

Promoting Mother-Child Health in Rural Sub-Saharan West Africa: A Sustainable Architectural Approach to Culturally Tailored Care

by Cecilia Ceccarelli, Francesco Branda, Marta Giovanetti, Mattia Albanese, Laura Elena Pacifici Noja, Fabio Scarpa, Massimo Ciccozzi, Giancarlo Ceccarelli*

Abstract

Maternal healthcare in rural Sub-Saharan West Africa faces significant challenges, including inadequate access to facilities, cultural barriers, and socio-economic constraints that jeopardize the well-being of pregnant women and their newborns. This paper explores the intersection of these challenges and presents a sustainable architectural approach aimed at enhancing maternity care. By focusing on culturally sensitive design principles, the proposed architectural solutions prioritize the needs and values of local communities while promoting safe pregnancy practices. The integration of traditional building techniques and local materials not only addresses environmental sustainability but also fosters a sense of ownership and acceptance among users. Furthermore, the design incorporates essential elements such as natural ventilation, passive cooling, and accessible healthcare facilities, which are crucial for improving maternal health outcomes. This research emphasizes the importance of creating spaces that are not only functional but also responsive to the cultural and social dynamics present in rural Sub-Saharan West Africa. Ultimately, this study advocates for a holistic approach to maternity care that combines architectural innovation with community engagement to promote healthier and safer pregnancies in the region.

Keywords

West Africa, Senegal, pregnancy, maternity, architectural design, clinic, infectious disease, tradition, culturally sensitive.

*Cecilia Ceccarelli, Architectural Science School, Department of Architecture, “Roma Tre” University; Migrant and Global Health Organization (Mi-HeRO). Francesco Branda, Unit of Medical Statistics and Molecular Epidemiology, Università Campus Bio-Medico di Roma. Marta Giovanetti, Department of Sciences and Technologies for Sustainable Development and One Health, Università Campus Bio-Medico di Roma; Instituto René Rachou, Fundação Oswaldo Cruz, Belo Horizonte, Minas Gerais, Brazil; Climate Amplified Diseases and Epidemics (CLIMADE). Mattia Albanese, Hospital of Tropical Diseases, Mahidol University, Bangkok, Thailand; Department of Public Health and Infectious Diseases, Sapienza University of Rome. Laura Elena Pacifici Noja, Italian Ministry of Foreign Affairs and International Cooperation (MAECI), Scientific and Technological, attaché at the Italian Embassy in Addis Ababa. Fabio Scarpa, Department of Biomedical Sciences, University of Sassari. Massimo Ciccozzi, Migrant and Global Health Organization (Mi-HeRO); Unit of Medical Statistics and Molecular Epidemiology, Università Campus Bio-Medico di Roma. Giancarlo Ceccarelli, Migrant and Global Health Organization (Mi-HeRO); Department of Public Health and Infectious Diseases, University Hospital Policlinico Umberto I, Sapienza University of Rome. Corresponding author: Cecilia Ceccarelli.

1. An Overview of the Geoeconomic, Political, and Health Dynamics in Sub-Saharan West Africa

Benn loxo du taccu – One hand does not clap.

(Wolof proverbs, Senegal)

The Sub-Saharan West African region, which includes countries such as Senegal, The Gambia, Guinea, Côte d'Ivoire, Ghana, Togo, and Benin, presents a complex interplay of geoeconomic, political, and health dynamics that significantly influence the experiences and opportunities of its populations. Economically, the region is characterized by a diverse array of economies ranging from resource-rich nations to those heavily reliant on agriculture and services. Countries like Côte d'Ivoire and Ghana are endowed with abundant natural resources, including minerals, oil, and gas, while agriculture employs a significant portion of the population and contributes to food security through key exports such as cocoa, cashews, and palm oil [1]. Regional economic integration efforts, notably those led by the Economic Community of West African States (ECOWAS), aim to foster trade and

collaboration among member nations; however, challenges such as infrastructural deficits, limited access to financing, and varying regulatory environments continue to obstruct economic growth and stability, impacting foreign direct investment opportunities [2]. Politically, the region displays a mix of democratic governance and instability, with countries like Ghana and Senegal making strides toward consolidating democratic processes, while others grapple with issues of governance, corruption, and political unrest. Electoral contests can be contentious, occasionally resulting in civil conflicts that complicate development initiatives [3, 4]. The region also faces significant security challenges, particularly from extremist groups such as Boko Haram and affiliated organizations, which threaten stability in countries like Nigeria, Niger, and Burkina Faso and have repercussions for neighboring states [5]. This intersection of security challenges, governance, and socio-economic development creates a nuanced political landscape. In terms of health, Sub-Saharan West African countries experience a high burden of infectious diseases, alongside

pressing maternal and child health issues and a rising prevalence of non-communicable diseases. Infectious diseases such as malaria, HIV/AIDS, tuberculosis, and viral hepatitis remain widespread, causing significant morbidity and mortality [6-8]. Despite progress made in addressing these health challenges, healthcare access and infrastructure deficiencies persist, especially in rural and underserved regions. The area's maternal mortality rates remain among the highest globally, driven by factors such as inadequate access to quality maternal healthcare, skilled birth attendants, and emergency obstetric care, with cultural beliefs and socio-economic constraints further complicating efforts to improve health outcomes [9-17]. The Covid-19 pandemic has intensified the vulnerabilities of health systems in these nations, underscoring the need for resilient public health responses and revealing existing healthcare disparities [18]. To navigate the interconnected challenges of geoeconomic development, political stability, and health outcomes, collaborative strategies involving governments, regional organizations, and international partners are essential. As

the region attempts to realize its developmental aspirations within the frameworks of globalization and local contexts, addressing these multifaceted dimensions will be critical for sustainable development in Sub-Saharan West Africa, ultimately enhancing the overall well-being of its populations.

2. Maternal Health in Sub-Saharan West African Countries

Maternal health remains a critical public health issue in Sub-Saharan West Africa, particularly in the Gulf of Guinea region. Despite significant progress in global health, maternal mortality rates in this area remain among the highest in the world. Various multifactorial elements contribute to this persistent challenge, including healthcare access, socioeconomic factors, cultural practices, and the prevalence of infectious diseases [19-23].

Access to Prenatal and Postnatal Care

Maternal health in Sub-Saharan Africa continues to pose a significant public health challenge, driven by a complex interplay of socioeconomic dis-

parities, inefficiencies within health systems, and deep-rooted cultural influences. Despite international efforts and commitments to enhance maternal health, the region grapples with some of the highest maternal mortality rates globally. This reality highlights a critical need to improve access to both prenatal and postnatal care, which are essential for safeguarding the health of mothers and their newborns [20, 22, 24].

Prenatal care encompasses vital medical check-ups and necessary interventions throughout pregnancy, playing a crucial role in minimizing both maternal and neonatal morbidity and mortality. Access to quality prenatal services facilitates early detection and management of potential complications that may arise during pregnancy. Furthermore, consistent prenatal care serves as a platform for educating expectant mothers about maternal health, thereby promoting healthy behaviors that can significantly impact outcomes for both mother and child. Similarly, postnatal care is of paramount importance, as it enables healthcare providers to closely monitor maternal recovery and the health of newborns. This period is crit-

ical not only for addressing potential complications such as postpartum depression but also for guiding mothers on proper infant feeding practices and the overall care of their newborns [20, 22, 24-27].

The current landscape of maternal healthcare in Sub-Saharan Africa is marred by multiple hindrances that impede access to these essential services. Geographical barriers play a significant role, particularly in rural regions where healthcare facilities are often situated at considerable distances. Poor transportation infrastructure exacerbates this challenge, making it difficult for women to obtain timely care, which is especially dangerous during emergencies. Economic factors further complicate access; many women face high costs related to healthcare services, including transportation fees and hospital charges. The opportunity cost of time spent seeking care can be particularly burdensome for low-income families, leading some to delay or forgo necessary prenatal and postnatal services altogether [24-27]. Socioeconomic disparities play a crucial role in maternal health outcomes. Women from low-income backgrounds

often face greater obstacles in accessing quality healthcare services. Financial constraints impact not only the ability to pay for services but also the opportunity cost associated with seeking care, particularly in low-resource settings where women may be responsible for household duties. Educational attainment is another critical factor, as women with higher levels of education tend to seek healthcare services more proactively and are generally more knowledgeable about reproductive health [28-31].

Moreover, many health systems throughout the region struggle due to inadequate funding, which results in understaffed facilities and a lack of essential medical supplies. The persistent shortage of skilled healthcare workers – such as midwives and obstetricians – compounds these challenges, severely compromising the quality of maternal healthcare services available to women. Cultural beliefs and social practices surrounding childbirth also influence women's decisions about healthcare. In some communities, there is a preference for traditional birth attendants over formal healthcare settings, which may discourage women

from seeking modern medical care even when it is necessary. Additionally, limited health education poses a barrier that cannot be overlooked. Many women remain unaware of the importance and benefits of prenatal and postnatal care, which discourages them from utilizing the available healthcare resources. Targeted education campaigns are essential in changing perceptions about maternal health and empowering women and communities to seek necessary care [32].

Cultural Practices and Beliefs

Maternal health in Sub-Saharan West African Countries is significantly influenced by cultural practices and beliefs, which shape women's experiences during pregnancy, childbirth, and the postpartum period [33]. Understanding these cultural dynamics is crucial for developing effective maternal health programs and interventions that respect and integrate local practices while promoting safe and evidence-based healthcare. Cultural practices related to maternal health often reflect a society's values, norms, and historical experiences. In many Sub-Saharan African communities, tradi-

tional beliefs about childbirth are deeply rooted and can differ significantly from biomedical perspectives. These cultural beliefs can dictate not only the choice of care provider but also the types of practices adopted during prenatal and postnatal care [33-36].

In regions where formal healthcare services are scarce or perceived as inadequate, traditional birth attendants (TBAs) often play a central role in maternal healthcare. Many women prefer to deliver with TBAs due to longstanding cultural practices, their familiarity with the community, and their perceived understanding of traditional healing methods. TBAs are usually deeply trusted figures, and their presence provides a sense of comfort and continuity during childbirth, reinforcing the social fabric of the community. However, while TBAs can be invaluable resources, their training and the quality of care they provide can vary widely. In some cases, reliance on traditional practices may divert women from seeking medical assistance during emergencies or complications, which can have detrimental health consequences. Therefore, integrating TBAs into formal healthcare

systems through training and collaboration could enhance maternal health outcomes while respecting cultural preferences [37-38].

Cultural beliefs surrounding pregnancy and childbirth can significantly influence maternal health behaviors. In many cultures, pregnancy is viewed not just as a medical condition but also as a significant social event with spiritual implications. Certain traditional practices, such as dietary restrictions, rituals for protection against evil spirits, and rites of passage, inform women's behaviors during pregnancy. These practices can promote emotional well-being and community support; however, they may also hinder appropriate medical care if they encourage avoidance of healthcare facilities.

Moreover, there are specific cultural taboos and practices related to postpartum care, which can impact maternal recovery and bonding with the infant. Practices like engaging in specific cleansing rituals or confinement periods often determine a woman's postpartum behavior, including breastfeeding practices. Such customs can sometimes lead to a lack of understanding of the importance

of professional follow-up care, potentially exposing mothers and newborns to preventable health issues [39-41].

Gender dynamics also play a critical role in shaping maternal health within Sub-Saharan African contexts. In many communities, women may have limited autonomy in health decision-making, often relying on male family members or elders to make significant choices regarding their health care. These dynamics can pose substantial barriers to accessing timely prenatal and postnatal services, as women may face opposition when seeking care [42, 43].

Cultural norms often define the expected roles of women and men within families, influencing how maternal health services are utilized. For instance, if seeking maternal health services requires traveling long distances or incurring costs, women may be deterred from doing so if their families hold traditional views that prioritize men's roles in decision-making. Therefore, addressing these gender norms and empowering women through education and advocacy are vital components for improving access to maternal healthcare.

Maternal Mortality in Sub-Saharan West African Countries

According to the World Health Organization (WHO), the estimated maternal mortality ratio (MMR) for Sub-Saharan Africa was approximately 542 deaths per 100,000 live births in 2017, with the Gulf of Guinea exhibiting ratios that often exceed this average [9, 10]. For instance, in Nigeria, one of the most populated countries in the region, the maternal mortality ratio is estimated to be around 917 deaths per 100,000 live births, making it one of the highest globally. Other countries, such as Guinea (724), Côte d'Ivoire (645), and The Gambia (432), also report significant maternal mortality figures. In contrast, countries like Ghana and Senegal, while still facing challenges, have achieved lower maternal mortality ratios, estimated at 308 and 315, respectively. An in-depth analysis indicates not only the critical health risk faced by women during pregnancy and childbirth but also highlight the disparities within the region. Factors contributing to such elevated MMRs include inadequate access to skilled healthcare personnel,

particularly during childbirth, and insufficient healthcare infrastructure [9-17].

Role of Infectious Diseases

Maternal health in Sub-Saharan Africa is profoundly impacted by the burden of infectious diseases, which contribute significantly to maternal morbidity and mortality rates. The interplay between reproductive health and infectious disease dynamics presents complex challenges that require targeted interventions and comprehensive strategies to improve overall maternal health outcomes in the region [6-8]. Infectious diseases, including neglected tropical diseases (NTDs), human immunodeficiency virus (HIV), tuberculosis (TB), and sexually transmitted infections (STIs), present formidable obstacles to achieving sustainable improvements in maternal health. These diseases can affect women's health before, during, and after pregnancy, indicating the need for integrated health services that address both maternal and infectious disease care.

Maternal health in Sub-Saharan Africa is intricately linked to the burden of NTDs, a diverse group of infectious

diseases that disproportionately affect impoverished populations in tropical and subtropical regions. These diseases, which include malaria, schistosomiasis, lymphatic filariasis, and onchocerciasis, present substantial challenges to maternal health by contributing to morbidity, mortality, and complications during pregnancy [6, 8, 44, 45].

NTDs significantly impact maternal health by exacerbating existing vulnerabilities among pregnant women. Malaria, for instance, remains a leading cause of morbidity and mortality for pregnant women in Sub-Saharan Africa. Due to physiological changes during pregnancy, women are more susceptible to severe malaria, which can lead to complications such as anemia, low birth weight, and preterm delivery. The consequences of malaria in pregnancy are profound, as they not only affect the health of the mother but also have long-term implications for neonatal health. The WHO recommends preventive measures such as intermittent preventive treatment in pregnancy (IPTp) and the use of insecticide-treated nets (ITNs) to mitigate the impact of malaria on maternal health. However, access to these interventions

remains inconsistent, particularly in rural areas [6, 8, 44-47].

Schistosomiasis, another common NTD in the region, can negatively impact maternal health as well. Infection during pregnancy is associated with adverse outcomes, including anemia and increased risk of premature birth. Moreover, the disease may contribute to increased susceptibility to other infections, further complicating maternal care. Addressing schistosomiasis through preventive measures, such as community health education and access to treatment, is essential for improving maternal health outcomes. Lymphatic filariasis and onchocerciasis can also pose significant risks to maternal and infant health. Lymphatic filariasis can lead to lymphedema and hydrocele, causing significant physical and psychological distress. Women suffering from these debilitating symptoms may face difficulties in accessing care or maintaining health during pregnancy, leading to poorer outcomes. Onchocerciasis, known to cause river blindness, can have indirect effects by reducing the availability of healthcare resources in affected communities, thus limiting access to essential maternal healthcare services [6, 8, 47, 48].

The intersections between NTDs and maternal health further highlight the importance of integrated healthcare approaches. Successful strategies must encompass not only the control and prevention of NTDs but also comprehensive maternal health services. This involves ensuring that pregnant women receive appropriate screenings, treatment, and preventive medications while effectively managing the broader health determinants that influence both maternal and neonatal outcomes.

Tuberculosis is another infectious disease of significant concern for maternal health in the region. Pregnant women with TB are at risk of severe morbidity, including respiratory complications and worsening nutritional status, which can lead to adverse effects on both maternal and fetal health. Co-infection with HIV and TB further complicates treatment and care, necessitating integrated service delivery that addresses both conditions simultaneously. Routine screening for TB in pregnant women, particularly in high-prevalence areas, should be prioritized to reduce maternal and neonatal risks [49-51].

Sexually Transmitted Infections (STIs), including

syphilis and gonorrhea, can have serious implications for maternal health and pregnancy outcomes. These infections can lead to complications such as pelvic inflammatory disease, maternal sepsis, miscarriage, and preterm labor. Furthermore, STIs can facilitate the transmission of HIV [52, 53]. In fact, the HIV epidemic poses significant challenges to maternal health in Sub-Saharan Africa. Women of reproductive age bear a disproportionate burden of HIV infection, and maternal health outcomes are adversely affected by the disease. HIV-infected women are at increased risk for obstetric complications, including maternal mortality. Antiretroviral therapy (ART) has improved life expectancy and health outcomes for HIV-positive women, but barriers to accessing testing, treatment, and care persist, contributing to preventable complications during pregnancy and childbirth. Moreover, the risk of mother-to-child transmission (MTCT) of HIV remains a critical concern during pregnancy, childbirth, and breastfeeding if adequate interventions are not employed. Comprehensive prenatal care must include routine HIV screening and linkage

to care, thereby improving maternal and infant health outcomes. Public health initiatives that promote regular screening, treatment, and education about safe sex practices are critical for reducing the incidence of STIs and their associated maternal health risks [54-56].

The intersection of maternal health and infectious diseases is influenced by various challenges. Inadequate healthcare infrastructure, coupled with limited access to essential services, hampers the ability to provide comprehensive care to pregnant women. Many women in rural areas face significant geographical barriers to accessing healthcare facilities, leading to underutilization of vital services including antenatal care, diagnostic testing, and treatment for infections. Additionally, the lack of skilled healthcare workers, particularly in remote regions, compounds these issues, resulting in inadequate screening, education, and care for infectious diseases [57].

Cultural beliefs and practices can also impact the recognition and management of infectious diseases among pregnant women. Stigma surrounding HIV and other infectious dis-

eases may discourage women from seeking testing or treatment and can lead to delayed presentations and poor health outcomes. Comprehensive community engagement and education initiatives are essential for addressing these cultural barriers and promoting understanding of the importance of maternal health and infectious disease prevention.

3. Strategies for Improvement of Maternal and Infant Health in Sub-Saharan West Africa: A Comprehensive and Culturally-Informed Approach

Addressing the multifaceted challenges of maternal health in Sub-Saharan West Africa necessitates a comprehensive strategy that encompasses the strengthening of healthcare systems, community education and engagement, integration of services, and advocacy for supportive policies. Enhancing healthcare systems is essential and involves training skilled healthcare providers, upgrading facilities, and ensuring the availability of essential medications and supplies. Community engagement through educational programs is critical to raising awareness of maternal health issues and promoting

positive health-seeking behaviors. Moreover, the integration of maternal health services with programs addressing infectious diseases, nutrition, and reproductive health is vital for providing holistic care. Policy advocacy plays a significant role in this multifaceted approach by prioritizing maternal health funding and resource allocation while mobilizing stakeholders at local, national, and international levels to support initiatives aimed at improving maternal outcomes [58-60].

Incorporating cultural practices into health programs offers an additional avenue for enhancing maternal health. By recognizing and respecting traditional beliefs, health initiatives can foster greater acceptance and utilization of healthcare services within communities. Engaging community leaders and implementing culturally sensitive educational initiatives can promote positive health behaviors that harmonize with both traditional practices and modern medical guidelines. For instance, integrating cultural celebrations surrounding childbirth with educational initiatives on prenatal and postnatal care can create an empowering environ-

ment for women, bridging the gap between cultural recognition and medical care [59, 61].

Another critical strategy in the management of maternal and infant health is the strategic design of rural maternity centers. These centers can be developed with targeted, sustainable architectural interventions that are culturally appropriate and responsive to the local context. By offering accessible and adequately equipped facilities, these maternity centers can significantly enhance maternal healthcare by meeting women's needs in a familiar and supportive environment, thereby increasing the utilization of healthcare services [61, 62].

4. The Role of Architectural Design in Creating Spaces and Facilities for Culturally Sensitive and Healthy Pregnancy Care

Architectural design plays a crucial role in shaping healthcare environments, particularly in the context of maternal and infant health. Designing spaces that cater specifically to the needs of pregnant women can significantly influence their overall well-being and health outcomes. Culturally sensitive architectural design not only

respects and reflects the cultural values of the community but also fosters an environment that promotes healthy behaviors during pregnancy [61-64]. Pregnancy is a critical period that requires both physical and emotional support. Facilities designed with the specific needs of expectant mothers in mind can enhance the experience of prenatal care. For example, waiting areas and consultation rooms should be designed to be welcoming, comfortable, and culturally appropriate. Incorporating natural light, soothing colors, and spaces for privacy can alleviate anxiety and promote relaxation, essential factors that can affect maternal health positively. Additionally, integrating culturally relevant design elements – such as traditional motifs, local materials, and communal gathering spaces – can enhance the acceptance and utilization of healthcare services by expecting mothers. Community engagement in the design process ensures that the facility reflects the local culture and traditions, creating a sense of ownership and belonging among users. Furthermore, the physical layout of clinics and maternity centers is vital for facilitating a seamless flow

of patients while maintaining privacy. Design features such as separate pathways for different types of patients, dedicated areas for prenatal education, and spaces that encourage companionship, like family waiting areas, can support a positive healthcare experience. Sustainability is another critical aspect of architectural design in healthcare. Utilizing environmentally friendly materials and energy-efficient systems not only minimizes the ecological footprint but also contributes to the health of patients and staff. Green spaces and gardens can be integrated into the design to provide therapeutic environments that promote mental well-being [63, 64].

Design Concept

Considering the multifaceted challenges of maternal healthcare, the proposed architectural approach aims to create a healthcare facility that effectively addresses these needs while prioritizing individual and public health within a safe, welcoming, and sustainable environment that is seamlessly integrated into the surrounding natural landscape (figure 1).

In the designer's vision and intentions, and ideally with-

in the collective imagination of the community, including users and their families, the maternity center represents a harmonious blend of heritage and innovation, serving as a welcoming and protective environment. Sustainability and harmony with the surroundings are prioritized in this design, enabling the facility to meet both present and future medical challenges within the context of global health. This architecture serves a vital healthcare function while seamlessly integrating into the natural landscape, maintaining a zero-impact footprint.

Layout and Zoning

The maternity center is thoughtfully organized into several key zones to ensure optimal functionality and facilitate ease of movement throughout the facility [64]. Each area is designed to support specific functions while enhancing the overall patient experience (figure 2). Upon entering, visitors are welcomed by a spacious reception and waiting area that exudes warmth and friendliness. This space features comfortable seating arrangements, natural ventilation, and an abundance



Figure 1. A visual sketch of the project illustrates the layout, form, and spatial relationships between the building and its environment, emphasizing the structure's integration with its surroundings and its responsiveness to user needs. Furthermore, it effectively conveys the architectural design and conceptual framework of the healthcare facility.

of natural light, contributing to a calming atmosphere. The inclusion of local artwork and decorative elements enriches the cultural resonance of the environment. Strategically located private consultation rooms provide patients with the privacy they need while ensuring easy access to medical care. Each room is outfitted with modern medical facilities and designed with patient comfort in mind. Large windows allow for ample natural light and ventilation, creating a pleasant setting for both patients and healthcare providers.

The labor and delivery rooms are specifically designed to offer a safe, comfortable, and supportive environment for childbirth. Each spacious room is equipped with state-

of-the-art medical equipment, while soothing colors and natural materials create a calming atmosphere that helps reduce stress and anxiety for expectant mothers. Adjacent to the labor and delivery suites is a dedicated neonatal care unit, equipped with incubators, phototherapy units, and other essential medical apparatus. This unit is designed to ensure quick and efficient transfer of newborns in need of specialized care, easily accessible from the delivery rooms. A single isolation room, equipped with a dedicated ventilation system, is incorporated into the design to prevent the spread of infectious diseases. Utilizing the “wind tower” technique, this room features a higher ceiling and elevated windows that promote effective air circulation, maintaining a

clean and healthy environment. Postpartum recovery rooms provide a comfortable space for mothers to recuperate after childbirth. Designed to foster a homelike environment, these rooms offer space for family members to stay and support the new mother. Natural light, ventilation, and soothing decor contribute to a relaxing and healing atmosphere. Additionally, medical and nursing staff offices are strategically located to support the efficient operation of the center. These functional and comfortable spaces are equipped with modern office equipment and benefit from ample natural light. The relaxation and study area for healthcare staff will include an internal window with a glass partition for direct observation of the neonatal intensive

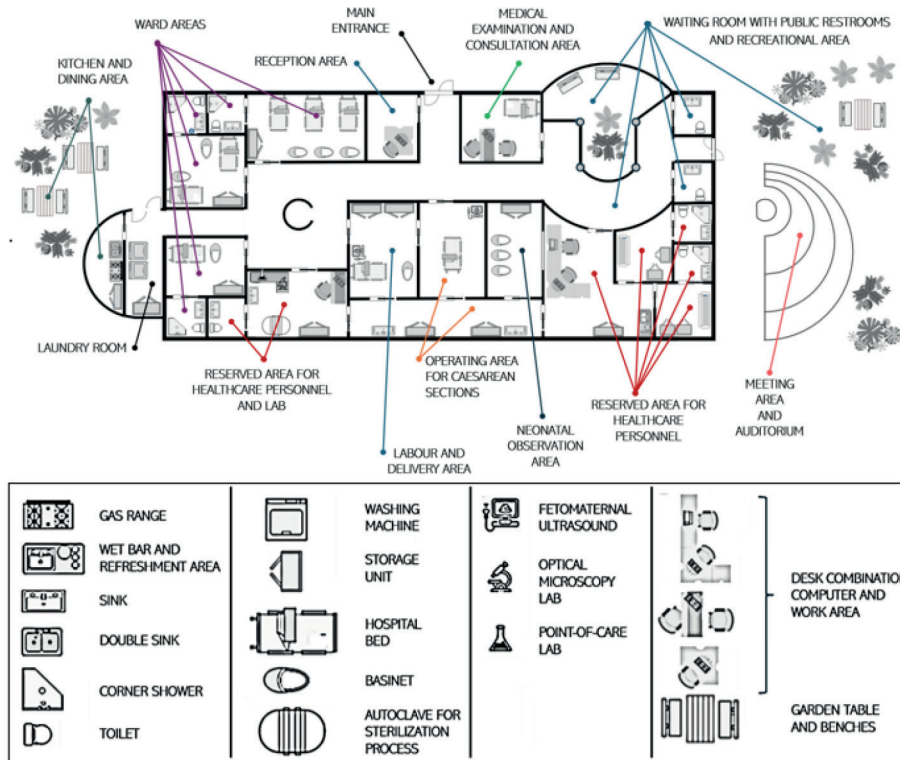


Figure 2. Proposed architectural layout of the maternity center, including the functional purposes of the various spaces.

care area. A multi-functional training and education area is dedicated to the continuous education of healthcare providers and to inform patients on maternal and neonatal health. This flexible space is equipped with modern teaching aids and is designed to facilitate interactive learning sessions, workshops, and community meetings. The center also features beautifully landscaped gardens and courtyards, creating tranquil outdoor spaces for patients, families, and staff. These areas foster relaxation and well-being, complete with shaded seating,

walking paths, and spaces designed for outdoor activities and events.

Architectural Solutions to Facilitate Clinical Pathways

The design of the maternity center focuses not only on providing the essential spaces for optimal care for women and newborns during pregnancy and childbirth but also rigorously applies the latest public health research to develop rational and functional care pathways [63, 66]. This involves the establishment of distinct

areas for hospitalized patients and outpatients, differentiated pathways based on the severity of clinical conditions, and specific health concerns (figure 3).

The design of patient rooms and care environments are focused on maximizing visibility and accessibility for healthcare providers.

Incorporating large windows and open sightlines allows staff to monitor patients effectively while minimizing unnecessary movement throughout the facility. This not only enhances safety and response times but also sup-

ports collaborative care models where multidisciplinary teams can work together seamlessly. Moreover, the layout of nursing stations and support areas is strategically placed to optimize workflow. By sitting in these spaces near patient rooms, nurses can quickly respond to patient needs and coordinate care without unnecessary delays. The incorporation of flexible workspaces and areas for collaboration further enhances teamwork and fosters a culture of communication among staff.

Finally, when possible, the integration of technology within architectural design is another critical aspect of facilitating clinical pathways. Spaces can be equipped with advanced medical technology and information systems that allow for efficient data sharing and communication among healthcare professionals. This ensures that critical patient information is readily available at the point of care, enabling informed decision-making and timely interventions.

Technical Solutions to Promote Infection Prevention and Control

Hygiene standards have been maximized by adapting the building's infrastructure to facilitate clean and contaminated pathways, along with a designated isolation space for pregnant women with communicable diseases [63, 67-75]. A single isolation room is provided, equipped with a dedicated ventilation system to mitigate the transmission

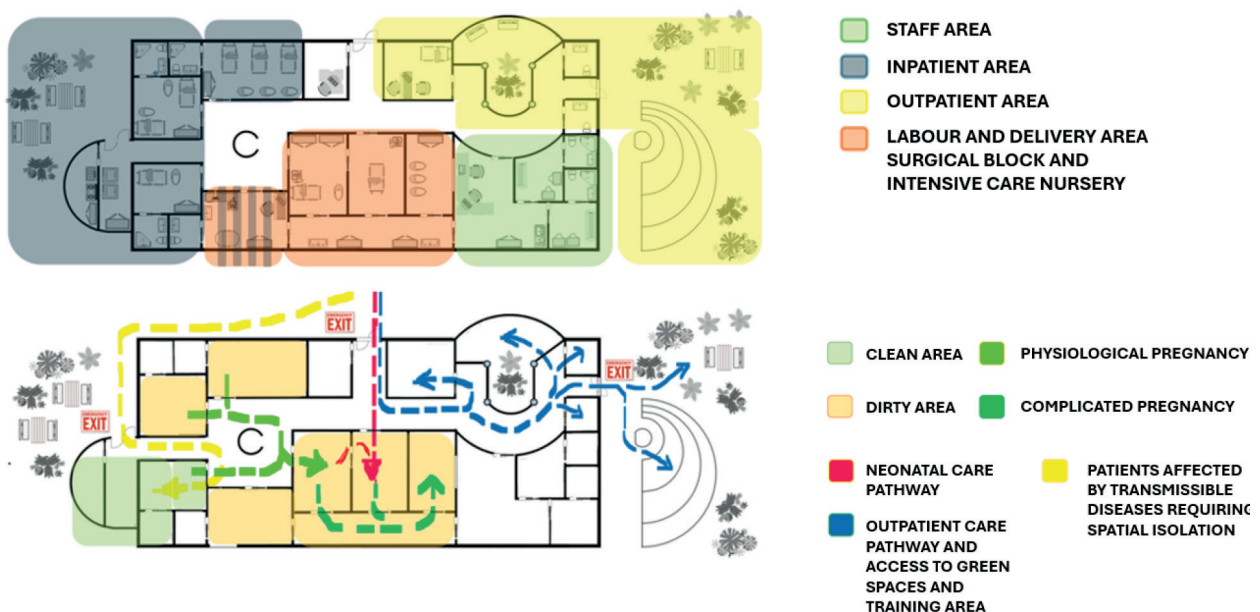


Figure 3. Architectural design plays a crucial role in enhancing the efficiency and effectiveness of clinical pathways within healthcare facilities. One of the primary architectural solutions is the creation of distinct zones within a healthcare facility that correspond to different stages of care. For instance, a well-defined triage area at the entrance helps to quickly assess patients and direct them to appropriate treatment zones, thereby streamlining the patient intake process. This prevents bottlenecks and ensures that individuals receive timely medical attention.

of infectious diseases. This isolation room utilizes the “wind tower” technique, featuring a higher ceiling and elevated windows, which facilitate effective air circulation and maintain a healthy environment (figure 4) [67, 68].

The integration of courtyard designs establishes coherent ventilation pathways and enhances infection control by promoting natural airflow within space. These courtyard areas serve as ecological interchange zones, creating an integrated ventilation channel that supports natural ventilation throughout the hospital building (figure 4).

Technical Solutions for Addressing Climate Challenges and Energy Autonomy

While architectural solutions that support hygiene and optimized clinical pathways are primary objectives of this design, sustainable features are equally vital to the overall concept. The project incorporates passive ventilation strategies to enhance natural airflow, reducing reliance on mechanical cooling systems. Additionally, the use of local materials minimizes

the environmental impact of construction and supports local economies. Techniques such as passive ventilation, natural heating, and the integration of green spaces also contribute to energy efficiency and reduced environmental impact (figure 5) [76-82].

The roofing system will be constructed using wood planks in conjunction with a waterproof membrane fabricated from recycled tires; this sustainable design not only provides a reliable waterproof barrier but also enhances passive ventilation capabilities. The layered structure created by the overlapping tiles allows for air circulation beneath the roof, promoting natural airflow that can help regulate indoor temperatures. This passive ventilation aids in maintaining a cooler environment, particularly in warm climates, by facilitating the dissipation of heat. As a result, the roofing system not only contributes to sustainable building practices but also plays a crucial role in preserving freshness and comfort within the space, minimizing the reliance on mechanical cooling systems. Moreover, roof design accommodates the possible installation of solar panels to meet the energy

needs of the center, ensuring autonomy from the unreliable energy supply often experienced in rural areas [83-84]. The center will include gardens that provide outdoor spaces for patients, families, and staff. These areas are thoughtfully designed to promote relaxation and well-being, featuring shaded seating areas and spaces for community events (figure 6).

An outdoor multifunctional auditorium will be dedicated to educating patients on sexual and reproductive health, facilitating interactive learning sessions, theater performances, and community meetings. A removable shade structure crafted from local fabric, supported by poles, will provide a practical and versatile solution for protecting attendees from sun and inclement weather during events.

Use of Materials and Construction Process

Utilizing locally sourced materials and artisanal craftsmanship enables architects to integrate traditional building materials, construction techniques, and design features that align with the cultural identity of the community. Additionally, these approaches

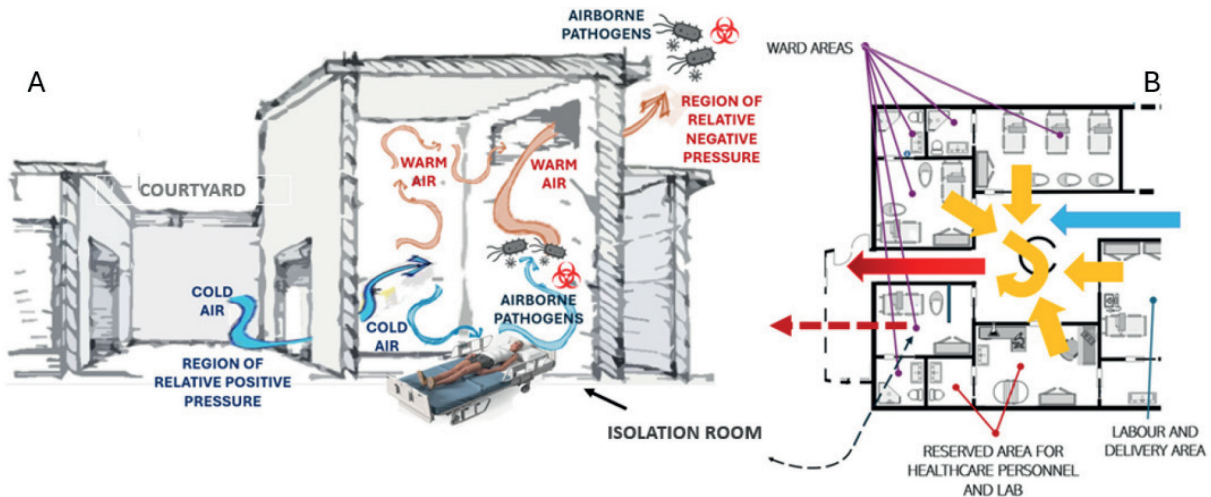


Figure 4. Architectural strategy for infection prevention and control. Passive ventilation systems, such as wind towers, can ventilate spaces and reduce the burden of airborne pathogens by utilizing regional pressure differences and the stack effect. The design approach (open-end corridor and court-yard) increases ventilation rate (air change per hour) thereby reducing the risk of infection significantly (Modified from: Emmanuel U et al. *J Environ Health Sci Eng.* 2020, doi: 10.1007/s40201-020-00580-y and Mahon H et al. *Energy*, 2022, doi: 10.1016/j.energy.2022.125118) [67, 68].

are economically sustainable. Furthermore, the use of local materials and craftsmanship fosters a cultural harmony with the heritage, traditions, and aesthetic preferences of the community that will use the healthcare facility.

Within this project, the primary structure of the hospital will be constructed using earthen bricks, coated with a layer of red clay that serves as plaster for both the external and internal surfaces. Internal flooring will feature standard tiles, while the cement and shell-tiled floors in the covered courtyard areas will be

constructed using disposable formwork. The exposed areas of the courtyards will be treated with small, crushed stones to facilitate drainage. The choice of standard tiles for internal spaces stems from the need for smooth, easy-to-clean surfaces, which must be professionally installed, particularly in operating rooms, with minimal joint spacing of approximately 2 mm.

The roofing system will consist of rosewood planks combined with a waterproof membrane made from recycled tires, created by cutting the tires into coplanar pieces that overlap. Windows will feature

frames constructed from rosewood beams, with wild bamboo canes inserted into the frames to provide partial light shielding while allowing for necessary air circulation. Sliding doors will utilize wooden planks and will be mounted on an external track trolley system, composed of an iron tube and specialized metal components.

Bamboo vulgaris will be employed to construct the columns supporting the fabric canopies over both the auditorium and courtyard areas. For the larger courtyard, three bamboo canes will be bundled and secured together, while all columns will

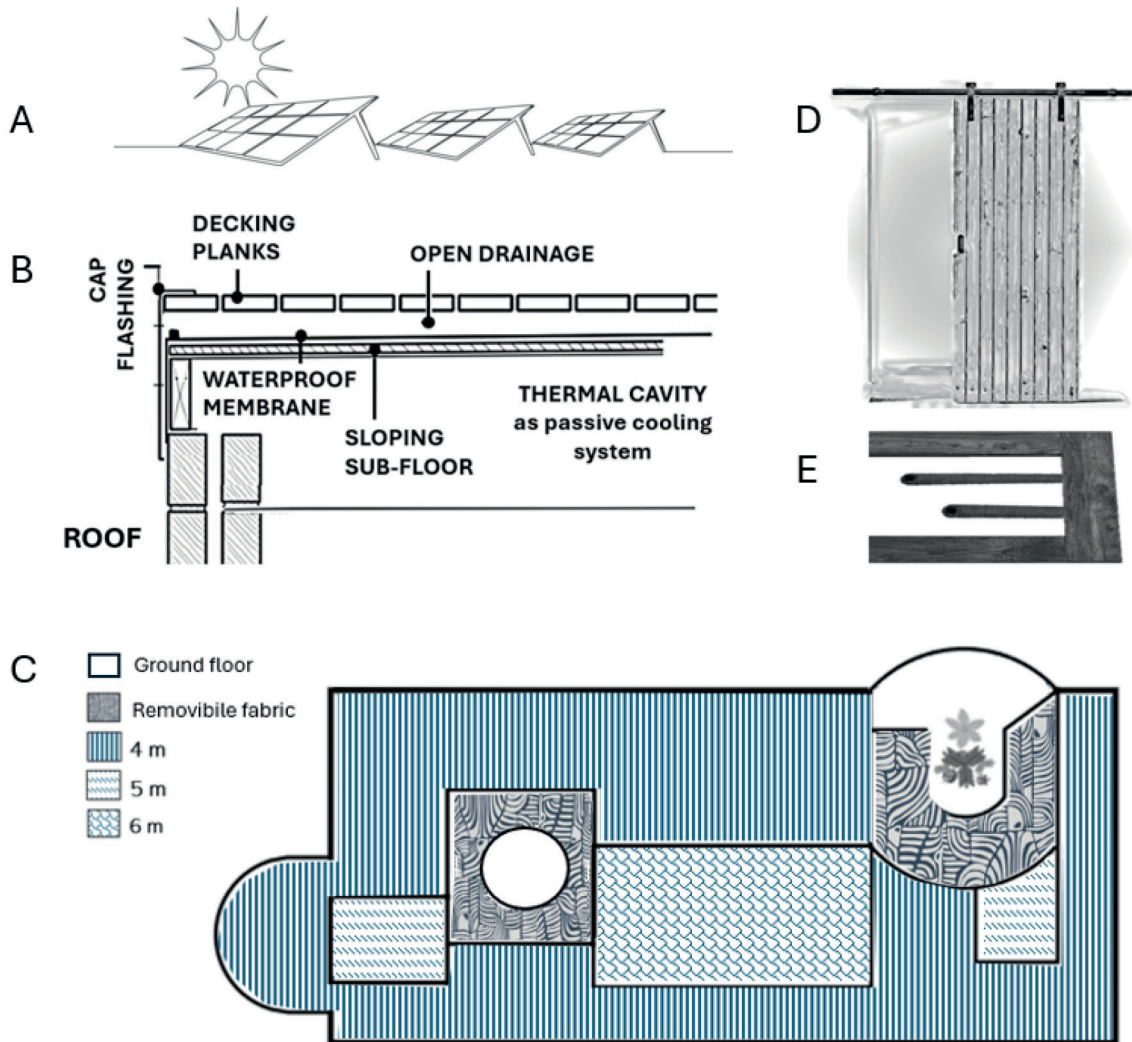


Figure 5. Construction Technical Details. A) Provision for the installation of solar panels on the roof, B) construction technical details for the roof, C) elevation of the building's roofs, D) Construction Technical Details for doors – The sliding doors will be crafted from high-quality wood to ensure durability and aesthetic appeal. These doors will feature an ergonomic design that allows for quick and easy access, reducing the need for contact with handles and thereby minimizing the risk of environmental microbial contamination within the healthcare space. The doors will be installed using an external track and trolley system, allowing for smooth and efficient operation. The track will be securely mounted to the wall, and the trolley system will consist of robust metal components designed to support the weight of the doors while allowing for effortless sliding, E) The windows will feature frames made from wooden planks, providing a sturdy structure. Dividers will be constructed using bamboo slats, which will allow for natural light and ventilation while offering partial light shielding. This combination of materials will enhance the windows' aesthetic appeal and contribute to the overall sustainability of the building design.

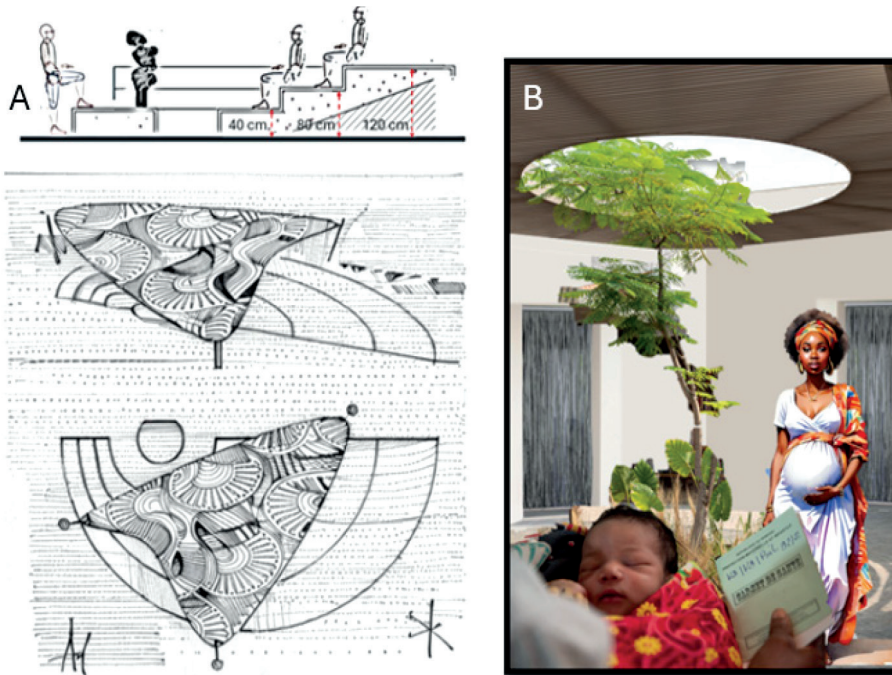


Figure 6. *Spaces for Relaxation, Training, and Social Interaction. A) Auditorium Open Space: The area features a removable sail cover crafted from traditional fabric, supported by three poles, providing shelter for the meeting space from weather. B) Rendering of Courtyard: This courtyard is strategically located near the patient rooms and is dedicated to relaxation and socialization, creating a tranquil environment for both patients and their families.*

be anchored in the ground for stability. Hooks attached to the walls will support the curtains in the smaller courtyard, with a metal ring inserted at the center of the curtain to create an opening for natural light and ventilation. Steps for the auditorium will be crafted from red clay. Tall trees will be planted within the courtyard and waiting area to provide shade and reduce ambient heat, with a medium-sized tree designated for the courtyard adjacent to the inpatient ward.

Minimized construction costs allow for the evaluation of allocating a portion of the budget to an autonomous

energy supply system, which includes solar panels. This setup will provide reliable and sustainable energy for lighting, medical equipment, and other essential functions [85-87].

Culturally Responsive Architectural Design: Embracing Local Traditions

Drawing inspiration from West Africa's rich architectural heritage, the design incorporates elements such as open courtyards, impluviums, verandas and towers that promote natural ventilation (figure 7 and figure 6B) [88-89].

The integration of traditional forms, materials, and

techniques ensures cultural relevance while enhancing the building's sustainability and environmental performance. The center is designed to harmoniously blend with its surrounding environment, creating a welcoming and protective atmosphere reminiscent of an embrace or a maternal womb (figure 8).

Culturally responsive architectural design plays a pivotal role in community acceptance; it involves creating structures that not only meet functional needs but also honor and reflect the cultural traditions and values of the local community [90-92]. This approach

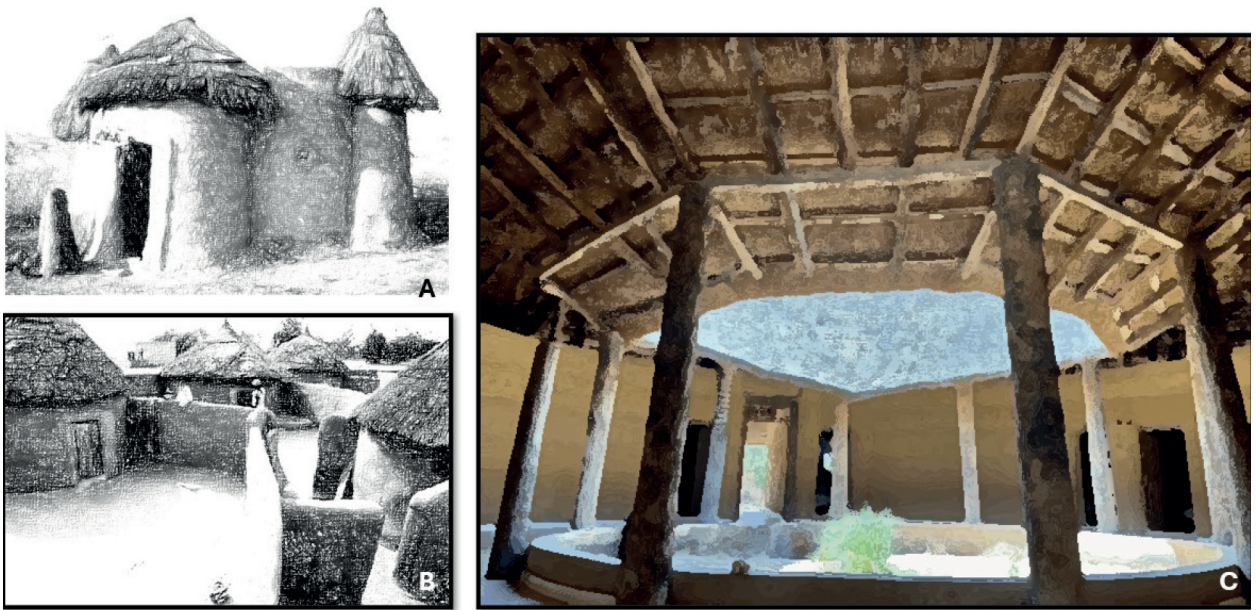


Figure 7. Charcoal sketches and watercolors depicting examples of West Africa's traditional architectural heritage. Vernacular and traditional housing in Sub-Saharan Africa has evolved over generations to meet the challenges posed by extreme climatic conditions. These indigenous structures often embody deeply rooted cultural values and provide insights into sustainable living. By effectively utilizing natural materials and innovative design, they create comfortable and resilient homes. Exploring these traditional architectural forms reveals valuable lessons in climate-responsive design, which are crucial for the advancement of sustainable architecture in the region. A) An example of vernacular and low-tech architecture is the Tata Somba or Takyenta tower-style mud houses in Koutammakou, Togo. These structures are composed of rammed earth and typically consist of about eight interlinked buildings, all surrounded by mud walls. B) A settlement of mud huts with contiguous central courtyards in Burkina Faso. C) The traditional Jola house in Senegal's Casamance region is a circular structure that exemplifies sustainable architecture. Characterized by mud brick walls and a central courtyard, or impluvium, it features a sloped roof that collects rainwater in a cistern for drinking. This design employs evaporative cooling, where evaporating water cools the indoor air while the thatched roof shields the thick walls from solar heat. Similar impluvial architectural styles are also present in the Igbo, Yoruba, and Edo cultures of southern Nigeria, utilizing sun-dried mud bricks and thatch.

is particularly important in regions with rich cultural heritages, as it fosters a sense of identity and belonging among residents while promoting social cohesion. To achieve this, architects must engage

in thorough research and dialogue with local communities to understand their history, customs, and aesthetic preferences. This collaborative process allows architects to incorporate traditional materials,

construction techniques, and design elements that resonate with the local culture. For instance, the use of indigenous materials and craftsmanship can enhance the authenticity of a building while supporting

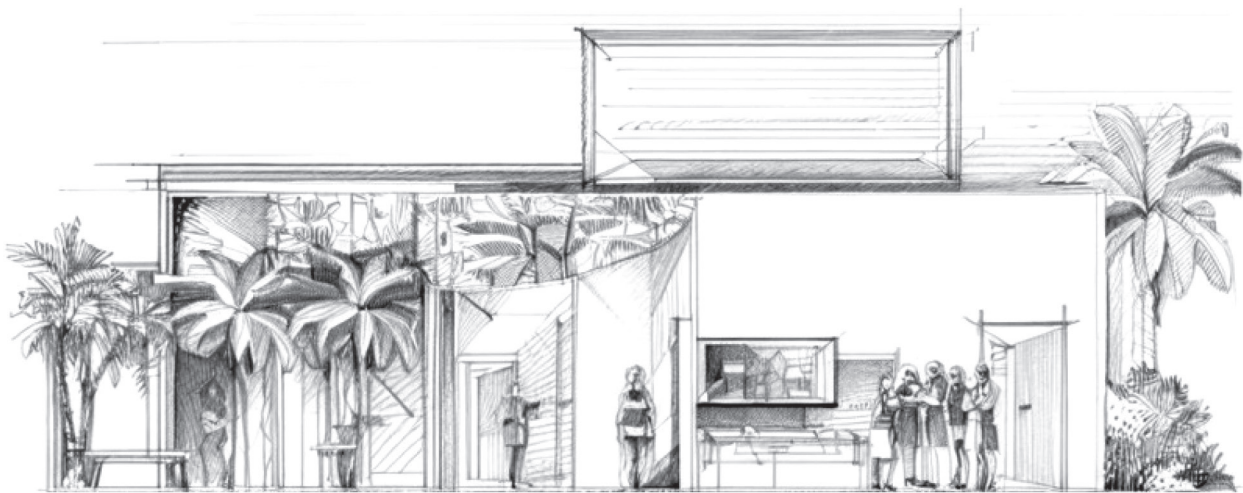


Figure 8. An ideal graphic sketch of a section of the building that illustrates the intersection between the health-care-related areas and the welcoming spaces, inspired by traditional West African architectural models such as open courtyards, impluviums, and verandas. A synthesis of heritage and innovation in healthcare architecture fosters a welcoming, protective environment. Prioritizing sustainability and environmental balance, this design paradigm addresses current and future medical challenges within a global health framework, focusing on comprehensive care for vulnerable populations. The architecture seamlessly integrates with the natural landscape, achieving a zero-impact footprint while effectively serving its healthcare function.

local economies. Moreover, culturally responsive design can address environmental sustainability by utilizing traditional practices that are inherently eco-friendly.

Conclusion

The state of maternal health in West Africa is a complex interplay of various determinants, including access to care, socioeconomic factors, infectious diseases, and cultural beliefs. As countries in this region strive to make progress toward achieving the Sus-

tainable Development Goals focused on reducing maternal mortality, it is imperative to adopt a multifaceted approach that addresses the underlying issues. Through concerted efforts in healthcare improvement, education, community engagement, and policy advocacy, it is possible to enhance maternal health outcomes and save the lives of countless women and their newborns. A multifaceted approach that includes strengthening healthcare systems, promoting community engagement, in-

tegrating services, advocating for supportive policies, and strategically designing culturally appropriate maternity centers is essential for enhancing maternal and infant health in Sub-Saharan West Africa.

Cultural practices and beliefs are fundamental determinants of maternal health in Sub-Saharan Africa. By understanding and respecting the cultural contexts that influence maternal health behaviors, health practitioners and policymakers can create more effective interventions. Pro-

moting dialogue and collaboration between traditional and formal healthcare systems will enhance maternal health outcomes, empowering women to access the care they need while honoring their cultural identities. In this way, addressing maternal health becomes not just a biomedical challenge, but a holistic one that incor-

porates the social, cultural, and economic dimensions of women's lives.

The role of architectural design in creating culturally sensitive spaces dedicated to healthy pregnancy care is essential. Emphasizing comfort, privacy, cultural relevance, and sustainability within healthcare environments can

significantly improve the experiences and health outcomes of pregnant women. As maternal health continues to be a pressing concern, investing in thoughtful architectural design is imperative for fostering health-promoting environments that meet the diverse needs of women throughout their pregnancy journey.

Notes and References

1. United Nations, Economic Commission for Africa, Sub regional office for West Africa (2017), *West Africa: a brief introduction*. Addis Ababa. © UN. ECA. <https://repository.uneca.org/handle/10855/23963>.
2. Herpolsheimer J. (2024), *The Economic Community of West African States (ECOWAS): A Region and an Organisation at a Crossroads*, Italian Institute for International Political Studies, available at <https://www.ispionline.it/en/publication/the-economic-community-of-west-african-states-ecowas-a-region-and-an-organisation-at-a-crossroads-172641>.
3. Isser D., Raballand G., Watts M., Zovighian D., *Governance in Sub-Saharan Africa in the 21st Century Four Trends and an Uncertain Outlook*, World Bank Group – Governance Global Practice, March 2024, available at <https://documents1.worldbank.org/curated/en/099808303042442715/pdf/IDU143e8beba17307142d319f8b1504c365946ed.pdf>.
4. Devermont J. (2020), *Politics at the Heart of the Crisis in the Sahel*, Center for Strategic and International Studies, Washington DC.
5. Kassim A. (2018), *Boko Haram's Internal Civil War: Stealth Takfir and Jihad as Recipes for Schism Report*, «Combating Terrorism Center at West Point & JSTOR», available at <https://www.jstor.org/stable/resrep214835>.
6. Branda F., Ali A.Y., Ceccarelli G., Albanese M., Binetti E., Giovanetti M., Ciccozzi M., Scarpa F. (2024), *Assessing the Burden of Neglected Tropical Diseases in Low-Income Communities: Challenges and Solutions*, «Viruses», 17(1), p. 29. <https://doi.org/10.3390/v17010029>.
7. Wang S., Sahr F., Jalloh M.B., Zheng C., Mi Z. (2023), *Editorial: Pathogenic microbiology in West Africa*, «Frontiers in microbiology», 14, 1255032, <https://doi.org/10.3389/fmicb.2023.1255032>.
8. Fenollar F., Mediannikov O. (2018), *Emerging infectious diseases in Africa in the 21st century*, «New microbes and new infections», 26, S10-S18, <https://doi.org/10.1016/j.nmni.2018.09.004>.
9. World Health Organization (2019), *Maternal mortality: Fact sheet*. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/maternal-mortality>.
10. WHO (2021), *Global Health Observatory Data Repository: Maternal mortality ratio (per 100 000 live births)*. Retrieved from [https://www.who.int/data/gho/data/indicators/indicator-details/GHO/maternal-mortality-ratio-\(per-100-000-live-births\)](https://www.who.int/data/gho/data/indicators/indicator-details/GHO/maternal-mortality-ratio-(per-100-000-live-births)).
11. United Nations (2019), *Progress towards the Sustainable Development Goals: Report of the Secretary-General*. Retrieved from <https://digitallibrary.un.org/record/3810131?v=pdf>.
12. Ope B.W., Wasan T., Hirst J.E., Mullins E., Norton R., Peden M. (2025), *Measurement, determinants and outcomes of maternal care satisfaction in Nigeria: a systematic review*, «BMJ Public Health», 3(1), e001278, DOI: 10.1136/bmjph-2024-001278.
13. Shiferaw K., Tiruye G., Bekele H. (2025), *Predictors of institutional delivery service utilization in Ethiopia: an umbrella review*, «BMC Pregnancy Childbirth». 25(1), 332, DOI: 10.1186/s12884-025-07464-9.

14. Ronsmans C., Graham W.J. (2006), *Maternal mortality: Who, when, where, and why*, «The Lancet», 368(9542), pp. 1189-1200, DOI: 10.1016/S0140-6736(06)69595-5.
15. Opara U.C., Iheanacho P.N., Petručka P. (2024), *Cultural and religious structures influencing the use of maternal health services in Nigeria: a focused ethnographic research*, «Reprod Health», 21, 188, <https://doi.org/10.1186/s12978-024-01933-8>.
16. Liu L, Johnson H.L., Cousens S., Perin J., Scott S., Lawn J.E., Rudan I., Campbell H., Cibulskis R., Li M., Mathers C., Black R.E., Child Health Epidemiology Reference Group of WHO and UNICEF (2012), *Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000*, «The Lancet», 379(9832), pp. 2151-2161, DOI: 10.1016/S0140-6736(12)60560-1.
17. Bossman E., Johansen M.A., Zanaboni P. (2022), *mHealth interventions to reduce maternal and child mortality in Sub-Saharan Africa and Southern Asia: A systematic literature review*, «Frontiers in Global Women's Health», 3, 942146, <https://doi.org/10.3389/fgwh.2022.942146>.
18. Ansah E.W., Salu P.K., Daanko M.S., Banaaleh D.N., Amoado M. (2025), *Post-COVID-19 conditions and health effects in Africa: a scoping review*, «BMJ Open», 15(1), e088983, DOI: 10.1136/bmjopen-2024-088983.
19. Kasa G.A., Woldemariam A.Y., Adella A., Alemu B. (2023), *The factors associated with stillbirths among sub-saharan African deliveries: a systematic review and meta-analysis*, «BMC Pregnancy Childbirth», 23(1), 835, DOI: 10.1186/s12884-023-06148-6.
20. Shimizu M., Nakata Y., Takahashi K. (2023), *Current findings and gaps in early initiation of breastfeeding practices in sub-Saharan African countries: A scoping review*, «Journal of global health», 13, 04036, <https://doi.org/10.7189/jogh.13.04036>.
21. Ouedraogo L., Habonimana D., Nkurunziza T., Chilanga A., Hayfa E., Fatim T., Kidula N., Conombo G., Muriithi A., Onyiah P. (2021), *Towards achieving the family planning targets in the African region: a rapid review of task sharing policies*, «Reproductive health», 18(1), 22, <https://doi.org/10.1186/s12978-020-01038-y>.
22. Faye C.M., Wehrmeister F.C., Melesse D.Y., Mutua M.K.K., Maïga A., Taylor C.M., Amouzou A., Jiwani S.S., da Silva I.C.M., Sidze E.M., Porth T.A., Ca T., Ferreira L.Z., Strong K.L., Kumapley R., Carvajal-Aguirre L., Hosseinpoor A.R., Barros A.J.D., Boerma T. (2020), *Large and persistent subnational inequalities in reproductive, maternal, newborn and child health intervention coverage in sub-Saharan Africa*, «BMJ global health», 5(1), e002232, <https://doi.org/10.1136/bmjgh-2019-002232>.
23. Kassa G.M., Arowojolu A.O., Odugogbe A.A., Yalew A.W. (2018), *Prevalence and determinants of adolescent pregnancy in Africa: a systematic review and Meta-analysis*, «Reproductive health», 15(1), 195, <https://doi.org/10.1186/s12978-018-0640-2>.
24. Eshetu H.B., Aragaw F.M., Negash W.D., Belachew T.B., Asmamaw D.B., Tareke A.A., Asratie M.H. (2024), *Assessing postnatal care for newborns in Sub-Saharan Africa: A multinational analysis*, «PloS one», 19(2), e0298459, <https://doi.org/10.1371/journal.pone.0298459>.
25. Mohale H., Sweet L., Graham K. (2017), *Maternity health care: The experiences of Sub-Saharan African women in Sub-Saharan Africa and Australia*, «Women and birth: journal of the Australian College of Midwives», 30(4), pp. 298-307, <https://doi.org/10.1016/j.wombi.2016.11.011>.
26. Tessema Z.T., Yazachew L., Tesema G.A., Teshale A.B. (2020), *Determinants of postnatal care utilization in sub-Saharan Africa: a meta and multilevel analysis of data from 36 sub-Saharan countries*, «Italian journal of pediatrics», 46(1), 175, <https://doi.org/10.1186/s13052-020-00944-y>.
27. Habte A., Hailegebreal S., Simegn A.E. (2024), *Predictors of maternal health services uptake in West African region: a multilevel multinomial regression analysis of demographic health survey reports*, «Reproductive health», 21(1), 45, <https://doi.org/10.1186/s12978-024-01782-5>.
28. Fetene S.M., Fentie E.A., Shewarega E.S., Kidie A.A. (2024), *Socioeconomic inequality in postnatal care utilization among reproductive age women in sub-Saharan African countries with high maternal mortality: a decomposition analysis*, «BMJ open», 14(10), e076453, <https://doi.org/10.1136/bmjopen-2023-076453>.
29. Asefa A., Gebremedhin S., Marthias T., Nababan H., Christou A., Semaan A., Banke-Thomas A., Tabana H., Al-Beity F.M.A., Dossou J.P., Gutema K., Delvaux T., Birabwa C., Dennis M., Grovogui F.M., McPake B., Beňová L. (2023), *Wealth-based inequality in the continuum of maternal health service utilisation in 16 sub-Saharan African countries*, «International journal for equity in health», 22(1), 203, <https://doi.org/10.1186/s12939-023-02015-0>.
30. Dadzie L.K., Gebremedhin A.F., Salihu T., Ahinkorah B.O., Yaya S. (2024), *Socioeconomic inequalities in uptake of HIV testing during antenatal care: evidence from Sub-Saharan Africa*, «International journal for equity in health», 23(1), 4, <https://doi.org/10.1186/s12939-023-02068-1>.
31. Brouckhoff M., Hewett P. (2000), *Inequality of child mortality among ethnic groups in sub-Saharan Africa*, «Bulletin of the World Health Organization», 78(1), pp. 30-41.
32. Flake S. (2022), *Lack of Access to Maternal Healthcare in Sub-Saharan Africa*, Ballard Brief Research Library, avail-

able at <https://ballardbrief.byu.edu/issue-briefs/lack-of-access-to-maternal-healthcare-in-sub-saharan-africa>.

33. Opara U.C., Iheanacho P.N., Petrucka P. (2024), *Cultural and religious structures influencing the use of maternal health services in Nigeria: a focused ethnographic research*, «Reproductive health», 21(1), 188, <https://doi.org/10.1186/s12978-024-01933-8>.

34. Adata P., Strumpher J., Ricks E., Mwini-Nyaledzigbor P.P. (2019), *Cultural beliefs and practices of women influencing home births in rural Northern Ghana*, «International journal of women's health», 11, pp. 353-361, <https://doi.org/10.2147/IJWH.S190402>.

35. Lang-Baldé R., Amerson R. (2018), *Culture and Birth Outcomes in Sub-Saharan Africa: A Review of Literature*, «Journal of transcultural nursing: official journal of the Transcultural Nursing Society», 29(5), pp. 465-472, <https://doi.org/10.1177/1043659617750260>.

36. Aziato L., Odai P.N., Omenyo C.N. (2016), *Religious beliefs and practices in pregnancy and labour: an inductive qualitative study among post-partum women in Ghana*, «BMC Pregnancy Childbirth», 16(1), 138, DOI: 10.1186/s12884-016-0920-1.

37. Kassie A., Wale A., Girma D., Amsalu H., Yechale M. (2022), *The role of traditional birth attendants and problem of integration with health facilities in remote rural community of West Omo Zone 2021: exploratory qualitative study*, «BMC Pregnancy Childbirth», 22(1), 425, DOI: 10.1186/s12884-022-04753-5.

38. Amutah-Onukagha N., Rodriguez M., Opara I., Gardner M., Assan M.A., Hammond R., Plata J., Pierre K., Farag E. (2017), *Progresses and challenges of utilizing traditional birth attendants in maternal and child health in Nigeria*, «International journal of MCH and AIDS», 6(2), pp. 130-138, <https://doi.org/10.21106/ijma.204>.

39. Mepukori N. (2013), *Digging deeper into pregnancy taboos among Togolese women*, Duke Global Health Institute, available at <https://globalhealth.duke.edu/news/digging-deeper-pregnancy-taboos-among-togolese-women>.

40. Ramulondi M., de Wet H., Ntuli N.R. (2021), *Traditional food taboos and practices during pregnancy, postpartum recovery, and infant care of Zulu women in northern KwaZulu-Natal*, «Journal of ethnobiology and ethnomedicine», 17(1), 15, <https://doi.org/10.1186/s13002-021-00451-2>.

41. Musie M.R., Anokwuru R.A., Ngunyulu R.N., Lukhele S. (2022), *Chapter 6 African indigenous beliefs and practices during pregnancy, birth and after Birth*, in Mavis Mulaudzi E., Lebesse R.T. (Eds), *Working with indigenous knowledge. Strategies for health professionals*, AOSIS, Cape Town.

42. Bras H., Smits J. (2022), *Contexts of reproduction: Gender dynamics and unintended birth in sub-Saharan Africa*, «Journal of Marriage and Family», 84(2), pp. 438-456, <https://doi.org/10.1111/jomf.12807>.

43. Nambile Cumber S., Williams A., Elden H., Bogren M. (2024), *Fathers' involvement in pregnancy and childbirth in Africa: an integrative systematic review*, «Global health action», 17(1), 2372906, <https://doi.org/10.1080/16549716.2024.2372906>.

44. Kabore A., Palmer S.L., Mensah E., Ettiegn-Traore V., Monteil R., Sintondji F., Tine J., Tesfaye D., Ogooussan K., Stukel D., Fuller B.B., Sanchez K., Pou B., Dembele B., Weaver A., Reid S., Milord M.D., Kassankogno Y., Seim A., Shott J. (2021), *Restarting Neglected Tropical Diseases Programs in West Africa during the COVID-19 Pandemic: Lessons Learned and Best Practices*, «The American journal of tropical medicine and hygiene», 105(6), pp. 1476-1482, <https://doi.org/10.4269/ajtmh.21-0408>.

45. Villacorta Linaza R., Garner T., Genovezos C. (2021), *Building supply chain capacity for neglected tropical diseases: experience from the Ascend West and Central Africa programme*, «Transactions of the Royal Society of Tropical Medicine and Hygiene», 115(8), pp. 841-846, <https://doi.org/10.1093/trstmh/trab068>.

46. Koita K., Kayentao K., Worrall E., Van Eijk A.M., Hill J. (2024), *Community-based strategies to increase coverage of intermittent preventive treatment of malaria in pregnancy with sulfadoxine-pyrimethamine in sub-Saharan Africa: a systematic review, meta-analysis, meta-ethnography, and economic assessment*, «The Lancet Global Health», 12(9), e1456-e1469, DOI: 10.1016/S2214-109X(24)00228-6.

47. Duguay C., Raduy S., Khov E., Protopopoff N., Feng C., Krentel A., Kulkarni M.A. (2024), *Have there been efforts to integrate malaria and schistosomiasis prevention and control programs? A scoping review of the literature*, «PLOS Neglected Tropical Diseases», 18(1), e0011886, <https://doi.org/10.1371/journal.pntd.0011886>.

48. Salawu O.T., Odaibo A.B. (2014), *Maternal schistosomiasis: a growing concern in sub-Saharan Africa*, «Pathogens and global health», 108(6), pp. 263-270, <https://doi.org/10.1179/2047773214Y.0000000150>.

49. Morton A.J., Roddy Mitchell A., Melville R.E., Hui L., Tong S.Y.C., Dunstan S.J., Denholm J.T. (2024), *Mycobacterium tuberculosis infection in pregnancy: a systematic review*, «PLOS Global Public Health», 4(11), e0003578, DOI: 10.1371/journal.pgph.0003578.

50. Adjobimey M., Ade S., Wachinou P., Esse M., Yaha L., Bekou W., Campbell J.R., Toundoh N., Adjibode O., Attikpa G., Agodokpessi G., Affolabi D., Merle C.S. (2022),

Prevalence, acceptability, and cost of routine screening for pulmonary tuberculosis among pregnant women in Cotonou, Benin, «PLoS One», 17(2), e0264206, <https://doi.org/10.1371/journal.pone.0264206>.

51. Korri R., Bakuli A., Owolabi O.A., Lalashowi J., Azize C., Rassool M., Sathar F., Rachow A., Ivanova O., TB Sequel Consortium (2022), *Tuberculosis and Sexual and Reproductive Health of Women in Four African Countries*, «International journal of environmental research and public health», 19(22), 15103, <https://doi.org/10.3390/ijerph192215103>.

52. Isara A., Baldeh A.K. (2021), *Prevalence of sexually transmitted infections among pregnant women attending antenatal clinics in West Coast Region of The Gambia*, «African health sciences», 21(2), pp. 585-592, <https://doi.org/10.4314/ahs.v21i2.13>.

53. Kinfé B., Abate H.M., Mankelkl G. (2024), *Determinants of self-reported sexually transmitted infections among reproductive age women in Senegal: evidenced by Senegal demographic and health survey*, «Contraception and reproductive medicine», 9(1), 53, <https://doi.org/10.1186/s40834-024-00318-3>.

54. Mohammed H., Kebir M.S., Obiribea C., Essuman M.A., Ahinkorah B.O. (2024), *Knowledge of HIV transmission during pregnancy among women of reproductive age in Ghana*, «BMC infectious diseases», 24(1), 507, <https://doi.org/10.1186/s12884-022-04786-w>.

55. Ceccarelli G., Giovanetti M., Sagnelli C., Ciccozzi A., d'Ettorre G., Angeletti S., Borsetti A., Ciccozzi M. (2021), *Human Immunodeficiency Virus Type 2: The Neglected Threat*, «Pathogens (Basel, Switzerland)», 10(11), 1377, <https://doi.org/10.3390/pathogens10111377>.

56. Ozim C.O., Mahendran R., Amalan M., Puthussery S. (2023), *Prevalence of human immunodeficiency virus (HIV) among pregnant women in Nigeria: a systematic review and meta-analysis*, «BMJ open», 13(3), e050164, <https://doi.org/10.1136/bmjopen-2021-050164>.

57. Solarin I., Dumbura C., Lakhoo D.P., Chande K., Maimela G., Luchters S., Chersich M., HE2AT Center (2025), *Characteristics of longitudinal maternal health studies in sub-Saharan Africa: A systematic mapping of literature between 2012 and 2022*, «International Journal of Gynecology & Obstetrics», 169(1), pp. 51-62, DOI: 10.1002/ijgo.16035.

58. Alliance for Maternal and Newborn Health Improvement (AMANHI) mortality study group (2018), *Population-based rates, timing, and causes of maternal deaths, stillbirths, and neonatal deaths in south Asia and sub-Saharan Africa: a multi-country prospective cohort study*, «The Lancet. Global health», 6(12), e1297-e1308, [https://doi.org/10.1016/S2214-109X\(18\)30385-1](https://doi.org/10.1016/S2214-109X(18)30385-1).

59. Serbanescu F., Kruk M.E., Dominico S., Nimako K. (2022), *Context Matters: Strategies to Improve Maternal*

and Newborn Health Services in Sub-Saharan Africa, «Global health, science and practice», 10(2), e2200119, <https://doi.org/10.9745/GHSP-D-22-00119>.

60. Martin Hilber A., Blake C., Bohle L.F., Bandali S., Agbon E., Hulton L. (2016), *Strengthening accountability for improved maternal and newborn health: A mapping of studies in Sub-Saharan Africa*, «International journal of gynaecology and obstetrics: the official organ of the International Federation of Gynaecology and Obstetrics», 135(3), pp. 345-357, <https://doi.org/10.1016/j.ijgo.2016.09.008>.

61. Diamond-Smith N., Lin S., Peca E., Walker D. (2022), *A landscaping review of interventions to promote respectful maternal care in Africa: Opportunities to advance innovation and accountability*, «Midwifery», 115, 103488, <https://doi.org/10.1016/j.midw.2022.103488>.

62. Dzomeku V.M., Mensah A.B.B., Nakua E.K., Agbadi P., Okyere J., Donkor P., Lori J.R. (2022), *Promoting respectful maternity care: challenges and prospects from the perspectives of midwives at a tertiary health facility in Ghana*, «BMC pregnancy and childbirth», 22(1), 451, <https://doi.org/10.1186/s12884-022-04786-w>.

63. Ceccarelli C., Ciccozzi A., Giovanetti M., Branda F., Pacifici Noja L.E., Scarpa F., Ciccozzi M., Ceccarelli G. (2024), *Architectural design strategies for infection prevention and control in resource-limited rural healthcare facilities in developing countries: bridging the gap with context-sensitive design*, «UGHJ – UniCamillus Global Health Journal», DOI: 10.36158/97888929595456.

64. Barquia E., Hoover A., High K. (2020), *Architecture of Maternity in Malawi Health Facilities*, Thomas Jefferson University, available at https://malawiglobalstudio.wordpress.com/wp-content/uploads/2020/05/03112020_print-for-malawi.pdf.

65. Amato C., McCanne L., Yang C., Ostler D., Ratib O., Wilhelm D., Bernhard L. (2022), *The hospital of the future: rethinking architectural design to enable new patient-centered treatment concepts*, «International journal of computer assisted radiology and surgery», 17(6), pp. 1177-1187, <https://doi.org/10.1007/s11548-021-02540-9>.

66. Aspland E., Gartner D., Harper P. (2019), *Clinical pathway modelling: a literature review*, «Health systems (Basingstoke, England)», 10(1), pp. 1-23, <https://doi.org/10.1080/20476965.2019.1652547>.

67. Emmanuel U., Osondu E.D., Kalu K.C. (2020), *Architectural design strategies for infection prevention and control (IPC) in health-care facilities: towards curbing the spread of Covid-19*, «Journal of Environmental Health Science & Engineering», 18, pp. 1699-1707, <https://doi.org/10.1007/s40201-020-00580-y>.

68. Mahon H., Friedrich D., Hughes B. (2022), *Wind tunnel test and numerical study of a multi-sided wind tower with horizontal heat pipes*, «Energy, Elsevier», vol. 260(C), DOI: 10.1016/j.energy.2022.125118.
69. Sparke V.L., Diao J., MacLaren D., West C. (2020), *Solutions to infection prevention and control challenges in developing countries, do they exist? An integrative review*, «International Journal of Infection Control», 16(1), DOI: 10.3396/ijic.v16i1.007.20.
70. Lewnard J.A., Charani E., Gleason A., Hsu L.Y., Khan W.A., Karkey A., Chandler C.I.R., Mashe T., Khan E.A., Bulabula A.N.H., Donado-Godoy P., Laxminarayan R. (2024), *Burden of bacterial antimicrobial resistance in low-income and middle-income countries avertible by existing interventions: an evidence review and modelling analysis*, «The Lancet», 403(10442), pp. 2439–2454, DOI: 10.1016/S0140-6736(24)00862-6.
71. WHO (2020), *Infection Prevention and Control*. Retrieved from: <https://www.who.int/teams/integrated-health-services/infection-prevention-control> (last accessed 23/06/2024).
72. Salonen N., Ahonen M., Sirén K., Mäkinen R., Anttila V.J., Kivisaari M., Salonen K., Peltö-Huikko A., Latva M. (2023), *Methods for infection prevention in the built environment – a mini-review*, «Frontiers in Built Environment», vol. 9, DOI: 10.3389/fbuil.2023.1212920.
73. Udomiaye E., Ukpong E., Nwenyi O., Muogbara R. (2023), *An Appraisal of Infection Control in the Built Environment: The Architect's Perspective*, «Universal Journal of Public Health», 11(3), pp. 314–323, DOI: 10.13189/ujph.2023.110305.
74. Siddiqui A.H., Umair R., Ahmad J. (2023), *Need for Infection Prevention and Control Curriculum for Nursing in Developing Countries*, «Journal of the Association of Physicians of India», 71(9), pp. 108–109, DOI: 10.59556/japi.71.0329.
75. Sastry S., Masroor N., Bearman G., Hajjeh R., Holmes A., Memish, Lassmann B., Pittet D., Macnab F., Kamau R., Wesangula E., Pokharel P., Brown P., Daily F., Amer F., Torres J., O’Ryan M., Gunturu R., Bulabula A., Mehtar S. (2017), *The 17th International Congress on Infectious Diseases workshop on developing infection prevention and control resources for low- and middle-income countries*, International «Journal of Infectious Diseases», 2017, 57, pp. 138–143, DOI: 10.1016/j.ijid.2017.01.040.
76. Boubekri M. (2008), *Daylight, architecture and health. Building design strategies*, Elsevier LTD, available at: https://issuu.com/rafaelcarias/docs/daylight__architecture_and_health (last accessed 25/01/2025).
77. Ren C., Zhu H.C., Cao S.J. (2022), *Ventilation Strategies for Mitigation of Infection Disease Transmission in an Indoor Environment: A Case Study in Office*, «Buildings», 12(2), p. 180, DOI: <https://doi.org/10.3390/buildings12020180>.
78. Tsang T.W., Wong L.T., Mui K.W. (2024), *Experimental studies on airborne transmission in hospitals: a systematic review*, «Indoor and Built Environment», 33(4), pp. 608–640, DOI: 10.1177/1420326X231205527.
79. Ren C., Wang J., Feng Z., Kim M.K., Haghighat F., Cao S.J. (2023), *Refined design of ventilation systems to mitigate infection risk in hospital wards: Perspective from ventilation openings setting*, «Environmental Pollution», vol. 333, DOI: 10.1016/j.envpol.2023.122025.
80. Rahman N.M.A., Haw L.C., Fazlizan A. (2021), *A Literature Review of Naturally Ventilated Public Hospital Wards in Tropical Climate Countries for Thermal Comfort and Energy Saving Improvements*, «Energies», 14(2), p. 435, DOI: <https://doi.org/10.3390/en14020435>.
81. Nejat P., Ferwati M.S., Calautit J., Ghahramani A., Sheikshahrokhdehkhordi M. (2021), *Passive cooling and natural ventilation by the windcatcher (Badgir): An experimental and simulation study of indoor air quality, thermal comfort and passive cooling power*, «Journal of Building Engineering», vol. 41, DOI: 10.1016/j.jobec.2021.102436.
82. Mahmoud E., El Badrawy A., Mousa M. (2020), *The Role of Atriums and Courtyards in Improving Natural Light and Ventilation in Hospitals*, «Mansoura Engineering Journal», 44(4), available at: <https://doi.org/10.21608/bfemu.2020.95011> (last accessed 01/02/2025).
83. Bhopal A., Norheim O.F. (2023), *Fair pathways to net-zero healthcare*, «Nature Medicine», 29(5), pp. 1078–1084, DOI: 10.1038/s41591-023-02351-2.
84. Salas R.N., Maibach E., Pencheon D., Watts N., Frumkin H. (2020), *A pathway to net zero emissions for healthcare*, «BMJ», 371, m3785, DOI: <https://doi.org/10.1136/bmj.m3785>.
85. Humphreys G. (2014), *Harnessing Africa's untapped solar energy potential for health*, «Bulletin of the World Health Organization», 92(2), pp. 82–83, <https://doi.org/10.2471/BLT.14.020214>.
86. Nuno A. (2022), *Solar power for rural Africa*. European Investment Bank, available at <https://www.eib.org/en/stories/solar-power-rural-africa>.
87. Soto E.A., Hernandez-Guzman A., Vizcarrondo-Ortega A., McNealey A., Bosman L.B. (2022), *Solar Energy Implementation for Health-Care Facilities in Developing and Underdeveloped Countries: Overview, Opportunities, and Challenges*, «Energies», 15(22), 8602, <https://doi.org/10.3390/en15228602>.
88. Bourdier J.P., Minh-ha T.T. (2011), *Vernacular Architecture of West Africa. A World in Dwelling*, Routledge, London.

89. Ale Taiwo Ayomide, Ajayi Olugbengba Victor, Taiwo Abraham Adeniyi, Fakere Alexander Adeyemi (2025), *Expression and communication in architecture philosophy of vernacular architecture of the Yorubas in Nigeria*, «Frontiers of Architectural Research», 14(2), <https://doi.org/10.1016/j.foar.2024.07.015>.

90. Choi J.Y., Choi J. (2024), *Cultural Imprints on Urban Housing: A Spatial Analysis of Apartment Designs in Kenya, Ghana, and South Africa*, «Buildings», 14(11), 3526, <https://doi.org/10.3390/buildings14113526>.

91. Ikhoameh M., Okete W.E., Ogboye R.M., Owoyemi O.K., Gbadebo O.S. (2024), *Integrating traditional medicine into the African healthcare system post-Traditional Medicine Global Summit: challenges and recommendations*, «The Pan African medical journal», 47, 146, <https://doi.org/10.11604/pamj.2024.47.146.43011>.

92. Keşeci K. (2024), *The Influence of African Architecture on Contemporary Design*, available at <https://dokmimarlik.com/en/the-influence-of-african-architecture-on-contemporary-design/>.