive conclusions, of whether the hub and desk are better located in the same place or not. Conversely, Foureur et al. (2010) highlighted that a central desk facilitates positive communication, enabling the concepts of risk and safety to be explored. Symon et al. (2008d) state that positioning the desk in the corridor does not help the staff as it leaves them exposed to noise and interruptions by users. When the desk is positioned close to the rooms the distance between midwives and women is

reduced, but staff interactions can be noisy and disruptive for the women (Foureur & Hastie, 2008).

In summary, **the best place to position the midwives' hub and desk has been under-explored** and is poorly understood. Further aspects need to be examined, for instance the ideal number of them, **whether the midwives' desk and hub are considered to be two different places or the same** (this very much depends on the care model), **and their optimum location in the spatial layout in order to foster relationships and preserve the privacy of all users.**

[Place Figure 3 approximately here]

Social room. The presence and location of social spaces such as kitchens and/or a living room is a matter for further investigation. These spaces are perceived very positively by people and seem to have two main functions: **facilitating relations between midwives, women and supporters** (Longo & Setola, 2009; Walsh, 2006), and providing a welcoming shared space, for instance a “family room” (Forbes et al., 2008; Foureur et al., 2011), to accommodate supporters, thereby encouraging exchanges of experiences and providing them with a place of rest and support (Foureur & Hastie, 2008; Harte, Sheehan, Stewart & Foureur, 2016; Jenkinson et al., 2014) in their positive role of assisting women during the labor and birth process. Therefore, the real role of this kind of space, the people who use them, the number of them and their location in the spatial layout require further exploration.

[Place Figure 4 approximately here]

Birth philosophy vectors. In this paper, *vectors* are defined as those elements designed to communicate information, such as posters, works of art, and images and writing on the walls of the unit and the birth room that convey a specific educational

meaning related to childbirth and help to create an emotional atmosphere in the environment.

This communication takes place on several levels. Harte, Sheehan, Stewart and Foureur (2016) have shown that posters and brochures showing birth and physiological labor and birth support activities influence the instrumental and emotional needs of supporters. McCourt, Rayment, Rance and Sandall (2016) describe how decorative changes in the environment can change the midwives' practice, and Mondy, Fenwick, Leap and Foureur (2016) present a large pin-up board with photos and event notices as a shared space between women, their families and midwives. In the guidelines (Foureur & Hastie, 2008; Foureur et al., 2011) use of the feminine archetype is suggested in artworks and symbols of beauty, wholeness and harmony as they help to reduce women's stress. Each vector conveys a meaning aimed to support the mood and wishes of the person who needs it at that moment. These vectors should be placed at strategic points for the users and integrated into the design of the unit.

[Place Figure 5 approximately here]

In addition to the previous four building spaces, another four concern the characteristics of the birth room, a space inhabited by mothers, midwives and supporters.

Configuration of the birth room. The birth room is a place where different activities occur at different times. It is used by women, their supporters and midwives before, during and after birth so the same environment must be capable of transforming itself accordingly. The solution the birth room should offer stakeholders does not just relate to the physical activities occurring during the intrapartum care process but it also concerns users' experiences, an awareness of "flexible definitions of normality" and "recognition of the 'unique normality' of each woman" (Downe & McCourt, 2008, p.23).

The birth room should be as flexible as possible and suited to different purposes. First of all, it should support the woman's changing needs as she progresses through the different stages of labor and requires different atmospheres and settings to foster relaxation, distraction from the pain and to create a more intimate birth space. Flexibility in the birth room configuration can contribute to a feeling of privacy and safety which, together with the ability to move around, are essential for women in labor (Franck & Lepori, 2007; Hammond, Homer & Foureur, 2017; Igarashi, Wakita, Miyazaki & Nakayama, 2014; Lawrence et al., 2013; Lepori, 1994; Stenglin & Foureur, 2013; Walsh, 2006) to support the physiological birth process.

Flexibility within the room could be provided by the types of fixtures and modular furniture. For example, minimal fixed items and a movable bed allow individual women to express themselves (Jenkinson et al., 2014; Foureur et al., 2011). Creating ancillary spaces to store equipment near the room allows for flexibility in the use of different support materials (Forbes et al., 2008). The use of mobile furniture means the space can be configured differently and this has an impact on the women and supporter's sense of control (Harte et al., 2016). An inflexible and impractical layout also has a negative effect on midwives (Hammond et al., 2014) who as a result may not be able to support the women adequately.

However, a number of unanswered questions remain and include the essential requirements of the furniture, the size and appearance of the intimate birth space and, importantly, how to achieve such a level of flexibility within sometimes rigid hospital environments.

[Place Figure 6 approximately here]

Size and shape of the birth room. A very important element linked to the configuration of the birth room is the room size. Having an empty space or an empty and

protected area in the room allows for freedom of movement and different birth positions and activities during labor and birth (Lepori, 1994). Being able to move freely during labor is important for positive birth outcomes (Forbes et al., 2008; Foureur & Hastie, 2008; Foureur et al., 2011; Hammond, 2015; Mondy et al., 2016; Rados, Kovács & Mészáros, 2015; Singh & Newburn, 2006). The room should be big enough to host supporters as well as the belongings of both the women and supporters (Jenkinson et al., 2014; Symon, Paul, Butchart, Carr & Dugard, 2008b) as this provides a welcoming feeling and the possibility of transforming the space into a familiar environment (Harte et al., 2016).

In relation to birth room size, standards in some countries indicate that the minimum size should be 24 square meters (m²) or 258 square feet (ft²) without a pool and 34.5 m² (371 ft²) with a pool in the UK; 28 m² (301 ft²) in Australia; 30 m² (323 ft²) in the USA; between 25 m² (269 ft²) and 30 m² (323 ft²) in Italy (AusHFG, 2016; Department of Health, 2013; FGI, 2018; Ipsel Guidelines, 2007). However, it is not known if this space is sufficient to facilitate women walking around and to allow for different configurations of furnishings.

It is also essential for the birth room area to have the most suitable shape. A narrow, long room would not be appropriate to achieve flexibility whereas a room with a more square shape probably would.

Furthermore, **the shape, favoring flexibility, also makes it possible to obtain the more intimate space** many authors speak of, **which is essential for childbirth**. This space should evoke the concept of a *nest*, a cozy and protected space in the room where the woman feels undisturbed, safe and focused on the changes taking place as the birth progresses, and therefore the space allows the physiological process to proceed through “good hormone orchestration” (Foureur et al., 2011; Hammond, 2015; Jenkinson et al.,

2014; Lothian, 2004; Odent, 2003; Stenglin & Foureur, 2013). For example, the morphology of a room with more convex angles naturally creates different and intimate spaces. However, it may be less flexible than a square room where the space can be altered and spatial situations created according to individual preferences (See Figure 6).

In summary, the size of the room should be sufficient to facilitate women's free movements and the shape of the room should offer maximum flexibility to facilitate individual women in reshaping *their* space. However, further investigation is needed to determine whether this intimate space represents the whole birth room and/or a specific space, a corner, or a hidden and more private space within the same room.

[Place Figure 7 approximately here]

Filter. The interface between the birth room and the corridor is an important spatial filter that marks the transition between two different inhabited spaces, one more public and the other more private. It is important to fully understand this physical element as it helps to favor a calm atmosphere and the concept of privacy (Forbes et al., 2008; Foureur & Hastie, 2008; Foureur et al., 2011; Jenkinson et al., 2014). In their study on birth room design elements, Shin, Maxwell and Eshelman (2004) investigated the entrance transition to the room and found that this space, depending on how it is designed, relates to a feeling of hominess, a preference for using the space and women's perception of personal control.

The position of the door with respect to the internal configuration of the furnishings, such as a pool or bed, becomes an important element to check what can be seen from the inside and outside, and provides users with an adequate level of privacy (Forbes et al., 2008; Foureur & Hastie, 2008; Foureur et al., 2011; Sheehy, Foureur, Catling-Paull & Homer, 2011). This level of privacy can be obtained by taking simple precautions, for example closing a curtain to obstruct the view of what happens in the

room from the corridor. The filter, however, seems to encompass many more purposes: the transition from a corridor to a more calm and personal atmosphere, separation from all that is external, and proximity to points of contact with the midwives. In the literature, there are no descriptions of these aspects.

The filter space could be of different dimensions and achieved in many ways, with furniture, fixed elements such as low walls, and even with the space that changes in itself creating indentations or small entrances, with lighting, etc., depending on what level of permeability with external spaces is required and why.

[Place Figure 8 approximately here]

Sensory elements. All the sensory elements embedded in the space are important to create a calm and relaxing atmosphere in the unit and especially in the birth room: from the possibility of having natural and artificial dimmer lights, to the colors of the walls and different touchable textural surfaces. According to many authors, the elements that affect our senses, such as light, noise, visual art, a view of nature, temperature control, warm colors, smells and surface textures, all promote a relaxing atmosphere that reduces anxiety and stress and in turn facilitates normal birth and produces physiological benefits (Aburas, Pati, Casanova & Adams, 2017; Balabanoff, 2016; Bowden et al., 2016; Carolan-Olah, Kruger & Garvey-Graham, 2015; Duncan, 2011; Felli & Lauria, 2006; Forbes et al., 2008; Foureur & Hastie, 2008; Foureur et al., 2011; Igarashi et al., 2014; Jenkinson et al., 2014; McCourt et al. 2016; Mondy et al., 2016; Stenglin & Foureur, 2013; Symon et al., 2008c).

Two studies detailed the characteristics of sensory environments. Hauck, Rivers and Doherty (2008) found that the use of a *snoezelen room* during labor provided women with distraction, relaxation, comfort, control, and the choice of complementary therapy. Hodnett, Stremmler, Weston and McKeever (2009) compared an *ambient room* (a room

with radical modification) with a normal labor room and found that there were positive childbirth outcomes for women who labored in the ambient room: they had a shorter labor and were less likely to need oxytocin infusions. A more recent experimental study conducted in Herning Hospital in Denmark investigated the use of a room with a 3D projection on three walls designed to create an immersive environment, though the findings have not yet been published.

In summary, although we understand the beneficial effect of this last group of elements on the birth process, little is known about which if any specific element has more impact and in what context. For example, it is not known if the dominant focus should be on projection, music, aromas, and moreover, the possibility of integrating them into birth room designs, from a cost competitiveness and technological perspective, remains poorly understood.

[Place Figure 9 approximately here]

The Impacts

The impacts column of Tables 2 and 3 describes the physical, psychological and physiological effects of the building spaces which can be organized into three categories: impacts on interventions, on users' experiences and behaviors and on staff practices.

Impacts on interventions. This category includes papers that investigated how some building spaces are correlated to intervention rates in childbirth: for example, less frequently required epidural analgesia (Duncan, 2011), the likelihood of using artificial oxytocin and shorter labor times (Hodnett et al., 2009), and the likelihood of having an emergency caesarean section (Singh & Newburn, 2006).

This category also includes studies highlighting building spaces that facilitated normal birth (Carolan-Olah et al., 2015; Newburn & Singh, 2003; Symon et al., 2008c),

the physiological benefits (Fahy & Parrat, 2006; Foureur et al., 2011; Jenkinson et al., 2014; Sheehy et al., 2011) and promoted the physiologic hormone process (Lothian, 2004).

Impacts on users' experiences and behavior. The majority of studies analyzed reveal impacts on the experiences of women, midwives and supporters. These include women's sense of self (Fahy & Parrat, 2006; Stenglin & Foureur, 2013); the perception of personal control (Shin, Maxwell & Eshelman, 2004); women's distraction and relaxation (Aburas et al., 2017; Foureur et al., 2011; Hauck, Rivers & Doherty, 2008; Igarashi et al., 2014; Lepori, 2008); women's perception of comfort and sense of wellbeing (Bowden et al., 2016; McCourt et al., 2016); lower levels of stress and anxiety in both staff and women (Forbes et al., 2008; Foureur et al., 2011; Hammond et al., 2017; Jenkinson et al., 2014; Rados et al., 2015; Stenglin & Foureur, 2013; Symon et al., 2008c); midwives' positive feelings (Hammond et al., 2014), supporters feeling welcome, privacy and social interactions (Harte et al., 2016). Furthermore, other elements impact women's behavior such as free movement, assuming different labor and birth positions and accomplishing different activities (Igarashi et al., 2014; Jenkinson et al., 2014; Lepori, 1994; Mondy et al., 2016; Walsh, 2006).

Impact on staff practices. Some studies highlighted the influence of the physical environment on midwives' practices through the impact on intra-professional communication (Berridge, Mackintosh & Freeth, 2010; Foureur et al., 2010) and on the ability to perform tasks comfortably and responsively (Hammond et al., 2014; Hammond et al., 2017; Symon et al., 2008d).

A Salutogenic Approach

The approach suggested by some of the analyzed papers reveals a health-orientation that aims to identify positive and negative impacts in order to create a path that favors physiological labor and birth. This argument refers to the Salutogenesis concept, a theory originally developed by the medical sociologist Aaron Antonovsky in the late 1970s which is concerned with understanding what generates and maintains health and wellbeing (Perez-Botella, Downe, Meier-Magistretti, Lindstrom & Berg, 2015).

From this positive health perspective, understanding which spatial determinants maximize health and wellbeing for women, supporters and staff offers architecture the potential of contributing to the understanding of pregnancy and childbirth as a health-producing processes (Downe, 2010).

Thus, the challenge is to focus on space as an intrinsically positive resource for wellbeing and to find ways to develop assets for maternity, where the space forms an important contributing factor and, along with other factors, holds the key to a positive change in outcomes for women.

Conclusions

The research investigated the impacts of birth space characteristics on intrapartum maternity care, arriving at the definition of a conceptual model to better understand the direct and indirect influences of the physical environment. The effects of the physical environment can be found not only by studying intervention rates, which represented the initial purpose of the study, but also all the transitional/intermediate impacts (behavior, experience and practice) elicited by the space which later influence intrapartum interventions.

The reviewed articles, limited to circumscribed and different birth contexts (mainly European, Australian and American), have highlighted aspects that are desirable to stakeholders but that should be contextualized in the care model, culture and health of every single woman.

The complexity and versatility of the building spaces identified should be further understood through the contribution of several disciplines, including architecture, midwifery and anthropology to enhance the meaning of each building space, provide knowledge about its nature and stimulate the creativity of architects to find the most appropriate architectural solutions.

The research shows the importance of considering environment design in maternity care and that even some existing studies not focused on this topic provide evidence of specific building spaces. The extrapolation of that data presents the existing studies in a manageable way to address specific research focused on architectural design in order to enrich our knowledge of what works well for women in childbirth, their supporters and caregivers. It also helps to expand on the evidence to prove the effect that the physical environment design has on birth outcomes and finally to develop accurate recommendations for designers.

References

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