Top Priority Characteristics of Blue Spaces Design for Stress Reduction: A Scoping Review and Delphi Technique Among BlueHealth Experts

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ABSTRACT

There is a growing need to identify blue space characteristics that optimize stress reduction. Few studies have directly linked specific variables of blue spaces to stress-reduction. To address this gap, this study aimed to develop a framework identifying priority blue space variables for stress reduction. A scoping review first compiled a comprehensive list of potentially influential factors. Using the Delphi technique, a qualitative study then evaluated the most significant of these variables through private interviews with eleven (11) BlueHealth experts. The experts, drawn from diverse disciplines, were asked to rate the importance of various blue space characteristics on a 6-point scale. The analysis revealed that factors such as size, colour/clarity, biodiversity, and time spent in the blue space may be the most critical for stress reduction. Experts highlighted the complex interrelationships between these variables, noting that the optimal design of blue spaces requires a delicate balance to maximize the stress-reducing potential. While further experimental validation is warranted, this expert-informed framework provides a solid foundation for designing blue spaces that support mental health and well-being. By prioritising the key variables and understanding their relative importance, architects, urban planners, and policymakers can make more informed decisions when creating or retrofitting blue spaces. The findings of this study come at a critical time, as the global mental health crisis continues to escalate, with depression and stress projected to be leading concerns by 2030. Integrating this evidence-based framework into the design of blue spaces holds the potential to mitigate the negative impacts of the built environment and contribute to the overall well-being of individuals and communities.

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INTRODUCTION

Blue Space is defined as "health-enabling places and spaces where water is at the heart of a variety of environments with identifiable potential for stress reduction and mental health benefits" (Foley & Kistemann, 2015). The water elements in a space, whether natural or man-made, reduces stress and has a therapeutic effect on human emotions and physiology. It alludes to water's ability to cure human emotions and mental health. The association of blue space with mental health has been established through three (3) pathways, one of the most significant of which is characterised as "psychological restoration" (Markevych et al., 2017), a natural process that restores cognitive resources depleted by everyday activities (Kaplan & Kaplan, 1989; Ulrich, 1983). This pathway is based in the notion, people have evolved with a deep connection to nature, which leads to subconscious seeking for natural environments, including blue spaces, which contributes to stress reduction (Edward O. Wilson, 2015). The value of blue space to health and well-being is recognised and evaluated using theoretical concepts from emotional and social geographies, as well as critical understandings of salutogenesis (Foley & Kistemann, 2015). However, not all blue spaces are created equally. Different blue spaces may evoke different restorative effects; for example; ocean, fountain, water, pond, and lake Canal, each has a different impact on stress levels (Völker et al., 2016). Gascon et al., (2015) concluded saying more research and detailed information are needed on the characteristics of blue spaces, such as quantity, colour and type for promoting better mental health. Therefore, considering the Preferred Reporting Items for Systematic Reviews Items (PRISMA), comprehensive literature was conducted to identify the variables affecting blue space quality. Twelve (12) variables affecting the restorative outcome of blue space were identified. Rather than focusing on the presence or absence of blue space, research should analyse the type and characteristics of the blue space, in addition to the way they contribute in producing better health benefits such as reduced stress levels (Gascon et al., 2015). Despite extensive study on natural environments, it is still unclear which type of blue space, with which attributes, are most beneficial for health, particularly mental health. According to WHO, Green and Blue Spaces and Mental Health; New Evidence and Perspectives for Action, (2021), only a few studies investigated the characteristics of blue space. Different blue spaces may evoke different restorative effects, , considering PRISMA guidelines, the reporting checklist of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Page et al., 2021), a holistic scoping review was conducted to identify the characteristics (variables) affecting the quality of blue spaces. The objective of the study is to evaluate the most affective characteristics of blue space design, using Delphi technique.

Blue space theory

The Blue space theory is described as "health-enabling places and spaces where water is at the centre of a range of environments with identifiable potential for the promotion of stress reduction and mental health benefits (Foley & Kistemann, 2015). More recently, the well-being benefits of blue spaces (e.g. inland waterways, lakes, rivers) have been related to improvements in anxiety, stress and emotional well-being (Maund et al., 2019), better self-reported general and mental health (Pasanen et al., 2019), improved subjective well-being and lower risk of depression (Garrett et al., 2019). Blue space association with mental health has been established through three main pathways, and one of the pathways related to the aim of the study is psychological restoration (Markevych et al., 2017). According to the attention recovery theory by (Kaplan & Kaplan, 1989) and the stress reduction theory (Ulrich, 1983). psychological restoration is a natural process that replenishes cognitive resources depleted by everyday activities. As a result, it causes stress reduction and improves mental health. Grellier et al., (2017) defined blue spaces as – either natural or manmade – that prominently feature water and are accessible to people either proximally (being in, on or near water) or distally/virtually (being able to see, hear or otherwise sense water). These include coasts, rivers, lakes and engineered water features such as canals and urban fountains. The concept of blue space was created about ten (10) years ago when researchers at the University of Sussex asked two thousand (20,000) people at random to record how they felt. After collecting over a million responses, they found that people in the blue room were by far the happiest. Recently, experts from the University of Glasgow

Caledonia (GCU) found that staying in the blue room reduces the risk of stress, anxiety, obesity, cardiovascular disease and premature death.

Stress Reduction Theory (SRT)

Ulrich's theory states that the natural environment promotes recovery from stress, but the urban environment hinders the same process. Being in a safe natural environment or seeing natural elements like plants or water immediately activates positive emotional responses and lowers blood pressure and heart rate, which are key indicators of the stress response. In addition, sustained attention is elicited, thereby blocking negative thoughts and feelings. Because humans have evolved and evolved in natural environments, as opposed to urban ones, Ulrich suggested that interacting with such environments continues to be a positive adaptation for modern humans. Showing a high physical arousal stress response in the face of an unhealthy natural environment is inappropriate, as this process causes fatigue and triggers chronic cardiovascular and endocrine responses that are detrimental to health; such behaviour is not common in humans (Ulrich et al., 1991). According to Ulrich et al., (1991), however, a similar innate willingness to react positively to urban conditions should not have developed, as in cities with high visual complexity, noise, intensity and movement. A city's stimulating environment can adversely affect people by generating stress and fatigue during psychological and physiological arousal. Nature is calmer and less messy than many urban environments. It tends to have a relatively positive stress-reducing effect on human health.

Size Of Blue Space

Recent studies suggest that urban areas should include sizable or large enough water bodies to promote an aesthetic experience and restorative effects (Karmanov & Hamel, 2008; Völker & Kistemann, 2013). Similarly, Völker et al., (2016) concluded that the quantity of water appears to be a significant influencing factor on the use of urban open space and, consequently, for potential health-improving activities. In a previous investigation by Berto, (2005), water made up around five percent (5%) of the picture in her non-restorative images, compared to up to fifty percent (50%) in her restorative ones. Similar ratios are evident in Pretty et al., (2005)'s Pleasant vs Unpleasant stimuli, and some nature scenes in (Berman et al., 2008) have about sixty percent (60%) water content. According to these results, restorativeness is thought to increase in direct proportion to the amount of water present in the sceneries (White et al., 2019).

Even in early examples of research by Herzog (1985), shows that the highest preference ratings were for "large bodies of water" implying that preferences might increase as the proportion of water increases. In their study, White et al., (2010) reached this conclusion. According to them, individuals were also ready to pay more for rooms with views of the outdoors that included water because they thought these views were more restorative. But the relationship was not simple. Much higher preferences and impact were recorded when water was added to green spaces, and further increasing the proportion of water had similar effects. Natural settings with large amounts of water (2/3) received higher ratings than those with less water (1/3). However, scenes containing only water were rated less positively than ones with two-third (2/3) water and one-third (1/3) Green space, on all measures except for willingness to pay. This finding suggests that the ideal habitat may be the boundary between land and vast bodies of water (Herzog, 1985).

Type of blue space

There are many types of blue spaces, such as oceans, fountains, water, ponds, and sea channels (Völker et al., 2016). Few studies suggest a relationship between health effects and different types of blue spaces. Because each blue space is different (Zaino & Rasiya, 2022), the healing effect seems to be different. The amount of water in any type of blue space has been suggested to be a factor that modifies treatment outcomes (Völker et al., 2016).

Herzog (1985) investigated preferences for various aquascapes and found that photographs of "marshlands" were rated significantly worse than rivers, ponds and lakes, mountain aquascapes and large

bodies of water. I discovered that This study suggests variability in responses to aquatic environments, but because it investigated non-aquatic environments, it was not possible to assess people's relative preferences between the two. Nevertheless, this study suggests a possible dose-response component in the aquatic environment. In particular, the highest preference ratings are for 'large bodies of water, suggesting that preference may increase with water fraction.

A second study by Ulrich et al. (1991) compared people's responses to videos of natural scenes with and without water (in addition to urban environments). However, instead of assessing preference, researchers were interested in how exposure to different environments after stressful situations could help restore physiological function in humans. Blood pressure and skin conductivity up to the preload value. Twenty participants were shown the "natural vegetation" video, and he showed the 20 "water" videos. The water video is described as: "A region dominated by trees and a fast-flowing stream. Waves and waves on the surface of the stream. No people, no animals. A constant 63-64 decibels sound from the stream. The authors stated that no significant differences were found between natural vegetation and aquatic environments (data not presented).

Colour and clarity of blue space

All water is not blue, it also comes in multiple shades and forms of grey, brown, dark, greasy, turbid, and clear (Foley & Kistemann, 2015). Photographs of artificially polluted and coloured water sceneries were used by (Dinius, 1981) to examine how the public perceives water quality. Interestingly, they assessed discoloured water as being worse than those with high trash levels, highlighting the significance of colour. The academic literature on the colour and clarity of blue spaces has revealed the emergence of several contrasting themes.

One such study done by Smith et al. (1995), described turbid and brown water, which is probably not the most suitable for bathing. However, clear waters that are naturally brown in colour may still be considered good for bathing and other aesthetic uses. Similarly, naturally turbid waters that are blue in colour may still be considered suitable for bathing.

Another study by Pitt (2018) informs that the colour and clarity of water may result from interactions with other materials and may have potentially negative impacts. He argues that few people understand water's colour or opacity, so they assume dirtiness with some configurations of water, resulting in less positive qualities such as muddiness, opacity, and risk. He went on to say that blue spaces can have more neutral or detrimental impacts on well-being when they seem brown, stagnant, opaque, and stinky. Less blue, more brown-green, in-land urban waterways may be less likely to promote well-being (Pitt, 2018).

The benefits of water for well-being are attributed to its clarity and association with freshness (Herzog, 1985). Natural courses and clear blue water assumed cleaner, are often pleasing (Völker & Kistemann, 2011), and preferred over tainted brown or stagnant water (Herzog, 1985).

Biodiversity

According to Coughlin (1976), a person's perception of blue space is influenced not just by the water's quality but also by the characteristics of its surrounding biodiversity. Similarly, a study conducted by (Dallimer et al., 2012) shows that species richness or abundance of biodiversity, such as birds and butterflies, have been found to improve well-being, though he argues that these trends were maybe inconsistent because people generally have poor biodiversity identification skills, compared with what objectively exists.

A different perspective has been adopted by (Garrett et al., 2019), who reported that feeling safe in blue space relates to greater subjective well-being and the restorative qualities of green and blue spaces are considered greater. While Fisher et al., (2021) further explain that people regard an area to be safe when it is species-rich and natural and where they can enjoy biophonic sounds that are principally bird-related.

Researchers are increasingly looking into the function of sound. Birdsong, for instance, has been shown to increase the perception of restorativeness (Ratcliffe et al., 2020), while other natural sounds, such as the breeze in the trees, have been shown to be more calming and pleasant than anthropogenic sounds and are associated with higher mental well-being (Bakolis et al., 2018; Moscoso et al., 2018). Those who can hear birds sing report feeling momentarily happier (Bakolis et al., 2018), and a variety of birdsong provides greater benefits than single-species singing, resulting in improved well-being (Hedblom et al., 2014).

Texture

Textures are spatially dynamic visual patterns that repeat or appear to repeat over time (Toet et al., 2011). In previous studies on the texture of blue spaces showed that the perception of movement is observed as exciting, while the perception of stillness is calming (Nasar & Lin, 2010), and more complex water textures are preferred over simple ones.

This view is supported by (Völker & Kistemann, 2015), whom attributed the restorative power of blue spaces to its appealing aesthetic textures (qualities of water) and sensory experiences, which were described as being relatively still but fascinating due to the movement and brilliance, particularly when coupled with reflecting properties, the ripples and flows (textures) appear to inspire contemplation or the enjoyment of simply sitting and watching.

Similarly, Dijkstra et al., (2006) suggest that the restorative value of healing environments may benefit from the introduction of relaxing dynamic textures like slowly undulating water surfaces.

These results were complemented by Toet et al.,(2011) study on thirty different dynamic textures of water, where the emotional effects of dynamic textures of water were observed; results showed that there was a trend towards a significant correlation between trajectory-type water textures and Pleasure. Contrarily, water in complex motion was perceived as relaxing, while water texture complexity and enjoyment are positively correlated. The study demonstrated that the speed of texture dynamics has a significant and arousing effect on human emotions.

Time spent

With more time spent outside, anxiety and depressive symptoms have been proven to decrease (Beyer et al., 2018). Based on this, Hermanski et al., (2022) proposed that similar to how green spaces enable, the time spent near blue spaces may have significant effects on mental health. He did a systematic review of the literature, which included five distinct research, and the findings are as follows.

According to Ashbullby et al., (2013)'s qualitative study, the most important experience from time spent in the blue space was mental and psychological health benefits, which exceeded social interactions and physical activity.

Two research concentrated solely on blue space visibility. (1) Dempsey et al., (2018) investigated the influence of coastal views on depression and concluded that exposure to coastal views reduced depression rates in the group with the most exposure time to coastal views. (2) Nutsford et al. (2016) discovered that more visibility was linked to better mental health outcomes and decreased psychological distress.

Garrett et al., (2019)'s study revealed statistically significant results of improvement in self-reported mental health and well-being before and after visual exposure to blue space. They also discovered a substantial decrease in depression, from one or more weekly visits to blue space as well as for visits 1-2 times per month.

Systematic literate review on blue space variables

Previously, we conducted a scoping review to identify variables affecting blue space's ability to heal. There were no scoping reviews previously conducted to identify the variables. However, we concluded six variables (Zaino & Rasiya, 2022). The table below presents the number of studies found for each variable,

and we rated each study based on the number of studies found. For example, the highest number of studies was 3 studies; therefore, this was rated as 1.

Table 1 Numbers of studies for blue space variables

	Number of studies	Rate
Size of the blue space	7	1
Type of the blue space	5	3
Colour and clarity	6	2
Biodiversity	5	3
Texture	4	4
Time spent	5	3

Source: Authors (2024)

MATERIALS AND METHODS

Considering the Delphi technique, a qualitative study was undertaken involving the use of semi-structured interviews to determine the current opinion concerning what is perceived as being the best predictive IVs for the best stress reduction among experts. Private one-to-one interviews were performed in mid-late 2022 by a PhD researcher using online platforms. Each interview began with a brainstorming session using a pre-recorded introductory video and a written paper followed by a 2nd round survey consisting of all variables of blue space extracted from a systematic literature review (Zaino & Rasiya, 2022) with a 6-point linear priority scale of 1= 'extremely important' to 6= 'not important. The interview time lasted no longer than 20 mins. However, the Delphi technique is a scientific method to manage structured group communication processes to generate insights on current or possible challenges (Beiderbeck, 2021), especially in situations with limited availability of information. Each Delphi statement, along with the related questions, was shown in randomised order, which prevents the risk that experts put more effort into early statements or get collectively biased due to previous answers, specifically to avoid "Anchoring bias".
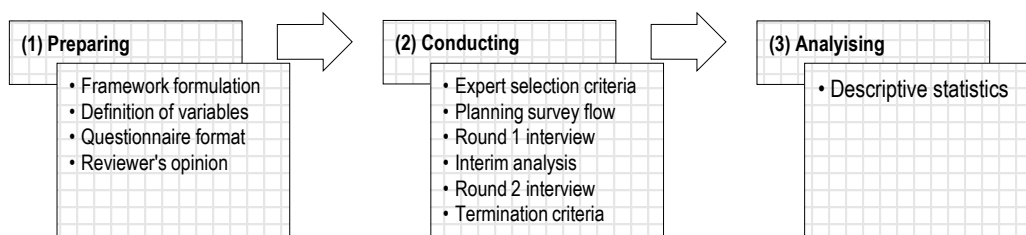

Fig. 1. Methodological approach
Source: Authors (2024)

Expert opinion was obtained using semi-structured interviews and the Delphi methodology. Subject experts were selected from the BlueHealth research initiative (an organisation that aims at investigating the links between blue spaces, climate and health). Expert's experience is holistic, ranging from various fields, including landscape architects, urban geographers, environmental scientists, and water and health experts. To reduce cognitive biases and improve assessment accuracy. Expert selection is very important in the Delphi technique. Therefore, we have followed specific criteria for selecting experts. We used the five criteria from (Beiderbeck et al., 2021) when selecting the Delphi panel. (1) panel size, (2) level of expertise, (3) level of heterogeneity, (4) level of interest, and (5) access to the panel. Identification of researchers specialised in blue space included (n=45). An invitation was sent to a total of (n=45) on Sat, 11/19/2022. A total of (n=11) experts agreed to conduct the structured interview, all had been registered in the blue space health initiative, and their experiences ranged from 6-30 years in the field (n=2 landscape planning

experts, n=2 urban geographers, n=1 environmental scientist, n=2 environmental health Expert, n=3 water and health experts, n=1 environmental architect).

Data was collated from each interview and analysed for repetitive responses. A two-round process was utilised to capture each group's option without compromising the response rate. In the first round, a brainstorming session was considered through an online pre-recorded video and a written introduction about blue space. The second round was a survey consisting of all unique responses grouped in themes with a 6-point linear priority scale of 1= 'extremely important' to 6=' not important. Participants were also invited to comment if they felt statements could be changed to improve the ease of rating. This online survey was emailed to all experts. Completed surveys were analysed prior to the administration of a second round survey consisting of the unique responses where consensus had not been agreed. The final analysis of the study was completed in March 2023. Ethical approval for this research was granted by The Research Ethics Committee of Universiti Teknologi MARA..

We aimed to determine the current option concerning what is perceived as being the best predictive IVs for the best stress reduction among experts. The opinions of 'experts' it captures a wide consensus of expert responses whilst avoiding biased from an individual. Whilst the participant size in this study is relatively small, we have captured a wide array of opinions from both professionals, male and female, landscape architects and non-architects with experience in blue health. From both males and females, various blue health backgrounds were interviewed to ensure a diversity of perspectives.

RESULTS

2.0   Table 2 Selection criteria of experts for Delphi interview

Summary of Expert Selection Criteria	
Criteria	Evaluation
Size of the panel	Invited (no=45), replied (no=11)
Level of Expertise	Registered in the BlueHealth research initiative. Holders of PhD in any related field, such as the environment, health, urban, landscape, biology, and water, with proven expertise in blue spaces. Research experience related to blue spaces
level of heterogeneity	We chose a comprehensive set of experts from different fields
level of interest	Will be evaluated during the first round
Access to panel	Unpredictable. (no=45) emails will be sent to the right expertise

Source: Authors (2024)

3.0   Table 3 Characteristics of participants that completed all aspects of the study

	Sex	Specialisation	Member of blue health research initiative
Subject 1	Male	landscape planning expert	Yes
Subject 2	Female	landscape planning expert	Yes
Subject 3	Male	urban geographer	Yes
Subject 4	Male	urban geographer	Yes
Subject 5	Female	environmental scientist	Yes
Subject 6	Female	environmental scientist	Yes
Subject 7	Female	environmental health expert	Yes
Subject 8	Female	environmental health expert	Yes
Subject 9	Male	water and health experts	Yes
Subject 10	Male	water and health experts	Yes
Subject 11	Male	water and health experts	Yes

Source: Authors (2024)

4.0   Table 4 Variables of blue space and response rate from 11 experts of blue space

Criteria	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11

Size of the blue space	1	2	1	1	4	5	4	4	1	3	1
Type of the blue space	1	3	5	1	4	5	3	6	1	4	2
Colour and clarity	1	1	6	1	4	3	1	1	5	1	3
Biodiversity	1	5	4	1	4	4	2	2	1	4	4
Texture	1	6	5	1	4	3	5	3	3	2	5
Time spent	2	4	1	1	6	4	6	4	4	5	4

Source: Authors (2024)

5.0   Table 5 Priority ratings of the variables

Criteria	Score	Rate
Size of the blue space	27	1
Type of the blue space	36	3
Colour and clarity	27	1
Biodiversity	32	2
Texture	38	4
Time spent	46	5

Source: Authors (2024)

DISCUSSION

Analysis of Data from the literature review

The literature review provided evidence that there is a lack of research and no deep understanding of the various restorative types and characteristics that can be utilised in designing spaces that support mental health. By having a better grasp of the positive and restorative qualities of blue spaces, we can design a better blue space for mental health (WHO, 2021) and (Gascon et al. 2015). The research tries to understand the design characteristics of blue spaces to determine which are more effective in stress reduction. There is an absence of categories of architectural design characteristics in blue spaces. Additionally, there is an absence of studies that aim to understand the physiological effects of blue space design characteristics on the stress levels of the blue space, all of which can help to understand blue space deeper to improve its stress-reducing effects (Gascon et al. 2015). We decided to start the study by searching and collecting the characteristics that influence the blue space quality. Systematic literature took place on March 2022 following the PRISMA guidelines (Zaino & Rasiya, 2022). Six variables were identified, including size, type, colour and clarity, biodiversity, texture and time spent in blue space. More studies focused on the type of blue spaces (n=3), size and colour of blue space had fewer studies (n=2) for each variable, whilst texture and time spent had only (n=1) studies found, the number of studies is not a measure of how important and effective the variables are. However, it gives us insight into how important the variable is between researchers. (Figure 2).
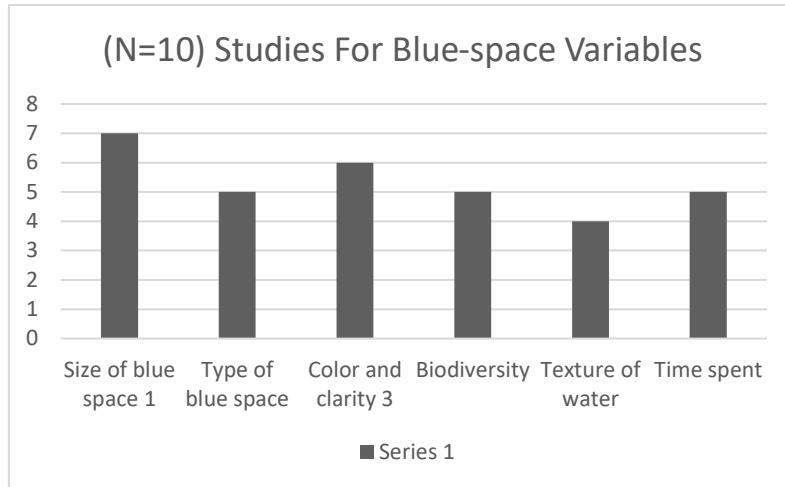
(N=10) Studies For Blue-space Variables

Fig. 2. The graph shows that a number of studies were found for each variable of blue space

Source: Authors (2024)

Analysis of data from the expert's perspective and Delphi interview

The variables extracted from the literature were further discussed and rated by experts from the blue-health research initiative. Another round of the survey was performed, consisting of all variables of blue space extracted from a systematic literature review (Zaino & Rasiya, 2022) with a 6-point linear priority scale of 1= 'extremely important' to 6= 'not important. The experts were selected from various backgrounds, yet all of them had a research experience in blue space.

Responses from experts showed a higher rate for the (1) size of blue space and colour and clarity, the second highest rate was (2) biodiversity of blue space, and the third place was for both texture and type of blue space. The last rated variable was the time spent.
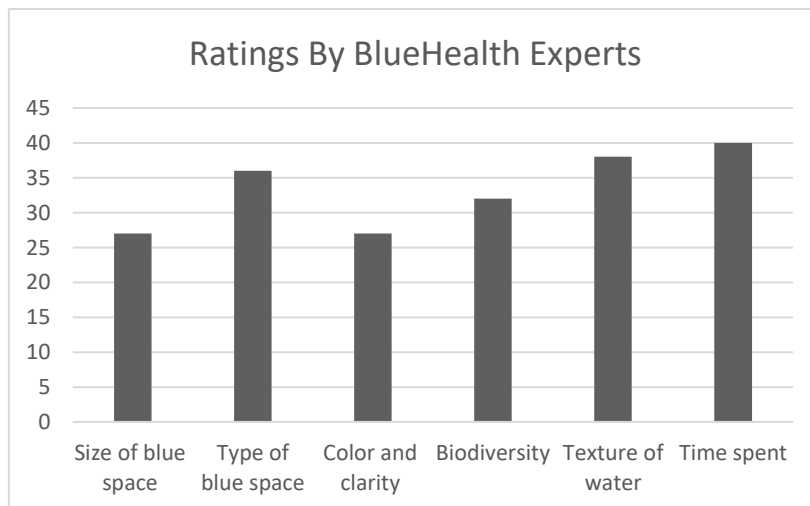
Ratings By BlueHealth Experts

Fig. 3 Chart presents the highest and lowest priority variables based on the ratings from experts. The low number means the higher the priority of the variable.
Source: Authors (2023)

Highest priority variable: The lowest number in the chart represents a high-priority variable in stress reduction. Findings from the Delphi interview with experts in blue space suggest that size and colour, and clarity had the lowest number (N=27). Lowest number refers to a high-priority variable as mentioned. Respondent 3 stated, "The size is important – an extensive ocean, sea or large lake where the views go the horizon provides many more possibilities than a small stream or pond. Respondent 4 commented, "the size is the most important feature comparing a water pond with a large tract of a river or the view of the ocean can be very effective." And also, it was commented, "In my research, we have found that water quality seems to be strongly related to recalled well-being from blue space visits. I have put size second as we typically find that the sea and coastal environments are associated with particularly high levels of well-being. Even in early examples of research by Herzog (1985) shows that the highest preference ratings were for "large bodies of water" implying that preferences might increase as the proportion of water increases. In their study, White et al., (2010) reached this conclusion. According to them, individuals were also ready to pay more for rooms with views of the outdoors that included water because they thought these views were more restorative. But, the relationship was not simple.

Equal importance: Few of the experts (N=3) gave an equal rating for all variables one has explained, suggesting that "all are equally important because stress reduction is a complex process and also because it is almost artificial to pull them apart. The type of blue space also often determines its size, colour, texture, and biodiversity. And these concepts are also related to each other. What does stand out for me is the time spent in BS. A greater amount of time spent in BS – in many cases – means more time spent in a recreational activity, which will benefit stress reduction."

The texture of blue space (N=2) experts commented about the texture of water, saying that they have no background nor experience with this variable, and they have some doubts about it. Whilst another expert noted the type and the texture of BS have more or less impact, more intricate natural textures favour full attention. However, they also stated that the texture of the water is so unpredictable and changeable according to the weather that I cannot see much correlation except that possibly in a more active condition where the water forms waves, the rhythmic movement can be calming. Perceived biodiversity is also related to naturalness. This is most likely to be on-shore biodiversity unless there are tidal pools or obvious water-associated vegetation and wildlife (reeds, birds, fish etc.) that is visible.

History and experience: He said that it's not possible to rate the variables. It depends on the individual and their history with blue spaces. There is evidence that early exposure in life to natural environments is important for the effects of blue space.

Colour and clarity: The opinions of some experts stated that apart from close views, colour and clarity are not an issue at a distance because the water then reflects the sky. At close distances, it may be associated with cleanliness etc. Time spent - the longer the time (up to a maximum, probably), the more the blue space experience can reduce stress.

Analysis of data from Delphi interview data vs literature review

We tried to find a correlation between data obtained from experts. Variables were rated similarly in the systematic literature review previously conducted about the same variables (Zaino & Rasiya, 2022). We rated the variables based on the number of studies found and put them in a butterfly chart (Fig. 4).
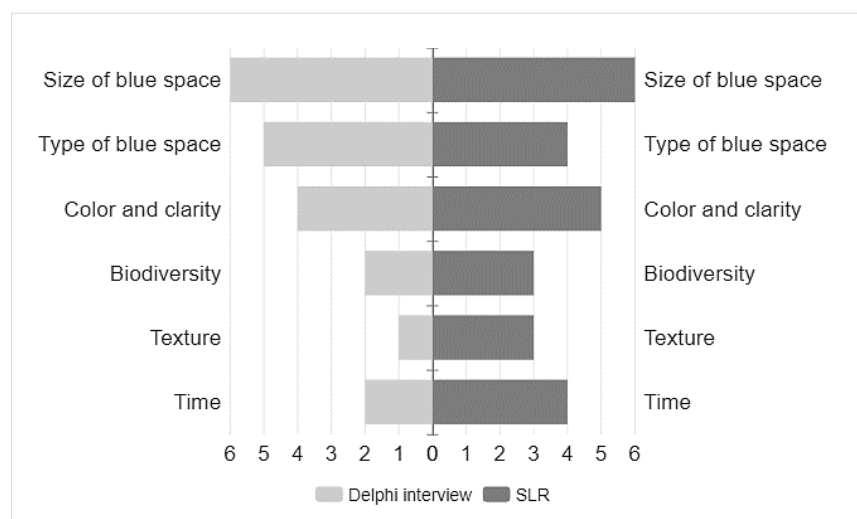
Fig. 4. Comparison between data obtained from experts interview vs LR, based on their priority

Source: (Authors,2023)

CONCLUSION

As far as we are aware, this is the first study that investigated a number of characteristics of blue space simultaneously. Our findings from experts showed a higher rate for the (1) size of blue space and colour and clarity, the second highest rate was (2) biodiversity of blue space, and the third place was for both texture and type of blue space. The last rated variable was the time spent. We also tried to find a correlation between data obtained from experts VS the systematic literature review previously conducted about the same variables, and there seems to be a match in regard to the priority of some of the variables. For example, the most priority variable based on the expert's opinion was the size of the blue space. In contrast to that, our systematic literature shows that the highest number of the study was for the size of the blue space, also. Although we believe that the stress-reduction process is a complex process involving many things, such as past experience and emotional status, we believe that the physical aspect of blue space is effective. And it is possible to study it in isolation from all other variables by controlling other variables.

ACKNOWLEDGEMENTS/FUNDING

CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Ammar Ayman Zaino was the primary researcher who conducted the scoping review and Delphi study. He was responsible for compiling the comprehensive list of potentially influential factors for blue space characteristics related to stress reduction. Zaino then designed and executed the qualitative Delphi study, engaging eleven (11) BlueHealth experts from diverse disciplines to evaluate the significance of these variables. He analysed the data collected through the expert interviews and developed the framework identifying the priority blue space variables for stress reduction, such as size, colour/clarity, biodiversity, and time spent in the blue space. He was the main author, writing and revising the manuscript for publication.

Jamalunlaili Abdullah provided supervision and guidance throughout the research process. As a senior author, Abdullah helped shape the research objectives, methodology, and interpretation of the findings.

Aishath Rasiya, contributed to the writing and review of the manuscript. Her insights on the relationship between architectural elements and human emotions helped strengthen the conceptual framework and its practical implications.

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