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Adaptive Strategies Used in Urban Houses to Overheating: A Systematic Review

*[1] Sakirat Abimbola Afolabi, [2] Assoc. Prof. Dr. Funmilayo Adedire

[1 & 2] Lead City University in Ibadan, Nigeria

[1] E-mail: afolabis2020@gmail.com, [2] E-mail: funmi.adedire@lcu.edu.ng

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ABSTRACT

Recently, urban regions are experiencing prolonged heat exposure due to climate change and increased population expansion. Physiological, psychological and behavioural measures improve residents' thermal comfort to solve the overheating issues generated by the scenario. However, adaptive strategies have not been clearly categorized based on the building construction process. This paper systematically reviews 101 documents published from 2013 to 2023, across 22 countries, with a focus on Nigeria. Using descriptive statistics and content analysis, we identify and categorize 52 adaptive strategies into four groups: urban design, effective building design, insulation, and occupants' behaviour. These strategies are further classified according to their application in the building process stages: pre-design, design, construction, and post-construction. The study provides a full response to overheating in the building sector with efforts to reduce energy consumption rate and greenhouse gas emissions. The findings of the study contribute, significantly to improvement in occupants' health care and well-being, as well as high productivity levels and socioeconomic benefits. Future research is therefore recommended in the efficiency of its implementation to develop innovative and cost-effective solutions in the construction industry towards sustainable urban development.

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Highlights:	Contribution to the field statement:
- This paper provides evidence for the geographical distribution of studies on adaptive strategies to urban overheating. - Detailed information on the causes, effects, and solutions to overheating issues in buildings was achieved through a mixed method of data collection. - A combination of both the active and passive strategies provides a lasting solution to overheating issues. - Categorisation of adaptive strategies into pre-design, design, construction, and post-construction stages improves the building construction industry thereby enhancing the building sector.	The knowledge gained from the study's systematic review is useful to policymakers, architects and urban planners in making decisions and regulations about urban development in accordance with the building regulations. The manuscript's knowledge gap is a valuable contribution to sustainable development by enhancing the building sector for socio-economic benefits. It will act as a web for all stakeholders in the building industry by addressing overheating issues in energy, environment, engineering, science and other areas which are most concerned with the socio-economic impacts of urbanisation.

***Corresponding Author:**
Lead City University in Ibadan, Nigeria
Email address: afolabis2020@gmail.com

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1. Introduction

Recent increases in consistently high temperatures and extreme heat have been negatively impacting both physical and mental health. This issue is particularly prevalent in heavily populated urban areas, where over half of the population resides (Olugbenga & Adekemi, 2013), and this urban population is projected to grow by an additional 13% by 2060 (Lembi et al., 2021). The rise in temperatures is associated with a mix of natural phenomena and human-induced urbanization factors (Keys et al., 2016). Buildings, which are meant to offer comfort and shelter, as people spend most of their time indoors, are failing to meet these expectations due to climate change impacts (Akande, 2021; Owolabi, 2017). The situation in urban houses is further aggravated by rapid population growth, leading to overcrowding, aging infrastructures, subpar housing conditions, and environmental deterioration (Akinyemi et al., 2020; Muhammad, Bello, & Ishaq, 2021). These issues have contributed to the expansion of urban built-up areas, especially in developing countries, leading to environmental challenges like greenhouse gas emissions, poor indoor air quality, and global warming (Adedire & Adegbile, 2018; Nazarian, et al., 2022; Lomas & Kane, 2013). The concept of adaptive capacity, defined as the ability of a system to adjust to climate change and mitigate its effects (Cinner et al., 2018; Adefisan & Ahmad, 2018), is vital in this context. Recent literature reviews emphasize that adaptive strategies are essential for managing overheating problems in buildings to ensure occupant comfort (Mesfin et al., 2020).

In a bid to manage the effects of overheating, it was observed that occupants of urban houses are exploring different adaptation measures to achieve effective building performance (Stagrum et al., 2020). Responding to these problems contributes to energy saving in buildings with the use of efficient appliances and materials (Gunawardena & Steemers, 2019). It further ensures residents' good and healthy condition thereby improving their productive lifestyle (Thathsarani & Gunaratne, 2018). This invariably boosts economic development and enhances the socio-economic status of the country (Sholanke, 2022; Folkerts, et al., 2020). The management principle is likened to the traditional architectural building style in terms of the building design, the materials used for construction, and the building operations, which display a passive solution to overheating (Adunola, 2014). This becomes a necessity, as an improper management of the excessive heat leads to an increase in energy consumption in trying to achieve a cooling effect; a higher cost of living that differentiates status among human living standards; sicknesses and heat-related issues that consequently leads to death (Adegun & Ayoola, 2019). Deduction from the ongoing gives the reason why previous works of literature are enriched with studies on various adaptation mechanisms (Adaji et al., 2019; Akinola *et al.*, 2020; Morey et al., 2020).

Previous studies have highlighted the factors that constitute overheating and classified the different adaptive strategies for overheating (Gamero-Salinas, *et al.*, 2021; Fosas *et al.*, 2018; Gunawardena, 2015; Vellei *et al.*, 2016), however, little efforts have been recorded to systematically identify and categorize them. Even though, the adaptive strategies were been identified in the existing works (Drury *et al.*, 2021), little attention is paid to the implementation of their application in the planning and designing of buildings in Nigerian urban areas (Hellwig *et al.*, 2019; Alozie *et al.*, 2019; Manzano-Agugliaro *et al.*, 2015). This has been a barrier to effectively managing the effects of overheating in urban houses (Hao *et al.*, 2022).

Given the above, this paper aims to investigate available literature on ways to improve the thermal comfort of occupants in urban housing provision by focusing on the effective utilisation of different adaptive strategies adopted for overheating in urban houses with the following objectives:

i. To identify countries that have studies published on adaptive strategies for overheating in urban houses.
ii. To determine from the literature, the methodologies adopted to carry out studies to identify the adaptive strategies.
iii. To investigate how the control of overheating has been accomplished in urban homes using the identified adaptive strategies.

This article contributes to knowledge by assisting in making policy decisions on the careful placement of urban fabrics in line with building regulation practices. It will improve the construction industry with the adoption of the right strategy for overheating at each stage of the building process for an effective result and also boost research knowledge about the geographical distribution of previous studies. The categorization of adaptive strategies based on the stages of the building construction process, as

highlighted in this study, creates a better understanding of how the strategies can be integrated into the building sector. This will, therefore, reduce overheating and improve occupants' thermal comfort and well-being to achieve a more cost-effective and sustainable development.

2. Materials and Methods

A systematic review of published literature was adopted because it accommodates the appraisal, summary, and findings of a large number of research publications on a particular subject (Nunn & Chang, 2020). Secondly, previous authors, as evident from the literature, adopted a similar approach in their respective studies (Kinnumen *et al.,* 2022; Chapman *et al.,* 2017). A five-step approach used in carrying out the review encompasses (i) formulation of research questions, (ii) search strategy, (iii) inclusion and exclusion criteria, (iv) selection criteria, and (v) data extraction and analysis as adopted in previous literature (Alrasheed & Mourshed, 2023).

2.1 Formulation of Research Questions

This first step is the basis of the research work to guide the review using information gathered from the collected data. The increasing potential of the impact of climate change and the rate of urban growth in cities has led to an increase in air temperature from 0.7^0C – 7.6^0C (Nazarian, et al., 2022). This has made the building sector account for over 25% of greenhouse gas emissions resulting in a high demand for spatial cooling (Tootkaboni et al., 2021). The negative effect is most noticeable in buildings with low thermal mass, no shading devices, or new homes with high energy efficiency, where the elderly, sick, and children are most vulnerable (Mourkos, 2020). While the extreme heat in most developing countries, with the building sector recording 53.3% of the highest consumption of energy, most research studies focused on physiological, psychological, and behavioural categories of adaptive measures to provide solutions to overheating problems. However, efforts to determine the causes of overheating and various ways to properly manage the problem in the building sector generated the following research questions; (i) which countries have studies published on the use of adaptive strategies to manage overheating in urban houses: (ii) according to the literature, what study methodologies have been used to examine the contributing factors and adaptive strategies to overheating in urban houses and (iii) how has the control of overheating in urban houses been accomplished using adaptive strategies?

2.2 Search Strategy

A comprehensive literature search was conducted using electronic databases including Google Scholar, Semantic Scholar, Science Direct, and Taylor & Francis to identify the articles to be included in the review. The search is based on the specified search engines owing to the fact that Google Scholar contains grey literature with records of online materials for both peer-reviewed and non-peer-reviewed journals (Shariff, et al., 2013), which, when combined with other databases, gives a detailed and wider coverage of the better results required for a systematic review (Teo & Ling, 2020). Searches were carried out using "overheating in buildings, thermal comfort in residential buildings, overheating, and urbanisation". A literature search was also carried out using keywords such as '*thermal comfort, adaptive strategies, urban development, heat island effect* and *urban overheating'* to be able to find papers that capture the scope of the studies. The documents found were in the form of research articles, conference papers, theses, articles in press, journal pre-proof, editorial journals, and book chapters. The literature search for the study was limited to the causes of overheating and the adaptive strategies used in urban residential buildings to manage the effects.

2.3 Inclusion and Exclusion

Since rapid urbanisation is occurring in major cities with people spending more than 80% of their time indoors (Liu et al., 2021a), the building sector has been recorded to account for more than 30% of global final energy consumption which leads to a greater percentage of carbon emissions (Thapa, 2022). It is therefore, paramount to have detailed information about the overheating experiences and the adaptive strategies captured from a comprehensive list of studies across an appreciable number of years for a

greater understanding of the phenomenon. This will also help determine areas where each adaptive strategy is most suitable for application in the building sector.

The inclusion criteria for the review comprised (i) studies focused on dwellings, (ii) studies that investigated factors causing overheating in buildings and ways to solve the problem, (iii) studies published in the English language, and (iv) studies published between the year 2000 and 2023. This resulted in the identification of 435 downloaded works of literature considered to have the potential to be included in this review. Reading through the titles of the downloaded papers, 227 documents that did not capture the scope of the study were excluded at the first stage. A further screening of the remaining documents based on the research objectives excluded 80 other papers in the second stage. Furthermore, scanning through the 128 documents left, 27 papers that do not contain relevant information needed on adaptive measures to overheating in dwellings were also excluded. After considering various factors that are relevant to the research questions, 101 papers determined to be related to the study were subjected to review. Fig 1 below shows how we arrived at a total of 101 articles for the review. The exclusion criteria include studies outside the inclusion criteria and not peer-reviewed studies.

2.4 Selection Criteria

After a thorough review of the screened search, the 101 documents drawn from Semantic Scholar (9), Google Scholar (45), Taylor & Francis (7), and Science Direct (40) were finally included in the review. The full text of the documents was read and analysed, in-depth to identify the adaptive strategies used in urban houses based on their methodology, context, and findings that are subjected to the currency of articles published within the last 10 years (2013 - 2023). These are based on documents with rich contents of empirical evidence and review by looking at their titles, abstracts, keywords, and conclusions. Additionally, the search extended to the reference list of identified articles for relevant studies.

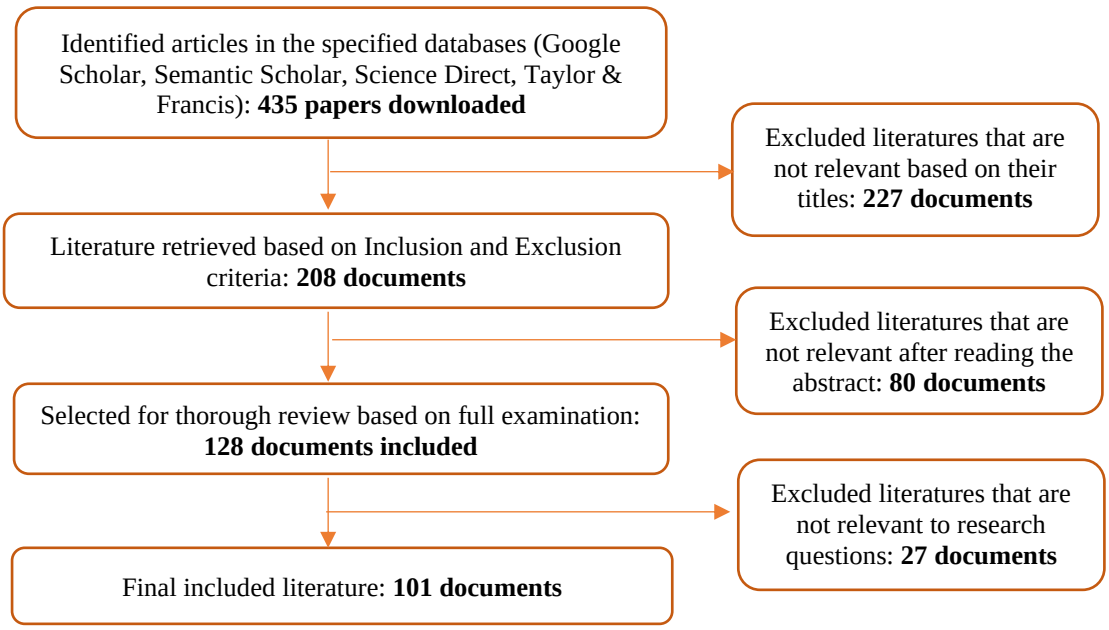

Figure 1: Inclusion and Exclusion Criteria.

2.5 Data Extraction

Considering the systematic review of the identified documents, the extracted data encompasses the context in which the study has been carried out, the methodology used in researching adaptive strategies for overheating in urban houses, and the categories of adaptive strategies used in urban houses. The findings are being presented in both qualitative data using thematic content analysis and quantitative data using frequencies, percentages, and rankings, with the results using tables, charts, and texts for better understanding.

3. Results

3.1 Publications on Adaptive Strategies to Overheating

Evaluation of the reviewed papers shows that twenty-two countries have published studies on various adaptive strategies for overheating. Figure 2 shows the distribution of the countries identified from the review against the number of studies done on adaptive strategies for overheating. Eighty-five percent (85%) of the studies were carried out between 2018 and 2023. This confirms the opinion of Laoudi et al. (2020) that overheating is a major concern for human health. It was found that the majority of studies in the downloaded papers were carried out in Nigeria and the United Kingdom. Nigeria ranked first on the list, with 22 published empirical studies carried out on a wide range of topics including indoor thermal comfort conditions, design strategies, building renovation, window configuration, the effect of vegetation, energy efficiency, and weather conditions. The data above confirms that emerging nations, particularly those in Africa, are struggling with overheating due to increased urban growth in Gamero-Salinas (2021). The United Kingdom comes next with eleven (12) published papers, while Europe comes third with five published papers.

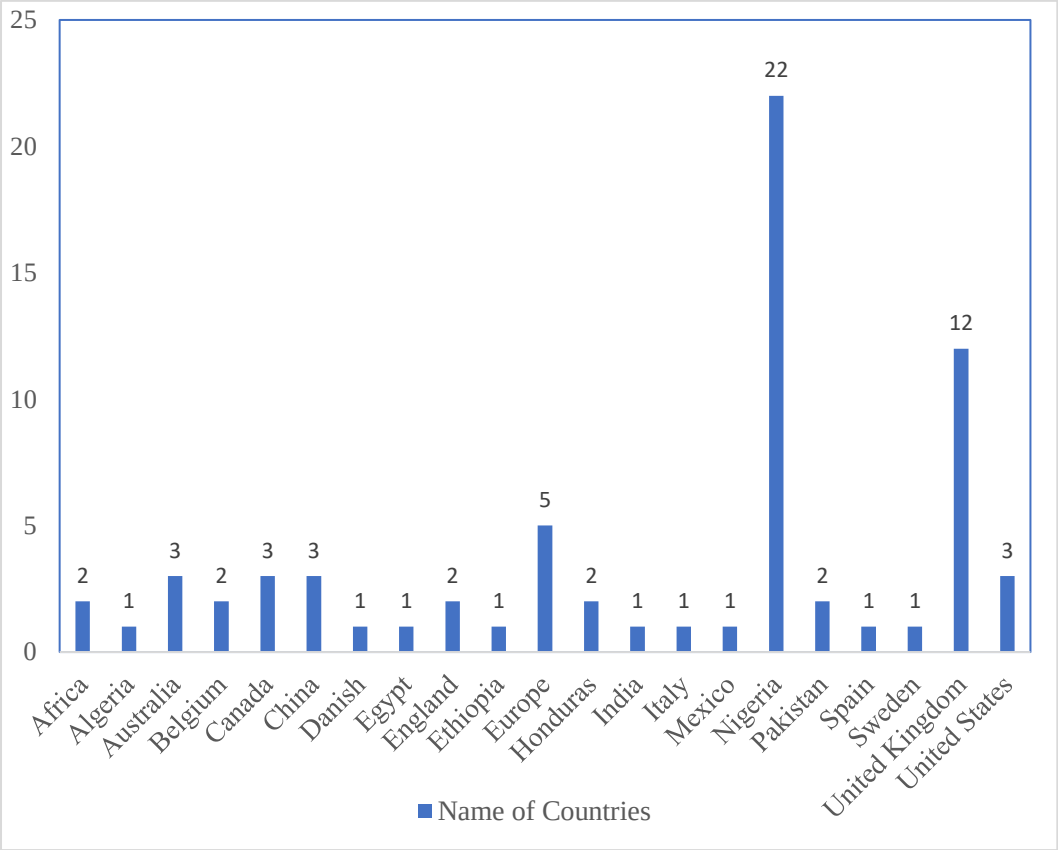

Figure 2. Distribution of Publication by Country.

3.2 Identification of Adaptive Strategies to Overheating in Urban Houses

The papers included in the article comprised various sorts of works of literature for which things downloaded were published. These have been divided into five categories for better analysis due to the larger coverage nature of data gathering to produce a comprehensive result. Energy-related articles are found in the first section, with Energy & Buildings at the top of the list, followed by Energy and Energy & Built Environment. The remaining sections are Science, Environment, and Engineering, while all other publications are categorised as others. Table 1 depicts the types of papers that have published studies on adaptive strategies for overheating.

The distribution of the 101 pieces of literature that were eventually included in the study comprises 52 (51.49%) publications that are editorials, review articles, and research articles that feature most in the

downloaded papers. Scientific articles come next with 17 (16.83%), followed by research papers with 9 documents (8.91%). Others are conference papers with 7 documents (6.93%), paper reviews 6 (6.94%), article-in-press, 4 (4.96%), book 1 (0.99%), book chapters 3 (2.97%), and academic journals 2 (1.98%). The distribution is shown in Figure 3 below. These elements were then thematically analysed to determine the coping mechanisms employed in urban houses.

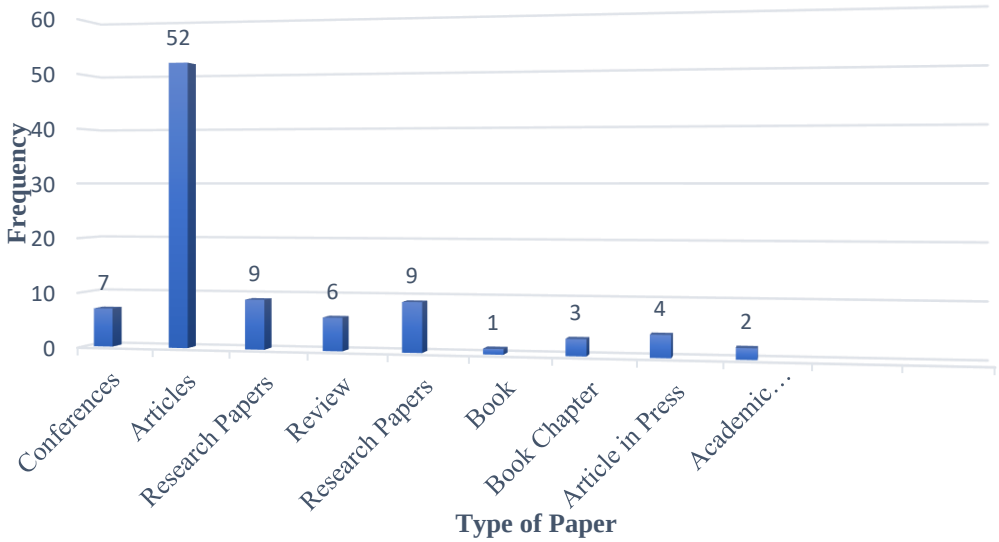

Figure 3. Distribution of Publications Included in the Study.

In the course of their research, several authors employed a variety of methodologies to analyse the remedies for overheating (Mourkos et al., 2020; Rodrigues & Fernandes, 2019; Daniel, 2015; Ashtiani et al., 2014). Investigations of the environment, structures, energy consumption, weather, and occupants are the different techniques discussed in the literature. All of these have played a role in urban overheating. Fig. 4 displays the methodologies that various researchers utilised to determine the adaptive strategies used to maintain overheating in buildings. Twenty-eight of the empirical studies which represent 50.91% employed the quantitative method, while twenty-one (38.18%) used the mixed method, and six (10.91%) carried out their studies using the qualitative method.

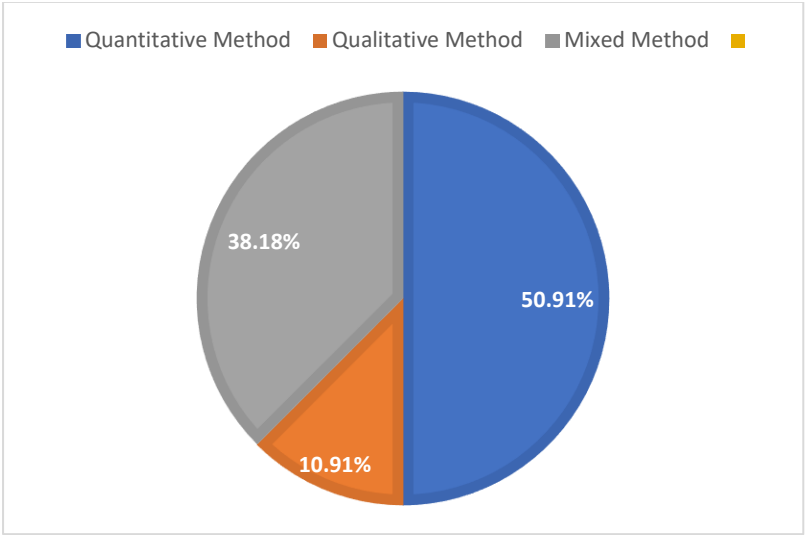

Figure 4. Distribution of Investigation on Adaptive Strategies to Overheating in Buildings.

The majority of the quantitative investigations carried out used survey techniques, where both the internal and external temperatures of the case buildings were tracked by field measurement with the use of monitored sensors and thermometers (Charles, 2022; Morey *et al.,* 2020). For better understanding, the actual building fenestration measurements were also taken along with pictures (Nwalusi et al., 2022; Okpalike et al., 2021). Data from the simulated scenarios on the building's and thermal performance were collected using questionnaires (Ouanes et al., 2022; Tettey et al., 2019; Mohammed & Alibaba, 2018; Bhikhoo et al., 2017; Argueso et al., 2014; Porrit et al., 2013). Focus group interviews were used to collect information for the qualitative technique on weather conditions and the thermal parameters of the buildings. In addition, participant observations with the aid of interviews were used to learn how occupants respond to and maintain overheating in relation to the review of literature on the phenomenon (Thapa, 2021; Gilabert et al., 2021; Laouadi *et al.,* 2020; Liu *et al.,* 2020; Baniassadi *et al.,* 2019; Verchev et al., 2019). However, several studies used both the qualitative and quantitative methods of research to provide a more reliable result (Bugenings & Kamari, 2022; Gupta *et al.,* 2021; Ochedi & Taki, 2021; Schunemann *et al.,* 2020; Ibrahim *et al.,* 2021; Williams *et al.,* 2019; Vellei *et al.,* 2016; Clear *et al.,* 2014; Mastrucci *et al.,* 2014).

Table 1: Groups of Downloaded Journals from the Databases.

Energy	**No**	**Environment**	**No**	**Engineering**	**No**	**Science**	**No**	**Others**	**No**
Energy & Built Environment	4	Indoor & Built Environment	5	Building & Engineering	1	iScience	1	American Journal of Engineering & Applied Science	1
Energy & Buildings	9	Building & Environment	8	Civil Engineering	1	Applied Sciences	1	International Journal of Interdisciplinary Research	1
Energy Reports	1	Climate	4	Journal of Engineering Research & Application	1	Thermal Science	1	Journal of Environmental Research and Public Health	2
Energies	3	Earth and Environmental Science	1	International Journal of Engineering & Advanced Technology	1	Technium Social Science Journal	1	South African Journal of Geomatics	1
Energy & Sustainable Development	1	Environmental Health and Ecology	1	Journal of Building Services Engineers research technology	1	Architectural Science Review	1	Advance in Hydrology & Meteorology	1
Energy Efficiency	1	Landscape & Urban Planning	1	International Journal of Applied Engineering Research	1	Path of Science	1	Sustainability	8
Applied Energy	3	Environmental Resource Letter	1			Acta Scientific Engineering Science	1	Building & Cities	4
Renewable & Sustainable Energy Review	1					Science of the Total Environment	1	Materials Today	1
						Wiki Journal of Medicine	1	Building Research & Information	4
						Journal of Medical Internet Research	1	Health Forum	1
								Public Health	1
								Conferences	7
								Book	1
								Book Chapter	3
								Community Development	1
								Sustainable Cities and Society	2
								International Journal of Building Pathology and Adaptation	1
								Nature Climate Change	1
Total	23		21		6		10		41

3.3 Adaptive Strategies for Overheating in Urban Houses

Previously published research demonstrates that efforts to prevent overheating and preserve thermal comfort in buildings have included adaptive techniques (Charles, 2022; Nazarian et al., 2022; Okafor et al., 2022; Gamero-Salinas et al., 2021; Chen, 2019; Wang, Ji, & Ren, 2017). Evidence from the literature review shows that adaptation strategies are ways to respond to uncomfortable situations of extreme heat in order to achieve thermal satisfaction (Nazarian *et al.,* 2022; Folkerts *et al.,* 2020; Fosas *et al.*, 2018). Because overheating is influenced by factors including outdoor environmental conditions, the design of the building, the internal production of heat, and the occupants' behaviour (Taylor et al., 2023; Gamero-Salinas *et al.,* 2020), the adaptive strategies are sectioned into four groups. These groups are (i) urban design strategies where the use of cool pathways lessens the intensity and impact of urban heat islands; (ii) effective building design that springs from the conventional architectural building style as a heat control strategy; (iii) exposed thermal mass where daytime lighting is absorbed and then released during the night; and (iv) occupant's behaviour. Table 2 depicts the list of identified adaptive strategies from the literature by grouping them in relation to the factors that influence overheating.

These four groups of adaptive strategies are further categorised based on their area of implementation in the building construction process in support of findings from the studies of Gamero-Salinas *et al.* (2021) that overheating reduces when proper building design is in place. The building construction process, denoted by different stages, includes (i) the pre-design stage, (ii) the design stage, (iii) the construction stage, and (iv) the post-construction stage. Table 3 shows the categories of adaptive strategies adopted at different stages of the construction process, as grouped in each section.

4. Discussion

An appreciable amount of literature was downloaded from the databases focusing on adaptation measures, which confirms the fact that overheating has been a pressing and current issue in the sustainable environment (Bundle *et al.,* 2018; Quinn et al. 2014). The evaluation states that a variety of methodologies comprising questionnaires, observations, instruments, and focus groups were used to gather data on subjects including the environment, buildings, and the people who are most concerned about overheating problems. This allows the authors to capture detailed information on how the problem of overheating has been managed within the environment. Nigeria ranked highest among the twenty-two nations with 14 documented research studies on adaptive measures to combat overheating in urban housing, bolstering the conclusion that emerging nations are already feeling the effects of urbanisation and climate change (Gamero-Salinas, 2021).

Moreover, despite being a developed country, the UK came in second with 11 documented studies on adaptive strategies for overheating. This problem has been discovered to be a reoccurring issue due to migration resulting from the economic benefit enjoyed by residents (Brotas & Nicol, 2017). The negative effect led to poor indoor air quality, in buildings coupled with heat-related diseases and sickness in residents (Chen & He, 2022). Finding solutions to the issue contributes to energy efficiency in buildings, enhances occupants' health and wellbeing, and thereby improves productivity and economic benefits. This has been discovered to boost development and socio-economic status. Consequently, urban migration is encouraged by a greater rate of socio-economic benefits, resulting to low labour rate, less productivity, and underdevelopment.

Active technologies provide an immediate response to lessen the risk of overheating, but a lasting solution can serve future generations through passive means (Taylor et al., 2023; Widera, 2021; Haruna, Muhammad, & Oraegbune, 2018; Clear et al., 2014). The active approaches contained in the literature feature mostly in the post-construction stage, where occupants of the building provided immediate responses to the uncomfortable situation. (Singh *et al.,* 2014; Clear *et al.*, 2014). Consequently, inappropriate implementation of these strategies can potentially increase the risk of overheating, resulting in high energy consumption and

increased health risk. This is due to the fact that the insulation and retrofitting domains have produced contradictory results with the choice and application of material for building construction (Onyenokporo & Ochedi, 2018; Psomas *et al.,* 2016).

However, the passive approaches highlighted in the literature are lasting solutions to overheating problems to achieve sustainable development (Mahar *et al.,* 2019; Moore *et al.,* 2017; Mulville & Stravoravdis, 2016; Santamouris & Kolokotsa, 2014). This measure is significant for the traditional architectural building styles, which prominently depict passive design strategies adopted to overcome overheating problems in most Nigerian buildings (Inusa & Alibaba, 2017). It is obvious that traditional architectural building styles are still relevant in the construction industry (Nwalusi et al., 2020). Therefore, it has become relevant to adapt our culture of building construction methods to account for a variety of elements across time.

Nevertheless, heat management measures are categorised to include (i) physiological adaptation where the body system is affected by environmental factors when exposed to heat, (ii) psychological adaptation which depends on individual feelings in relation to some factors like body weight, age and financial status, and (iii) behavioural techniques subjected to both conscious and unconscious acts as ways to enhance human thermal comfort (Ma, et al., 2021; Alwetaishi, 2016; Yang et al., 2014). This has further been discovered to cover both active and passive design methods (Garcia *et al.,* 2019). The analysis of the groups of adaptive strategies highlighted in this review is composed of passive approaches as a reflection of (i) heat and solar protection that prevent interior heat buildup, (ii) heat modulation, which has the extra benefit of minimising significant temperature when both internal and external temperatures rise, and (iii) heat dissipation, which releases surplus heat from within the building at a reduced temperature (Gamero-Salinas et al., 2021; Vellei et al., 2017; Wang et al., 2017).

The appropriate arrangement of urban fabrics produced by the application of government regulations for the thoughtful placement of parks and gardens throughout urban regeneration activities is a hallmark of a good urban design approach. Developmental activities will also centre on urban greening, which includes using trees as canopies to shade open areas and vegetated land cover to stop rainwater runoff from depleting the soil. All of these will facilitate government decision-making on social development and geographic distribution.

More intelligent building design is informed by an adherence to legal requirements. Effective space placement within the building also heavily weighs the building's orientation to maximise the advantages the surrounding area has to offer. This establishes the kind of building design and construction style, which is shown in the kind and arrangement of window openings, the materials utilised for the building envelope, the ventilation system, and the utilisation of balconies to improve the building's perspective. Stated differently, these techniques look at the height and treatment of the roof, the energy consumption rate of the appliances, and the qualities of the materials used for the building parts in order to prevent heat gain from the building. A quick action taken by conscious or unconscious human behaviour contributes to a cost-effective measure that is demonstrated in moving from one location to another, having a cold drink or shower, adjusting activity level, wearing less clothing, sleeping outside, and turning on the air conditioner and fan.

An examination of the identified strategies described in the published works concludes that adaptive strategies reduce energy consumption levels in buildings, enhance occupants' health care and wellbeing, improve productivity levels, and contribute to the economic benefits and social development of urban areas. Therefore, deduction from the explanations provided in the literature shows that the building life cycle requires a combination of active and passive measures (Vázquez-Torres & Gómez-Amador, 2022; Ibrahim *et al.,* 2021; van Hooff, Blocken, Hensen & Timmermans, 2014). An all-encompassing strategy is therefore highlighted in this study to manage overheating problems in the building sector based on the building construction process (pre-design, design, construction, and post-construction stages) to manage the overheating challenges.

Table 2: List of Adaptive Strategies by Group.

Groups	Adaptive Strategies	Sources
Urban Design Strategies	Urban greening	Mastrucci et al. (2014), Matandirotya e*t al.* (2020), Alrasheed & Mourshed (2023), Ashtiani *et al.* (2014), Ehsan *et al.* (2021), Akinola *et al.* (2020), Widera (2021), Chen (2019).
	Vegetation	Nwalusi *et al.* (2020), Adegun & Ayoola (2019), Alozie *et al.* (2019), van Hooff *et al.* (2014), Alrasheed & Mourshed (2023), Brotas & Nicol (2016).
	Careful placement of parks/garden	Muhammed & Alibaba (2018), Ehsan *et al.* (2021), Chen & He (2022), Chapman *et al.* (2017).
	Tree canopies	Chapman *et al.* (2017), Ehsan *et al.* (2021).
	Urban renewal	Chen & He (2022).
	Blue/green infrastructure	Santamouris & Kolokotsa (2015).
	Government policy decision	Attia & Gobin (2020), Bundle *et al.* (2018).
	Proper layout of urban fabrics	Chen & He (2022).
	Enforcement of building guidelines	Akinola *et al.* (2020),
Effective Building Design	Building orientation	Nwalusi *et al.* (2020), Muhammed *et al.* (2018), Mohammed & Alibaba (2018), Brotas & Nicol (2016), Haruna *et al.* (2018), Tettey *et al.* (2019), Bhikhoo *et al.* (2017), Adegun & Ayoola (2019).
	Window orientation /configuration	Ibrahim *et al.* (2021), Tettey *et al.* (2019), Alozie *et al.* (2019), Bhikhoo *et al.* (2017).
	Type of building	Mohammed & Alibaba (2018), Williams *et al.* (2019), Ochedi & Taki (2022), Bundle *et al.* (2018), Alozie *et al.* (2019).
	Higher roof fraction	Nwalusi *et al.* (2020).
	Use of stack ventilation	Adaji *et al.* (2019), Fosas *et al.* (2018), Gupta *et al.* (2021), Bhikhoo *et al.* (2017).
	Low window-to-floor ratio	Okpalike *et al.* (2022), Haruna *et al.* (2018).
	Weather consideration	Liu *et al.* (2021a).
	Building form	Nwalusi *et al.* (2020), Gamero-Salinas *et al.* (2021), Liu *et al.* (2020b).
	Use of balconies	Gamero-Salinas *et al.* (2021), Nwalusi *et al.* (2020).
	Natural shading	Bugenings & Kamari (2022), Gamero-Salinas *et al.* (2021).
	Adequate ventilation	Gamero-Salinas *et al.* (2021), Ochedi & Taki (2022), Alwetaisi (2016), Thapa (2022), Alozie *et al.* (2019).
	Shaded space	Brotas & Nicol (2016), Fosas *et al.* (2018), Liu *et al.* (2021a).
	Cool paint	Alrasheed & Mourshed (2023).
	The right choice of building materials	Nwalusi *et al.* (2020), Adaji *et al.* (2019), Attia & Gobin (2020), Alozie *et al.* (2019), Ehsan *et al.* (2022).
	Effective positioning of spaces	Mohammed *et al.* (2018)
Insulation	Cool roof	van Hooff *et al.* (2014), Santamouris & Kolokotsa (2015), Attia & Gobin (2020).
	Roof/window overhang	Williams *et al.* (2019).

	External shutters	Liu *et al.* (2020b).
	Permeable surfaces	Ochedi & Taki (2022), Tettey *et al.* (2019), Bundle *et al.* (2018), Akinola *et al.* (2020).
	Energy-efficient measures	Okafor *et al.* (2022).
	Use of curtains/blinds	Okafor *et al.* (2022), Matandirotya *et al.* (2020), Williams *et al.* (2019), Schunemann *et al.* (2020), Chen & He (2022),
	Utilization of natural building materials	Chen (2019), Attia & Gobin (2020), van Hooff *et al.* (2014), Vellei *et al.* (2016), Thapa (2022).
	Retrofitting	Mastrucci *et al.* (2014), Ibrahim *et al.* (2021).
	Green roof / green wall	Morey *et al.* (2020).
	Low thermal mass of building envelope	Nwalusi *et al.* (2020), Gamero-Salinas *et al.* (2021), Liu *et al.* (2020b), Hao *et al.* (2022), Liu *et al.* (2021a), Thapa (2022), Ehsan *et al.* (2021), Widera (2021), Bhikhoo *et al.* (2017).
	Cool pavement	Garcia *et al.* (2019).
	Phase change materials	Schunemann *et al.* (2020), Alrasheed & Mourshed (2023), Chen (2019), Haruna *et al.* (2018), Santamouris & Kolokotsa (2015), Nwalusi *et al.* (2020), Liu *et al.* (2020b).
Occupants' Behaviour	Movement action	Zepeda-Rivas & Rodriguez-Alvarez (2020), Laouadi *et al.* (2020), Vellei *et al.* (2016), Singh *et al.* (2014), Ehsan *et al.* (2021).
	Better housekeeping	Vellei *et al.* (2017).
	Opening/closing window/door	Gamero-Salinas *et al.* (2021), Gunawardema & Steemers (2019), Clear *et al.* (2014), Alwetaishi (2016), Laouadi *et al.* (2020), Gupta *et al.* (2021), van Hooff *et al.* (2014), Vellei *et al.* (2017), Wang *et al.* (2017), Singh *et al.* (2014).
	Sleeping outside	Ehsan *et al.* (2021).
	Taking cold drinks/plenty of water	Zepeda-Rivas & Rodriguez-Alvarez (2020), Gamero-Salinas *et al.* (2021), Morey *et al.* (2020), Alwetaishi (2016), Gupta *et al.* (2021), Vellei *et al.* (2017).
	Adjustment of human activity	Gunawardema & Steemers (2019), Chen & He (2022), Clear *et al.* (2014), Attia & Gobin (2020).
	Taking a shower/using a wet towel	Ehsan *et al.* (2021).
	Reducing clothing level	Zepeda-Rivas & Rodriguez-Alvarez (2020), Chen & He (2022), Morey *et al.* (2020), Clear *et al.* (2014),
	Night-time ventilation	Alwetaishi (2016), Laouadi *et al.* (2020), Attia & Gobin (2020), Gupta *et al.* (2021), Wang *et al.* (2017), Singh *et al.*(2014).
	Personal environmental control	Ma *et al.* (2021), Alwetaishi (2016).
	Reduced energy consumption	van Hooff *et al.* (2014), Fosas *et al.* (2018), Gupta *et al.* (2021), Vellei *et al.* (2017), Ibrahim *et al.* (2021), Alozie *et al.* (2019), Widera (2021).
	Refurbishment	Vellei *et al.* (2016), Singh *et al.* (2014).
	Drawing curtain/blind	Vellei *et al.* (2017), Adaji (2017).
	Use of ceiling fan	Adaji (2017), Ochedi & Taki (2022).
	Use of an air-conditioning system	Williams *et al.* (2019), Morey *et al.* (2020), Alwetaishi (2016), Gupta *et al.* (2021), Chapman (2017), Santamouris & Kolokotsa (2015), Thapa (2022).

Table 3: Categories of Adaptive Strategies based on the Building Construction Process.

Group	Pre-Design Stage	Design Stage	Construction Stage	Post Construction Stage
Urban Design Strategies	Government policy decision Proper layout of the urban fabric	Enforcement of building guidelines Careful placement of parks and garden Urban greening	Blue/green infrastructure Tree canopies	Urban renewal Vegetation
Effective Building Design	Weather consideration Compliance with building regulations Type of building design	Building orientation Building form Window orientation Effective positioning of spaces Low window-to-floor ratio Incorporation of balconies Natural shading Green wall Use of stack ventilation	The right choice of building materials Window configuration Proper landscaping Cool paint Green roof Higher roof fraction Introduction of external shutters	Vegetation Shaded space Adjustment of indoor shading/ventilation
Insulation	Tree planting Blue/green infrastructure	The low thermal mass of the building envelope Green wall Window overhang Roof overhang Higher roof fraction Landscaping Cool roof Roof overhang	Utilisation of natural building materials Low thermal properties of building materials Phase change materials Double glazed window Permeable surfaces Retrofitting Use of external shutters Cool pavement Reflective materials	Energy-efficient measures Use of ceiling fan Installation of air-conditioning system Use of curtains/blinds
Occupants' Behaviour	Compliance with building regulations Weather consideration	Reduced energy consumption Night-time ventilation	Energy-efficient appliances Retrofitting Refurbishment	Movement action Adjustment of human activity Taking shower Taking cold drinks Spending time outside Opening/closing windows/doors Putting on the fan/air conditioning system Personal environmental control Changing clothing level Drinking plenty of water Sleeping outside Taking a shower/using a wet towel Drawing curtain/blinds Better housekeeping

5. Conclusion

This article has identified the countries that have conducted research on adaptation strategies, the methodology used to identify the adaptive methods used in urban homes to manage overheating issues, and the approach for controlling overheating in urban homes through a systematic review. The following conclusions are drawn from the data: First, research on responses to overheating was conducted using both qualitative and quantitative research methodologies, and a mixed method was used to provide full results on the adaptive tactics employed. Second, papers on different overheating management strategies were found in twenty-two (22) different countries, with the majority of them being from Nigeria. Third, the four groups of the identified adaptive strategies from the literature (urban design strategies, effective building design, insulation & occupants' behaviour) were further categorised based on the building construction process to consist of the pre-design, design, construction and post-construction stages.

The findings of this review show that the application of these categories of adaptive strategies in the building construction process will improve the indoor and outdoor air quality of buildings to achieve comfort. Additionally, despite the trend in technical advancement and modernization, the old architectural construction styles remain essential in the building sector to achieve a comfortable and successful lifestyle. Therefore, by addressing the impacts of indoor air quality and urban overheating based on the highlighted categories, this study has the potential to reduce greenhouse gas emissions, energy consumption, and urban heat island effects. Its adoption would also enhance both the health and well-being of the populace; their productive lives as well as the nation's economic growth towards sustainable urban development and public health.

The knowledge acquired from the systematic review of the study is valuable to policymakers and urban planners in making policy decisions and regulations relating to the layout of urban fabrics in accordance with building regulation practices. Furthermore, it will assist Architects in the production of functional and effective building designs to suit occupants' comfort. It will also benefit the researchers by assisting them to determine the geographical distribution of research efforts. In all, the review serves as a web among urban planning, architecture, environmental science and economics considering various topics that have addressed overheating issues in energy, environment, engineering, science and others which are most concerned with the socio-economic impacts of urbanisation.

Given the aforementioned, it is suggested that more research be done on the efficiency of implementing these categories of adaptive strategies to overheating in the building sector for new innovations and cost-effective construction practices towards achieving sustainable development and healthy living.

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