Universidade do Minho
Escola de Engenharia

Jhonnathan Abrahan Mora

Study of risk factors that influence visual fatigue and musculoskeletal stress in an open office

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Ana Sofia de Pinho Colim

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

ABSTRACT

Work-related musculoskeletal disorders (WMSD), affecting tendons, bones, ligaments or vertebral discs, are very common today. Actually, companies opt for open spaces, these are spaces where there are no walls, doors, or workspaces for each employee, they simply bring them all together in the same area, with continuous desks and next to each other.

This study is focused on an open office and aimed to identify and evaluate the main risk factors for musculoskeletal problems and visual stress. First, the place was visited to have a more specific idea of this, then a questionnaire based on the Nordic questionnaire was applied to 20 workers, to which other questions related to demographic data, lighting, visual stress, among others were added.

In order to develop an ergonomic assessment, the Rapid Office Strain Assessment (ROSA) was applied, which is a method commonly used to evaluate jobs in offices. In addition, the lighting data were recorded in 35 desks/workplaces, according normative requirements.

From the Nordic questionnaire, the body regions more affected by musculoskeletal pain/discomfort during the last 12 months were the feet (70% of the 20 workers), lumbar (65%), neck (55%) and knees (50%). Considering the ROSA assessment, the final value was 5 points, which indicates that exists a risk for high discomfort and possible occurrence of musculoskeletal disorders. Therefore, these results pointed out the need for further research and modifications to the workplaces.

Relatively to the lighting, the illuminance values obtained are lower than the values recommended by the European Standard – ISO 8995: 2002, justifying the visual complaints reported by some of the workers.

Summarily, this open space needs intervention at the level of lighting, since adequate lighting of the workplace contributes to the safety, well-being and comfort of the employees. At the same time, ergonomic measures (such as occupational gym and physical reorganization of the workplaces) were needed to decrease the musculoskeletal risk. In this domain, the ROSA method is a useful and easy method to assess WMSD risk in offices.

Keywords: WMSD, open space, ROSA method, Illuminance, visual fatigue

RESUMO

As lesões musculoesqueléticas relacionadas com o trabalho (LMERT) que afetam tendões, ossos, ligamentos ou discos vertebrais, são muito comuns hoje em dia. Na atualidade, as empresas optam por *open spaces*, os quais são espaços onde não há paredes, portas ou espaços de trabalho para cada funcionário, estão estão juntos na mesma área, com mesas contínuas e próximas umas das outras.

Este estudo é focado num *open space* e tem como objetivo identificar e avaliar os principais fatores de risco para problemas musculoesqueléticos e stress visual. Primeiro, o local foi visitado para se ter uma ideia mais específica e, em seguida, um questionário baseado no questionário nórdico foi aplicado a 20 trabalhadores, aos quais foram adicionadas outras questões relacionadas com dados demográficos, iluminação, stress visual, entre outras.

Para desenvolver uma avaliação ergonómica, foi aplicado o *Rapid Office Strain Assessment* (ROSA), que é um método comummente usado para avaliar trabalhos em escritórios. Além disso, os dados de iluminação foram registrados em 35 mesas/postos de trabalho, de acordo com os requisitos normativos.

No questionário nórdico, as regiões corporais mais afetadas pela dor/desconforto musculoesquelético nos últimos 12 meses foram os pés (70% dos 20 trabalhadores), a região lombar (65%), o pescoço (55%) e os joelhos (50%). Considerando a avaliação do ROSA, o valor final foi de 5 pontos, indicando que existe risco de alto desconforto e possível ocorrência de problemas musculoesqueléticos. Portanto, esses resultados apontaram a necessidade de mais investigação e modificações nos postos de trabalho.

Em relação à iluminação, os valores de iluminância obtidos são inferiores aos recomendados pela Norma Europeia - ISO 8995: 2002, justificando as queixas visuais relatadas por alguns trabalhadores.

Resumidamente, este *open office* precisa de intervenção ao nível da iluminação, pois a iluminação adequada do local de trabalho contribui para a segurança, o bem-estar e o conforto dos funcionários. Ao mesmo tempo, medidas ergonómicas (como ginástica laboral e reorganização física dos locais de trabalho) são necessárias para diminuir o risco musculoesquelético. Neste domínio, o método ROSA é um método útil e fácil para avaliar o risco de LMERT nos escritórios.

Palavras-chave: LMERT, *open space*, método ROSA, iluminância, fadiga visual

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LIST OF ABBREVIATIONS

ROSA: Rapid office strain assessment

GDP: Global Domestic Product

WMSD: Work-related musculoskeletal disorders

WHO: World health organization

DALY: Years of Life Lost and Lived with Disabilities

EU: European Union

LIST OF VARIABLES

Emean = mean level of illuminance (lux);

n = Total of measurements made;

Ei = Illuminance level (lux) in the measurement i.

U = Emin / Emean

U = Illuminance uniformity;

Emin = Minimum level of illumination (lux);

Emean = mean level of illumination (lux).

1. INTRODUCTION

Work-related musculoskeletal disorders (WMSD) in offices have increased in recent years, mainly due to the regular use of computers at work stations. These musculoskeletal disorders are significantly presented in different areas of work (Fredriksson et al., 2001). The principal risk factors for WMSD are related to activities of heavy loads, repetitive tasks and awkward work postures (Linton and Kamwendo, 1989).

Employees who perform activities in offices have a higher rate of WMSD occurrence, this is due to the continuous use of the keyboard mouse and high muscle tension in the neck and shoulders (Kryger et al., 2003).

In this field, the Rapid Office Strain Assessment (ROSA) is an assessment method of efforts in offices, that is based on a checklist with images of positions that allows to quantify the exposure of workers to risk factors in the office environment. The objective of this method is to serve as a classification tool to identify problems in the work of a markedly administrative nature (Sonne & Andrews, 2012).

In addition, visual fatigue in an office in terms of poor lighting conditions can lead to serious problems of eye fatigue, blurred vision and increased sensitivity of the light, which can lead to work incapacity (Aara, Horgen, Bj, & Ro, 2001). Preto & Gomes (2019) has recommended increasing levels of office lighting, depending on the profile of age and workforce.

Therefore, the current study intends to analyze the possible lighting effect that plays an important role in the daily performance of the activities and the comfort of the office workers. Additionally, it is also intended to study the musculoskeletal risk factors in this occupational context. According to the above mentioned, the current study aims to know the main risk factors for musculoskeletal and visual stress in an open office and the possible effects in the wellbeing and comfort of employees.

1.1 Objectives

Summarily, the main objective is the following: identify and assess the principal risk factors for musculoskeletal desorders and visual stress in an open office. Based on this objective, operational objectives were defined, namely:

- Characterize the open office considering the physical arrangement and the lighting conditions at the workplace;
- Analyse the musculoskeletal and visual symptoms reported by the workers;
- Assess the risk factors for musculoskeletal and visual stress in the open office through specific methodologies and normative recommendation;
- Compare the workers' perceptions with the assessments' results;
- Identify ergonomic recommendations in order to eliminate/reduce the risk factors identified in the open office.

1.2 Structure of the dissertation

This dissertation is structured in 4 chapters, the first chapter refers to the introduction of the topic to be studied and objectives to be achieved. The second chapter refers to the bibliography review centred on the area of work related musculoskeletal injuries and lighting. The third chapter presents the methodology applied, i.e. the materials, data collection and procedures performed throughout the study. In the fourth chapter, the results obtained from the work are presented and discussed, with the recommendations or suggestions provided and finally the bibliographic references.

2. BIBLIOGRAPHIC REVIEW

2.1 Work-related musculoskeletal disorders – WMSD

According to the World Health Organization (WHO, 2019), WMSD encompass more than 150 diagnoses that affect the locomotor system, that is, muscles, bones, joints and associated tissues, such as tendons and ligaments. These symptoms occur when performing any physical or professional activity (Kuorinka and Forcier, 1995). WMSD is generally characterized by pain (often persistent pain) and limitations in mobility, dexterity and functional ability, which reduces people's ability to work. WMSD in the neck and upper limbs caused or aggravated primarily for work and the environment in which it develops (OSHA, 2007).

WMSD is the leading cause of disability and low back pain is the most common cause of disability in the world. Osteoarthritis, back and neck pain, fractures associated with bone fragility, injuries and systemic inflammatory conditions such as rheumatoid arthritis are the most relevant musculoskeletal disorders worldwide. WMSD can appear at any time in life, between one in three and one in five people, including children, suffer from a musculoskeletal and disability disorder, occurring mainly from adolescence to old age. Its prevalence and its effects are expected to increase with the aging of the world population as well as the frequency of risk factors for noncommunicable diseases. (WHO, 2019).

WMSD and discomfort are related to a prolonged sitting position, accelerated work, static and uncomfortable postures, and highly repetitive movements. In addition, inadequate working conditions can cause musculoskeletal disorders and affect people's well-being, as well as reduce the productivity (Straker, Abbott, Heiden, Erik, & Toomingas, 2013) WMSD are considered the main contributing factor in work absenteeism, reduced quality of life, change of occupation, increased work-related injuries and increased medical expenses due to disability. In 2016, approximately 2.4 million non-fatal accidents were reported requiring at least 4 days of absence from work and 3,182 fatal accidents in the EU Member States. In addition to these accident rates, 2013 figures show that 7.9% of the workforce suffered from occupational health problems, of which 36% resulted in the absence of work for at least 4 days (Tompa et al., 2019).

In-office work, there is a growing community that is associated with an increase in WMSD, such as the upper extremities and the neck. Given the high problems of WMSD among computer users and the worldwide increase in computers, there are concerns about the increase in these injuries related to WMSD (Choobineh, Motamedzade, Kazemi, & Moghimbeigi, 2011). A limited number of controlled studies of ergonomics in the office have investigated the impact of ergonomic intervention in the workplace (Brewer et al., 2006). Computer workers also report that they experience visual disturbances and symptoms, such as visual fatigue, blurred vision, dryness and difficulty concentrating, many risk factors that contribute to WMSD and visual discomfort of the computer workers in the office (Robertson, Ciriello, & Garabet, 2013).

According to Amick et al. (2012) the changes in visual symptoms result from alterations in illumination and the use of corrective lenses. In an increasing number of workers using computers, visual strain can affect the performance and overall productivity of the workforce. Ergonomics training and the use of highly adjustable chairs in offices, reduce the visual symptoms of workers at the end of the working day and minimize WMSD.

WMSD has taken considerable importance in Europe in recent years. Assessing the cost worldwide and in Europe, work-related accidents and illnesses have reported considerable costs of 2680 billion euros representing 3.9% of global gross domestic product (GDP), compared with Europe representing 3.3% of global GDP, raising costs to 476 billion of euros (Elsler, Takala, & Remes, 2017)

2.1.1 Causes and types of WMSD

The causes of WMSD are related to pathophysiological mechanisms, in which there are some models that correlate different types of risk factors with certain injuries. The models focus on mechanical exposure, however, there are models including other factors, such as psychosocial aspects (Alvarez-Casado, Hernandez-Soto & Sandoval, 2009).

The occurrence of musculoskeletal problems is mainly when the biomechanical requests of a task are superior to the functional capabilities of the worker (Dempsey, 1998).

The most common WMSD results from the bad positions of the workers, the repetition of movements and the lack of training to perform the correct movements that are associated with the performed activities. The main parts affected by these disorders are the upper limbs, back, and mostly the cervical and lumbar spine (Bernard, 1997).

The symptoms presented most frequently are localized pain, feeling of discomfort or fatigue located in a certain part of the body, the sensation of weight or the sensation of not being able to manipulate that weight for a certain time may become the beginning of an injury (Serranheira, Uva & Lopes, 2008). Considering the office's work activity, the most frequent musculoskeletal problems are the following:

- Tendonitis: is an inflammation of the tendon. The tendons are structures that are connected to the muscles, the tendons work every time the muscle works, therefore, when an effort is made repeatedly the muscle tends to warm up and the tendon becomes overused. If an injury has already occurred in the tendon or has an accumulation of lesions, the body usually tends to repair it naturally. When inflammation occurs, if the problem persists or if the tendon is still overused it may be more vulnerable to overloading. This is called tendonitis (Simoneau, St-Vincent & Chicoine, 1996);
- Cervical tension syndrome: this syndrome is determined by the set of muscular pains in the shoulders and neck, this injury is related to repetition tasks and static postures, most injuries of this type are related to office work (Nunes & Bush, 2012);
- Bursitis: is an inflammation of the Bursa. The Bursa is a sac that contains a synovial fluid between the tendon and the bone. Then, after the inflammation of the Bursa comes to the tendon inflammation, this swelling accompanies the tendonitis and the bursa ends compressed between the bones. Friction and compression can injure the bursa and cause bursitis. Bursitis is sometimes the complication of tendonitis in the shoulder (Simoneau, St-Vincent & Chicoine, 1996);
- Carpal tunnel syndrome: the wrist is made of many carpal bones, these bones form a cavity called carpal tunnel in which many tendons, nerves, and blood vessels pass. The carpal tunnel is an affliction of the nerves that are compressed, usually by the inflammation of tendons that pass nearby, in a limit of space that constitutes the carpal tunnel. This syndrome is the only one that presents a strong pain at night when the swelling reaches its maximum (Simoneau, St-Vincent & Chicoine, 1996). These diseases are mainly generated by repetitive movements of the hands and arms.

The OSHA (2019) conducted a study evaluating the main work-related illnesses and the DALY (Years of Life Lost and Lived with Disabilities) per 100,000 workers. In most of the EU

(European Union), Iceland and Norway, the main part is due to cancer and then to WMSD. In the European Union, 15% represent WMSD diseases, while for Portugal it represents 24.46% of WMSD (OSHA, 2019).

2.1.2 Risk factors of WMSD

WMSD are the most common occupational diseases that affect millions of workers across Europe and cost entrepreneurs billions of euros. The development of the most WMSD occurs over time, usually, there is not a single cause of MSD, but there are several factors that work together, such as physical, organizational, individual and psychosocial risk factors (OSHA, 2017).

2.1.2.1 Physical risk factors

There are several physical risk factors which are related to the appearance of WMSD. These physical factors may cause harm when performing repetitive movements, heavy work, improper handling of loads, bad postures, exposure to vibrations, exposure to cold or excessive heat and lighting problems are performed. All these elements combined with the absence of recovery periods increase the chance of musculoskeletal injuries (Serranheira, 2007).

WMSD is reflected in alterations of muscles, nerves, tendons, ligaments, and joints. Posture and repetitiveness are influenced by the task in the office area. In a work environment, repetitiveness is considered to exist when identical movements are made more than two to four times per minute, above 50% of the work cycle, in cycles lasting less than thirty seconds or for more than four hours in a day work (Serranheira et al., 2008). These movements generate an overload in the muscle and tendons that generally lead to the appearance of skeletal muscle lesions (Cordeiro & Freitas, 2013).

Lighting is an important factor in the indoor workplaces since it avoids forcing the vision and therefore allows to maintain a stable posture when performing work in the office (Punnett & Wegman, 2004).

The most common occupational health problems among computer users are visual and musculoskeletal symptoms and disorders. For the health problems related to the eye discomfort, the main risk factors include hours of computer use and low lighting conditions (Brewer et al., 2006). Matos & Arezes (2015), highlight that office work represents a complex physical work context, with interactions among the various dimensions of the workplaces, speed of data entry in computer, position, and lighting of visual targets (such as documents and screens).

2.1.2.2 Individual risk factors

Different individual risk factors are related to WMSD. The workers' age is considered as a cumulative risk factor at work promoting the reduction of muscle strength and joint mobility (Serranheira et al., 2008).

The gender is also often considered a risk factor, it should be noted that on average women have less muscle strength. The height, weight and other anthropometric characteristics are also considered risk factors, differences between these personal characteristics and the jobs, especially for those who are not within the average values, can generate injuries or diseases. People with diseases such as diabetes, trauma, and even pregnancies are more susceptible to any injury (Sousa, Carnide, Serranheria, Cunha & Lopez, 2008).

There are diseases such as diabetes, or illnesses in the mobility system which in themselves make the worker more susceptible to health problems. Stress is also a conditioning factor as it causes constant muscle tension, inhibiting the muscles from working properly (Uva, Carnide, Serranheira, Miranda, & Lopez, 2008).

2.1.2.3 Psychosocial and organizational risk factors

Psychosocial risks are the risks for mental, physical and social health, according to the working conditions and organizational factors produced by the work team, the structure and business culture, to which employees are exposed, those may have a positive or negative impact on the organization (Jiménez, 2011).

Some organizational and psychosocial risk factors are related to:

• Requirements of productivity, causing intense work performance and stress;

• Monotony in activities, which can lead to stress or not enough stimulus for work;

• Insufficient social support, there must be a balance between social life, the positive or negative mood, work environment, thus providing an emotionally stable environment to the worker, promoting the execution of a good job.

• The organization's model for example schedules, breaks, work environment, incentives, production cycles, all these elements can increase the workload (Sousa, Carnide, Serranheria, Cunha, & Lopes, 2008).

2.2 Methods for ergonomic assessment

In general, these ergonomic methods make it possible to evaluate the postures of several corporal segments and also critical factors of physical exposure, such as strength and repetitiveness. David (2005) categorized the ergonomic methods for assessing exposure to WMSD risk factors into three groups:

- Self-reports from workers;
- Observational methods based on the observation of real work activity, using predefined assessment sheets for estimating the risk level and supporting ergonomic interventions;
- Direct measurements using monitoring instruments for the quantification of exposure variables at work (such as the electronic goniometers and electromyography).

The self-reports and the observational methods are the most applied in the occupational contexts, being the direct measurements more used in research studies. Self-reports from workers constitute an approach to identify WMSD risk factors and to collect workers' perceptions about this topic. The questionnaires applied to workers are frequently applied during ergonomic interventions (David, 2005). The Nordic questionnaire is a standardized questionnaire used to evaluate and to characterize musculoskeletal symptomatology perceived by workers, considering their entire body (Crawford, 2007). Mesquita et al. (2010) developed and validated the Portuguese version of this questionnaire.

As observational methods, the Rapid Entire Body Assessment (REBA) (Hignet & McAtamney, 2000) and the Rapid Upper Limb Assessment (RULA) (McAtamney & Corlett, 1993) are examples of methods based on postural analysis of different body segments, taking into account the force exerted, the movement repetition, the type of muscular work (static/dynamic). The Rapid Office Strain Assessment (ROSA) (Sonne & Andrews, 2012) is a recent office workplace assessment method and it was formulated through the RULA and REBA methods as references. This is an observational method that shows acceptable levels of reliability, accuracy, and validity (Sant et al., 2019).

2.3 ROSA method

The regular use of the computer in the office contributes to the appearance of many risk factors related with WMSD, such as maintaining static sitting postures for long time and awkward postures of the head, neck and upper limbs, leading to increased muscle activity in the cervical spine and shoulders (Matos & Arezes, 2015).

The office work has been increasing day by day and with them the incidence of musculoskeletal disorders, some of its causes are related to the mouse use, keyboard, for example, due to repetitive movements of the fingers, hands, wrist, uncomfortable postures of the lower limbs, among others (Diego-Mas, 2019). For this, exist a method that aims to assess the level of risk associated with office work, this is the ROSA (Sonne & Andrews, 2012). This method is applied in the office work area composed by a chair, a desk, and computer. Then the elements evaluated are the chair, work surface, keyboard, mouse, screen, telephone; being each element assessed, according to the position adopted for the employee,obtaining intermediate scores before the final ROSA score. Therefore, the ROSA assessment is divided according to three subsections, namely: chair, monitor and telephone, mouse and keyboard. The last step of this method is the achievement of a final score. The final score indicates the risk level, as shown in Annex I.

The ROSA method has been designed to quickly quantify the risks associated with computer work and establish a level of action to characterize the level of risk in the workplace and to know the postures that workers adopt (Figure 1) in the workplace (Matos & Arezes, 2015).

Figure 1 - Examples of orrect and incorrect postures of an office worker (Camons, 2017).

2.4 Lighting of workplaces

Lighting and vision are strictly related. Vision is strongly related to the sensitivity of the eye and the electromagnetic visual system (Anshel, 2005).

The lighting is strictly connected to the health of the employees, there are two types of lighting, the first one is natural and the second one is artificial, this artificial is normally used when the natural is absent or does not provide comfort. Natural lighting produces less visual fatigue, allows to appreciate colors as they are and produces an increase in well-being due to outdoor exposure (Ferreira, 2012). In fact, the illumination may derive from electric/artificial light, daylight or combination of both, but this factor must create a visual environment that enables workers to see, to move safely and to correctly perform visual tasks (ISO 8998:2002).

Good lighting practices for workplaces is nothing more than providing good visibility for the performance of the tasks, it is extremely important that work tasks are performed easily and in excellent comfort. The lighting must satisfy the aspects of quantity and quality in the work environment. In general, lighting should guarantee:

- Visual comfort, where the workers have a feeling of well-being;
- Visual performance where the workers are able to perform their visual tasks, speedily and accurately even under difficult circumstances and during long periods;
- Visual safety, to aim and detect hazards (ISO 8998: 2002).

There are some parameters that contribute to an adequate lighting environment such as:

- luminance distribution;
- illuminance;
- glare;
- directionality of light;
- colour aspect of the light and surfaces;
- flicker;
- daylight;
- maintenance.

In addition to lighting, there are other visual parameters that influence visual performance of workers (such as:

- the intrinsic task properties (size, shape, position, colour, and reflectance of detail and background);
- ophthalmic capacity of the operator (visual acuity, depth perception, colour perception). (ISO 8998:2002)

Relatively to the naatural light, this can provide all or part of the lighting to perform visual work, the intensity and the range of radiation that is received daily for lifestyle, is incomparable with artificial lighting. Natural light is the ideal source for animal and plant life on earth (Ferreira, 2012).

Natural light conditions are an important factor that condition the well-being of employees. Besides lighting, solar radiation leads to a series of important consequences in relation to environmental factors in internal areas, such as overheating in summer seasons or as a heating effect in winter seasons (Lopez, 2010).

There are some recommendations for the distribution of luminance, illuminance and reflections. The luminance distribution in the field of view controls the adaptation level of the eyes, which affects task visibility. A well-balanced adaptation luminance is needed to increase:

- Visual acuity (sharpness of vision);
- Contrast sensitivity (discrimination of relatively small luminance differences);
- Efficiency of the ocular functions (such as accommodation, convergence, pupillary contractions, eye movements).

Diverse luminance distribution in the field of view also affects visual comfort and should be avoided:

- Too high luminances can give rise to glare;
- Too high luminance contrasts will cause visual fatigue due the continue readaptation of the eyes;
- Too low luminances and too low luminance contrast result in a dull and non-stimulating working environment.

The luminances of all surfaces are important and will be determined by the reflectance of and the illuminance on the surfaces. The range of useful reflectances for the major interior surfaces are:

- Ceiling: 0.6 – 0.9;
- Walls: 0.3 -0.8;
- Working planes: 0.2 – 0.6;
- Floor: 0.1 – 0.5.

The ISO 8995:2002 standard also specifies the necessary requirements for lighting in interior and local work areas, so employees can perform visual tasks efficiently, comfortably and safely during their work period. The ISO 8995:2002 lighting of indoor workplaces standard recommends that for work done in office areas, the lighting levels must be between 500 lux and 300 lux around the work area.

In this context, Pais (2011) summarizes some concepts, namely:

- Luminous flux: It is the amount of light emitted by a light source, on a surface per unit of time (t), Measured by Lumen unit (lm);

- Light intensity: measurement of luminous flux emitted by a source, in a certain direction, within a solid unit angle, expressed by candle unit (cd);

- Luminance: Luminous intensity emitted or reflected per unit area, is the luminous flux seen from a surface and reaches the eyes of an observer. Its unit is candle per square meter (cd/m^2);

- Illuminance: Measurement of incident luminous flux per unit area, expressed in lux (lx).

The recommended level of illuminance for a specific activity refers to the amount of light that is considered necessary for the proper execution of that task, also determining the quality of visual perception (ISO 8995:2002).

Visual comfort is considered adequate when the illuminance values are closer to the maximum acceptable value for each work area, performing faster and more perfect work without making the minimum errors and having a higher level of safety. Illuminance and its distribution on the task location and surrounding areas have a great impact about how quickly, safely and comfortably the person perceives and accomplishes the visual task. All values of illuminances specified in this standard (ISO 8995:2002) are maintained illuminances and will be provided for visual safety at work and visual performance needs.

The average illuminance to perform a task takes into account the following factors:

- Minimum requirements to perform the task;
- Security;
- Psychophysiological aspects such as visual comfort and well-being;
- Economy;
- Practice experience.

The value illuminance may be adjusted if the visual conditions differ from the normal assumptions. The illuminance should increase when:

- Low contrasts are present in the task;

- Visual work is critical;
- Errors are costly to rectify;
- Accuracy or higher productivity is of great importance;
- The visual capacity of the worker is below normal.

On the other hand, the illuminance values may be decreased when:

- The details are unusually large or high contrast;
- The task is performed for a very short period of time.

In areas where continued work is carried out the maintained illuminance shall not be less than 200 lux(ISO 8998:2002).

Illuminance both in the work area and around the work area must be stable and similar around the work area in order to obtain greater performance and productivity when executing a task, as well as avoid stress and visual impairment.

2.5 Symptomatology and visual comfort

- Some diseases can occur when the eye and the visual system stop working properly.The most common diseases are: Myopia is the visual disturbance that produces a focus on the image before reaching the retina. Myopia occurs in a series of effects of which there are two mechanisms: the increase in the axial length and curvature of the eyeball and an increase in the anterior-posterior diameter of the eyeball, known as axial myopia (Ibrahim, 2008).

- Astigmatism is a visual deficiency due to the irregular format of the cornea, which shows the image in several focus that are in several differentiated axes. Astigmatism can occur in conjunction with myopia, the main symptoms are blurred vision, fatigue, and headaches (Pais, 2011).

- Hyperopia is the error of focus of the image in the eye, which causes the image to form after the retina. This is because, in these cases, the eye is slightly smaller than normal. Hyperopia occurs when the closest point of the eye is farther than the normal eye due to an abnormality of the lens, insufficient curvature, which causes difficulties to see at close (Anshel, 2005).

3. METHODOLOGY

The study was done in an open office composed of 35 desks. The sample studied was a group of researchers (*n* = 20). These workers have different degrees of instruction such as graduates, MsD and PhD. The duration of workday is eight-hour shifts daily from Monday to Friday, working on a total of 40 hours per week.

(i) The main objective of this study is to identify and evaluate the main risk factors for musculoskeletal and visual stress in an Open Space, considering the physical space and lighting conditions in the work area. The methodology of the current study is divided into the following steps: Collection of the workers' perceptions by a questionnaire, considering symptoms of visual stress and musculoskeletal complaints;

(ii) Characterization of the illuminance in the workstations;

(iii) WMSD risk assessment by ROSA.

3.1 Characterization of the survey by questionnaire

The questionnaire "*refers to a way of obtaining answers to the questions by a formula that the respondents by themself completes*" (Maxwell & Oliveira, 2011). A survey is much more important than building a questionnaire, it is a process with multiple steps in which each stage must be well defined, where the questions that are intended to be asked must be adapted to a language and visual scheme appropriate to the population under study (Maxwell & Oliveira, 2011).

There are different variables that define different types of survey, such as:

- The structure of the survey if the questions are open or closed;
- The type of interview or survey provided by a researcher or if it is a questionnaire or self-supplied survey (Maxwell & Oliveira, 2011).

In this work, a manual filling survey option was selected, where the survey was applied to each person, clarifying doubts during the survey. The idea of this data collection measure was to obtain the most relevant information of the people surveyed in the office area.

This questionnaire survey technique is the most used by researchers because of the advantages it presents. It allows defining a large number of people to be interviewed, it is economical and the standardization of the questions allows a more uniform interpretation of the respondents, which facilitates the compilation and comparison of the chosen answers, in addition to ensuring the anonymity of the respondent.

However, the questionnaire also has some inconvenient, such as, the anonymity that does not ensure the sincerity of the responses obtained, since it implies aspects such as quality of respondents, their competence, openness, and goodwill. (Maxwell & Oliveira, 2011).

3.2 Questionnaire structure

Before data collection, participants read and signed an informed consent (Annex II). This questionnaire (Annex III) was made based on the study of Maria & Pais (2011) and complemented with some questions related to the objectives of the current study. For instance, in this questionnaire, the Nordic Questionnaire was included.

Therefore the questionnaire's first part is structured in order to collect demographic data of the respondents, namely: age, gender, laterality, workload, professional function, as well as other data about their routine life (if practice a sport or if have any musculoskeletal injury).

The second part aimed at the evaluation of musculoskeletal symptoms, based on the complaints and injuries that the respondents may present, all this complemented by a Nordic questionnaire (Mesquita & Moreira, 2010).

This questionnaire is divided into different sections, showing the body regions in areas (neck, thorax, lumbar, shoulders, elbow, hand, hips, knees, feet), the presence of these symptoms are shown in a time of 12 months, 7 days and if they ever had absenteeism due to any activity at work that caused an injury. The intensity of discomfort or pain was shown on a scale of 0 (no pain) to 10 (maximum pain).

A third part evaluates the visual symptoms, analyzing some office activities in relation to the computer screen, (the type of computer, pauses while working on the computer, type of adjustable chair, eye position in relation to the screen of the computer). Adjustment of the height of the eyes with the upper part of the computer screen, the perception and sensitivity of visual comfort (the quantity and quality of lighting, eye health, visual requirement, existence of shadows and brightness in the area of work) and finally the perception of visual discomfort (visual fatigue, blurred vision, eye irritability, headaches, stress and difficulty concentrating).

3.3 Illuminance measurement

To measure the illuminance in the work area and around it, a camera, paper, pencil, Lux Meter, tripod, tape measure and mold were used (Figures 2 and 3) . For the illuminance measurements, these were made on two different dates, the first was on 31st of May of 2019, a sunny day with a temperature of 31 °C, the next measurement was on 6th of June of 2019, a cloudy, dark and rainy day with a temperature of 19 °C at the time of measurement. The registration form sheet for measurement of lighting levels is found in Annex IV.

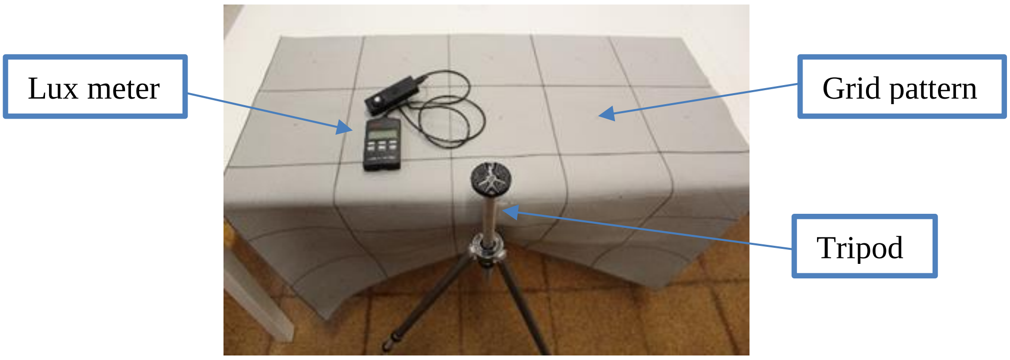

Figure 2 - Measuring tools.

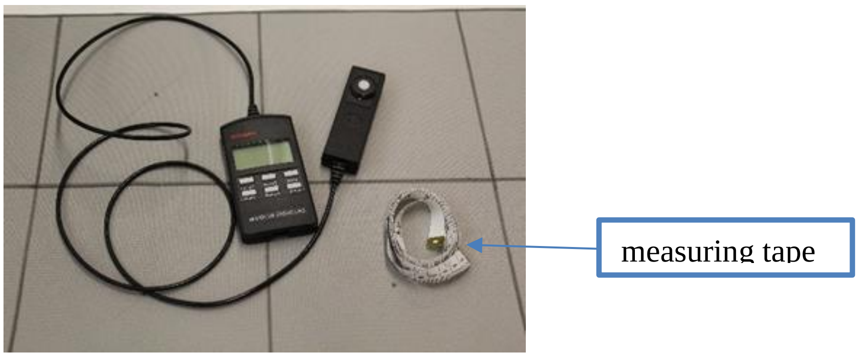

Figure 3 - Lux meter.

To make the lighting measurements in 35 desks, a sheet with a record of lighting measurements was used, of which 3 measures were taken for each work area (desk) and 3 measures around it. To know the measurement points, a grid pattern with squares of approximately 20 cm size was used, then the measurements were taken in the centre of each square.

The lighting measurement around the work area was made at a distance of 50 cm within the employee's field of view, these measurements were taken to the left, right and front. The measurements were made in the best way by placing the Lux Meter and move away as far as possible to avoid generating any type of shadow that could alter the measurement. For the measurement around the work area, the tripod was used and placed at the same height as the work area.

The data collected were analyzed and were used as a diagnosis to assess the principal risk of visual stress.

3.3.1 Calculation of mean level of illuminance and uniformity

The measurements described above and the calculation developed respected the guidelines of ISO 8995:2002. Then, the mean level of illuminance is determined by applying the following equation:

$E_{mean} = \sum_{i=l}^{n} Ei/n$

Where:

E_{mean} = mean level of illuminance (lux);

n = Total of measurements made;

E_i = Illuminance level (lux) in the measurement i.

Relatively to the illuminance uniformity, it is determined by the equation:

$U = E_{min} / E_{mean}$

Where:

U = Illuminance uniformity;

E_{min} = Minimum level of illumination (lux);

E_{mean} = mean level of illumination (lux).

The recommended values for the mean level of illuminance in an office work, as well as the recommendations for the uniformity of the illuminance are presented at Tables 1 and 2.

Table 1 - Recommended mean illuminance values for visual office tasks (ISO 8995: 2002)

Office tasks	**Mean task illuminance**
Filing, coping, circulation, etc.	300 lux
Writing, typing, reading, data processing	500 lux
Technical drawing	750 lux
CAD workstation	500 lux
Conference and meeting rooms	500 lux
Reception desk	300 lux

Table 2 - Recommended illuminance and uniformity values for the task area and surrounding, including office tasks (ISO 8995: 2002 and EN 12464: 2001)

Task illuminance lux	**Illuminance of Immediate surrounding lux**
≥750	500
500	300
300	200
≤ 200	Same as task illuminance
$E_{min}/E_{mean} = 0.7$	$E_{min}/E_{mean} = 0.5$

3.4 WMSD risk assessment

In the current study, for the WMSD assessment, two approaches were selected, namely: the Nordic questionnaire (included in the questionnaire described previously), and the ROSA method.

The Nordic questionnaire analyzes and evaluates musculoskeletal symptoms perceived by the workers (as above explained).

The ROSA method is a tool that was developed to quickly determine if an office workstation requires additional evaluation or intervention. This ROSA method is based on the risk factors of WMSD identified through specific research in an office and computer workplace. The risk factors incorporated in the method are organized into three subsections: chair, monitor and telephone, mouse and keyboard (for the current study the subsection of the telephone was only applied to one employee) (Sonne & Andrews, 2012). This method is based on a set of scoring diagrams in order to reach a final ROSA value and the respective action levels.

This ROSA method was applied to 20 workers in the open space, these action levels of the ROSA method are described in the following Table 3.

Table 3 - Action levels of ROSA method (Sonne & Andrews, 2012).

Action level									
1	2	3	4	5	6	7	8	9	10
Low risk workstation of discomfort.		Risk of discomfort. Job requires investigation and modifications may be required.		Risk of high discomfort and potential appearance of injury. Workstation requires immediate investigation and modification.					

3.5 Data analysis

The data obtained were analysed according to a descriptive analysis. The analysis of the data and the characterization of the sample was performed through descriptive statistics, such as mean, standard deviation, maximum, minimum and percentage, according to the variable. The analysis of the interpretation of the data was carried out through the Microsoft Excel programs (version 2013) and the R Studio 1.1.463.

4. RESULTS AND DISCUSSION

4.1 Description of the work area

As the first phase of this study, the general working area was evaluated, with the objective of fulfilling the objectives to be studied. In the study area there are 20 employees, who are sitting in their longest working time in an Open-Space, whose work is divided into four workers per work area. The tasks to be performed are mainly working on the computer most of the day, reading documents and some other tasks that they do sporadically during the day. The work area is equipped with chairs, desk, and computer (monitor, keyboard and mouse).

Figure 4 - Working area.

4.2 Demographic data

The sample was composed by 20 workers, only 4 were female and 16 male; The age distribution is the following represented in Figure 5, differentiating the percentage of workers according to their gender.

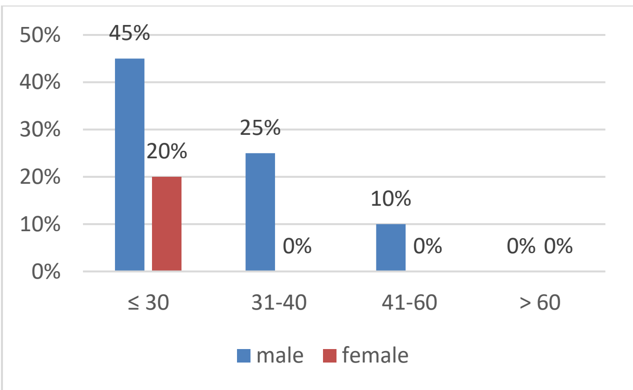

Figure 5 - Percentage of participants by gender and age (years old).

Regarding the laterality, 100% of the respondents are right-handed. This question was asked to distinguish the positions of the employees with respect to the posture and the light received in the work area, with the possibility that left-handed employees were positioned incorrectly or also generated a shadow that obstructs the light in the work area.

Figure 6 represents the distribution of employees with respect to seniority in their profession (work experience). Most of the employees have a seniority profession of less than or equal to 2 years, representing (45%) of the total. This factor shows that the majority of employees represent a relatively low level of work experience, being able to infer that the symptoms that employees can report regarding muscle pain and visual fatigue could be influenced by this factor.

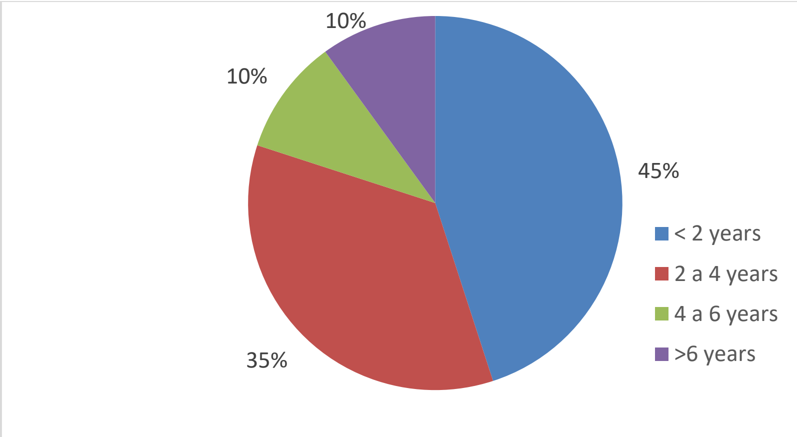

Figure 6 - Seniority in the profession

In Figure 7, the distribution of the degree of instruction of the participants is represented. The majority of respondents are Master researchers with 60%, 15% are PhD researchers and another 25% are graduates.

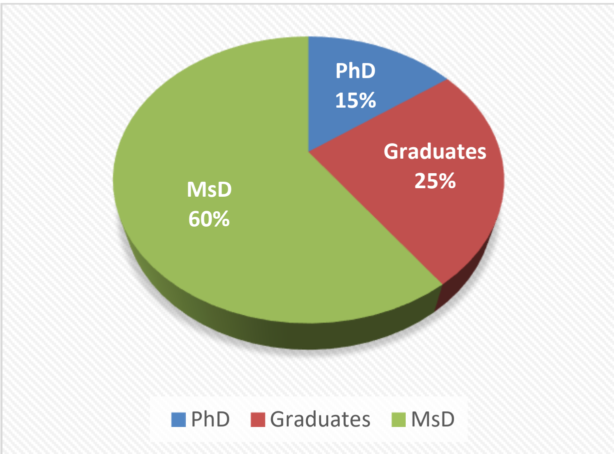

Figure 7 – Professional degree

The respondents also reported that 70% of them practice a sport regularly, such as, yoga, football, gym, running, cycling, among others. Concerning previous musculoskeletal injuries diagnosed by a doctor, 20% of the employees have musculoskeletal injuries, some of them are: right shoulder problems, left acetabular femoral conflict, scoliosis, left elbow tendinitis, cervical tendinitis, carpal tunnel syndrome, and epicondylitis.

4.3 Work activity

The work activity is related to the duration of the work time per day, activities that must be carried out during the workday, the type of computer and the time the employee uses on it, the pauses that the employee does during the work day, the distance of the employee in relation to the computer's screen (chair adjustments, frequency of use the chair and visual posture in relation to the computer's screen).

Most of the workers considered perform an average of 40 hours of work per week, approximately 8 hours per day (from Monday to Friday).

The computers that they normally use are laptops and the time of use is more than 4 hours, also all the chairs are adjustable and can be lifted and lowered to adjust the height and position according to the employee.

Table 4 summarizes the distribution of the activities performed in the work area during a working day.

Table 4 – Percentages of the activities done during the working day

	None working time	Short work time	Some working time	Most of the working time	All working time	Total
Time of writing and reading documents	0.0%	15.0%	5.0%	3.8%	1.3%	25.0%
Computer work time (visualization, reading and data entry)	0.0%	7.5%	5.0%	0.0%	0.0%	12.5%
Print documents, photocopies	0.0%	12.5%	2.5%	0.0%	0.0%	15.0%
Other tasks	0.0%	22.5%	25.0%	0.0%	0.0%	47.5%
Count	0.0%	57.5%	37.5%	3.8%	1.3%	100.0%

4.4 Visual fatigue and other symptoms

The study also showed that 50% of employees wear glasses and 60% have ophthalmological problems, such as, myopia and astigmatism, thus generating greater visual fatigue.

In Table 5, the prevalence of the visual fatigue is expressed in percentage, relavely to the total number of the participants. In this case, 30% of respondents feel visual fatigue 17% have visual fatigue at the beginning of the day, 33% in the middle of the day and 50% at the end of the day, as is show in Figure 8. These results indicate that after several hours of continuous work with few pauses, it can lead to long-term visual problems.

Table 5 - Prevalence of visual fatigue

	Feels visual fatigue	**%**
yes	**6**	**30%**
no	**14**	**70%**

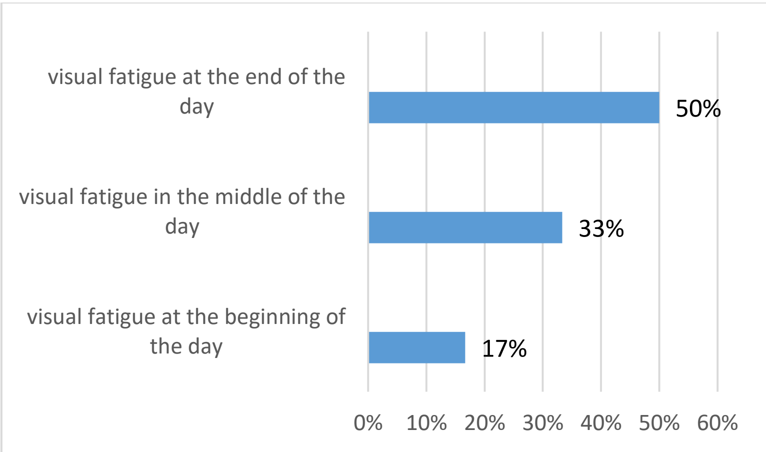

Figure 8 - Visual fatigue during the working day

Figure 9 shows a sample of the main symptoms related to visual discomfort. This approach was defined to distinguish the different symptoms associated with this problem, namely the visual fatigue, blurred vision, visual irritability, headaches, stress, and difficulty concentrating. These results also show the frequency of these symptoms.

According to the results obtained by the employees surveyed, the respondents pointed out that sometimes feel: concentration problems (16% of respondents),stress (13%) and headaches (13%) these representing the 30% who present with visual fatigue. Here could take into account that the respondents are young people, so the symptoms presented are related to this individual factor. However, in order to prevent these symptoms, the workers should avoid too long continuous time periods. The lighting of these workplaces is an important factor that influences these symptoms.

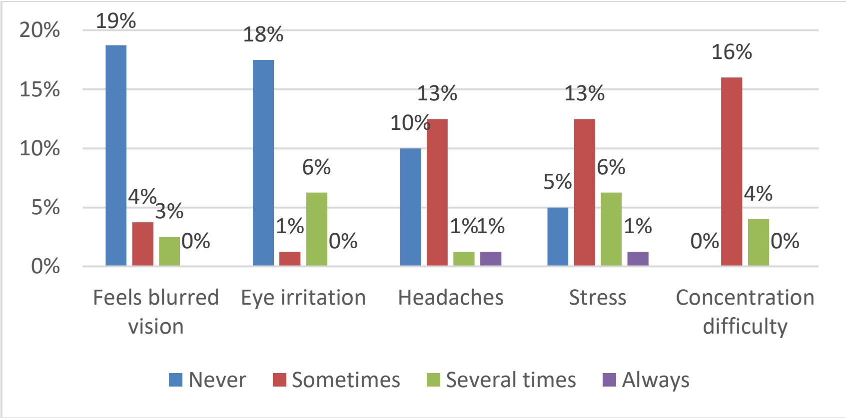

Figure 9 - Visual Discomfort and other symptoms

4.5 Musculoskeletal symptoms

The Nordic questionnaire was applied to employees in the area studied, obtaining information about musculoskeletal complaints. In Table 6 the prevalence of pain/discomfort for the sample (expressed in percentage) is presented across different body parts. This prevalence is indicated for the last 12 months and the last 7 days. In addition, it is also indicated if absenteeism motivated by these musculoskeletal complaints ocurred.

Table 6 - Results of Nordic Questionnaire

		No	%	Yes	%
Neck	12 months	9	45%	11	55%
	7 days	13	65%	7	35%
	Absentieeism	18	90%	2	10%
Lumbar	12 months	7	35%	13	65%
	7 days	16	80%	4	20%
	Absentieeism	14	70%	6	30%
Thorax	12 months	18	90%	2	10%
	7 days	18	90%	2	10%
	Absentieeism	18	90%	2	10%
Hips	12 months	12	60%	8	40%
	7 days	14	70%	6	30%
	Absentieeism	15	75%	5	25%
Knees	12 months	10	50%	10	50%
	7 days	10	50%	10	50%
	Absentieeism	13	65%	7	35%
Feet	12 months	6	30%	14	70%
	7 days	7	35%	13	65%
	Absentieeism	12	60%	8	40%

According to these results, it is evidenced that the main discomfort is related to the following body regions: feet (70% of respondents), lumbar area (65%), and neck (55%).

Figure 10 shows the results of other three body parts (shoulders, elbows, and hands), differentiating the following situations: no pain/discomfort, pain only on the left or right side, or both sides. Considering the answers, 75% referred no pain prevalence during the last 12 months, but 25% report that had discomfort in their right hand.

The 70% of respondents do not present discomfort for the elbow, but a 20% for the right elbow present discomfort and 10% for the left. For the shoulder, 70% do not present discomfort, but a 5% for the right shoulder present discomfort, 10% for the left shoulder and 15% for both shoulders.

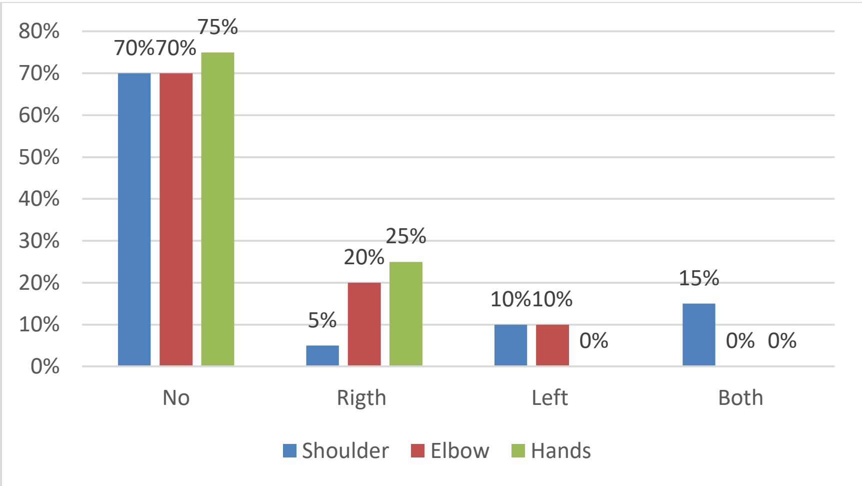

Figure 10 - Discomfort last 12 months for shoulders, elbow and hands

The discomfort presented on the last 7 days by the respondents shown Table 6 is 65% feet , 50% on the knees and 35% on the neck, the lumbar in relation to the 12 months is low with a 20%.

Related to the discomfort in the last 7 days shown figure11 observing results of other three body parts: (shoulders, elbows and hands), noticed that 90% do not present any problem with the elbow but present discomfort 5% for the right elbow and 5% for the left.

70% of employees do not have problems with the shoulder, but present discomfort 15% for the right shoulder, 5% for the left and 10% for both shoulders. The hands 80% do not present any problem while 20% has discomfort in the right hand.

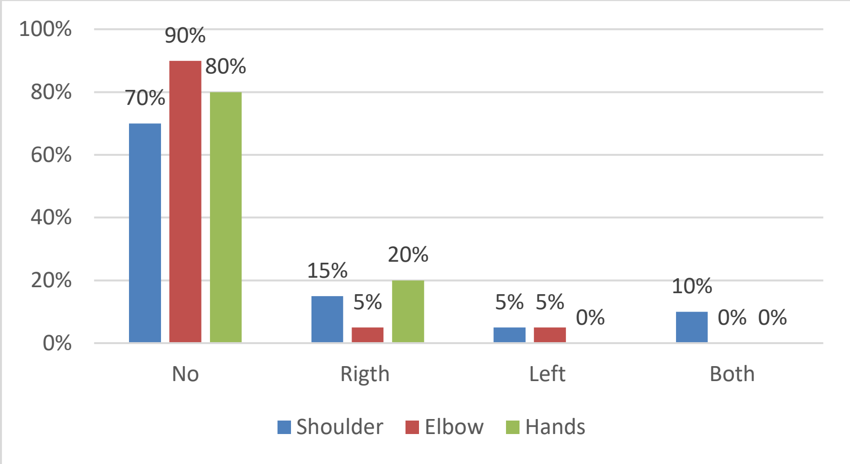

Figure 11 - Discomfort last 7 days for shoulders, elbow and hands

Considering the last 12 months, the respondents indicated that have to be absent to their job due problems affecting different body regions, for example 40% due to feet problems, 35% in knees and 30% in the lower back, (Table 6).

In relation to absenteeism for the last 12 months shown figure 12 for elbow, hand and shoulder, 10% of the respondents presented absenteeism due to problems in their right hand, while 5% were absent due to problems of the right elbow. Due to shoulder problems, only 5% were absent due to problems in the left shoulder and 10% in both shoulders.

The percentage presented in these results for hands and shoulders is related to the bad postures that are adopted by the respondents, with the position of the forearm and the hands, because they work supporting the forearm in the work table and not in the armrest, this makes the raising shoulders when manipulating the mouse and keyboard, causing muscle tension.

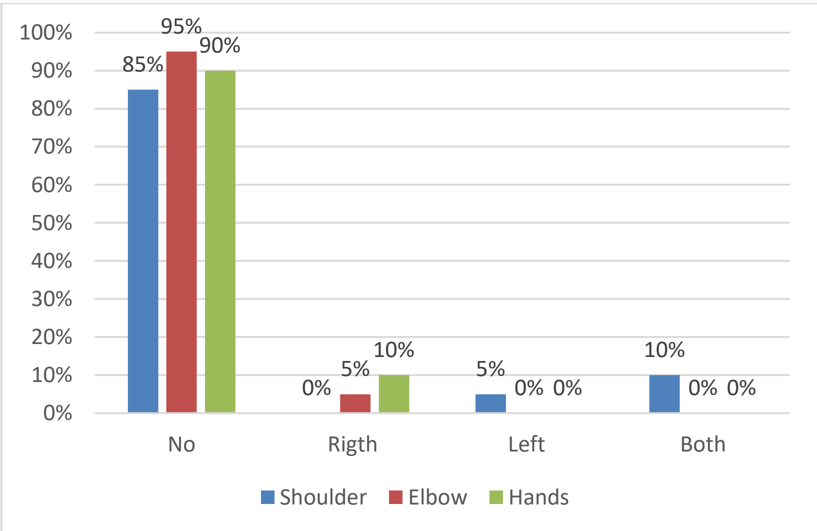

Figure 12 - Absenteeism last 12 months for shoulders, elbow and hand

According to the study done by ParentThirion, Macías, Hurley, & Vermeylen (2007) the fourth survey on working conditions in Europe, they evaluated a list of 16 main symptoms on the health of workers in Europe, showing that the problems mostly reported are musculoskeletal injuries (with a prevalence of 22.8%), lower back pain (24.7%), fatigue (22.6%) and stress (22.3%). The results obtained in the current study are aligned with this data, because the main problems evaluated are strictly linked to musculoskeletal disorders, in this case discomfort in the feet, lower back, and knees, so, it is important to evaluate the workplace in order to identify the physical problems and apply training programs that influence the prevention of musculoskeletal injuries as recommended by Matos & Arezes (2015).

4.6 ROSA Method

The postures adopted by the 20 workers were evaluated by ROSA method and the mean values are presented in Table 7 to Table 9.

Table 7 - ROSA score of the risk factors of section A "Chair"

Section A "Chair"	**ROSA Score** **Mean ± SD**
Chair Height	1.45 ± 0.51
Seat Depth	1.95 ± 0.22
Arm Rests	1.45 ± 0.51
Back Support	1.25 ± 0.44
Time	1.00 ± 0.00

Table 7 demonstrated that the highest average score is found in the depth of the seat (1.95 ± 0.22). The depth of the seat is influenced because the employees did not maintain a correct posture while sitting in the chair, stretching the knee and generating an angle greater than 90 degrees, causing strong pressure on the lower part of the thigh, at the same time this position generates a slight pain in the lower back.

In the case of the armrest, some employees do not use this support since they prefer to place their arms on the main work table, which generates an elevation of the shoulders and consequently generate a tension in the neck that can cause stress.

In relation to the height of the chair some employees do not adjust the chair according to the height of each one. This implies that in some cases the knees may be in a higher or lower angle of 90 degrees depending on the height of the respondents, this can generate a pressure on the thighs and if another factor is added, like time during several hours of work, can lead to muscle fatigue becoming more susceptible to the appearance of WMSD.

The associated risk factors for section B "Monitor and telephone" (presented in Table 8) are related to the position of the head and the monitor, in most cases the respondents use laptops, forcing them to make a downward movement generating a slight flexion in the cervical spine. Activities where the head remains displaced forward and in the same positions for hours, which can cause cervicalgia, this symptomatology can include pain or intense pressure in the neck or back, to this is added the suspension of the arms causing an overload or contracture generating pain in the muscle (Gómez Sánchez, 2014).

In relation to the telephone, sometimes the respondents are obliged to use the neck and head to hold the phone while doing another activity, this can generate muscular tension in the cervical spine and shoulder. In this study, The risk factor related to the telephone is very low since in the evaluated area only one person uses the telephone, this worker uses the telephone approximately twice per hour for less than three minutes.

Table 8 - ROSA score of the risk factors of section B "Monitor and Telephone"

Section B "Monitor and telephone"	ROSA Score Mean ± SD
Monitor	3.1 ± 0.57
Telephone	0.05 ± 0.22

Sonne & Andrews (2012) conducted a study to determine if office workers were able to use a line version of the ROSA method tool to accurately assess musculoskeletal disorders in their own offices and see online training that can reduce discomfort presented by workers. Fifty-five workers were evaluated for four weeks in which they evaluated their own office simultaneously with a trained observer, receiving a feedback on their performance. Getting significant differences between the final ROSA values reported by the workers and observer, and for the evaluation of the telephone monitor there were no significant differences in relation to the workers and observer. The value obtained in the analysis of the mouse and keyboard section is related to the position and location (Table 9). An important factor is the time each respondent uses these equipment during a work day. In this case, the time is more than 4 hours. Most workers use laptops, which compromises the position of the hand in relation to the forearm. According to Matos & Arezes (2015), the risk factors related to muculoskeletal disorders in an office can be evaluated using the ROSA method. After observing and taking the appropriate score depending on the position of the workers and the time spent in each posture, the final ROSA score is presented in Table 10.

Table 9 - ROSA score of the risk factors of section C "Mouse & Keyboard"

Section C "Mouse and keyboard"	ROSA Score Mean ± SD
Mouse	2.25 ± 0.55
Keyboard	2.55 ± 0.83

Table 10 - Final ROSA score.

Section	ROSA Score Mean ± SD
Secction A – Chair	3.6 ± 0.50
Section B – Monitor and Telephone	2.15 ± 0.59
Section C – Mouse and Keyboard	2.8 ± 0.95

In the analysis of the final ROSA score, a mean value and standard deviation of 5 ± 0.50 points were obtained. This value was achieved by making different measurements of the areas of the workplace, the combined score from the arm and back rest section will then compared on the horizontal axis against the seat pan depth and height on the vertical axis (section A). The score of telephone and monitor, select score as present related to the monitor position for the worker, this score is then to be used along the horizontal axis, the select score related to the position and usage of the telephone is then to be used along the vertical axis getting the (section B). The score keyboard and mouse was selected a score based on the position of them, a score by finding the intersection between the keyboard and mouses, this score was used to retrieve a score for the peripheral, monitor and telephone, getting section C. Finally, using the score obtained from the monitor and telephone score in section B, highlight the correct number on the horizontal axis. Using the correct score retrieved from the monitor and telephone section, highlight the correct number on the vertical axis, finding the corresponding value within the score chart. the value found from this scoring chart was used to find a final score by comparing it against the value retrived from section A - Chair. The score from Section A is seen along the vertical axis, and the score from section B and C is seen along the horizontal axis. these scores are then combined to get the scoring ROSA final score from the office. The square in which the score land will then be the for chair.This value indicates that there is a risk of discomfort and high discomfort generating the possible appearance of WMSD, and these workplaces require immediate investigation and modifications. These values generated by the ROSA score are strictly related to the positions of the employees in each work area, in this study most of the respondents did not adjust their chair to the appropriate height and did not keep their knees at 90 degrees. They also used laptop without any support and it is located at a very low height forcing the respondents to make a slight movement down of the neck for long periods of time, causing muscular tension in the cervical spine and shoulders.

Bakri, Azlis-sani, & Ngali (2018) evaluated the work posture of bus traffic controllers, determining the existence of musculoskeletal disorders and exposure to ergonomic risk factors (considering 16 men and 10 women). The data collected were evaluated through a Nordic questionnaire and through the ROSA method (as applied in the current study). The mentioned traffic controllers presented extreme postures with a high ergonomic risk level, an investigation and additional changes were requested to avoid these musculoskeletal disorders, recommending that the designs of the Computer-based workstations should be improved based on ergonomic principles.In this study, according to the values obtained, it can be concluded that the activities analysed represent situations of risk and discomfort. Having to act quickly with the modification of the work area and interact with the workers to give information about the correct and appropriate working postures. In this domain a program of occupational gym could be also an important measure to prevent WMSD (as recommended by Matos & Arezes, 2015).

4.7 Illuminance measurements

The workplace has linear lighting that only reflects light to a central part of the area under study, this light is fluorescent bulbs, also has small windows on the top in the left part of the work area.The Figures 14 and 15 show the type of lighting and the windows existing in the working area.

Figure 13 - General view of work area

Figure 14 - Distribution of work area

The illuminance measurements made in the work area and surroundings are presented in Tables 11 and 12, showing the means, standard deviations and uniformity for the sunny day and for the cloudy day.

Table 11 - Mean values (lux for illuminance) measured in the sunny day.

Sunny Day	Work area	Surrounding
Mean	196	184
Standard deviation	8	19
Uniformity	0.52	0.47

Table 12 - Mean values (lux for illuminance) measured in the cloudy day

Cloudy Day	Work area	Around area
Mean	176	169
Standard deviation	8	18
Uniformity	0.57	0.49

The minimum recommended value for the mean illuminance in offices tasks: writing, reading, data processing is 500 lux. The minimum recommended value for mean illuminance for the surroundings of the work area is 300 lux (ISO 8995:2002).

The uniformity of the illuminance is the ratio of the minimum to average value. The illuminance shall change gradually. The task shall be illuminated as uniformly as possible. The uniformity of the area task illuminance shall not be less than 0.7 and the uniformity of illuminance of the immediate surrounding areas shall be not less than 0.5, according to the ISO 8995:2002.

According to the results obtained in this study, that the mean values illuminance for the sunny day and for the cloudy day are very low in relation to European regulations, the values are: 196 lux for the work area and 184 lux for around work area in the sunny day; 176 and 169 respectively in the cloudy day. Respecting ISO 8995:2002 the values obtained are lower than those recommended, meaning that the lighting values for this study area are considered as not acceptable. The uniformity values obtained are also lower than those recommended by the ISO 8995:2002. I It indicates that measures must be taken to improve the lighting conditions in this work area, for example through the improvement of the distribution of the lamps.

Therefore these results demonstrate that the space studied needs immediate modifications in terms of lighting, although the perception of respondents according to the answers given in the survey does not totally coincide. According to the survey, the following results must be highlighted:

only 30% of respondents feel visual fatigue, 60% indicate that lighting is sufficient, only 45% are aware that they perform tasks with visual demands. Additionally, 55% of respondents identify brightness or reflections in the work area, of which 30% indicate that it is on the computer screen and 30% do not identify;

30% identify brightness or reflections around the work area and 20% shadows as well.

In this domain, only three recommendations were obtained from respondents:

• Importance of having natural light, because most of the workday only have access to artificial light;

• Insufficient lighting;

• Importance of assessing the temperature of the workspace (this could be considered as a topic to another work).

5. CONCLUSION

Nowadays, the concern of companies for the health and well-being of workers in office areas has increased due to the main problems reported by workers and the diseases that occur in this area of work. This chapter presents the conclusions of this work, as a way of synthesizing the results obtained.

The main objective of this study was to identify and evaluate the main risk factors for musculoskeletal and visual stress in an Open Space office. To achieve the objective of this study, some evaluation methods were used, such as the Nordic questionnaire that allowed the detection of the main musculoskeletal discomforts reported by the workers. The questionnaire also allowed identifying the main problems of visual stress and discomfort in an Open Space. Posteriorly, the ROSA method was applied, which consisted of evaluating the interaction between the workers and the office work area, considering the physical space and the lighting conditions.

The results obtained show that the main musculoskeletal problems presented by workers are mainly related to body parts such as feet with 70% of discomfort in the last twelve months of work, 65% of the lumbar part and 55% of the neck.

Complementing this study when applying the ROSA method, the final average value obtained was five, which shows that there is a high risk of discomfort and possible occurrences of WMSD, so these jobs require immediate investigations and modifications, to avoid some future injuries in office workers. Continuous training focused on postural correction in the work area is recommended.

With respect to the evaluated lighting positions, the average values obtained for the area and around the work area are low, as well as the uniformity values, which according to ISO 8995:2002 the study area requires immediate modification in terms of lighting.

In this work, there were some limitations because the sample size was very small, being able to perform non-parametric statistical tests that throw not very accurate results, which is why a descriptive and exploratory analysis of the data was performed.

In the surveys applied some workers gave some recommendations that could serve in future jobs, such as having greater access to natural light and less to artificial light and assessing the importance of temperature in the work area.

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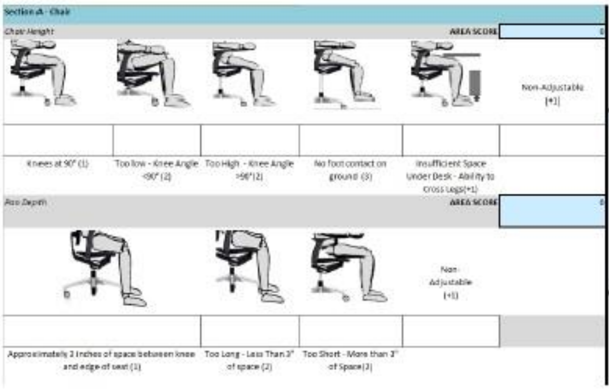
ANNEX I – RAPID OFFICE STRAIN ASSESSMENT (ROSA) METHOD (7 PAGES)

Scoring within ROSA



Seat pan height /depth	Arms / Back rest 2	3	4	5	6	7	8	9
2	1	2	3	4	5	6	7	8
3	2	2	3	4	5	6	7	8
4	3	3	3	4	5	7	7	8
5	4	5	4	4	5	7	7	8
6	5	5	5	5	5	8	8	9
7	6	6	6	7	7	8	9	9
8	7	7	7	8	8	9	9	9

Section A – The Chair
Chair Height and Pan Depth

Select the position of the seat height and chair pan. The first position in the left column indicates the neutral position. This corresponds with a score of "1". The remaining positions are marked with increasing scores. Those sections with scores such as (+1) (ie., Insufficient Space Under Desk) are additive scores. These can be added on to the other scores. For Example, if the chair height is too high (2), and it is non-adjustable (+1), this becomes a score of 3.

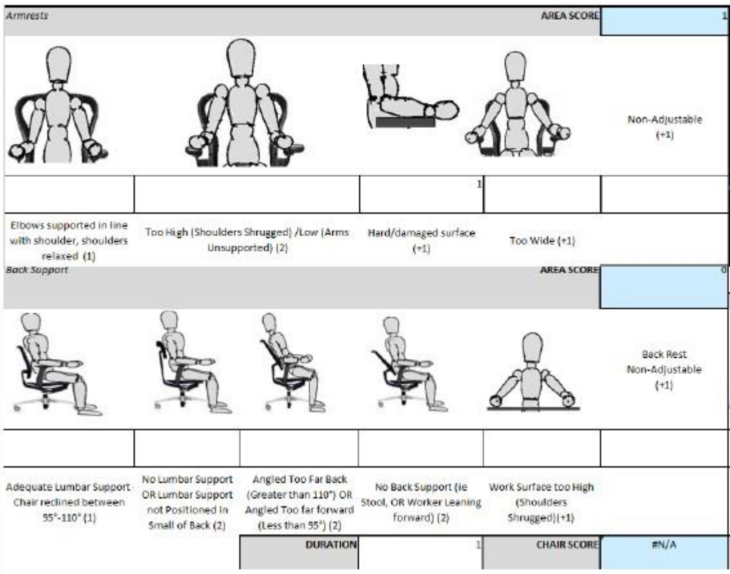
The score from the Chair Height is then added to the Pan Depth to receive the final score from this section. This score will correspond with the vertical axis along the Section A scoring chart.

Scoring Examples – Chair Height

Risk Factor	Example	Picture
Too low	The height adjustment cylinder is set to its lowest height, and the worker is tall.	
Too high	The knee angle is greater than 90 degrees, and there is pressure under the thigh.	
Too high – no foot contact	The worker is using a stool or lab height chair, so the feet cannot physically touch the floor.	
Insufficient space under the desk	The keyboard tray or a computer tower blocks the legs from moving freely under the desk.	

Scoring Examples – Chair Depth

Risk Factor	Example	Picture
Seat pan depth – too long	There is less than 2-3" of space behind the knee when the person sits back in the chair.	
Seat pan depth – too short	There is more than 2-3" of space behind the knee when the person sits back in the chair. This may focus pressure on the underside of the thigh, and the thigh will not be supported.	



seat pan height /depth	Arms / Back rest							
	2	3	4	5	6	7	8	9
2	1	2	3	4	5	6	7	8
3	2	2	3	4	5	6	7	8
4	3	3	3	4	5	7	7	8
5	4	5	4	4	5	7	7	8
6	5	5	5	5	5	8	8	9
7	6	6	6	7	7	8	9	9
8	7	7	7	8	8	9	9	9

Section A – The Chair, Continued
Arm Rests, Back Support and Duration of Sitting

Select the position of the arm rests. Once again, the scores that can be added on to postures are indicated by a (+) in front of the number. The scores from both the arm rest section and the backrest section combined will amount to the score across the top axis on the scoring chart.

Scoring Examples – Backrest

Risk factor	Example	Picture
No lumbar support	The chair has a flat backrest, possibly a plastic or board room chair. This is usually seen in less expensive models. The chair may have lumbar support and it is not positioned correctly in the lower back	 
Angled too far back	The backrest recline is too far back, causing the person to either sit forward, or reach to the keyboard.	
No Back Support	The worker is using a stool or the backrest is not positioned against the back	

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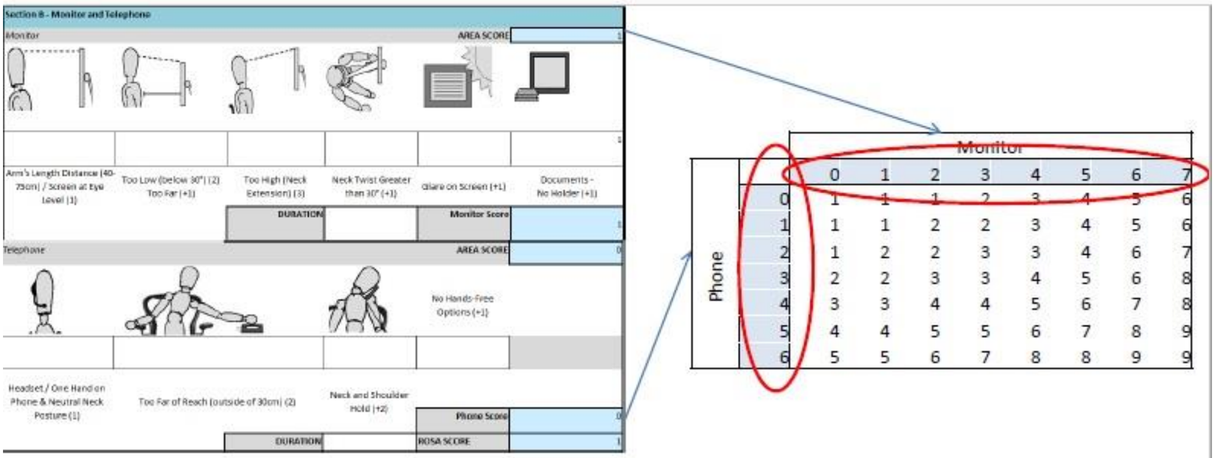
Seat Pan Height /Depth	Arms / Back rest: 2	3	4	5	6	7	8	9
2	1	2	3	4	5	6	7	8
3	2	2	3	4	5	6	7	8
4	3	3	3	4	5	7	7	8
5	4	4	4	4	5	7	7	8
6	5	5	5	5	5	8	8	9
7	6	6	6	7	7	8	9	9
8	7	7	7	8	8	9	9	9

Duration	1	CHAIR SCORE	5

The combined score from the arm and back rest section will then be compared on the horizontal axis against the seat pan depth and height on the vertical axis. The square in which the scores land will then be the score for the chair.

To account for the duration that the worker spends in the chair per day, a score of -1 will be assigned if the worker spends less than 1 hour a day in the chair throughout the day, or for less than 30 minutes consecutively. If the worker spends 1-4 hours a day intermittently, or between 30 minutes to 1 hour continuously in the chair, the duration score is 0. If the worker spends more than 4 hours a day in the chair intermittently, or greater than 1 hour consecutively, the duration score will be +1. Add the duration score to the chair score to receive your final chair score.



Phone \ Monitor	0	1	2	3	4	5	6	7
0	1	1	1	2	3	4	5	6
1	1	1	2	2	3	4	5	6
2	1	2	2	3	3	4	6	7
3	2	2	3	3	4	5	6	8
4	3	3	4	4	5	6	7	8
5	4	4	5	5	6	7	8	9
6	5	5	6	7	8	8	9	9

Section B – Telephone and Monitor

Select the scores as present related to the monitor position for the worker. With this score, add 1 for use of the monitor of greater than 4 hours per day intermittently, or 1 hour consecutively. Add a duration score of 0 if the work is between 1-4 hours intermittently, or 30minutes to 1 hour consecutively. Subtract 1 if there is less than 1 hour of work done per day intermittently, or less than 30 minutes consecutively. This score is then to be used along the horizontal axis

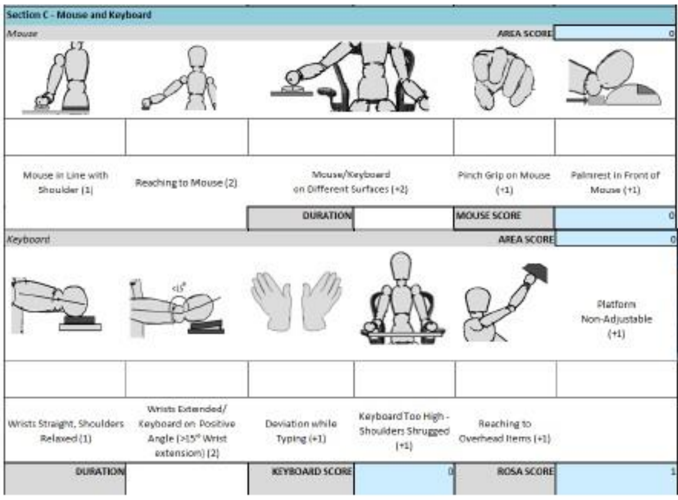
Select a score related to the position and usage of the telephone. Add in a duration factor of +1, 0 or -1 based on the amount of time the worker spends on the phone per day. This score is then to be used along the vertical axis.

Scoring examples - Monitor

Risk Factor	Example	Picture
Monitor too low	The top of the screen is 30 degrees below the sitting eye height causing neck flexion	
Monitor too high	The top of the screen is above eye level, causing the neck to be extended while viewing the screen.	
Neck twist	The monitor is positioned to the side of the worker, or dual screens may cause the worker to rotate the head back and forth.	
Documents used – no document holder	The worker has to flex and twist the neck in order to view papers positioned on the desk	

Scoring Examples - Telephone

Risk factor	Example	Picture
Too far – reach	The phone is positioned at the back of the desk, and when it rings, the worker has to extend and bend over the surface to grab the handset.	
Neck and Shoulder hold	The worker has to use the phone and computer at the same time, and in order to type, they will pinch the handset between the neck and the shoulder.	



		Keyboard							
		0	1	2	3	4	5	6	7
Mouse	0	1	1	1	2	3	4	5	6
	1	1	1	2	3	4	5	6	7
	2	1	2	2	3	4	5	6	7
	3	2	3	3	3	5	6	7	8
	4	3	4	4	5	5	6	7	8
	5	4	5	5	6	6	7	8	9
	6	5	6	6	7	7	8	8	9
	7	6	7	7	8	8	9	9	9

Section C – Keyboard and Mouse

Select a score based on the position of the keyboard. If the keyboard is used for greater than 4 hours per day intermittently, or 1 hour consecutively, use a duration score of +1. For between 1-4 hours intermittently, or 30minutes to 1 hour consecutively, use a score of 0. For 1 hour or less intermittently, or less than 30 minutes consecutively, use a score of -1.

Select a score based on the mouse position. If the mouse is used for greater than 4 hours per day intermittently, or 1 hour consecutively, use a duration score of +1. For between 1-4 hours intermittently, or 30minutes to 1 hour consecutively, use a score of 0. For 1 hour or less intermittently, or less than 30 minutes consecutively, use a score of -1.

Select a score by finding the intersection between the keyboard and mouse scores. This score will now be used to retrieve a score for the peripherals, monitor and telephone. 16

Scoring Examples - Mouse

Risk Factor	Example	Picture
Pinch grip on mouse	The mouse is small (such as a notebook mouse) leading to a pinching of the mouse.	
Reach to mouse	The mouse is out to the side of the keyboard, causing abduction of the arm. This may because the person is small through the shoulders, and the numeric keypad causes further mouse position.	
Different surfaces	Mouse reach may also be cause if the keyboard tray is too small, and the mouse is on a separate surface.	

Scoring Examples – Keyboard

Risk Factor	Example	Picture
Wrists extended	The tray may be angled, or the legs on the back of the keyboard may be up causing the wrists to be extended while typing.	
Deviation while typing	A small keyboard can cause wrist deviation while typing (ie, laptop keyboards)	
Keyboard tray too high	When typing, the shoulders are shrugged in order to rest the arms or hands on the appropriate desk surface.	

Phone \ Monitor	0	1	2	3	4	5	6	7
0	1	1	1	2	3	4	5	6
1	1	1	2	2	3	4	5	6
2	1	2	2	3	3	4	6	7
3	2	2	3	3	4	5	6	8
4	3	3	4	4	5	6	7	8
5	4	4	5	5	6	7	8	9
6	5	5	6	7	8	8	9	9

Mouse \ Keyboard	0	1	2	3	4	5	6	7
0	1	1	1	2	3	4	5	6
1	1	1	2	3	4	5	6	7
2	1	2	2	3	4	5	6	7
3	2	3	3	3	5	6	7	8
4	3	4	4	5	5	6	7	8
5	4	5	5	6	6	7	8	9
6	5	6	6	7	7	8	8	9
7	6	7	7	8	8	9	9	9

Monitor and Telephone \ Mouse and Keyboard	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	2	3	4	5	6	7	8	9
3	3	3	3	4	5	6	7	8	9
4	4	4	4	4	5	6	7	8	9
5	5	5	5	5	5	6	7	8	9
6	6	6	6	6	6	6	7	8	9
7	7	7	7	7	7	7	7	8	9
8	8	8	8	8	8	8	8	8	9
9	9	9	9	9	9	9	9	9	9

Peripherals and Monitor/Phone Score

Using the score retrieved from the Monitor and Phone score in Section B, highlight the correct number on the horizontal axis. Using the correct score retrieved from the monitor and telephone section, highlight the correct number on the vertical axis. Find the corresponding value within the scoring chart.

The value found from this scoring chart will now be used to find a final score by comparing it against the value retrieved from Section A – The Chair.

seat pan height /depth \ Arms / Back rest	2	3	4	5	6	7	8	9
2	1	2	3	4	5	6	7	8
3	2	2	3	4	5	6	7	8
4	3	3	3	4	5	7	7	8
5	4	4	4	4	5	7	7	8
6	5	5	5	5	5	8	8	9
7	6	6	6	7	7	8	9	9
8	7	7	7	8	8	9	9	9

Monitor and Telephone \ Mouse and Keyboard	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	2	3	4	5	6	7	8	9
3	3	3	3	4	5	6	7	8	9
4	4	4	4	4	5	6	7	8	9
5	5	5	5	5	5	6	7	8	9
6	6	6	6	6	6	6	7	8	9
7	7	7	7	7	7	7	7	8	9
8	8	8	8	8	8	8	8	8	9
9	9	9	9	9	9	9	9	9	9

Chair \ Peripherals and Monitor	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10
2	2	2	3	4	5	6	7	8	9	10
3	3	3	3	4	5	6	7	8	9	10
4	4	4	4	4	5	6	7	8	9	10
5	5	5	5	5	5	6	7	8	9	10
6	6	6	6	6	6	6	7	8	9	10
7	7	7	7	7	7	7	7	8	9	10
8	8	8	8	8	8	8	8	8	9	10
9	9	9	9	9	9	9	9	9	9	10
10	10	10	10	10	10	10	10	10	10	10

The score from Section A is seen along the vertical axis, and the score from section B and C is seen along the horizontal axis. These scores are then combined through this final scoring chart to receive the ROSA final score from the office.

The ROSA final score is broken into two areas: further assessment not immediately required, and further assessment required as soon as possible.

ANEXO II – TERM OF CONSENT

Universidade do Minho
Departamento de Produção e Sistemas

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO Nº____

Título do estudo: *Study of risk factors that Influence visual fatigue and musculoskeletal stress in an open office*

Investigador envolvido: Jhonnathan Mora – Aluno do Mestrado em Engenharia Humana da Universidade do Minho (jhonnathanmora1985@gmail.com)

Orientadora responsável: Professora Ana Colim (Departamento de Produção e Sistemas, Universidade do Minho)

Objetivo central do estudo: Identificar e avaliar os principais fatores de risco para a sobrecarga musculoesquelética e visual num escritório *Open-Space*, considerando o espaço físico e as condições de iluminação na área de trabalho.

Procedimentos: Ser-lhe-á disponibilizado um questionário em papel, que depois de preenchido deve ser devolvido ao investigador. Durante o desenvolvimento das suas atividades profissionais serão recolhidas algumas imagens e vídeos para avaliar posturas durante o trabalho, bem como dados de iluminação nessa área.

Todos os dados registados no questionário, assim como as imagens e vídeos recolhidos, serão tratados de forma confidencial, nunca sendo divulgado qualquer dado que permita a sua identificação.

Benefícios: A sua participação neste estudo é voluntária. Assim, estará a contribuir para um trabalho de investigação que sem a sua participação não seria possível desenvolver e, no final deste, terá acesso a todos os resultados obtidos. E sempre que necessário poderá contactar-nos para o esclarecimento de dúvidas.

Declaração de anonimato: Os resultados deste estudo serão publicados para informação e benefícios deste e de outros estudos, mas a sua identidade permanecerá sempre anónima. Os seus dados pessoais nunca serão publicados sem o seu consentimento, a não ser requerido por lei.

Guimarães, ___/ ___/ ___

Diante do exposto, eu, ____ (Nome completo), concordo em participar de forma voluntária e esclarecida no estudo anteriormente exposto.

Assinatura:____

Investigador responsável:

____
(Jhonnathan Mora)

ANEXO III – QUESTIONNAIRE (5 PAGES)

<u>QUESTIONÁRIO</u>

Este questionário é composto por uma série de questões no campo da iluminação e da sintomatologia musculoesquelética, os dados recolhidos pelo questionário serão complementados com a avaliação da iluminação e das posturas adotadas. A presente técnica de recolha de informação permite-nos desenvolver um trabalho de investigação inserido na dissertação de mestrado em Engenharia Humana da Universidade do Minho, que se intitula "*Study of risk factors that Influence visual fatigue and musculoskeletal stress in an open office*".

Contamos com sua colaboração. Garantimos o anonimato e a confidencialidade das respostas. Obrigada!

1. Dados para caracterização do participante

1.1 Idade: Menos de 30 □ 31 a 40 □ 41 a 60 □ Mais de 60 (anos) □

1.2 Género: Masculino □ Feminino □

1.3 **Lateralidade:** Esquerdino □ Dextro □

1.3 Habilitações Literárias (grau) :________________

1.4 Função Profissional:_______________________

1.5 Antiguidade na profissão (meses):_____________

1.6 Horas semanais de trabalho:________________

1.7 Horário de trabalho:______________________

1.8 Pausas fixas (em média para refeições, fumar, etc.): ____ (minutos/dia)

1.9 Faz exercício físico de uma forma regular? Não □ Sim □

Se sim, indique qual:________________________

E há quanto tempo:_______________________

1.10 Tem alguma lesão musculoesquelética (diagnosticada por médico)?

Não □ Sim □

Se sim, indique qual: ______________________________

2. Avaliação da sintomatologia musculoesquelética percecionada

2.1 No caso de sentir dor e/ou fadiga muscular, atribui isso:

À sua atividade profissional □ A outro tipo de atividade, não profissional □

2.2 Seguidamente, responda a cada questão assinalando um “X” na caixa apropriada. Marque apenas um “X” por cada questão. Para responder, considere as regiões do corpo conforme ilustra a figura em anexo.

Considerando **os últimos 12 meses**, teve algum **problema (tal como dor, desconforto ou dormência**) nas seguintes regiões:	**Responda, apenas, se tiver algum problema**		
	Teve algum problema nos **últimos 7 dias,** nas seguintes regiões:	Durante os **últimos 12 meses** teve que evitar as suas atividades normais (trabalho, serviço doméstico ou passatempos) por causa de **problemas** nas seguintes regiões:	
1. Pescoço? Não 1 □ Sim 2 □	2. Pescoço? Não 1 □ Sim 2 □	3. Pescoço? Não 1 □ Sim 2 □	4. Sem Dor 0 1 2 3 4 5 6 7 8 9 10 Dor Máxima
5. Ombros? Não 1 □ Sim 2 □, no ombro direito 3 □, no ombro esquerdo 4 □, em ambos	6. Ombros? Não 1 □ Sim 2 □, no ombro direito 3 □, no ombro esquerdo 4 □, em ambos	7. Ombros? Não 1 □ Sim 2 □, no ombro direito 3 □, no ombro esquerdo 4 □, em ambos	8. Sem Dor 0 1 2 3 4 5 6 7 8 9 10 Dor Máxima
9. Cotovelo? Não 1 □ Sim 2 □, no cotovelo direito 3□, no cotovelo esquerdo 4□, em ambos	10. Cotovelo? Não 1 □ Sim 2 □, no cotovelo direito 3□, no cotovelo esquerdo 4□, em ambos	11. Cotovelo? Não 1□ Sim 2□, no cotovelo direito 3□, no cotovelo esquerdo 4□, em ambos	12. Sem Dor 0 1 2 3 4 5 6 7 8 9 10 Dor Máxima
13. Punho/Mãos? Não 1□ Sim 2□, no punho/mãos direitos 3□, no punho/mãos esquerdos 4□, em ambos	14. Punho/Mãos? Não 1□ Sim 2□, no punho/mãos direitos 3□, no punho/mãos esquerdos 4□, em ambos	15. Punho/Mãos? Não 1□ Sim 2□, no punho/mãos direitos 3□, no punho/mãos esquerdos 4□, em ambos	16. Sem Dor 0 1 2 3 4 5 6 7 8 9 10 Dor Máxima
17. Região Torácica? Não 1 □ Sim 2 □	18. Região Torácica? Não 1 □ Sim 2 □	19. Região Torácica? Não 1 □ Sim 2 □	20. Sem Dor 0 1 2 3 4 5 6 7 8 9 10 Dor Máxima
21. Região Lombar? Não 1 □ Sim 2 □	22. Região Lombar? Não 1 □ Sim 2 □	23. Região Lombar? Não 1 □ Sim 2 □	24. Sem Dor 0 1 2 3 4 5 6 7 8 9 10 Dor Máxima
25. Ancas/Coxas? Não 1 □ Sim 2 □	26. Ancas/Coxas? Não 1 □ Sim 2 □	27. Ancas/Coxas? Não 1 □ Sim 2 □	28. Sem Dor 0 1 2 3 4 5 6 7 8 9 10 Dor Máxima
29. Joelhos? Não 1 □ Sim 2 □	30. Joelhos? Não 1 □ Sim 2 □	31. Joelhos? Não 1 □ Sim 2 □	32. Sem Dor 0 1 2 3 4 5 6 7 8 9 10 Dor Máxima
33. Tornozelo/Pés? Não 1 □ Sim 2 □	34. Tornozelo/Pés? Não 1 □ Sim 2 □	35. Tornozelo/Pés? Não 1 □ Sim 2 □	36. Sem Dor 0 1 2 3 4 5 6 7 8 9 10 Dor Máxima

3. Avaliação da sintomatologia visual percecionada e fatores de risco

3.1 Marque com um “X” a opção para cada tarefa descrita na seguinte tabela.

0 – Nenhum tempo de trabalho (0 horas)
1 – Pouco tempo de trabalho (até 2 horas)
2 – Algum tempo de trabalho (2 – 4 horas)
3 – A maior parte do tempo de trabalho (4 – 6 horas)
4 - Todo o tempo de trabalho (6 – 8 horas)

TAREFAS	**CLASSIFICAÇÃO**				
	0	**1**	**2**	**3**	**4**
Leitura de documentos e escrita em papel.					
Trabalho em computador (visualização, leitura e introdução de dados).					
Tirar fotocópias, enviar faxes, imprimir documentos.					
Outras tarefas (reuniões, formação, etc).					

3.2 Indique o **tipo de computador** com que trabalha habitualmente e quantos em simultâneo (Nº):
Portátil □/ Nº____ e/ou Computador fixo de secretária □/ Nº ____

3.3 Costuma fazer **pausas** quando trabalha com computador?
Nunca □ Raramente □ De 4 em 4 horas □ De 2 em 2 horas □
Outra opção:______________

3.4 A **cadeira** que usa é ajustável? Sim □ Não □
Se sim, Indique os ajustes possíveis:

Altura	Encosto	Assento

3.5 Indique a **distância habitual dos seus olhos em relação ao ecrã** do computador:

Longe (> 30 cm) □ Perto (± 30 cm) □ Muito Perto (< 30 cm) □

3.6 Pode **ajustar a parte superior do ecrã do seu computador** de acordo com a sua altura de olhos?
Sim □ Não □

3.7 Indique se **usa óculos graduados**: Sim □ Não □
Se sim, indique em que situação necessita de usar óculos:
Nunca □ Apenas para trabalhar □ Sempre □

3.8 Indique se tem algum dos seguintes **problemas oftalmológicos**:
Miopia □ Astigmatismo □ Hipermetropia □ Outro(s)□__________

3.9 Indique se costuma sentir **cansaço/desconforto visual** durante a atividade de trabalho:
Sim □ Não □

Se sim, em que altura do dia?

Começo do dia □ Metade do dia □ Fim do dia □ Todo o dia □

Se sim, assinale com X a sua opção para cada sensação de desconforto apresentada na tabela.

1 – Nunca ou raramente
2 – Às vezes
3 – Muitas vezes
4 – Sempre.

Desconforto visual e outros sintomas	Classificação			
	1	**2**	**3**	**4**
Fadiga visual				
Visão turva				
Irritabilidade ocular				
Dores de cabeça				
Stress				
Dificuldade de concentração				

3.10 Como avalia a **quantidade de iluminação** disponível no seu posto de trabalho?

Insuficiente □ Suficiente □ Excessiva □

3.11 Como **avalia as suas tarefas** em termos de **exigência visual**?

Nada exigentes □ Pouco exigentes □ Exigentes □ Muito exigentes □

3.12 No seu **plano de trabalho/secretária** identifica a existência de:

Sombras □ Brilhos ou reflexos □ Luz não homogénea □ Luz homogénea □

3.13 Na sua vizinhança imediata/**área em redor da secretária** identifica:

Sombras □ Brilhos ou reflexos □ Luz não homogénea □ Luz homogénea □

3.14 Quando está sentado(a) à sua secretária (plano de trabalho), **identifica reflexos** nas seguintes superfícies?

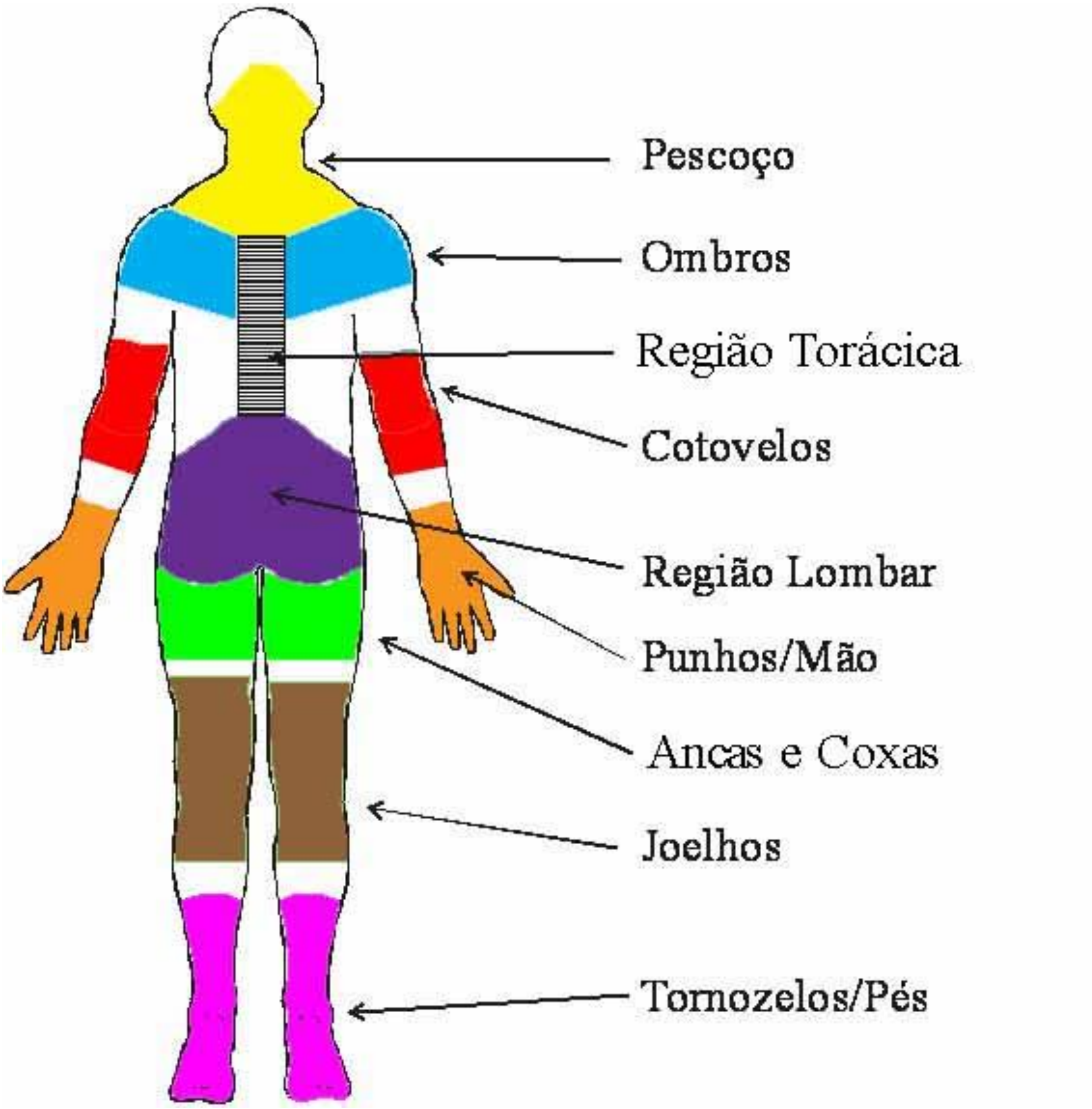
Ecrã do computador □ Teclado do computador □ Superfície da secretária □
Superfícies envidraçadas □ Outra: ________________________ Não identifica □

3.15 Considera que as **cores do espaço de trabalho** são em geral:

Nada agradáveis □ Pouco agradáveis □ Agradáveis □ Muito agradáveis □

3.16 Comentários/Sugestões que queira acrescentar:

ANEXO – Figura de apoio à **questão 2.2** com a representação de cada parte corporal indicada:



ANEXO IV – REGISTRATION FORM FOR MEASUREMENT OF LIGHTING LEVELS (2 PAGES)

WORK STATION	ILLUMINATION LEVELS IN THE WORK AREA			ILLUMINATION LEVELS AROUND WORK AREA			OBSERVATIONS
	READINGS			READINGS			
Station 1							
Station 2							
Station 3							
Station 4							
Station 5							
Station 6							
Station 7							
Station 8							
Station 9							
Station 10							
Station 11							
Station 12							
Station 13							
Station 14							
Station 15							
Station 16							
Station 17							

Station 18							
Station 19							
Station 20							
Station 21							
Station 22							
Station 23							
Station 24							
Station 25							
Station 26							
Station 27							
Station 28							
Station 29							
Station 30							
Station 31							
Station 32							
Station 33							
Station 34							
Station 35							