The effect of daylight on the elderly population

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***Abstract*— A study was completed among 9 participants, 3 housebound and 6 non-housebound, to identify whether the relationship between daily activities including light exposure, and sleep disorders in the elderly population, reveal any patterns worth further investigation. Participants were invited to take part in a semi-structured interview. Questions regarding their daily activities, ability to go out, or not, and sleep patterns were asked. Building orientation, room dimensions, window positions, room wall-reflectance and illuminance levels were recorded. This study supports evidence that suggests that people over the age of 60 spend most of their "indoor" time under low illuminance levels. Also, a notable difference in the health and sleep condition between housebound and people able to go out was observed. This means daylight availability is particularly important for housebound elderly with limited access to outdoors.**

***Index Terms*—elderly, health, lighting, well being.**

I. INTRODUCTION

The world population is ageing. In 2014, according to the Office for National Statistics, 17.7% of the UK population was aged 65 and over and this figure is expected to grow to 23.3% by 2034. This implies a potential increase in the demand for healthcare service provision. A prevalent condition that comes with age is sleep disturbance, which is associated with alterations in the circadian system [1]–[3].

Light is a powerful cue to entrain the circadian clock [4]–[10] and it is also important for vision, however, requirements for the good functioning of circadian entrainment are different from the requirements for vision[11]. There have been numerous studies focused on the benefits or disadvantages that light might have on people's physical and mental health[12]. When it comes to sleep disorders a similar conclusion arises, if people are exposed to light during the night or if they are not having enough light during the day, their sleep can be disturbed.

Research has shown that, due to our daily patterns and designed environments, people may be less exposed to daylight than in the past[9], this affects health and wellbeing, especially in the population aged 65 and more. The visual system of older people is diminished due to changes in the physiology of the eye and therefore appropriate lighting requirements are needed.

A study was completed in 2001 by Bakker, Iofel & Lachs[13] in New York City. Illuminance measurements were taken in dwellings of housebound people over 65 years, and participants were asked for their perceptions of lighting. The results were compared to the IESNA standard minimum illuminance levels and found to be below those recommended. Despite this, participants were satisfied with their lighting condition. All participants mentioned that their main light source was daylight. Another qualitative study was recently completed in the Netherlands[14]. The focus of the study was the experience of old people in the house as a *home*, even though it was not focused on light, it turned out that people made modifications to their home relating to the orientation towards the sun and the amount of daylight it might gain. One of the participants decided to create a full-height glass façade in order to have more daylight in his living room.

The aim of the present study was to analyse the relationship between daily activities, the ability to go out and be exposed to daylight and sleep patterns.

II. PILOT STUDY

A. Method

A qualitative study design was performed to comprehend the relationship between daily behaviour patterns and the impact those might have on the elderly populations' sleep patterns. Interviews enquired about the time spent indoors and outdoors by the participants, as well as their sleeping habits. The study was carried out in locations with different orientations across London.

1) Participants

Nine participants, 6 females and 3 males, over 60 years were interviewed in their homes. All participants were currently living alone. From the 9 participants, 1 was semi-housebound and 2 were completely housebound, see Table I. The criteria needed to take part in the study was to be above 60 years of age and willing to be interviewed in their own homes. Additionally, taking photographs of their non-personal spaces and site measurements were agreed in advanced. Participants were compensated for the time invested in the interview. This study was approved by the UCL's BSEER Chair of the Departmental Ethics Committee. Eight of them provided written consent and one verbal consent due to her visual impairment. Data were collected between April and May 2017.

TABLE I. CHARACTERISTICS OF PARTICIPANTS' LIVING ALONE

Name(not real)	Gender	Age Range	House Type	Illuminance (lx) At sitting spot	Non-housebound/ housebound	Sleep Conditions
Nancy	F	60-65	One bedroom flat	~253	Housebound	Naps. Sleeps 3-4 hours at night
Betty	F	65-70	3 bedroom house	~138	Non-housebound	Four night of good sleep, one night interrupted sleep.
Brian	M	65-70	One bedroom flat	~279	Non-housebound	Naps during commuting. Four hours of sleep at night
Marco	M	65-70	One bedroom flat	~2,368	Non-housebound	Eight hours of sleep at night. No naps
Nell	F	65-70	Studio flat	~233	Non-housebound	Eight hours of sleep at night. No naps
Tony	M	70-75	One bedroom flat	~180	Housebound	Naps. No sleeping schedule
Rachel	F	80-85	One bedroom flat	~129	Non-housebound	Sometimes no sleep at all. Otherwise 8 hours sleep
Diana	F	90-95	Studio flat	~582	Semi-housebound	Sleeps 3-4 hours at night
Stephanie	F	90-95	One bedroom flat	~580	Non-housebound	Naps. Eight hours sleep at night

2) Data Collection

A semi-structured interview was designed to gain an insight into older people's perception of their living conditions, their needs and the influence that the environment might have on their health and overall well-being. The aim of this study was to find a relationship between exposure to daylight and the consequences this might have in their sleeping habits. To reduce bias during the interview none of the questions were directly related to the concept of "light" or "daylight". The interview focused on their daily routines, including the amount of time spent indoors and outdoors; whether they require help to accomplish any activity; their home, including preferred room and sitting spot and also their opinions about their living surroundings. They were asked to describe how they begin and finish an ordinary day, what they normally eat and if they had a regular schedule to do so. Finally, questions related to their sleep schedule were asked. All questions formulated were open ended and because of the different characteristics within the sampling, questions were excluded or added in response to participants' specific conditions.

At the end of each interview, photographs and measurements of the living room, kitchen and hall/stairs were taken. Only one person declined this section of the study. Both photographs and measurements provided evidence of their existing living condition. Location of the dwelling and measurements facilitated a broad impression of how much daylight participants receive in their preferred room. In addition, illuminance was measured (using an illuminance meter-Konica Minolta T-10M) inside the room where the interview took place, in most cases the participant's preferred room was where the interview was held.

3) Data analysis

The recorded interviews were transcribed verbatim. Theme coding and deductive analysis were used.

III. RESULTS

In order to identify any differences among them, participants were classified into two groups (house bound and non-housebound) depending on their ability to go out and carry out physical activities.

A. Non-Housebound Elderly

1) Dwelling Perception

One aspect considered is sitting preference and what they consider when choosing a sitting spot inside their home. Preference inside their home was asked, which also led to questions related to the perception of the place, surrounding and how they deal with them. Apart from Nell, who lives in the studio flat, all of the non-housebound mentioned that the bedroom is only used for sleeping. One interviewee, Marco, has a conservatory room, adapted to accommodate a working table. He prefers this room because it is "sunny". Also, he mentioned that the living room is "only to watch TV", but he did not spend a lot of time watching TV. Three female interviewees had a similar response regarding their preferred room, all of which were facing the garden. Also, each of these 3 rooms faced south. Betty mentioned she enjoyed spending time in there because it was "nice and bright"; Rachel said that "there (the room) is sunnier so I would probably (…) spend more time there, it looks out to a small garden". Brian's and Nell's rooms faced east. Nell, who lived in the studio flat, did not have a choice of internal rooms, nonetheless her preferred sitting spot was near the window. Brian spends most of his time in the living room, where he has the TV and karaoke equipment.

Different aspects were revealed when people were asked about their surroundings: the importance of the neighbourhood; people living nearby; the convenience of local shops and public transportation. All participants made positive comments related to their neighbours and the importance of having "friendly" ones. Brian commented, "They really look after (me), not just like a simple neighbour, they really treat you as family". Interaction with neighbours is an accessible way of being socially active.

2) Daily patterns

When people were asked about their daily routine, most of them emphasised going out and keep by themselves "active". In the group, all subjects were engaged in recreational activities, such as "morning coffee", yoga, going to church, to libraries, etc., and two of them were active members of the Chinese Centre, located in North London.

Besides one person, interviewees wake up early in the morning, around 07:00, without any clock alarm. The average hour-time to go out and return to their homes is 10:00 and 18:00, respectively. In relation to eating habits, all mentioned having breakfast before going out. All interviewees described their breakfast in similar tone, one of them, Brian described it as having a "light breakfast". The only similarity this group have regarding eating habits was the type and time of breakfast. Otherwise eating patterns with the group were different, depending on their resources, time and habits.

As people age, sleep problems are more present[1], [2], [15]. From the 6 interviewees, at least 4 had a self-reported sleeping problem, however this was not supported by the amount of sleep they had, typically from 23:00 hours to 07:00 hours. Two female participants mentioned having a bad sleep pattern and that they needed to take sleeping pills, when necessary. One of them, Rachel, responded, "sleeping is not very good, I'm not good at sleeping. Sometimes I don't sleep…I really do have problems sleeping"; she was aware that the problem worsened when she didn't go out or do any activity. While Nell responded "I have to take a sleeping pill at night, and some nights I skip it…", the reason for her to skip pills was because she wanted to feel healthier. The other two females, have different medical conditions which somehow disturb their sleep. Stephanie solved her condition easily without taking any medication and now she could sleep eight hours at night. Betty mentioned that discomfort in her arm kept her awake some nights. Her response was, "my sleep really works for four nights then I have a night where I can't sleep, I don't know why". In her case, she mentioned it was worst when she felt stress about a situation she could not control.

Brian responded "…is very strange…sometimes I can sleep very early about 22:00 hours but only 4 hours basically…I sleep 4 hours". Although, it is only 4 hours, he never mentioned it was a problem. He is used to sleeping that amount of time. Marco was the only interviewee with no sleep disturbances. He responded, "I need a lot of sleep, I usually need eight-hour sleep to be fully energise". He pointed out that, in order to get a good sleep, he needs a complete dark environment, and in summer he does not need to set the alarm clock, because light wakes him up. Stephanie and Marco were the ones with more weekly activities and with less sleep disturbances. One of them was the youngest of the group and the other the oldest.

B. Housebound Elderly

Two people were classified as totally housebound; they cannot go out unless escorted to the hospital by an ambulance. The other person was semi-housebound; she could go out but she has visual deficiency in both eyes.

3) Dwelling Perception and Weekly Pattern

The three participants were living in their flats for more than 15 years. Two of them live in a one-room flat and the other on live in studio flat. Diana, has been living in a third-floor studio flat for twenty-seven years. Her room/living room has a large window facing south and she likes to sit next to the window on daily basis. Once a week she uses the "transport support" service. This service picks her up and take her to the grocery store, the service waits up and returns her to the flat. She mentioned, because of the time she has living there, she knows her way around the flat and she is satisfied with it. Although she commented that she would like to do some changes in the kitchen to feel "more safety" when she needs to clean up. What she does on a weekly basis is listen to music, clean her flat, ring her acquaintances or brother, cook 2-3 times a week and go shopping when necessary. Regarding her sleeping habits, she responded "I don't think I have problems to sleep, I think I sleep what I'm supposed to…", she only wakes up at night when she needs to go to the toilet, which is a prevalent situation in old people.

Tony is completely housebound as he requires twenty-four-hour supplementary oxygen, he also has anxiety and mental problems. "Because I'm always connected to it, it limits what I can do…" His daily activity is to sit down in the living room, next to the window facing west, watch TV, read, and fall asleep in the chair. He only goes out when he needs to go to the hospital, normally once every 3 months. As a result of his regular naps during the day, he does not have a defined sleep pattern. "I hate to go to sleep at night…I feel tired but I fall asleep on the chair".

Nancy, has living in a ground floor one-bedroom flat for fifteen years. She needs help to accomplish any activity, she is entirely dependent on her 4 carers. She spends all day sitting next to a window facing north. Her activities are praying, watch TV, and spending time at her computer. Like Tony, she only goes out when she needs to visit a doctor, which is once every 3 months. She mentioned she can sleep 3-4 hours in a row, then fall asleep again until the morning carer wakes her up and helps get her out of bed. During the interview, she showed memory and breathing problems.

The last two interviewees had a similar cluttered room condition which appeared gloomy. Windows were blocked in order to reduce glare on the TV screens. All three participants mentioned that because of their condition, they do not meet with other people, therefore feel alone.

IV. DISCUSSION

As people get older their frequency of sleep disturbance increases due to various reasons[1], [16],which can have repercussions on their health and well-being. The results in this study, as it was expected, showed a difference between the groups regarding their daily activities and how this might affect their sleep, mood and health condition[17]

In the first group, composed of people who can go out, it can be assumed that they are exposed to sufficient levels of daylight and their circadian system should be normally entrained[18]–[20], hence, they should have less sleep problems. One of them, which is the youngest of the group, reported to have 8-hours of sleep. He likes to spend most of his time working in the conservatory and when it is time to go to bed he blocks all the light in the room. On the other hand, the oldest participant from the same group mentioned that she notices her sleep worsen when she does not have enough exercise or go out. She likes to spend time in the room facing south, although, her preferred sitting spot was near the window, it is blocked by a tree and does not receive direct sunlight. These are two people with more than fifteen age gap, and with different levels of activities, however, it can be noted that exposure to daylight might be a factor in improved sleep quality.

In the second group, despite the sample size, comparisons were made. There were more sleep problems with the two completely housebound than with the semi-housebound who is still able to go out, move around and sit next to her facing south window. Participants' health condition in this group is a significant variable to consider and sleep disorder cannot be only related to the lack of light and dark pattern in their daily pattern, however, it might enhance their mood[21]–[23] and have some benefit on their health and wellbeing

Regarding preferred rooms and ambient light, as Sörensen and Brunnstom indicate in their study[24], is difficult to measure non-standard situations, nevertheless, illuminance was measured inside their preferred room. It was noticed that, without exception, rooms of the housebound participants appeared gloomy. This was related to the colour on the walls, floor, the number of personal belongings in the room and the distance between the location where illuminance was measured to the nearest window. There was an average illuminance of ~290 lux in most of the rooms which is a little less than recommendations for residential buildings in the US [25]. There are no general requirements in the UK for minimum illuminance in domestic dwellings. Regardless, participants did not appear to have a problem with light. This might be due to the ability to adapt to their current living conditions without making adjustments. People are restricted by the architecture of their home, and it can be noted that all participants' preferred room was one with windows having outdoor view. Additionally, when the rooms were facing south, participants made positive comments about sunlight and the brightness that they perceive in the room. Finally, the study revealed the importance of all participants being able to be independent by going out and accomplishing simple activities unaided.

The evidence shows that people who are able to go out and spend time under daylight might reduce their sleep disorder. In this study, it was evident that people that could not go out have more sleeping problems, however it was clear that their health condition had an impact on their sleep pattern, perhaps more than the dark-light pattern. In order to fully understand and propose what could be the best quality of light for elderly population to enhance their sleep pattern, more research is needed; and it is also important to bear in mind the existing differences between elderly peoples' physical and social living situations.

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VI. REFERENCES

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