

Designing interior spaces for hyperthyroid patients in hot climates. (A sustainable and energy efficient approach - Applying on an office space design)

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Abstract

As a result of global warming, a dramatic rise in temperatures is increasing rapidly across the globe, with naturally hot countries like Egypt experiencing even more severe increases. This leads to unbearably hot interior spaces, pushing people to seek unsustainable solutions, such as excessive air conditioning and temporary cooling devices. These methods often exacerbate the problem instead of solving it, and unfortunately, some people cannot tolerate extreme heat due to medical conditions.

This paper aims to develop sustainable, energy-efficient design guidelines that can be followed when designing for clients suffering hyperthyroid problems in specific who represent a significant yet often overlooked segment of the population and despite it being considered one of the most common immune diseases of this era and despite patients suffering the most from high temperatures than normal people, leading as a result to increased stress, nervousity, and loss of focus among other symptoms. The paper emphasizes the role of interior design in addressing different user needs while simultaneously promoting environmental sustainability. To achieve this, the paper follows the experimental-comparative method using Design Builder software. An office space design is selected because working spaces are always a fertile ground for activating those symptoms even more. Various proposals are tested, including material finishes, usage percentages, and spatial orientations. The performances are compared to determine the best options for achieving thermal comfort for hyperthyroid patients. The paper reached an important conclusion about the optimum sustainable material selection, percentages of usage, style to follow in an overall sustainable, energy efficient strategy and much more...

Keywords

Sustainability, hyperthyroid patients, office space design, thermal comfort, energy use, interior design.

الملخص

نتيجة لظاهرة الاحتباس الحراري، يتزايد الارتفاع الكبير في درجات الحرارة بسرعة في جميع أنحاء العالم، وتشهد البلدان ذات الحرارة المرتفعة مثل مصر زيادات أكثر حدة مما يؤدي إلى ارتفاع درجة حرارة الحيزات الداخلية بشكل لا يطاق، الأمر الذي يدفع الناس إلى البحث عن حلول غير مستدامة، مثل الإفراط في تكييف الهواء وأجهزة التبريد المؤقتة وغيرها. وغالبًا ما تؤدي هذه الطرق إلى تفاقم المشكلة بدلاً من حلها، وللأسف، لا يستطيع بعض الأشخاص تحمل الحرارة الشديدة بسبب ظروف طبية. تهدف هذه الورقة إلى تطوير إرشادات تصميم مستدامة وموفرة للطاقة يمكن اتباعها عند التصميم للعملاء الذين يعانون من مشاكل فرط نشاط الغدة الدرقية على وجه الخصوص والذين يمثلون شريحة كبيرة ولا يتم إلقاء

الضوء على هذا المرض بالرغم من إعتبارها واحدة من أكثر الأمراض المناعية شيوعاً في هذا العصر بالرغم من معاناة المرضى من إرتفاع درجات الحرارة أكثر من الأشخاص العاديين، مما يؤدي نتيجة لذلك إلى زيادة التوتر والعصبية وفقدان التركيز من بين أعراض أخرى. تؤكد الورقة على دور التصميم الداخلي في تلبية إحتياجات المستخدمين المختلفة وفي نفس الوقت تعزيز الإستدامه البيئية.

ولتحقيق ذلك إتبع الورقة المنهج التجريبي المقارن باستخدام برنامج Design Builder ، ولقد تم اختيار تصميم الحيزات المكتبية لأن حيزات العمل دائماً ما تكون أرضاً خصبة لتفعيل تلك الأعراض بشكل أكبر. تم اختبار المقترحات المختلفة، بما في ذلك خامات التشطيب ونسب الاستخدام وأماكنها بالحيز ومقارناتها لتحديد أفضل الخيارات لتحقيق الراحة الحرارية لمرضى فرط نشاط الغدة الدرقية. ولقد توصلت الورقة إلى بعض النتائج الهامة حول الاختيار الأمثل للمواد المستخدمة، ونسب الاستخدام، والأسلوب الذي يجب إتباعه في استراتيجيات شاملة مستدامة وفعالة في استخدام الطاقة وغيرها الكثير...

الكلمات الإفتاحية

الإستدامه، مرضى فرط نشاط الغدة الدرقية، تصميم الحيزات المكتبية، الراحة الحرارية، إستخدام الطاقة، التصميم الداخلي

Introduction

The world has become a very stressful place and this leads every day to the increase in the number of diseases associated. Global warming and the noticeable unbearable rise in temperatures is a significant factor in increasing stress levels and other diseases as well. As per studies “Extreme heat poses a direct threat to cardiovascular and respiratory health and is projected to cause approximately 250,000 additional deaths per year between 2030 and 2050 from heat stress alone”. (World Health Organization, 2023). So Can we imagine people already feeling temperatures higher than normal ones due to medical issues? Living in hot climate countries like Egypt that have no other solution than seeking unsustainable solutions such as excessive air conditioning and temporary cooling devices to compact the heat damaging the environment even more.

This paper will focus on a largely overlooked group that has been silently suffering despite their significant numbers “Hyperthyroid patients” and despite it being one of the most common disease of our time .The paper contributes to finding ways to better design interior spaces for hyperthyroid clients ,yet they won't be the only ones benefitting, but a lot of people around , as a recent study investigating data from 897 buildings worldwide found that 39% of building occupants are dissatisfied with their thermal environment and 35% stated the negative impact of this on their working performance as well (Graham et al., 2021).

Coming back to the focus of this paper, Thyroid Gland diseases are the most abundant endocrine disorders to be second after diabetes (Hage et al., 2011). According to the American Thyroid Association, only in the United States of America (USA), it is reported that 20 million American suffer from this disease and at least 12% will develop a thyroid condition during their lifetime, mostly in women especially over the age of 50 (Muñoz-Ortiz et al., 2020), while another study says it is between the age of 20 to 40. The matter was further proved in different parts of the world, chances of women getting this disease in specific is known to be much higher in general especially with age, yet the exact percentages in data for ethnic as well as age differences are scarce based on scanning all the available data (Author 2024).Whoever is the unlucky to be

attacked by this disease, the good news is that this disease can still be cured either by a surgery or by tablets, but it can easily return again based on general patient life style and general surrounding environment factors. The struggle is even higher when those people live in extremely hot climates like Egypt no doubt where a noticeable high percentage is already recorded and is estimated to be even higher than recorded due to this disease being associated with other diseases that are already widespread in Egypt , in addition to other factors that may stimulate the spread of the disease further and the will be discussed in details and numbers in the problem section (Author 2024) .On the other hand, Despite the seriousness of this disease and its danger impact on all body functions, there are no deep investigations on how we can design appropriate interior spaces for this category of people so as we can at least avoid activating the disease symptoms and still following a sustainable energy efficient approach .In addition , most of the research done is basically on impact of interior space design on mental health and general wellness, but there are no available research on impact of interior space design and material finish selections on this type of disease in specific. The conclusion can be of great importance specially when being required to design an interior for this particular type of customer who has to struggle with this type of this disease for the rest of his life and that as well in hot climate countries like Egypt.

Research Problem

-Despite the rising global prevalence of hyperthyroidism, including Egypt, there are no design guidelines for interior spaces tailored to hyperthyroid patients. In Egypt alone, 19.2% of patients suffer from hyperthyroidism, with an additional 15.8% undiagnosed subclinical cases going unnoticed, primarily affecting women aged 21-40 (Rashad & Samir, 2020). This percentage could be significantly higher due to widespread diseases like cardiovascular conditions and Graves' disease, responsible for 93.9% of cases (Elsherbiny, 2023), along with hepatitis C and diabetes contributing to thyroid dysfunction (Fayed et al., 2020) and even more higher by Globally hyperthyroidism affecting 0.2% to 2.9% of populations, particularly in iodine-deficient areas Egypt included (Taylor et al., 2018), making it easily considered a "silent monster," steadily growing in the shadows, fueled by environmental factors like pollution, stress, and modern lifestyle pressures. Putting even healthy individuals at risk especially if with family history of the disease. To our shock, In Egypt the situation is even worth as it was noticed that disease does not target middle aged women only but young children as well. In Egypt, 13.6% of South Sinai schoolchildren have goiter, indicating thyroid enlargement despite the national salt iodization program, with 31% of children showing low urinary iodine levels (Yamamah et al., 2013).This combined with the prevalence of Graves' disease known to be one of the top reasons for hyperthyroidism (Elsherbiny & El-Aghoury, 2024) even in iodine-sufficient areas, making hyperthyroidism a significant concern, affecting both children and adults (Hatch-Machesney & Lieberman, 2022).

- Resorting to unsustainable and energy consuming solutions in interior space that destroys the environment even more to make it feel cooler.

AIM

- Reach some design guidelines (following a sustainable, energy efficient) approach for reference when designing an interior space to customers suffering from hyperthyroid disease in Egypt specifically and all over the world in similar hot climates generally.
- Proposing energy efficient sustainable solutions through interior space design.

Importance

- Generate design guidelines for interior spaces designed especially for hyperthyroid customers for designers as an overlooked segment of people.
- Encouraging following a sustainable and energy efficient approach in interior designing to save the environment.
- Test the power of different interior space finish solutions on interior space thermal comfort.
- Finding interior space solutions that can achieve the required thermal comfort for hyperthyroid clients in specific and other people suffering the same in general.
- Encouraging interior designers to learn more about BIM programs as a good reference for designing in a sustainable way.

Methodology:

The paper follows the meta-analysis, experimental and comparative method where different already available data on impact of interior design elements on symptoms similar to the symptoms of hyperthyroid patients will be analyzed, design guide lines will be initially concluded then experimenting with different proposals and compare results to conclude the best one and confirm or deny the initial concluded design guidelines using BIM based app (Design builder) takes place.

Hypothesis

Mixing different design solutions that cure different symptoms similar to symptoms resulting from hyperthyroid disease can lead to concluding design lines that help in designing overall interior environments and can control activation of hyperthyroid disease in people who have been historically suffering from it by keeping the temperature cooler and achieving thermal comfort all in a sustainable, energy efficient way.

Limitations

-Spatial limitations: The study focuses on Egypt given the high percentage of disease recorded which are prone to be even higher and given that Egypt is considered a hot climate country. Yet the concluded design guidelines can be applied to design any interior space in any hot climate in the world.

-Temporal limitations: The study focuses on data no older than 11 years with most references ranging from 2013-2024.

-Data availability

No prior research has been found that specifically addresses the design of healthy interior spaces for individuals suffering from hyperthyroidism, making this paper the first to explore this important topic.

PAPER STRUCTURE

The paper will be divided into 6 main sections excluding the introduction as follow:

Table1, paper structure and section's objectives (Author, 2024)

Section number	Title	Section objective
2	Hyperthyroidism definition and causes	In this section hyperthyroid symptoms will be analyzed in detail were symptoms that can be cured through interior design elements will be specified.
3	Controlling hyperthyroid symptoms through interior design elements	In this section the meta-analysis method will be applied by analyzing previous study results and solutions to cure symptoms similar to that of hyperthyroid patients, in addition to analyzing different studies that address the impact of different interior design elements on the previous addressed symptoms.
4	Initial concluded design guide lines	Based on all the previous studies, some considerations will be concluded to be tested in the following section.
5	Testing and experimenting with selected materials usage alternatives impact on office space temperature	In this section, several design alternatives for an office space design will be conducted using the concluded materials and thermal comfort will be compared using BIM app (design builder).
6	Final Concluded design guide lines for hyperthyroid customer's interior	In this section the final guide lines will be concluded after testing.
7	Conclusion, Recommendations and future studies	

HYPERTHYROIDISM CAUSES AND PATIENTS STRUGGLES.**HYPERTHYROIDISM DEFINITION AND CAUSES**

The thyroid gland is a small organ that's located in the front of the neck, it's shaped like a butterfly, smaller in the middle with two wide wings that extend around the side of the throat (Kawashima et al., 2011). There are several diseases associated with this gland mostly related to a disorder that occurs leading the thyroid gland to generate either less or more thyroid hormones than what the body needs. This paper will focus on the type of disorder that makes the gland generate more than what is required and that is known as "Hyperthyroidism".

Hyperthyroidism scientifically is defined as "the excess secretion and release of thyroid hormone by the thyroid gland sequencing in improperly high serum levels". The thyroid is responsible for the general body metabolism and different organs' function and any disorder does impact the whole body. The cause for this disease is partially genetic, yet external

environmental factors can help in activating the disease for those who are ready for it genetically.

Hyperthyroidism Patient Struggles

Hyperthyroidism patients always suffer from nervousness or irritability, fatigue and muscle weakness, heat intolerance, sleeping disorder, rapid and irregular heartbeats weight loss and mood swings(Mayo Clinic, 2024).We undoubtedly cannot control all external factors leading to hyperthyroidism activation like dealing with everyday pressure, hard people and general daily struggles ,but as interior designers ,we can surely design spaces that at least do not play an additional role in activating those symptoms ,but on the contrary can play a good role in controlling some of those factors to a great extent instead of acting as a catalyst and worsen the matter and damage the environment in the process .

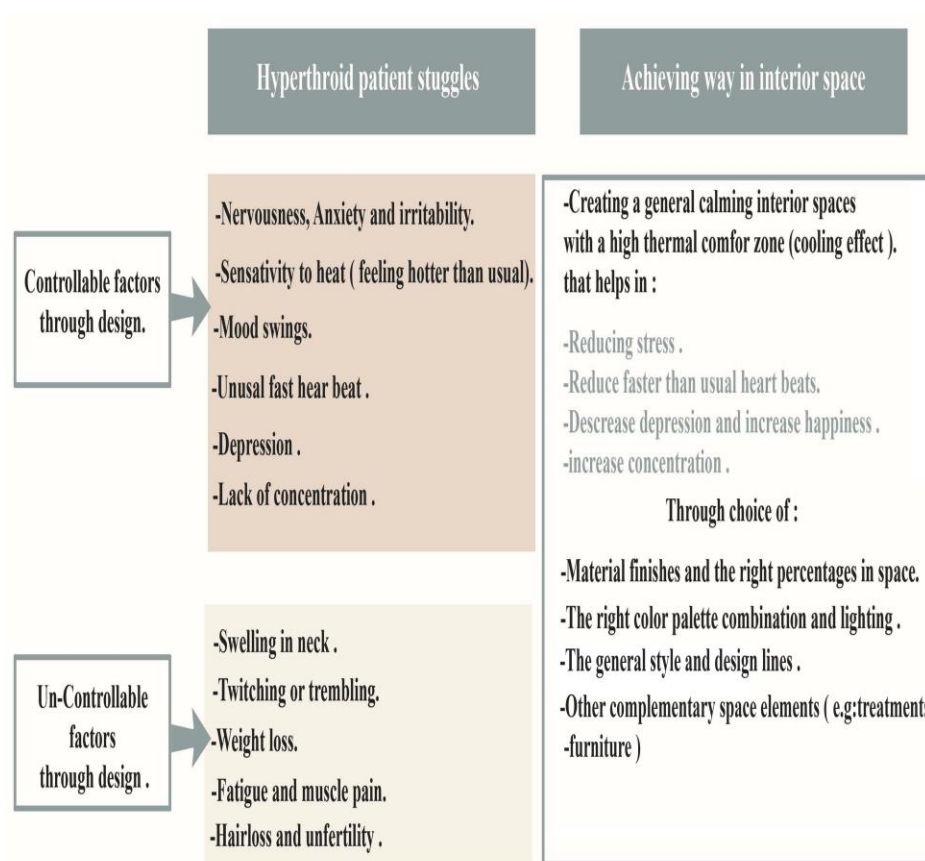


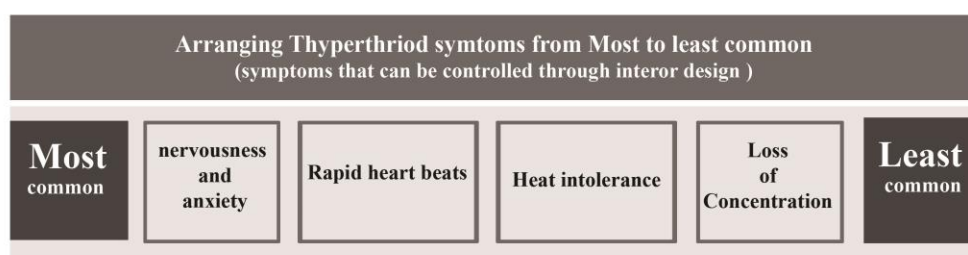
Figure (1) _ hyperthyroid patient struggles and ways of controlling through design (Source: The Author, 2024)

By deeply analyzing the struggles, it is concluded that hyperthyroidism patients are mostly in need of interior spaces that gives a calming effect to decrease anxiety, nervousness and decrease heart beat rate in addition to spaces that helps in achieving thermal comfort and in this case

giving a cooler effect than the actual temperature so that hyperthyroid Patients feel comfortable in addition to spaces that can help in concentration. Most of those factors can be achieved through the right choice of materials, colors, general design lines as well as other complementary items which we will be trying to conclude by the end of this paper. Accordingly, the previously mentioned factors will be deeply investigated in the coming section.

Controlling Hyperthyroid Symptoms Through Interior Design Elements

A lot of researches have already proved impact of different interior design elements (wall, ceiling, floor treatments in addition to furniture materials ...etc) on users' general well-being in the space but none have focused on hyperthyroid disease in specific. By investigating the common symptoms and trying to arrange (the ones that can be controlled through interior



design) from the most common to the least common it can be summarized as follow:

Figure (2) _ hyperthyroid symptoms from most common to least common (Source: Author, 2024)

In this regard, it is worth mentioning that materials have a vital role in forming both the physical and psychological form of the space, materials do form the external structure as well as integrated in all interior design elements (ceilings, floorings till furniture and other complementary elements). In other words, it forms the majority of the interior space, making it a priority to investigate in curing or decreasing symptoms of hyperthyroid patients. By checking (fig.2) , it is worth mentioning that nervousness and anxiety can contribute in the other three popular symptoms making them related to each other, and the solution for both are mostly related which is clear by analyzing previous studies in the matter , while heat intolerance symptom will be related to investigate materials that can create the necessary thermal comfort , in this case cooling the actual room temperature in different ways based on material different specifications that will be investigated deeply .

Material Finishes Impact

Along the years, several studies and experiments have been done to test the impact of material finishes on interior space user's general health, stress levels, concentration levels and heart beat rate. In this section the meta-analysis method is applied and the table attached below summarized some of the most prominent studies in the last 10 years and results with aim to conclude some interior finishes that can be the optimum selection when designing for a hyperthyroid patient customer based on the hyperthyroid patient struggles and needs concluded in the section above.

Criteria of paper selection (for analysis) is done using keywords like: Interior material finishes impact on Thermal comfort, human health, stress levels and a combination of those and the papers are arranged below from the most recent to the older ones as follow:

Table (2), most prominent papers to symptoms similar to hyperthyroid (Author, 2024)

Study no.	Hyperthyroid symptom like	Study year and short description	Important findings
1	Nervosity, anxiety and rapid heart beats	Ojala et al. (2023) conducted an experiment to investigate the impact of wooden materials in office environments on human psychology and physiological well-being with a target to measure the impact on different aspects: Psychological (anxiety, mood, energy, restoration) and physiological (heart rate variability, skin conductivity) responses were recorded.	Regarding Psychological factors (e.g. Anxiety, Mood, energy, and negative emotions), all are proved to be positively better in the wooden room. Yet when it comes to other Physiological effects (e.g.: the sympathetic nervous system), it has proven to be more active in parts of the experiment as contrary to expectations.
2	Stress (Nervosity and , anxiety)	Douglas et al. (2022) have done a recent experiment to test interior material finishes as well as other elements on biobehavioral outcomes (e.g : stress and anxiety).	In terms of self-reported negative arousal and physiological (skin conductivity) measures, participants' immediate stress reaction was lower in a room with natural materials—such as wooden tables and chairs—than in a room with artificial materials.
3	Stress and heart beat rate	(Grote and Frühwirth, 2021) done an experiment to test Cardiorespiratory interactions (heart beat and respiration) of users while sleeping on beds of different materials in specific a bed made of melamine faced chipboard with a wood-like appearance, while the other type was made	The results showed that a reduction occurred in stress parameters and decrease in heart beats upon contact with solid wood surfaces than artificial ones.

		of solid wood from stone pine (Pinus cembra).	
4	Nervosity and anxiety	A study done by(Li et al., 2021) with an aim to test the effect of percentage of wood used in interior spaces on people's visual psychological perceptions. The study compared varied levels of wood utilization in interior environments and looked into how wood covering and surface variations affected visual attention and psychological impressions.	Spaces with a moderate amount of wood use drew more visual attention and elicited psychological sensations of naturalness, warmth, relaxation, and want to use.
5	Heart beat rate	(Schreiner et al., 2020) , mentioned about an experiment that was done to test the impact of Wood on stress levels and heat beat rates by comparing between a Japanese traditional room that has wood mainly on the flooring and another that has wood integrated in other elements in the design.	The experiment recorded a significantly increased heart beat in the more designed room that has wood integrated in other areas rather than flooring.
6	Concentration levels	Several studies done in the year 2020 to test different interior material finishes impact on concentration levels with an experiment mainly done to compare wood finishes with concrete ones . Shen et al. (2020) , Lipovac et al. (2020).	Shen's study concluded less mistakes conducted by the users of wooden room in comparison to the concrete one, while Lipovac's study denied this difference.
7	Stress and heart beat rate	Burnard and Kutnar (2019) did a study showing that Sympathetic Nervous System (SNS) is influenced by the view of different wood finishes and the duration of this view .	cortisol levels decreased in front of a light-colored oak desk, whereas cortisol levels were unaffected by a dark walnut desk in a relatively long duration of 75 minutes, while less duration of 1 or 2

			minutes proved of having no effect.
8	Nervosity and anxiety (through sensory experience)	An experiment done by Bhatta et al. (2017) investigated how people perceive wooden surfaces through touch by testing several ones impact on human emotions	-Natural wood finish (sanded, brushed) was perceived more positive than coated ones (e.g.: Varnished, waxed) and have scored higher in its impact on relaxation as one of the most important targets here.
9	Nervosity and anxiety (through sensory experience)	(Ikea et al., 2017) has done an experiment comparing oak to other materials (marble , tiles , stain steel) impact on brain activity and autonomic nervous activity through touch .	The study shows the calming effect of touching wood in comparison to other materials on the nervous system and heart beats especially oak.
10	Nervosity and anxiety (through sensory experience)	(Burnard et al., 2017) , investigating impact of wood color on stress levels.	The study proved that lighter colored wood especially oak helps in lowering stress levels in comparison to other dark colored wood (e.g : walnut) when under the same other conditions.
11	Nervosity , anxiety and heart beat rate	In a study presented at the 9 th Biennial Conference on Environmental Psychology (Kelz et al., 2011), researchers were investigating impact of wood in comparison to other materials on students' stress levels and heart rate beats in the classrooms.	Classrooms featuring wooden flooring, ceilings, cabinets, and wall panels have been demonstrated to reduce pupils' heart rates and perceived stress when engaging with teachers. In contrast to traditional classrooms with linoleum flooring, plasterboard walls, and chipboard cupboards where students' heart beats and stress levels climbed
12	Nervosity and anxiety (through sensory experience)	(Nyrud and Bringslimark, 2010) investigated in their study the best place for wood usage for the best impact.	The study concluded that it has the best impact on vertical walls.

13	Nervosity and anxiety + heart beat rates	(Tsunetsugu et al., 2007) in an experiment tested the impact of different wood material percentage usage in an interior space on stress levels through measuring blood pressure and hear beats due to complexity and impact on general mood , 3 percentages were tested 0%, 45% and 90% in a room of area 13m ² .	The results showed that the most comfortable with a positive impact was applying wood with a percentage of 45% and as opposed to predilections increasing wood percentage to 90 % proved to increase hear beats .
14	Nervosity and anxiety by regulating mood swings	Sakuragawa's (2006) study tested the prefrence of wood usage in different interior elements through a group of photos shown to audience .	The photos showing wood materials only used for flooring were selected the best and the most livable places to live in .
15	Stress (Nervosity , anxiety)	(Sakuragawa et al., 2005) have done an experiment examining human stress responses in two offices with wood furniture (one with oak and one with American walnut) in comparison to an office with white furniture in a within-subjects design.	Stress levels throughout the entire period and during the response period were significantly lower in the oak environment.

By deeply investigating previous paper's findings, it is clear that Wood generally and to a great extent has proved to have a positive impact on human's stress levels, anxiety and hear beat rates and is always a winner when in comparison with other materials, yet it was found that the percentage of wood used , the areas where it is used and the visual aspect of wood (color and texture) play a vital role as well (referred to in papers no.(4,5 ,7,10,11,12,13,14,p.8,9). Natural wood is always the better option when compided to artificial wood (referred to in papers 2,3, p.7). By scanning papers, Oak wood has proved to have a very positive impact in comparison to other wood species as well as other materials in general in curing a lot of the symptoms previously mentioned whether through sight or touch (Author 2024), this in addition to its hygienic properties where Oak wood has proved to be a favorite even in clinics and hospital areas due to its antimicrobial activity when compared to other types (Lipovac & Burnard, 2021)

It is worth mentioning that the papers mentioned above are selected based on them addressing the impact of different material finishes on symptoms similar to the ones hyperthyroid patients suffered from, but there are also other papers that address impact of interior material finishes on other aspects which can generally be classified as follow (Author 2024):

Classification of papers investigating impact of material finishes on users in

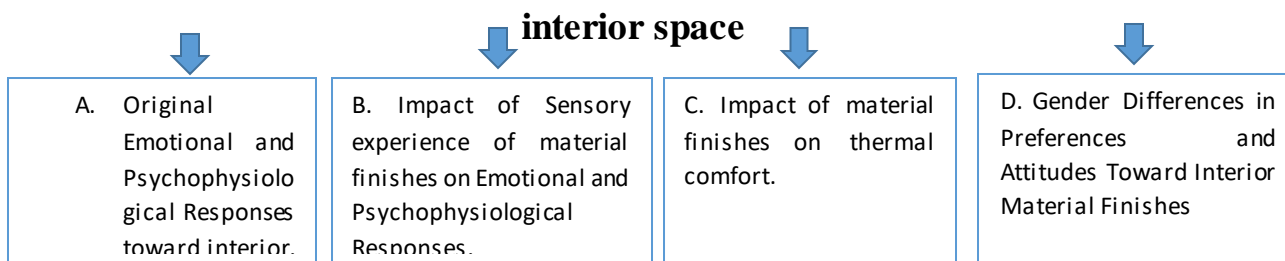


Figure (3) -

classification of all papers available related to material finishes (Source: The Author, 2024)

A. Original Emotional and Psychophysiological Responses toward interior material finishes:

Papers falling into this category discuss impact of material finishes in interior space on general satisfaction with the space, comfort, relaxation stress levels which is directly linked to the Psychophysiological Responses represented on: Heart rate, Blood pressure, Skin Conductance and Neurophysiological Responses.

B. Impact of Sensory experience of material finishes on Emotional and Psychophysiological Responses:

Papers falling into this category discuss the impact of seeing a material from a visual aspect (color, texture) , touching it (smooth , rough) , smelling the odor and other sensory related aspects on the emotional and Psychophysiological Responses as well (either for one of the 5 senses) or the impact of a multi-sensory experience .

C. Impact of material finishes on thermal comfort:

Papers that fall in this category discuss the impact of different material finishes on interior thermal.

D. Gender Differences in Preferences and Attitudes toward Interior Material Finishes:

Papers that fall into this category address impact of different material species, color and texture on user’s mood and general satisfaction based on gender (male or female).

The difference between point (A) and (B); Category A takes a broader view of the impact of material finishes on emotions and physiological states without detailing specific sensory experiences, whereas Category B focuses on the nuances of how distinct sensory interactions (visual, tactile, auditory) with materials affect those responses either one of them or combined. By scanning papers falling into each of the four previously mentioned categories, the matter that Stimulated the author’s curiosity even more to investigate, is there a link between the four categories? Can the sensory experience of a material impact the way user perceive interior space temperature achieving the required thermal comfort even if not with real decrease in room temperature (in this case)? Can material sensory feel have an impact on users’ overall satisfaction and does it differ and from male to female?

There is no doubt that the sensory feel of a material impacts human Psychophysiological Responses. A Japanese study was conducted to know impact of different wood type odors on stress level and heart rate beat , in specific oils from cedar and pine wood among others , where Pine odor was perceived as the most pleasant among the wood odors, whereas cedar wood odor was perceived as the least pleasant. The odor of lavender was rated as being pleasant (Schreiner et al., 2020). Other more recent studies started to investigate a more complex direction of multi-sensory experience impact. A recent study has done an experiment using VR technology where it has been proved that a Multisensory experience significantly improve thermal comfort and perception and to the surprise Gustatory and auditory stimuli were proved to be the most effective (Marey & Alsabbagh, 2022).

Based on the previous, it was initially concluded that (Author 2024):

- Oak wood in specific is always a favorite when compared to other wood species and its impact on human overall health solving a lot of hyperthyroid like symptoms (regulating stress, anxiety and nervousity as well as rapid heartbeats. In addition, wood has proven to a great extent to be a good helper in increasing concentration levels despite a study or two arguing that it makes no difference.
- Natural wood without being given an artificial finish is always a better option.
- Creating a multi-sensory experience and using Wood (in this case Oak is suggested) with the right percentage of max.45% and mixing it with another one of pleasant odor can help in decreasing anxiety and quick heat. And now the question comes: Can Oak wood be the solution to ‘heat intolerance symptom and contributing in achieving the required thermal comfort (in this case cooler temperature? To answer this question a deeper dig into thermal comfort and how to achieve it generally is required. It is worth mentioning that factors affecting thermal comfort in interior space can be classified as follow:

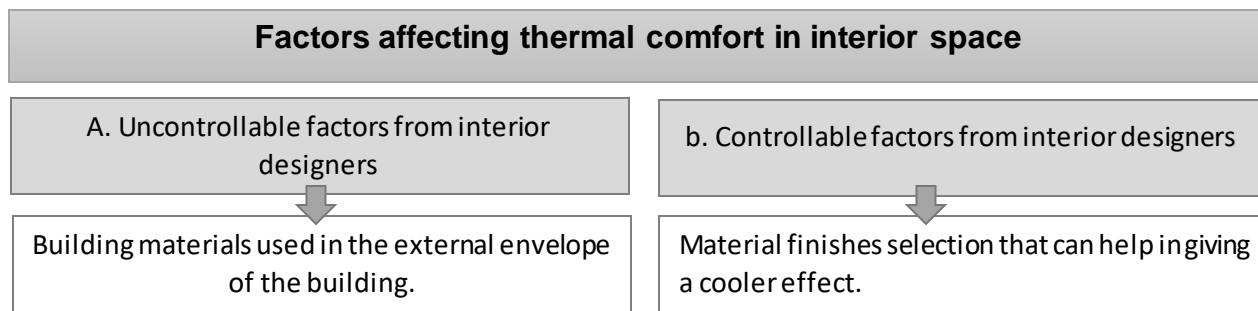


Figure (4) _ Factors affecting thermal comfort in interior space (Source: Author, 2024)

A. Uncontrollable factors: are the factors that interior designers have no say at it which is mostly related to external building materials that have a core impact on interior thermal comfort, orientation and openings. This point is the one most covered in papers published (Author 2024).

B. Controllable factors from interior designers: On the contrary to point A; We can smartly and accurately select materials to try and make interior spaces cooler by selecting materials that retards audio transfer for instance. This point has almost little to no existence in published papers (the Author 2024).

To further investigate if oak wood can really contribute in the heat intolerance symptoms by acting as a heat insulator to keep interior spaces cooler and if there are any other wood species (given the pros of wood usage previously mentioned) that the papers previously mentioned have

not investigated or mentioned and can be of a good choice. It is important to know factors that actually.

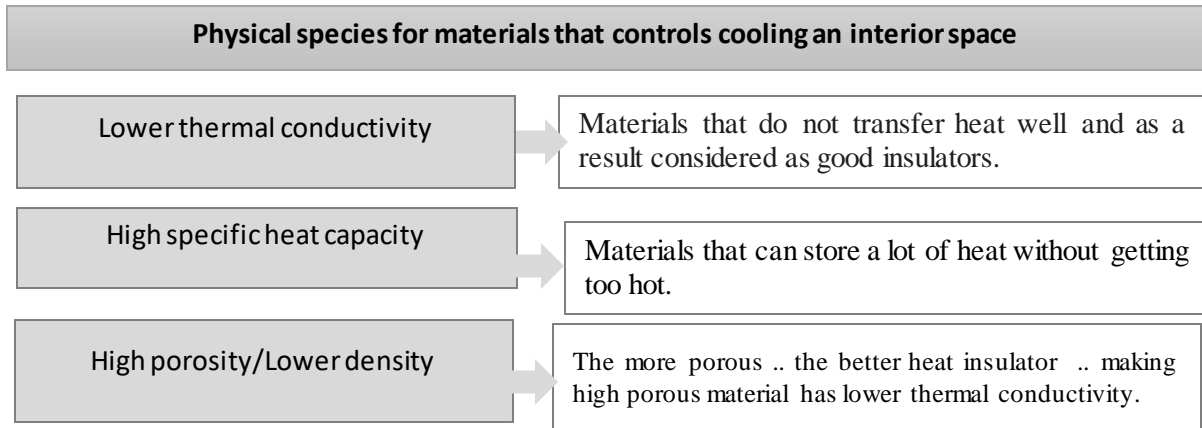


Figure (5) _ influential material specs in cooling (Source: The Author, 2024)

The following table will arrange types of wood from the best to the least in each of the previously mentioned species keeping in mind that the one factor that have the highest impact are the ones that fall in (the lower thermal conductivity category):

Table (3), list of wood species from the most to least of each category (Source, the Author 2024)

Lower thermal conductivity	High specific heat capacity	High porosity/Lower density
Canadian poplar	Oak	Balsa
Monterey cypress	Beech	Canadian poplar
Black poplar	Birch	Monterey cypress
Fir	Maple	Black poplar
Aspen	Ash	Fir
Bass wood	Elm	Aspen
Cedar	Hickory	Basswood
pine	Walnut	Cedar
spruce	Mahogany	Pine
hemlock	Spruce
Balsa	hemlock

In addition to the schedule above, it is worth mentioning that in regard to (thermal conductivity), there are other species that are slightly higher than the previously mentioned yet they are considered good heat insulators in order as follow : maple , birch, Ash, oak, Walnut and mahogany . By deeper investigating the schedule as well as gathered info. It can be concluded that wood species worth trying and deeper investigate when designing for hyperthyroid clients are (Author 2024):

●First: Canadian poplar

Being the top in lower thermal conductivity list as well as second in lower density list as well as a type of wood easily found in Egypt, it is worth investigating more. The second and third type in the list will be ignored as they are not widely available in Egypt.

●Second: Oak wood

Despite it being not the lowest in thermal conductivity list, yet it is considered a good insulator, being the top one on (High specific heat capacity list), in addition to the other advantages (previously mentioned) in lowering heart beats and decreasing stress in addition to being available in Egypt which makes it an overall very good option to keep in consideration.

Since, wood has been proved to be better used in interior space within a specific range not exceeding 45%, the search for other materials that can contribute in making interior spaces cooler to be used with wood is a must, in this regard, another material known to keep spaces cooler (even if not with actual decrease in temperature) are stones. As the table above, this table summarize different stones based on the same three factors as follow:

Table (4) _ list of stone spices from the most to least of each category (Source, Author 2024)

Lower thermal conductivity	High specific heat capacity	High porosity/Lower density
Soapstone	Marble	Tuff
Pyrophyllite	Limestone	Travertine
Diatomaceous earth	Sandstone	Limestone
Vermiculite	Granite	Sandstone
Perlite	Soapstone	Slate
.....	Lava rock

Based on the table below, it's concluded that stones that can be a good option for trial and further investigations can be summarized as follow:

▪First: Soap stone

Reason of choosing it is topping the list of (Lower thermal conductivity), in addition to being available in Egypt in comparison to others on the list .

▪Second: Marble.

Reason of choosing it is topping the list of (High specific heat capacity), making it a good option to not contributing in heating the space quickly at least.

Digging deeper in usage of marble and trying to identify specific types better than others in full filling the target and by analyzing marbles, it is concluded that the following types have lower thermal conductivity than the average thermal conductivity of marble (which is 2.53 W/mK : White Onyx (2.07 W/mK), Carrara marble (2.53 W/mK), Thassos marble (2.75 W/mK) , Crème marfil marble (2.87 W/mK) , Calacatta marble (2.94 W/mK). In this case Carrara marble will be used in the experiment being the most available one in Egypt as well as being cheaper than other types, as well as being known to have a high thermal mass in addition to being a healthier option than other materials as studies have proved that marble is a better option than granite where some types cause respiratory tract diseases due to the radon gas they spread to the environment.

Based on the previous, it was initially concluded that (Author 2024):

- A Good material selection for cooler interior spaces can be using Oakwood with a controlled percentage as well as carara marble. Now, what about paints as another main material and other factors contributing to interior space mood? The answer to this question will move us to investigate Colors (Represented as Paints material) as well as light.

Colors And Light

First: Colors

There is no doubt that the right choice of colors (represented in paints) can have a positive impact in controlling anxiety, stress levels and even help in increasing concentration levels. Color impacts have been historically discussed in different cultures, the matter started with the idea of color therapy that first appeared in the ancient Egyptian culture, who used activated solarium rooms constructed with colored glass for therapeutic purposes (Gul, Nadeem, & Aslam, 2015). In Indian culture, they do practice the same treatment through treating chakras. Based on Indian beliefs, the chakras are considered the centers of spiritual power and energy within our bodies, there are seven chakras and different colors represent a different chakra. Thyroid and body metabolism chakra is controlled with the blue color (Gupta, 2021). If this proves something, it proves the previous theories about impact of visual aspects on our body functions. By further investigating previous studies that tests impact of colors on stress and heart beat rates, blue has always proved and topped the list of having a positive impact on decreasing anxiety and stress levels (Author, 2024), but the question is which exact tone? A study investigating impact of pale vs. vivid tones for several colors including blue one has proved that there are no major difference between both tones on heart rate as already blue had proved to have a calming effect in general, but vivid blue has proved to increase concentration levels (AL-Ayash, Kane, & Green-Armytage, 2016), making it a good choice to for hyperthyroid patients who have an issue in concentration levels (as one of the hyperthyroid symptoms), especially in tasks that need high concentration . In regard to mood swing challenge and depression hyperthyroid patients suffer from , some studies claim that colors have no impact on mood and that it depends mainly on personal preference or gender , while other studies testing specific colors impact on users have always raised blue as a winner and an all people favorite regardless of gender (Author,2024), making deeper investigation needed even more to make sure that Blue is optimum for use when designing for both women and men given the fact that the highest percentage of hyperthyroid patients are women. An experiment was conducted to investigate gender differences in color preference on 4 interior spaces (office spaces, meeting room living room and bedroom). It was concluded that for offices, both males and females preferred white color, yet surprisingly blue color was mentioned as a third favorite for women (after white and having no exact color preference as second), while for meeting rooms light blue was a third favorite for men (after white and no preference as well), (Van der

Voordt, Bakker, & De Boon, 2017). Another study had contradicting results to this one by mentioning that Women actually showed more dissatisfaction, confusion, and anger in response to low-saturated office colors like white, gray, and beige (Kwallek, Lewis, Lin-Hsiao, & Woodson, 1996). Another even more recent study that was testing the impact of colors physiology, and work-related outcomes in the workplace conclude the Blues and greens are the colors with the most positive impact on users at workplace, while white still had mixed reviews confirming the older study (Savavibool, Gatersleben, & Moorapun, 2018). By this, it is initially concluded that blue paints are the best as it always makes it to the list of top favorites for both genders. The Suitability of blue to create thermal comfort as well proved the theory even more. Al Khazaali & Wajeeh (2020), mentioned that in an administrative context when a winter room paint was tuned into light blue and the temperature felt very low even after temperature was raised several degrees. On the contrary when paint is converted to yellow, staff asked for temperature reduction making it an optimum choice to feel cooler for hyperthyroid patients and in hot countries as well and given the positive feedback on green paints, it is expected that blue greens can have a good impact as well. Saying this, there is a myriad of blue tones as well as blue greens and now the question is: Which tone exactly? What is the best color palette combination?

To answer this question; the author scanned and compared all scib blue paint tones and compared between them based on (Wave length, color lightness, saturation and RGB), where based on the research; it should have a short wave length, great lightness, high percentage of saturation and highest percentage of blue in comparison to green and red). It was concluded that "Blue chase 9149" tone is the best choice (the Author, 2024). While when selecting from green tones palette, the author selected from the most bluish ones and by comparing all available options in this regard; "Elm Grove 7453" is selected as the best option from this category (Author, 2024). Those two should be available with the greatest percentage in space, yet other light blue colors are still acceptable. Now, to select the best matching palette to those paints adding medium brown color that will represent oak wood. The type of color palette suitable for an office to a hyperthyroid patient as well as other color paints needs to be investigated. Studies comparing achromatic vs. chromatic color palette in office design context has suggested the positive impact of chromatic palettes in general mood and performing tasks. Coutinho and Akbay (2023) stated that Chromatic color schemes tend to enhance performance, particularly in tasks requiring creativity or attention to detail. In contrast, environments with low value and high saturation, like red, can negatively affect performance, especially in tasks requiring focus and precision. In addition, having a pop of color can be a solution to balance out what a very few studies pointed out that darker blue shades or overexposure could potentially contribute to feelings of sadness or depression for certain individuals or can sometimes lead to lower mood states given the over calmness the color helps to achieve. The fact that the higher percentage of hyperthyroid patients are woman, pushed the author to investigate further the impact of pink paint in specific given the known fact of color association with females. Tarajko-Kowalska and Kowalski (2023) discussed in a whole paper the multifaceted use of pink in architecture from historical, cultural, and aesthetic perspectives. The different ways we perceive the color pink and how it was always associated with women for the longest time. Pink is now appreciated not just for its feminine associations but also for its ability to convey

peace, tolerance, and individuality making it a good replacement to red and at the same time giving a feminine pop of color and due to conflicting points of statements regarding color impact in specific. Based on all previous analysis, the author concluded a color palette that can have a good impact on interior space, by choosing matching colors to each of the main ones (Blue chase, Elme grove) as well as a third color palette that includes the two tones together in case of excluding pink especially for male manager offices to be as follow:



Figure (6)_Suggested color palette for hyperthyroid patients including Oakwood (Source: Author, 2024).

It is worth mentioning that gender preference is not only inclusive to color paints but materials as well as other factors. The matter was addressed in papers from a very long time ago. Blomgren, (1965) stated that Oak wood was considered masculine while Mahogany was considered feminine. Another very recent study done on a group of males and females and their depression level in offices of different colors, it was found that males felt more depressed in colors with more saturation and vice versa. The difference in preferences was not limited to paints' colors or color of materials but it extended to thermal comfort in normal conditions (without suffering hyperthyroid issues). A recent study stated that women prefer warmer indoor temperatures than men where each perform better under those circumstances. Even when it comes to light sensitivity and preferences, men prefer cooler, blue-enriched light, while women favor warmer light (Haselsteiner, 2021), and this moves us to further investigating lights in general.

Second: Lights

Ćurčić et al. (2019) proved that there is no difference in using light or warm light especially in the morning with the presence of an interior space naturally well lighted, but if there is a need for it; warm light colors are known to give those relaxing vibes, while blue light color is proved

to be best in post stress relaxation when compared to white light; it is even recommended to be used for a short while before starting any negotiation, making it a perfect choice to use in offices and meeting rooms. Regarding cooler color lights, despite helping in increasing focus and making the brain work faster (Souza 2019), it has been proven to have negative impact especially on people who are suffering from panic disorder (Bossini et al., 2005).

Based on the previous, it was initially concluded that (Author 2024):

- Several light options should be available for the preference reason as well as for different tasks, so when relaxation is needed, warm light can be a success, while when a task needing concentration or negotiation skills required, blue light is a winner. Yet when using warm light, cooler paints should be used in the interior space in order to keep the balance and not to make the interior space feels warmer than it is.

Space Planning And General Style

Space planning and the style used has a huge impact on how users perceive the space and definitely affects both his mental and physical health. Talking about the focus of our study (individual office spaces in specific) where the priority is to design and keep in consideration user's needs as a hyperthyroid patient can be classified as:

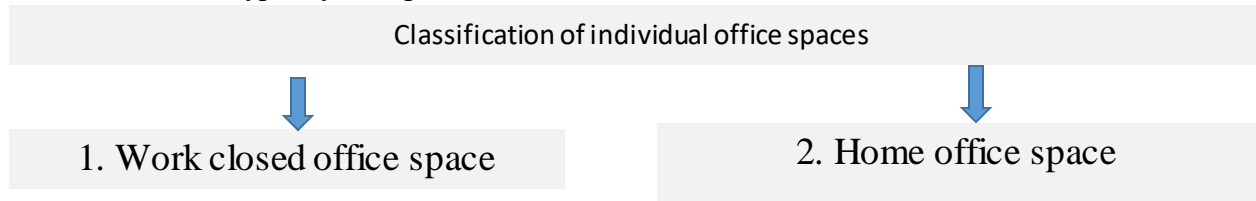


Figure (7) _ classification of office spaces for individuals (Source: The Author, 2024)

1. Closed office space, and what is meant by it: It is the traditional office space used by only one individual. This type in specific is categorized to several levels as follow:

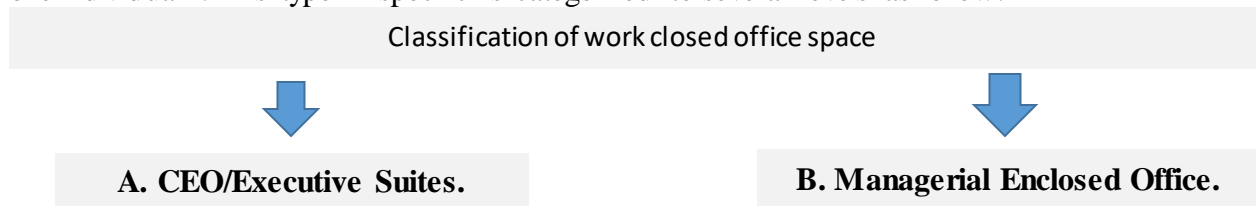


Figure (8) _ classification of work closed office space (Source: Author, 2024)

A. CEO/Executive Suites: It is a more of a fancy office designed to provide the highest level of comfort, privacy, and functionality. These suites often reflect the prestige and status of the executive with over-the-top luxury in furniture, art pieces, and spacious layouts, separate rooms inside the suite, a private bathroom and even a bed area for rest some times.

B. Managerial Enclosed office: This type is the most common one, designed to provide a functional and private workspace for mid to upper-level manager, it has good furniture and good comfort level but less luxurious than the previous type. By scanning the best space planning for this type of office and if there is a difference in preference between males and females (Given that Women are the most attacked by this immune disease), it was concluded that there is almost no difference in furniture orientation preference based on gender as both males and

females prefer desk layouts that balance the need for privacy and concentration with the flexibility to interact with visitors while the only two main differences as per gender, first that women prefer the availability of a sofa activating the concept of “home away from home vibes” . Second is that women tend to change office layout more frequently compared to men (Kalayci, 2009).

2. Home office space: It is worth mentioning that the idea is not new at all. Working from home have been around for the longest time. Separating work and home have not begun until the industrial revolution due to the rise of information technology. Through the years, there was a decline in the idea of home office, till the break through after corona virus in 2019 which has normalized the idea again and not from women only but men as well (Silver, 2023), and it is expected to continue as studies have already proved that hybrid work mode is a better option for human health, stress and work-life balance (Albreiki et al.,2023). In addition to this, Innstrand, et al. (2022) mentioned in their study about investigating home-office productivity that employees in remote settings had better performances, produced quality work, and had more motivation compared to those working from the office. In addition to those benefits, studies have proved that when compared to working from office. Hybrid work mode has proved to be best in minimizing distractions and lack of concentration (which is a major issue to hyperthyroid patients) and as a result to get rid of one of the top stressors of workers at work (Orhan et al. 2021). This in addition to having control on your favorite setting which positive ly impacts the performance as well and much more. Mentioning this, it is a well-known fact that (at home in specific) , we do not necessarily have in closed office space .In this regard , Home office types can be classified as follow :

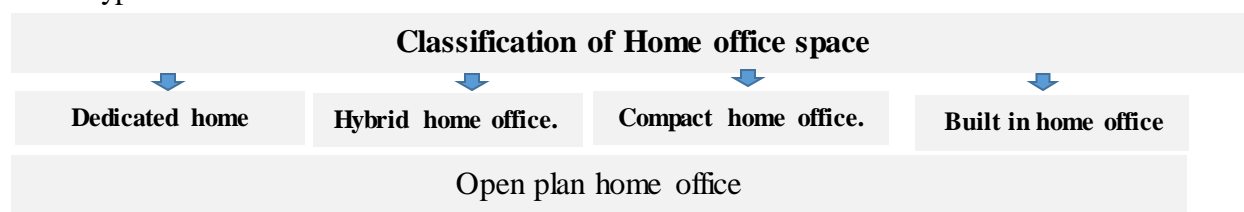


Figure (9) _ classification of home office types (Source: Author, 2024)

Regarding the dedicated home office is an enclosed office space (previously talked about). The hybrid home office is a closed room space that serves as an office as well as another activity (e.g: guestroom) , while the compact home office is a very small and minimal workspace often integrated into another room by using space saving furniture and solutions while in built home office is custom-designed office area that is permanently integrated into the structure of another room .The difference between both is that one is a fixed décor while the other is opened on task .Last but not least , the open plan home office is simply a workspace integrated into a larger, open living area. It is open to other home areas, yet well defined as an office space through arrangement and logistic. Anyone of the previous mentioned offices can be available at home, but which is the best option for hyperthyroid patients at their homes? Bergefurt et al., (2023), in his paper; he gathered from further other studies the most important findings related to impact of home office layout on human health generally where it was found that not having a dedicated workroom at home impact the mental health hugely and are more prone to develop depression, mode swings and trouble concentration, making the dedicated home office the best option. And

by this, it was concluded that closed planning is the best option for hyperthyroid patients. And when it comes to style, Minimalism style is a clear winner based on the style description and target by several researchers, where Verhetsel, Pombo, & Heynen (2013) said “Emptiness is a key component of minimalist design”. Architects and designers often employ it to create spaces that are simple and pure to prevent the stressful, busy and noisy outside world. Another experiment done by Stamps III (2011), showed that environments that do not provide enough space are considered ambient stressors, as a result it was concluded that the more the space seems spacious (even if not by actual area, m²), but by removing any interior element that can give the opposite feeling or make it noisy, the better the impact is on users and stress levels (which is needed for hyperthyroid patients). To deeper investigate the impact of this style; a study deeply targeted studying the impact of minimalism on creativity in general, given that well known fact that people working in the creative field could prefer a touch of creativity in space to boost the same in their work. The shocking fact is that only 8% of designers preferred a noisy environment in number of elements as well as noise vs. 46% of designers preferred a quite environment, yet the same study mentioned that a little bit of accessories boost creativity more than a minimal styled room with no accessories at all (Brewer, 2019).

Other Complementary Items In Interior Space (Treatments And Furniture Pieces)

One of the most complementary items that needed investigation based on the previous known facts about it and being a solution to represent green color in interior space (given its positive impact after blue) is availability of green walls in interior space and its impact, which pushed the author further to investigate its impact on hyperthyroid symptoms generally and thermal comfort in specific, given the shortage in number of papers targeting this point in comparison to other symptoms. Sedghikhanshir et al.(2022) , green walls can have a positive impact on the feeling of thermal comfort through visual stimuli without actual changes in the room temperature and given the importance of the sensory experience (previously mentioned), it can be a good solution .In addition to this; Yan et al. (2022), stated that using green walls can be a good noise insulator which can as a result protect users from the negative impact of being exposed to noise on gaining diseases (e.g : stress , cardiovascular diseases, including hypertension, myocardial infarction, stroke in addition to Metabolic disorders) which are directly or indirectly related to hyperthyroid patient symptoms.

Regarding the optimum furniture design lines, materials and colors, an experiment was done measuring impact of wood surface percentage not only on room level but pieces of furniture as well and it was found that light and medium wood colors with low wood coverage are preferred in office spaces. (Wang, Shao, Zhang, & Wang, 2022). This can be simply translated for example into using the optimum oak wood (which is considered a medium-colored wood) with a mix of other materials in table, chair legs (e.g: metal, glass) to make furniture look lighter, less bulky and as a result making the space look more spacious.

▪ Final General Conclusion by author (2024):

-The more a room is designed and full of details, the more heart beats increase even when using wood especially in other surfaces than flooring (reference study 5,p.8) , which is contrast to another study indicating the positive impact of using wood in vertical walls on nervousity and anxiety levels (reference study 12,p.9) , selecting it the best place to do this and by this

concluding that it has nothing to do with the material itself but utilizing it in its simplest form (without ornaments ..etc.) and by this highlighting the pros of using a minimal style which is further proved through studies discussing the positive impact of using spacious less detailed interior space on stress levels.

- The calming effect of touching wood (especially oak) in comparison to other materials even marble included with natural wood finish (sanded / brushed) and no coated making it the priority material choice for the standard closed office, a built-in home office or the compact office type with the right percentage.

-When it comes to the best color paints, there are always mixed reviews. But the most color all agreed on regardless of gender was blue color, followed by green which can be represented in space through greenery (e.g: green walls). While white has proved to be less favorite when compared to blue despite it being a more popular and commonly used color in work places.

▪ Most of the papers found where targeting mostly (nervosity, stress and heartbeat rate), symptoms related to hyperthyroid patients. Least was found regarding material finishes impact achieving thermal comfort. That's why the focus of the study in the next section will be impact of materials concluded in design guidelines on thermal comfort.

Concluded Design Guide Lines For Hyperthyroid Customer's Interior (For Testing).

▪Regarding materials:

-Optimum percentage for wood usage to decrease stress and quick heart beat ranges from 30 to 45% maximum, (where to better be used to keep room temperature the coolest is yet to be tested).

. -Oak wood is the solution to a myriad of hyperthyroid symptoms and is considered the best option. It can be merged with other types of wood with a good calming scent (e.g: pine, lavender) for a multisensory experience (proved best results).

-In woods, Canadian poplar wood is another good option for trial due to lowest thermal conductivity.

-Soap stone as well as white carara marble are 2 options that are worth trial to make spaces cooler.

Mix of marble and wood can be a good choice in treating surfaces that are in direct contact with hyperthyroid clients, as wood has proved as well to decrease heart beats rate while being touched and marble is known to give this cooler effect, (and by this; solving two main struggles of hyperthyroid patients).

▪Regarding Color paints:

-Color palettes that includes Blue, Brown (representing wood) followed by bluegreens or greens is the best to fight most of hyperthyroid patient struggles. And to be specific, blue chase paint tone from blues and Elm Grove from greens are the best in making space feel cooler (at least through visual perspective). A pop of warm color represented in pink can be added to create a good balance with dark blue tones (in accessories) for women in specific and a color palette including both Blue and green can-do magic.

▪Regarding Lights:

-Providing different light options for different gender preference as well as creating the required balance so as space do not seem warmer by visual stimuli by using warm lights. In addition, the availability of blue light as it helps in relaxation as well as successful negotiation skills (which is a must for offices and successful business).

▪Regarding Style: Minimalism is a winner.

▪Regarding complementary items and furniture in interior space:

-Green walls can be a good solution to visually achieving thermal comfort and it can be a good noise insulator. When it comes to furniture pieces, it has to be of thin lines not bulky with a low percentage of medium colored wood.

▪In offices like Built in home office or other type of offices the same considerations should be followed if it's just a desk top then utilizing Oakwood is a priority with thin lines in other surrounding items.

Mentioning this, it is worth saying that implementation of those guidelines (in case proven right), it can have variations as one of the main targets is to keep the office space spacious. So, room space, proportions, orientation and opening will be good decisional factors to the interior designer in charge in applying those guidelines. For instance, in case of a large office space two or three colors of the mentioned including colors of textiles and accessories can be used, the smaller the office, the lesser the details to make it feel more spacious (the Author 2024) .

Testing And Experimenting With Selected Materials Usage Alternatives Impact On Office Space Temperature (Using Design Bulider).

It's a well-known fact in the field that Architects have been utilizing Building Information Modeling (BIM) for some time to improve energy efficiency and thermal comfort, particularly in green and smart building applications. A recent study in 2023 proved the positive impact of using BIM soft wares to get accurate evaluation of energy use and thermal comfort evaluations resulting in improved building management and design (Wei et al., 2023). And, just as AI is used in almost everything now, so it is with BIM soft wares where AI have contributed in enhancing the performance of those soft wares. In this regard, it's worth noting that some academics have developed newer approaches for addressing individual thermal comfort problems. For example, Ma, Liu, and Shang (2019) presented a BIM-based system paired with an Artificial Neural Network (ANN) to assess personal thermal comfort and recommend energy-efficient design layouts (Ma et al., 2019). In even recent studies, BIM's role in passive architectural design solutions has also been investigated, particularly in improving thermal comfort through natural ventilation, shading, and thermal mass strategies. Boosting both building performance and occupant satisfaction (Erişen, 2023). And despite the outer building envelope having the biggest impact on interior space thermal comfort. Interior space material distribution can have an impact as well the fact that pushed the author to study “ design builder software “ as an interior designer and investigate the matter practically to reach some conclusions .

To do this, the Author followed the traditional design thinking process, starting with emphasizing with hyperthyroid client needs of a thermally convenient (cooler) and stress free environment ,defining the problem in a clear statement moving on to the ideation process where the Author utilized AI Microsoft creator to generate ideas as inspiration applying the initially

concluded design guidelines (yet to be tested) then creating an initial prototype to be tested on design builder which is the last step then concluding the final design after either confirming or declining the initial guidelines .

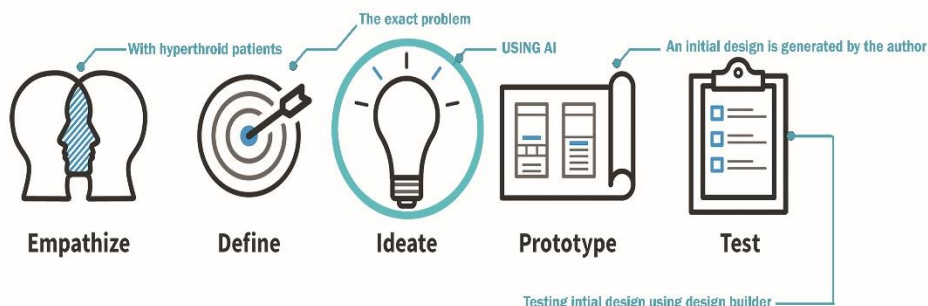


Figure (10) _ Design thinking process followed in this project (Source: The Author, 2024)

The author tried a myriad of image generations using Microsoft-Designer using prompt concluded from the initial design guide lines, where the most accurate results to the required (despite the technical errors found was: “A minimal styled manager office with a general color of medium blue office. Office accessories should be pink. Oak wood can be used in other walls with a low percentage, same with marble stone. Floorings are Oakwood. The office furniture should be thin (not bulky) with a very low coverage of oak wood. Ceiling should be minimal and reflective”.

A myriad of images where generated and the author found it as a good inspiration for material distribution but there were enormous errors and the color palette was not accurately achieved despite it mentioning it directly in another prompt (the Author 2024) , yet the image generated were a good inspiration for author generating her own approved mood boards based on previous



Fig (11) _Mood board with blue chase paint as main.

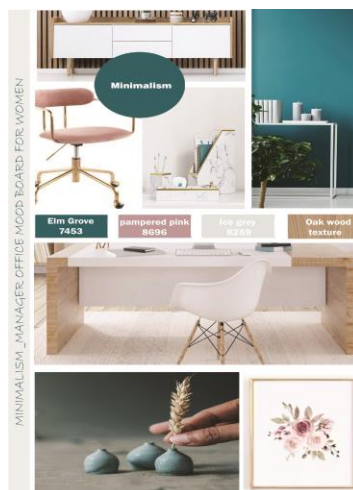


Fig (12) _Mood board with Elm Grove paint as main.



Fig (13) _Mood board with mix of blue chase and Elm Grove paint as main.

studies .

The following 3 mood boards are the ones validated based on author’s analysis and studies. The author started her experiment on a manager office of area 34.05 m², which is a room from a huge administrative company with thick external walls and two windows (figure 14). An initial sketchy material distribution was done to calculate the optimum percentage of material based on the initial concluded guide lines so as to make sure oak wood did not exceed 45% (fig16,17). Yet materials were embedded in surfaces of design builder (based on the material covering a surface with the highest percentage) which makes the results are nearly accurate and not 100 % accurate but of good guidance to designer to answer what is the best material distribution based on office orientation and openings to make space feel cooler and if there are other alternative and more sustainable materials that can contribute into this. Location was specified as Cairo, and the day specified to measure room temperature was 15th August (Being known as the hottest day in Cairo).

N.s: Wall input materials were considered as 25 and not as thick and the plan was mainly taken as an inspiration to opening places for testing, and all materials were installed without extra isolation spaces to measure materials impact without any extra treatment, which will be surly better with treatments.

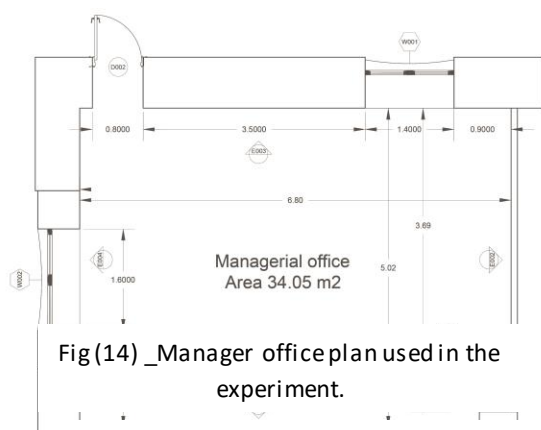


Fig (14) _Manager office plan used in the experiment.

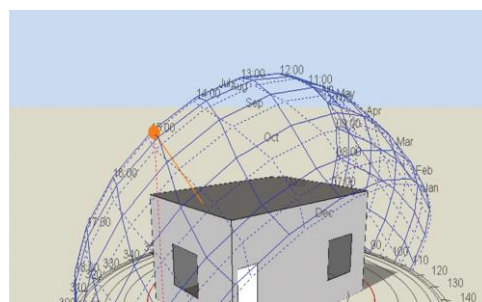


Fig (15) _ Office room build on design building Showing north direction.



Figs (16,17) _ Initial material distribution for testing on design builder

Several proposals were embedded on design builder based on materials’ orientation to openings where testing material alternatives in walls first (supposing the most impactful) , then moving on to other alternatives (in flooring) as well as other alternatives with materials. In this regard the proposals tested on design builder were as the following:

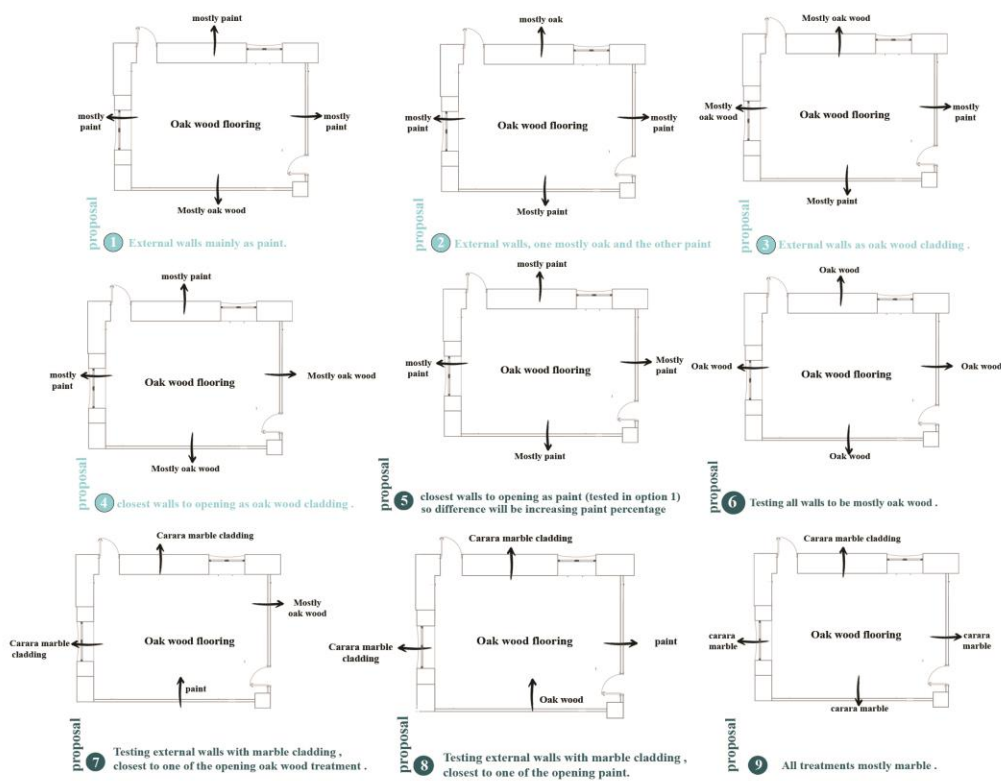


Fig (18) _ Material distribution alternatives tested on design builder.

All proposals were compared regarding air temperature and operative temperature and the results were summarized as follow:

Table (5) Summarizing most important findings regarding room temperature (Source, the Author 2024)

Proposal No.	Brief description	Recorded Air temperature	Recorded Operative temperature
1	External walls as paint	40.54	40.72
2	External walls; one paint and other is oak cladding	40.59	40.77
3	External walls as oak wood cladding	40.85	41.04
4	Closest walls to opening oak cladding	40.13	40.29
5	All walls mostly paint	40.26	40.43
6	All wall mostly oak wood cladding	40.73	40.89
7	External walls carara marble, one internal wall paint and other is oak - oak closest to opening	40.38	40.56

8	External walls carara marble, one internal wall paint and other is oak - paint closest to opening	40.53	40.72
9	Mostly all carara marble	40.39	40.56

Author observation and conclusions:

The lowest Room air temperature and operative temperature were recorded in (proposal 4) , where the external walls (including openings) are mostly paint and nearest two walls to opening are oak wood cladding mostly . Followed by (proposal 7) , where external walls were mostly marble.

Accordingly further material testing with modification on the best proposal.

First: Testing with ceiling material (modifying on proposal 4).

- Ceiling: Mostly oak wood paneling
- Flooring: Oak.
- External walls: Mostly paint
- Internal walls: Mostly oak

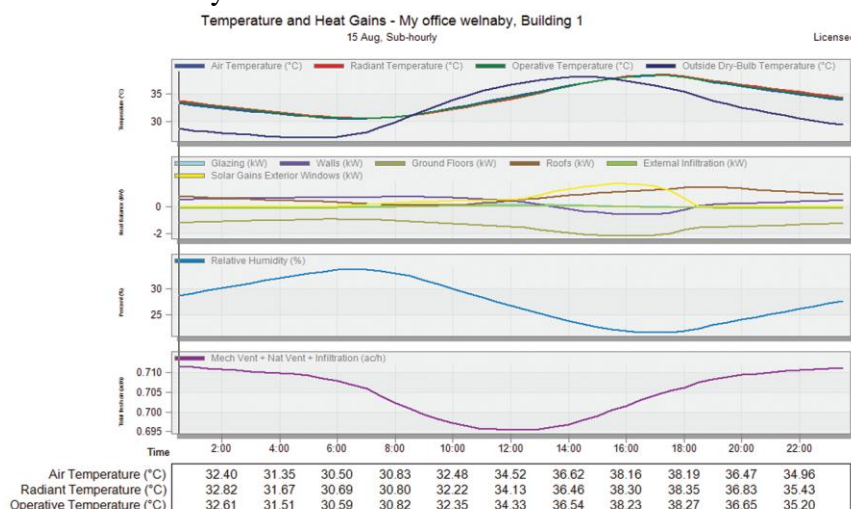


Fig (19) _ Focusing on results from modifying on winning proposal 4

The results in figure (19), show that the highest temperature recorded decreased for air temperature to 38.19 from 40.13 and operative temperature to 38.27 from 40.29 confirming changing ceiling material from paint to wood is more impactful.

Second: Investigating flooring material alternatives to proposal (4)

Further investigations were done on the latest version by trying alternative sustainable flooring materials (polished concrete flooring and epoxy) and surprisingly a noticeable decrease in room temperature happened by replacing Oakwood flooring with epoxy (Fig.17).

Air Temperature (°C)	29.36	28.46	27.75	28.08	29.63	31.45	33.17	34.35	34.38	32.97	31.62
Radiant Temperature (°C)	29.47	28.49	27.67	27.82	29.11	30.80	32.65	34.05	34.19	33.00	31.75
Operative Temperature (°C)	29.41	28.47	27.71	27.95	29.37	31.13	32.91	34.20	34.28	32.98	31.69

Fig (20) _ Results from design builder replacing flooring material to epoxy

The results confirmed as well that flooring have a larger impact than ceiling in regulating room temperature.

Third: Testing with other alternative sustainable materials for wall treatments

In this regard, other famously known sustainable materials were tested (Bamboo and cork). Even epoxy coating for walls was tested given the outstanding results in decreasing temperature for flooring. The results showed that paints still the best option.

▪ Based on the previous, the author suggested a design applying the mentioned guidelines for an individual office as well as each type of the previously mentioned offices as before and after. (the Author 2024).

Conclusion:

Regarding Design Guidelines:

Incase of designing a home office or work enclosed office where there is an option to design it as per user's preference:

-The author reached a conclusion of using the suggested design guidelines previously mentioned, taking inspiration from the previously mentioned mood boards when designing (based on user's preference regarding preferred color palette) and taking into consideration always applying the paints in the external wall of the designed room, oak wood with a percentage not exceeding 45% of the total room space (acceptable even in walls opposite to windows). Oak wood stripes can be used in the ceiling design while flooring can be a light-colored epoxy and by this using all materials as well with extra insulation properties for even better solutions.

-As an inspiration from Mood board 3, green wall can be utilized as a noise insulator to decrease stress and visually decrease temperature.

-In case of compact office or build in office, priority to desk top surface to be oak in specific and then surroundings as required.

-When designing an office for women, preferably go for a flexible design that can be easily changed every now and then.

General Observations:

-Out of all room surfaces; flooring has proved to be the most impactful, followed by ceiling then walls.

Recommendations:

-Not only architects but also interior designers should possess sufficient knowledge of BIM software to guarantee energy-efficient designs.

-DesignBuilder software needs improvement to accurately account for multiple materials on a single wall. Currently, it approximates material properties based on the dominant material, which can lead to inaccurate results.

-For developers: Simplifying design builder or utilizing AI to predict thermal comfort conditions based on design parameters, occupancy patterns, and climate data, enabling real-time adjustments to help designers while designing in real time.

- Working on developing other AI tools that can help interior designers measure hyperthyroid real body reactions when being immersed in an interior space following the concluded design guidelines for better and accurate guidance to designers (e.g.: VR immersive experience ...etc.).
- Further studies on how to design other different interior spaces not only for adults but as well for children in Egypt (Given the high percentage), in addition to designing for investigating designing for **hypothyroidism patients**.

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