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Applying the Onion model of Ergonomics to Optometrists

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Abstract:

The intent was a literature review about applying ergonomics for optometrists and indicates the link between optometrists and patients. The method was the Onion model focusing on tasks, equipment and machine, and wider workspace. The results were clear discomfort for both optometrists and patients in the eye examination room during the diagnosis process. Also, an awareness of the poor sitting position is required because of fatigue and chronic back pain. The affected of room lighting and machine lighting on the optometrist's cause.

1. Introduction:

1.1 Background:

In a 1994 survey, Chatterjee et al. (1994) reported that 54% of UK ophthalmologists had serious back pain, and 52% of US ophthalmologists had back and neck symptoms. A 2019 survey of 169 Canadian optometrists revealed 61% of musculoskeletal disorders (MSDs) pain of optometrists within the previous 12 months (Uhlman et al., 2019). Work environment and work design are key to present safe physical ergonomics and avoid physiological workloads at a workstation. Such ergonomics can support doctor health, allowing proper patient diagnosis (Long, 2014).

There is clear correlation between optometrists and patients (BMA, 2018). Researchers used the Ovako Working Analysis System (OWAS) to evaluate and analyse ergonomics in optometrists postures during ophthalmology clinic activity, confirming high back pain caused by wrong sitting position for a long time (which would need to change in the near future) while analysing the potential increase of damaging doctors and nurses (Herzog et al. 2015). Patients visiting an ophthalmology department regularly, patients who had eyesight problems, would also experience negative effects from poorly designed environments (Hemphälä and Eklund, 2012).

1.2 Aim and Objective:

This review will discuss elements related to ophthalmology examination rooms and directives from the literature addressing the consequences of bad design, such as lighting and equipment design. This review will apply the Onion model to literature on ophthalmology department ergonomics and focus on three elements of onion model for optometrist's ergonomics: tasks, machines and equipment, and the wider workspace (Wilson and Corlett, 1995). This study shall explore the opportunity to improve workstation ergonomics for both doctors and patients, since research has shown that doctor fatigue and patient discomfort diagnosis (BMA, 2018). Such fatigue can lead to uncomfortable workstations and unsafe environments.

2. Methods:

This literature review paper followed the human factors technique in an ophthalmology department, specifically in optical eye, and the link between optometrists and regular patients is implemented. Wilson and Corlett's (1995) Onion model is often used to describe the workplace and mentions interaction between system elements to direct the design of safer environments, achieving the best possible practices and services (Appendix 1). The model covers seven internal elements, which is people, tasks, equipment, personal workspace, wider workspace, physical environment and work organization, and four external elements, which is financial, social, legal and technical, to analyse ergonomic principles in an ophthalmology department (Wilson and Corlett, 1995).

2.1. People:

Ophthalmology departments, and examination rooms in particular, involve doctors and patients and studying ergonomics requires considering interaction between them. Clinical optometrists are primary physicians who perform eye examinations in consultation rooms (Long et al., 2011). Patients with eye issues can visit an optometrist regularly, depending on the optometrist's recommendation (NHS Opticians, 2019). This explains why ophthalmology ergonomics is important for optometrists and also for patients.

Ergonomics exists not to change people, but to change things for them, such as organising the best environment for people via the workstation (Hignett et al., 2018). Ophthalmologists capabilities and limitations are understandable as human traits that focus on preventing errors and extending a safe ophthalmology environment (Long et al., 2010). Optometrists functioning under an identical workload environment for between six to eight hours daily experienced MSDs pain, fatigue and eye strain which affected their performance (Hignett et al., 2018). While some patients must visit the optometrist regularly, they still feel anxiety or discomfort from the optical environment (Margrain et al., 2003).

The communication between optometrists and patients can affect optometrist diagnosis, but it could be managed to reach to the patients' comfort (Long, 2014). Although extensive research has been carried out on patient anxiety in healthcare, both generally and during eye examinations.

2.2. Tasks:

An optometrist's tasks are examining patient eye structures for macular degeneration, glaucoma and cataracts (NHS Opticians, 2019). This practice takes from 10 minutes to an hour depending on a patient's issues and their acceptance of the diagnostic process (Long et al., 2010). Figure 1 shows a doctor's workstation position, which shows poor setting posture identified on OWAS as need to change on the near future, when experienced consistently over time, leads to back problems (Appendix 2). Illustrates that while optometrists perform their work, they are suffering from chronic back pain diseases after a long period of time for poor posture setting daily (Herzog et al., 2015).

Figure 1. Position at workstation (Herzog et al., 2015).

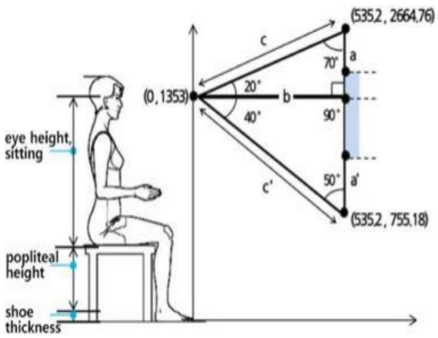

Figure 2. Right position (Cha and Choi, 2017).

According to Herzog et al. (2015), maintaining an optometrist's posture (bent neck and shoulders with a curved back position) at a workstation causes MSDs. If the workstation table moves up and down, the optometrist will adjust the table measurements according to the patient's measurements while the optometrists remains in a harmful posture to provide an appropriate diagnosis. Figure 1 shows the elbow was not in the correct posture and the wrist had considerable motion during the examination. Figure 2 shows the proper position for doctors and patients when sitting on a backless chair (Cha and Choi, 2017). ‘Fit the job to the worker’ (Waterson and Sell, 2006, p. 757).

However, performing this movement regularly can cause chronic back pain disease and fatigue, which can affect worker performance (Wilson and Corlett, 1995). Hemphälä and Eklund (2012) observed most studies of ophthalmology ergonomics as viewing the subject from the perspective of patient eyestrain. It is common to inflict MSDs during a regular eye examination (Hemphälä and Eklund, 2012).

Analysis has revealed that optometrists and patients reporting eye discomfort also reported higher MSDs problems (Hemphälä and Eklund, 2012). ‘When vision is unsatisfactory, the body adapts to a posture aimed at improving it: “The eyes lead the body”’ (Hemphälä and Eklund, 2012, p. 1). While the doctors examine patient eyes, they are exposed to high levels of varying light from their machines (Herzog et al., 2015). Daily use of these devices can cause dry eye, eyestrain, light sensitivity and headache (Hemphälä and Eklund, 2012). Lighting is one of the most harmful factors in the ophthalmology department, which is affected by concentrated on patients and optometrists (Çakir, 2014). ‘While the word light means ‘optical radiation from ultraviolet (UV) to infrared (IR)’ in medicine’ (Çakir, 2014, p. 3).

Patients can have similar symptoms depending on the number of visits they make to an ophthalmology department (Hemphälä and Eklund, 2012). Visual workstation ergonomics at patient’s diagnose stages are a poorly designed optometrist environment that can lead to visual fatigue and eyestrain (Anshel, 2007). Most importantly, the significant relation between the eyes and the body indicates that if vision is unsatisfactory, the body effort reaction translated into setting position (Hemphälä and Eklund, 2012), decreasing doctor productivity and patient comfort while exposing both to visual stress (Wilkins et al., 2016). Logically, optometrists are exposed to such poor environments more than the patients (Anshel, 2007).

2.3. Equipment and Machine:

Equipment and machinery should be designed to help workers. In this case of optometrists, they should enable best practices (Wilson and Corlett, 1995). However, according to Marmot (2012), poor machine design affects doctor behaviour at a workstation. In terms of repetitive motion for more than six to eight hours per day, the machine did not provide safety for doctors regarding posture and screen replication (Newman, 2005). For example, slit lamp ophthalmoscope, tonometer and phoropter machine.

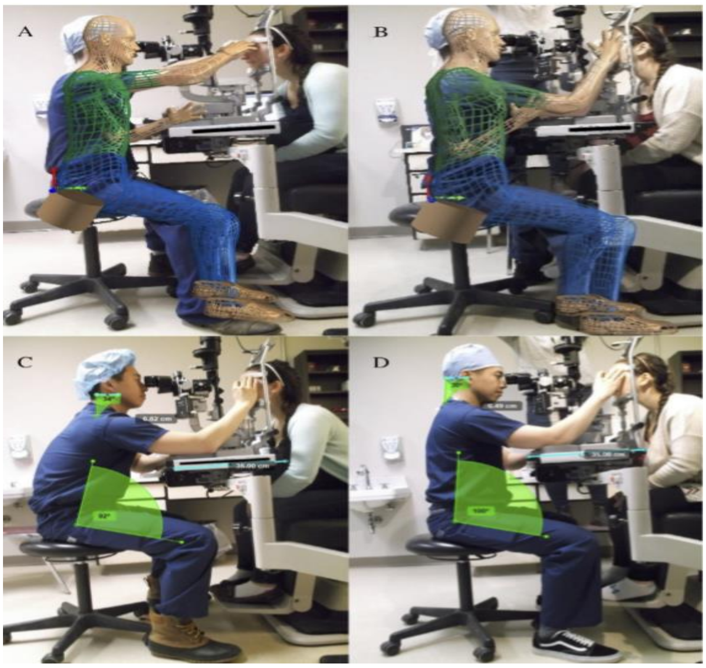

Figure 3. Slit Lamb Ophthalmoscope device Positions (Ratzlaff et al., 2019).

One piece of equipment is the phoropter, which is used to determine eyeglass prescriptions and measure eye error. Niwot and Centennial (2004) found optometrists using awkward positions when operating phoropter machines, which could lead to shoulder, back and arm problems. Another study reported 339 Australian optometrists with physical problems due to phoropter and slit lamp use, such as back pain and optometrist physical discomfort (Long et al., 2012). Other examination room machines such as tonometer, that are used to detect glaucoma disease) have been proven to cause harm to patients during exams.

The tonometer in particular emits cobalt blue light, which can cause corneal abrasions unless patients avoid tangential movement during eye measurement (Bader and Havens, 2019). This makes patient anxiety or posture discomfort during the eye measurement processes an issue, as such factors can lead to involuntary movement affecting patient safety, which could be blamed on the optometrist.

Another piece of optical equipment is the slit lamp, a microscope used to examine eye structures and diagnose eye disease (Figure 3). According to Hostetler et al. (2019), the device does not fit a wider variety of patients, depends on patient's obesity; the authors redesigned the lamp to improve its ergonomics and capability (Figure 4). The change allowed patients in the US to control the equipment's light intensity, adjust the slit lamp machine for overweight patients and support patient heads at an exact eye position (Hostetler et al., 2019).

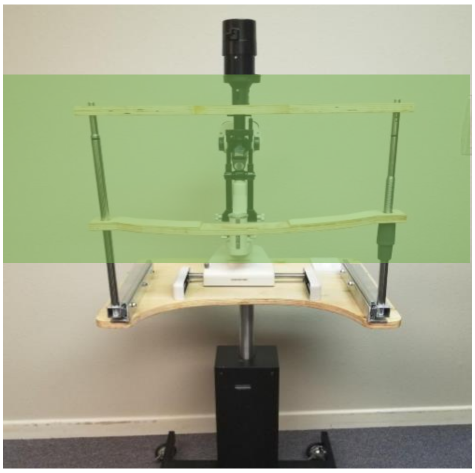

Figure 4. Redesign of slit lamp device (Hostetler et al., 2019).

Figures 3 and 4, indicated in yellow highlighted, what has been changed in the slit lamp devices. The skeleton of the new design is coated by a clear layer of polyurethane to provide an easily sterilised wood surface and aesthetic finish. The new design also changed the headrest to support overweight patients and increase patient comfort during examination (Hostetler et al., 2019). This redesigned device could help patient posture and reduce diagnostic times, allowing optometrists to adjust their sitting positions more quickly. However, the redesign may not change or the better for both the patients and the optometrists.

2.4. Personal Workspace:

The personal workspace for the optometrist's ergonomics repetitive harmful motions during a daily practice, for example efforts leading to hands sleep and become painful (Niwot and Centennial, 2004). According to the Health and Safety Executive (2004), the workspace aims to satisfy health, safety and welfare regulation. Other point is that personal workspace should have enough high and floor area as well as unoccupied space has given the context of a patient's presence and an optometrist is performing with required machines. Minimum workspace requirements should be 11 cubic meters per person (Health and Safety Executive, 2004). These measurements have indirect effects to the personal psychology. However, most research has described the physical and psychological roles of personal and social workspace. Herzog et al. (2015) assumed that physical factors affect psychological factors, such as human well-being, yet gender and age can also affect optometrist well-being.

2.5. Wider Workspace:

In ergonomics, a wider workspace is considered to be a key concept in workplace and equipment design (Waterson and Sell, 2006). Examination room lighting has health and safety aspects, as the Health and Safety Executive (2004) indicated that poor room lighting can be affected by optometrists' and patients' eyes and make work systems harder, leading to unhealthy sitting postures in the workplace (Hemphälä and Eklund, 2012). Hamedani et al., (2020) had recent research that has determined that daily visual workspace affects physical and psychological. For example, a glaring room light increased discomfort, choosing lamp types is important. While a minimum amount of sunlight is necessary for a comfortable workspace environment (Hamedani et al., 2020).

However, Çakir (2014) argued that sitting daily for long periods of time behind windows while being exposed to sunlight would cause many diseases including cancers and that windows are artificially designed. This disagreed with the idea of a comfortable workplace design.

Hamedani et al., (2020) claimed that presence of a window allows the entry of sunlight while the sunlight changes doctor and patient psyches positively, taking into consideration the location of the window and the times of exposure of the sun directly to it, as well as the location of the optometrist and patients setting. It is also important to avoid sun reflection with devices so that the optometrist and the patient vision becomes clear. The sunlight is important, but the critical points are where to locate the window to manage the sun path and how much it is appeared to transmit light (Appendix 3). Developing an eye examination room with a wider workspace depends on an optometrist's views about sunlight as well as whether sunlight and window placement affects eye testing processes.

The wider workspace should be free from reflections of sunlight and room light, such as the reflection on the floor and the machine screen, to avoid visual symptoms which also affect the workers' capacity (Anshel, 2007). The reflection phenomena lead to discomfort eyes vision in daylight, so addressing the visual issues is primary care, which required to support workers' productivity as a visual and task performance to increase speed workers (Hamedani et al., 2020). Likewise, Anshel (2007) indicated the visual task performance increased for full-day workers, it could cause serious eye problems such as astigmatism and dry eyes.

2.6. <u>Physical environment:</u>

The physical environment of an ophthalmology department, especially in the examination room, is significant because it can affect patient treatment. Physically, limited mobility required to provide more space in examination room to move comfortably while working, such as the room size and the space between each equipment to allow comfortable movement for the optometrists and the patients between the equipment (Leng, 2018). However, human performance is affected by the thermal environment in an eye examination room, which should be balanced to prevent heat or cold stress (Wilson and Corlett, 1995). The World Health Organization (WHO) environmental noise guidelines also require managing noise levels from people and machines to prevent negative impacts on human well-being, safety and health (WHO, 2018).

2.7. Work Organisation and Job Design:

The ergonomics society has developed since 1949 to provide seven main categories of the ergonomics society: growth and influence, education and training, external relations, ergonomic society publications, key individual and initiation, influence on government and image or identity (Waterson and Sell, 2006). These categories changes have affected optical organisational work, which is also affected by workplace culture, the core element to improve the ergonomics in the optometry. It is believed that a positive cultural environment creates positive patient outcomes (Sholl et al., 2019). Optometrist and patient knowledge about healthier sitting positions and movement, the meaning of a safe environment and focusing on ergonomics are parts of a developing ergonomics culture in the future.

The optometry workplace environment should not be exposed to any injury or risk, designed with the understanding that worker and patient needs change with age, gender and size. Starting from the height of the reception counter, which should be between 1,200 mm and 1,250 mm above the floor level (International Health Facility Guidelines, 2015), the optical examination room should be designed a floor of linoleum, rubber or ceramic to ensure a better environment (Dixit et al., 2019). The optical clinic is a variable that depends on technical, social, legal and financial aspects wherever it is located, which are represented by the outside influences on the Onion model (Wilson and Corlett, 1995).

3. Result:

Ergonomics adapted in healthcare under health and safety organizations. Developing a hospital environment and approached a good healthcare culture for both patients and doctors (Lang and Hignett, 2018). A discussion took place in a clear discomfort for the optometrists and patients during the eye's examination process, which appears in most of the Onion model elements for different reasons. A possible explanation for the optometry ergonomics was a lack of optometrists' awareness and routinely work for the organization.

Decreasing poor positions risk started with making optometrists aware, reminding them how position affects body health, as they usually deal with machine-like tools to assess patients and focus on performance rather than posture (Newman, 2005). Unanimously, the human factor of the ophthalmology department is harmful because of poor design and work organization. Doctor fatigue requires immediate management to reduce the risk of working for a long time (Long, 2014).

To implement an active result, engaging optometrists and other workers while conducting patient surveys to understand their perspectives would make it possible to build good ergonomic systems, support better treatment quality and assist patients in making good decisions.

4. Recommendations:

- A suggestion is encouraging the optometrists and ergonomists to communicate with each other about the discomforting position and reporting the issues (Long, 2014). To aware of both of them and arrange a meeting.
- Studying the distances and angles of lighting as well as reflections on room surfaces and machines could reduce eyestrain as would changing lamp types (Health and Safety Executive, 2004).
- BMA (2016), recommended ensuring optometrists work schedules while avoiding workload and poor repetitive postures.
- Encouraging optometrists to do body and eye stretching exercise to reducing the possibility of developing the chronic disease and improving the workers productivity (Pereira et al., 2019).

5. Conclusion:

Improved eye test examination room quality requires physical and psychological comfort in the workstation environment for optometrists and patients. Safety and health are the core purpose of ergonomic development, which is why involving workers in the workplace and job design is important, As they possess the best understanding of how they suffer from repetitive the same poor position most of the working hours. Engaging optometrists and other workers to organize their environment increase their ergonomic knowledge while helping them focus on their postures. Workload makes the optometrists distracted from the focus of the harmful position. While patients trust their optometrists, they can be exposed to the same harmful position, not just once but regularly, which can cause problems over time. The optometry clinic purpose is treating the patients, to achieve a successful treatment, provide a safe and comfort work environment for the optometrists is require.

'The consequences of not applying ergonomics, or of wrongly applying ergonomics through inappropriate methodology, can increase risks of ill health and injury, dissatisfaction, and discomfort for workforce' (Wilson and Corlett, 1995, p. 2).

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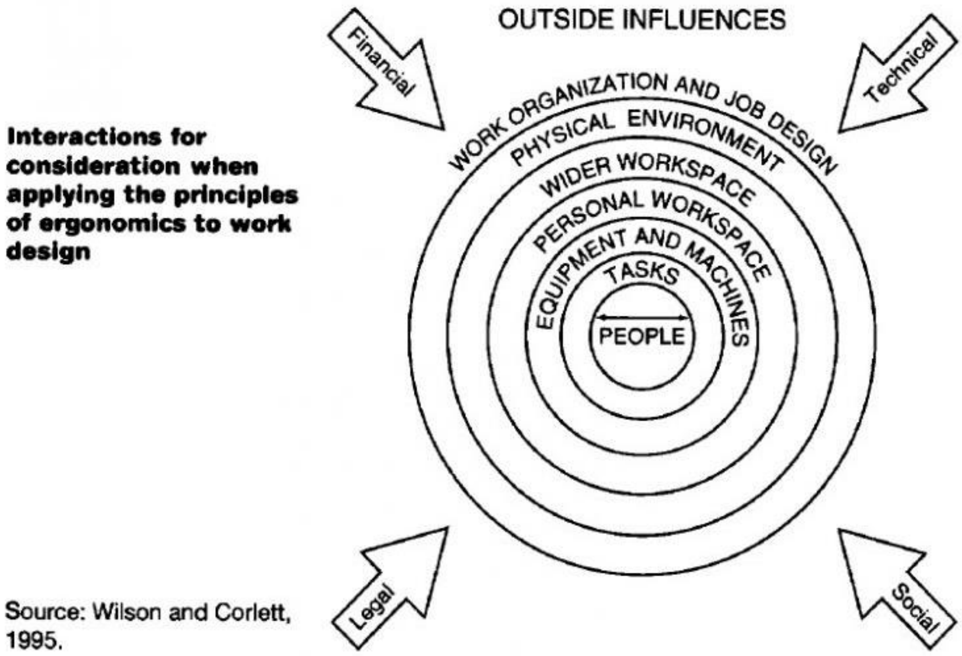
6. Appendices:

- Appendix 1. The Onion Model (Wilson and Corlett, 1995).



- Appendix 2. OWAS table of position measures (Herzog et al., 2015).

Part	Thoraxlumbal spine				Upper limb			Hands		Lower limb				Head		
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	4.1	4.3	4.4	4.6	5.1	5.2	5.3
OWAS / %																
10	□	□	□	●	□	□	□	□	□	□	□	□	□	□	□	□
20	□	□	□	●	□	□	□	□	□	□	□	●	□	□	□	□
30	□	□	●	●	□	□	□	□	□	□	□	●	□	□	●	●
40	□	●	●	▲	□	●	●	□	□	□	●	▲	□	□	●	●
50	□	●	●	▲	□	●	●	□	□	□	●	▲	□	□	●	●
60	□	●	▲	▲	□	●	●	□	□	□	●	▲	□	□	▲	▲
70	□	●	▲	▲	□	●	●	□	□	□	●	▲	□	□	▲	▲
80	□	▲	▲	▲	□	▲	▲	★	★	□	▲	▲	□	□	▲	▲
90	□	▲	▲	▲	□	▲	▲	★	★	●	▲	▲	●	□	▲	▲
100	□	▲	▲	▲	□	▲	▲	★	★	●	▲	▲	●	□	▲	▲

Legend:
□ - changes are not needed
● - changes needed in near future
▲- changes needed immediately
★- needed intensive observation

- Appendix 3. Sun Path (Hamedani et al., 2020).