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ERGONOMICS AND POSTURAL ASSESSMENT OF DENTISTS TO PREVENT MUSCULOSKELETAL DISORDERS, DESIGNING AN ERGONOMIC CHAIR

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Abstract: *Occupational diseases are a category of ailments encountered at the level of the body and acquired because of participation in carrying out a work process. In the dental field, the musculoskeletal system is the most affected during the work process. The position of the body in the dentistry field must be symmetrical and straight, the imaginary lines passing through the eyes, shoulders, elbows, waist, knees, and ankles must be parallel to the line of the earth. Starting from the existing ergonomic demand for dentist chair formats and by analysing the existing chair used by dentists, we started to propose new chair design as ergonomic as possible.*
Key words: *Ergonomic, Stomatology, Musculoskeletal disorder, Product design, Dentist*

1. INTRODUCTION

Occupational diseases are a category of ailments encountered at the level of the body and acquired because of participation in carrying out a work process. According to the definition given by the World Health Organization, occupational diseases are various diseases whose specific etiological agents are present in the workplace, associated with certain industrial processes or the exercise of certain professions. This notion of occupational disease implies the existence of a causal relationship between the risk factors existing in the work process and their effect, materialized in the occurrence of the disease [1-4].

Some of the jobs are more susceptible to musculoskeletal disorders (MSD) than others, Jim Rohn says that any human may “Take care of your body. It’s the only place you must live” [2]. There are job occupations that are classified as high risk of MSD, and all of those share some common factors that start those problems, one of the principal factors is the worksite environment. Because of the occupational stresses placed on their bodies, oral health care providers are also vulnerable to MSD [1].

During the dental interventions is requested that the dentists must have good concentration and physical preparation, due to prolonged working hours that drive to an improper working posture [1]. Those wrongs posture and long hours of working predispose dentists to different occupational-related diseases and disorders, but the most common are musculoskeletal disorders (MDS), that conduct to irreversible injuries [5].

Over the years it was noticed that the most common injuries that appear to the dentist during work times occur on the wrists, elbows, and shoulders, but most often injuries appear in the neck area and back spine. Often associated with the stomatology work field the most common diseases are carpel tunnel syndrome, tension neck syndrome, tendinitis, Guyon's syndrome [6].

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with the stomatology work field the most common diseases are carpel tunnel syndrome, tension neck syndrome, tendinitis, and Guyon's syndrome [5]. Hindol suggests that 29.5% of the people that work in the stomatology field suffer from one or more MDS, which conduct to early retirement from the work field [2]. Thus, is necessary to know and discover which of the elements that dentists use, conduct to different injuries, and to design ergonomic products that are much more efficient in preventing MDS and other posture-related injuries that over time can lead to different disabilities [6].

The most common injuries to which dentists are subject during the medical act appear due to a non-ergonomic position have conducted to the objective proposed for this paper, namely, to develop a new chair design as ergonomic as possible for the dentists [7].

To reach the proposed goal, the starting point is to analyze the most often injuries and disorders of the musculoskeletal system to which dentists are subject, the position that those have during a medical act, and what chair designs they are using during an intervention [5].

2. MUSCULOSKELETAL DISORDER

MSDs refer to a wide range of inflammatory and degenerative disorders of muscles, tendons, and nerves [5]. These disorders can result in pain and functional impairment and may be caused or aggravated by the presence of one or any combination of the following risk factors:

- Hand efforts: long grip on small instruments, clamping, and release of the instruments in general on the procedures like tooth extraction, scaling, polishing;
- Repetitive movements: scaling, root gliding, brushing, etc.;
- Fixed and uncomfortable positions: of the neck, shoulders, hands, and wrists, standing or sitting position during the intervention;
- Vibrating instruments: prolonged use of turbine, contra-angle, etc.

When one or more of the factors exist simultaneously, appear the risk to developing MDS. In different research papers is show that in symptoms of discomfort for dentists appear in the neck area (68.5%), hands and wrists (69.5%), upper back (67.4%), lower back (56.8%), and in the shoulders area (60%) [7]. Also, is show in different research that most of the dentists have or had at least one job related disorder in the past 12 months [2, 6].

Classification of the main MSD associated with the dental work files are presented in the following.

A. Carpal Tunnel Syndrome (CTS) - As is shown preview, 69.5% of dentists are affected by the most common disorders that affect the hand and wrist. Carpal Tunnel Syndrome (CTS) appears when the median nerve that runs from the forearm into the hand, becomes pressed or squeezed at the wrist [7].

It has been associated with both repetitive work and forceful work. Symptoms can appear from any activity causing prolonged and increased pressure (passive or active) in the carpal canal [8].

B. Guyon's Syndrome - Guyon's canal represents the space at the wrist that appears between the pisiform bone and the hamate bone through which the ulnar artery and the ulnar nerve travel into the hand. Compression of the ulnar nerve occurs in this space at the base of the palm [8] [9].

Symptoms are characterized by pain, weakness, tingling, burning in the little finger [9][10].

C. DeQuervain's Tenosynovitis - This disorder is characterized by pain and swelling in the thumb and wrist area when grasping, pinching, twisting, and a decreased range of motion of the thumb with pain [8] [10].

Possible causes: include synovial sheath swelling, thickening of tendons at the base of the thumb, and repeated trauma or twisting hand/wrist motions [9].

Fig. 1. Trigger finger [7].

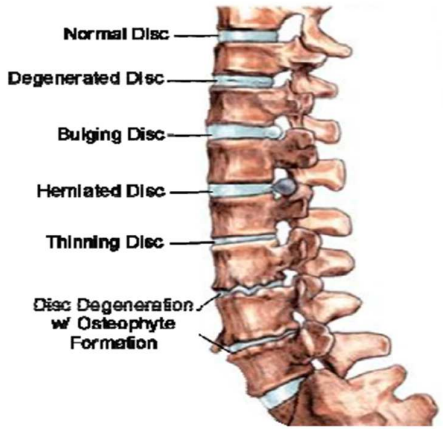

Fig. 2. Disc problems [7].

D. Trigger Finger - Trigger Finger appear often because of a forceful grip and repetitive motion that irritates the tendon and tendon sheath (tenosynovium), nodules form on the tendon causing tenderness of the tendon and appear pain during movement reaching up to finger lock in the "Trigger Position" [2].

E. Epicondylitis

Injuries that appear at the elbow area are in two ways, first is when the injury appears inside of the elbow Medial Epicondylitis, and de second is when the injury appears outside known as Lateral Epicondylitis [7].

F. Cubital Tunnel Syndrome -

In general, is caused by prolonged use of different tools whit the elbow flexed, resting on the armrest, or trauma from overuse can compress the ulnar nerve. Cubital tunnel syndrome is characterized by pain, tingling, and impaired sensation in the little and ring fingers that conduct to the loss of fine control and reduced grip strength. [10].

G. Bursitis - The shoulder part that is called the bursa, when is inflamed lead to bursitis disorder. The appearance of bursitis is due to different wrong movements of the shoulder that can inflammation the bursa [10].

H. Thoracic Outlet Syndrome (TOS) - It is a disorder that results from the compression of the nerves, arteries, and veins that pass over the neck to the arm, this compression can appear due to the contraction of the scalene and pectoralis muscles for a long period. This disorder is characterized by pain in the neck area, shoulder, and arm. [9, 10].

I. Rotator Cuff Tear - The group of four muscles (supraspinatus, infraspinatus, teres minor, and subscapularis) represent the rotator cuff, and those help to control the arms. the rotator cuff disorder tends to appear where the muscles and tendons are attached whit the bone [11, 12].

J. Rotator Cuff Tendonitis - The pain and stiffness in the shoulder associated with backward and upward arm movements and weakness of rotator shoulder muscles is associated whit rotator cuff tendonitis. The causes possible of this disorder include swelling or tearing of the rotator cuff soft tissue, shoulder joint bone/ abnormalities, or poor shoulder posture [4, 8].

K. Myofascial Pain Disorder (MPD) - The pain in the neck area, shoulder, and arm that restricts the range of motion of the head is characterized as Myofascial Pain Disorder (MPD) [11]. The causes that provoke this disorder include the overloaded of the shoulder and neck muscles by working into a non-ergonomic position [7].

L. Cervical Spondylosis

If appears intermittent/chronical neck and shoulder pain, or stiffness, headaches, arm and hand pain or tingling is probably to be installed a cervical spondylosis disorder. This disorder can appear due to the ageing of the dentist and due to the neck awkward posture. [5].

M. Disc Problems - It was observed that if is use a sitting position, the pressure on the lumbar discs increases by 50% compared to the orthostatic position (Fig.2) [12]. Furthermore, the sitting posture in an unsupported posture (without a backrest) may use double the amount of stress as a standing position. During the intervention time, when the dentist has a different posture, like bending (forward flexion) or twisting de body (rotation of the spine) the pressure on the lumbar disc area increases by 200%. Those postures can conduct compression of the spinal nerve, which causes bulge or herniation [8].

N. Sciatica - If appear pain in the lower back or in the hip radiates to the buttocks and legs is possible that is stabilizing the sciatica disorder. This disorder causes leg weakness or tingling and is due to increased pressure on the lower

back and herniated discs compressing a spinal nerve and it aggravates whit prolonged sitting position or excessive banding (forward flexing) in the sitting position [7].

3. ANALYSIS OF RISKS

Other risk factors based on various studies, that affect the musculoskeletal disorder (MSD) that are encountered in the dental fields are: medical conditions, genetics, poor lighting, environmental factors, improper work habits, poorly designed equipment, etc. [2].

The decreased ranges of motion manifested by: excessive fatigue in the neck and shoulder; loss of normal sensation in the arms by tingling or burning sensation; loss of coordination in the arms; hypersensitive hand and fingers represent the clinical features of musculoskeletal disorders. [10].

"Prevention is better than cure", prevention of any disease saves time, money, and most of all pain [11]. The principal disease amongst the dentists in musculoskeletal disorder and the solution of this disease (problem) is in the field of Ergonomics. Therefore, the goals of Ergonomics in the stomatology work field are by reducing the risk of MSD, improving work comfort and safety, minimizing the fatigue of de dentist, and most of all improving the quality of the work [2, 12].

To achieve those goals in stomatology, the field is necessary to analyse the positions that the dentist has during an intervention. The correct work position means a resting human position. The longitudinal, sagittal, and transverse planes must make an angle of 90 degrees, so it is considered that in this position the natural balance is maintained, and small groups of muscles are engaged. [12]. There are also deviations from the natural balance such as:

- Asymmetrical movements. They need to be offset by opposing forces
- Orthostatic position. This position is much more tiring than sitting, and this can impede blood circulation and at the same time the weight is spread over a smaller area which will upset the balance.
- Working in orthostatism leads to slowing down and dexterity in terms of hand movements [11, 13].

3.1 Orthostatic position

In the orthostatic position, the energy consumption is about ten times higher than in the sitting position, the heart rate increases, and as a result, more static muscle movement will be performed [14]. In the case of this position, it has been observed from studies that there are frequent pains and diseases of the skeletal system and blood vessels, the most affected being the spine, shoulder area, and lower limbs [2].

This position brings with it a non-physiological bending of the spine which impedes the pumping mechanism, and which plays a decisive role in the exchange of substances between the intervertebral disc and its environment. Equally unfavourable is the case when the orthostatic position is often used in long-lasting forced positions such as raised hands or various rotations of the body. There is often pain in the lower limbs in the case of individuals who work exclusively on their feet, and improper footwear can also lead to painful deformities [2, 3].

Orthostatic posture due to the reduced muscle movement involved causes the blood and fluid in the tissues to be deposited in large quantities in the blood vessels and tissues in the lower extremities, thus preventing proper and sufficient circulation, and the consequences could be leg pain. chronic-venous. It promotes the production of cramps, fatigue, leg cramps, feeling of heaviness, tingling in the legs during the night [2].

3.2 Sitting position

Regarding working in a sitting position, there are three positions [4, 14]:

- Sitting position in front where the torso is left in front - use as short a time as possible (e.g., when objects need to be caught);
- Medium sitting position, with the torso straight or slightly bent forward - used for writing and for treating the patient lying down;

- Sitting in the back position (or resting position) with the torso left behind - is suitable for discussions with the patient. In this sense, a seat back is required.

This position compared to the orthostatic one has advantages such as low energy consumption, comfortable and stable position, minimum muscle contraction being an ideal position for achieving fine movements. It also has a major disadvantage which shows that the pressure at the level of the intervertebral discs is about 50% higher than the orthostatic one, which in time leads to the wear of the spine and the appearance of the herniated disc [3, 13].

Given the summary of working positions, both the orthostatic position and the sitting position have advantages and disadvantages. Usually, the advantages of working in a sitting position on the lying patient are several. Dentists working in an orthostatic position were required to have forced work positions in 33.7% of working time, according to a study. The sitting position is used in most cases, but not permanently because each position can lead to fatigue and muscle tension. It is recommended to change the standing position alternately with the sitting position [5, 15].

4. WORKING CHAIRS OF DENTISTS

One of the important pieces of equipment into a dental cabinet represent the chair of the dentist. An appropriate chair for this group of professionals is a complex subject, about which there are many opinions. Recent research it is shown that dentists who are used to working in a sitting position for a period of 80 to 100% of their program present an increased risk of developing one of the MSDs [6]. Sitting on a poorly designed chair for a prolonged period, whit inadequate back rest or without the possibility to adjust the height contributed to increasing the possibility to develop different musculoskeletal disorders [7, 16].

Studies show that during a dental intervention the dentist moves almost every minute their chair, as the dentist is continually adjusting their positioning to improve visual access and accommodate patient movement, and to have a comfortable position, too [6, 7]. As a simple deduction, the support of the chair must be rigid and very easy to move, for sustained repeated stress, as result the chair must be constructed from a rigid frame [18]. The frame base must be designed whit a minimum of five rollers to prevent rearward tipping. The base should not be wide so that the wheels do not interfere whit the feet, foot controls, or patient chair. The seat, to be considered adequate, must be whit 25% wider than the total breadth of the buttocks and the front edge of the seat should taper off and away from the legs so the blood circulation to the legs should not be hindered [7]. Dentist's chairs must meet the following criteria:

1. Can be operated on five rollers.

2. The height adjustment without steps must be between 47-65 cm (distance of the seat surface from the ground). This type of adjustment must be possible for hygienic reasons without touching the seat by hand [6, 8, 18].

3. The seating surface with the possibility of rotation, with a flat and not too soft cushion, must be horizontal and not left on its back, as in this case the working frame with the body bent forward would require the seat to be tilted backward so that the organs of the chest and stomach are pressed harder than usual [6, 15].

4. The front edge of the seat surface should be rounded so that the thighs are not pressed.

5. Backrest adjustable both horizontally and vertically. A narrow "Shield of the Hip" backrest is recommended because it gives tactile arousal, a feeling of support [9, 12].

The position of the body should be symmetrical and straight, the imaginary lines passing through the eyes, shoulders, elbows, wrist, knees, and ankles should be parallel to the line of the earth (Figure 3). In this way, the weight of the body is best distributed, reducing overloads, changes in body position, and movements that are easier to perform (Figure 4).

The legs are not allowed to be too stretched or too bent.

Fig. 3. Incorrect work position [18].

Fig. 4. Incorrect work position [18].

Fig. 5. Correct work position [18].

Fig. 6. Different chair design solutions [2].

The height of the seat is adjusted correctly only if the angle between the thigh and the leg is approximation 105 degrees, and the hand must be able to slide slightly over the thighs in the area in front of the seating surface sitting below, with 90 degrees, knee bend narrows the possibility of the trunk and legs moving. The seat should be slightly raised to allow the seat to rotate slightly. His movement back and forth by 20 cm, with his feet, fixed on the floor, or his rotation around a leg fixed on the floor [5].

This prevents not only the stress on the joints, tendons, and muscles, but through a high activity of the pelvic and leg muscles generates an exchange of fluid between the vessels (muscle pumping) (Figures 3 and 4) [4].

The height of the seat is absolutely influenced by the body size of everyone, so in the case of people who have lower upper body height they will sit a little higher, and those with longer legs will sit lower. The back of the thighs is about two-thirds on the seating surface, the other third near the knees remaining free and unsupported. The front edge of the seating surface should be at least 10 cm away from the knee joint. In this way and by the correct height of stay it is ensured that the blood circulation in the blood vessels in the lower thighs is not impeded [6].

The position of the legs should be perpendicular (not tilted forward or backward). The legs will lie flat on the floor in a median position, and the median axes of the legs overlap with the sagittal axis of the thighs. Due to this, the body is best supported [5].

The torso must be bent slightly forward (maximum 20 degrees from the vertical), so it is not allowed to be bent sideways. The rotation of the spine in the lumbar region should be avoided, the shoulders should be straight and without tension on them. The head is bent slightly towards the front, the axis between the eyes forms a horizontal line, and the line between the opening of the ear and the end of the eyes forms an uncle of approx. 45 degrees (Figure 5) [5].

The arm support for dentist chairs is a controversial subject, many dentists and experts consider that they are essential for comfort. The capacity to sustain the arm is an option that most modern dental stools, but the functionality is made through a wide range of motion. The most pressing problem in using the armrest is to have the possibility to adjust the height and should not impede access to the patient [7, 8, 18].

Arm support must be fixed in length but should allow rapid height adjustment and full articulation (Figure 6). Researchers have discovered the use of arms and elbow rests conduct to reducing upper trapezius muscle load and the same time reduces the frequency and

range of arm abduction during dental interventions [7].

Selecting a dental chair is necessary to meet the above criteria and allows one to fulfil the task in a neutral body position. On the market are numerous designs currently available, and each chair has its unique advantages and disadvantages [6].

5. DESIGN NEW FORM OF CHAIR FOR DENTISTS

Starting from the existing ergonomically request for the dentist's chair formats and by analysing the existing chair used by the dentists.

Working in a sitting position for a prolonged period leads to the risk of appearing lower back pain. working in a sitting position for prolonged period results in activation (elongation) of the upper and lower erector spine muscles, and significant compression of the lumbar spine muscle, this is significantly different when the position is orthostatic.

In addition, Al-Eisa et al. discover that pelvic asymmetry could conduct an asymmetric trunk movement when working in a sitting position, this observation is seen in differences in lower-back pain [19]. Therefore, they observed that in the human body whit the asymmetric pelvis during working movements, the body makes compensatory movements, and those movements place the lumbar spine under significantly higher stress [20].

In most cases, dental stools are provided with a horizontal seat style that conducts in posterior rotation of the pelvis, at the same time can also cause compression on the posterior thighs and the front edge causing pressure on the blood vessels. Tilted seats help to reduce pressure on the posterior thighs and keep the lumbar curve of the lower back, by placing the pelvis in a more neutral position, which naturally balances the spinal curves (Figure 7) [10].

The new concept aims to improve the professional activity of dentist's doctors and correct their posture for better performance in the workplace and reduce the risk of MSD.

Starting from the observation mentioned previously and from the functionals analysis of the chair design made by Varier in 1979 is proposing a new design form for dentist's chair.

For reducing the risk for low-back pain that is associated with work undertaken for prolonged periods of time in a seated position is proposes in the chair design the use of a seat based on the leg coccis.

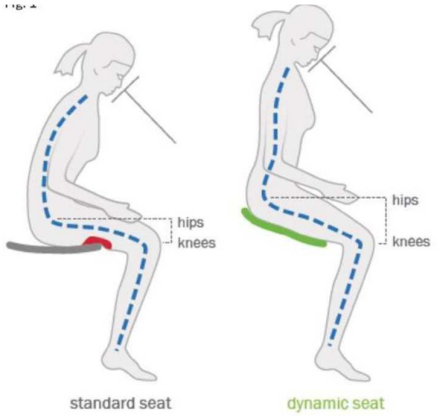

Fig. 7. Seating position [18].

This form of the chair seat can provide benefits like:

- Releases pressure on the spine. The U-shaped cut-off lowers the pressure on the last vertebrae (Figure 8)
- Relieves back pain: lower back, sciatic and coccis
- Improves posture and blood circulation.

The anatomical shape supports the spine and improves posture in a sitting position, lowering the pressure on the lumbar area. The shape of the seat reduces the pressure exerted by some stools on the thigh and the seat and thus the blood circulates unrestricted.

The design consists of two pillows built (Figure 9) in an ergonomic shape with multiple roles:

ROLE 1 - If the chair is used with one of the pillows sitting at the knees and the other one in a dynamic way (whit a seat inclination angle of 10 degrades) it is observed that the neck will adopt a posture that reduces tension in the cervical area, thus preventing headaches due to excessive muscle tension.

In the case of the hip area, sitting on a chair with supported knees leads in a normal and natural way to the correct curvature of the spine, and this helps to eliminate the need for a backrest. Thus, the spine will reach the point where it will balance and will naturally lead to

the strengthening of the muscles of the soup, thus reducing the tendency to tilt.

The specific inclination of the seat will move the pelvis forward, will establish the right angle between the upper and lower body reducing the pressure on the back. To prevent excessive bending of the body, part of the load is transferred to the tibia due to the pillow at the knees.

The feet in the kneeling position are in a normal posture in which the circulation improves naturally. The feeling of numbness and swelling of the feet, which is usually due to the static position during work, is reduced.

Another advantage created by using it in this form is the improvement of the concentration level of the person who uses it because a proper posture increases the oxygen supply.

ROLE 2 - Another form of seat use due to the versatile concept of the adjustable seat is when the lower cushion is used as a seat, and the second cushion can be used to support the back. Being a multifunctional chair concept, it has an exceptional advantage and comes to the aid of users so that it can be used as needed.

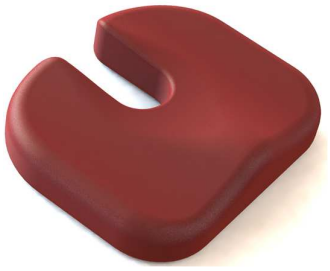

Fig. 8. The new seat design.

Fig. 9. Chair design.

When the upper pillow is used to support the back, meaning it has the role of the backrest, it can be observed that its shape adapts to the curve of the lumbar area and thus avoids any kind of overload and damage in this area. The pillow can only be used as a backrest when it is tilted at a 90-degree angle. Also, both pillows can rotate on the clamping system.

ROLE 3 - The seat can also be used with the lower cushion as part of sitting, and the second pillow can be used to support the chest areas. If the chair is used in this way, the pain in the cervical and lumbar area will be reduced because the doctor's body will be more relaxed and there will not be as much pressure on the spine. Such a position whit a higher tilt angle that in general is favourable when the dentist must perform more difficult and precise interventions, which require a closer approach with the patient.

6. CONCLUSIONS

Applicating ergonomics ideas in designing new products ensure increased productivity and conduct to avoid illness, disorders, and injuries. For designing new products is crucial to detect the list of risk factors and the correct ergonomic strategies.

With the desire to help counteract the health problems that occur in one of the most widespread medical sectors and to reduce the occurrence of musculoskeletal diseases, this prototype chair has been developed for healthcare professionals, especially in the field of dentistry.

Considering the theoretical details regarding the problems that appear especially in the structure of the spine, the ergonomics of the dentist during dental interventions, and considering the movements made, a chair has been developed for dentists that promise to improve professional activity.

Therefore, this dental chair differs from other models in that, due to the ergonomic design of the cushions, it reduces the pressure on the spine, relieves back pain, and improves posture and blood circulation. In addition, because it is adjustable, both in height and by the possibility of adjusting the pillows can be used on a large scale. It is a versatile chair, because, as it was

presented, it has at least three ways of use, while the chairs currently used in dentists have a classic shape and do not make a significant contribution to the prevention of musculoskeletal diseases.

Future interdisciplinary investigations should be developed using modern methods and tools as those presented by [21] to provide a more accurate approach of the dentists' tasks analysis. The musculoskeletal disorders and the associated diseases are of great interest for ergonomists and occupational medical staff, to design adequate prevention programmes for stomatologists. An innovative approach in this case is to use online lessons and tutorials as debated by the developments of [22, 23].

7. REFERENCES

[1] Gupta, A., Bhat, M., Mohammed, T., Bansal, N., Gupta, G., *Ergonomics in dentistry*, International Journal of Clinical Pediatry Dental, 7(1), pp. 30-34, 2014.

[2] Hindol, D., Vaibhav M. and Mrinalini, S., *Ergonomics in dentistry: Narrative review*, International Journal of Applied Dental Sciences, 4 (04), pp. 104-110, 2018.

[3] Hauke, A., Flintrop, J., Brun, E., Rugulies, R., *The impact of work-related psychosocial stressors on the onset of musculoskeletal disorders in specific body regions: A review and meta-analysis of 54 longitudinal studies*, Work & Stress, 25(3), pp. 243-256, 2011.

[4] Lindfors, P., Von Thiele, U., Lundberg, U., *Work characteristics and upper extremity disorders in female dental health workers*, Journal of occupational health, 48(3), pp. 192-197, 2006.

[5] Kovacevska, I., Dimova, C., Georgiev, Z., Sabanov, E., Petrovski, M., Foteva, K., *Ergonomics at dentistry*, Science & Technologies, 4(l), pp. 83-86., 2014.

[6] Valachi, B., *Ergonimics and Ingjury in the dental office*, 2010, http://www.ineedce.com.

[7] Occupational Health Clinics for Ontario Workers Inc, *Ergonomics and Dental Work*, Ontario, 2012.

[8] World Health Organisation, *Global Strategy on Occupational Health*, WHO/OCH/95.1.

[9] Bernard, B., Putz-Anderson, V., *Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health: Cincinnati, OH, USA, 1997.

[10] Yamalik, N., *Musculoskeletal disorders (MSDs) and dental practice Part 2. Risk factors for dentistry, magnitude of the problem, prevention, and dental ergonomics*, International Dental Journal, 57, pp. 45-57, 2007.

[11] Harutunian, K., Gargallo Albiol, J., Barbosa de Figueiredo, R. P., Gay Escoda, C., *Ergonomics and musculoskeletal pain among postgraduate students and faculty members of the School of Dentistry of the University of Barcelona (Spain). A cross-sectional study*, Medicina Oral, Patología Oral y Cirugia Bucal, 16(3), pp. 425-429, 2011.

[12] Hayes, M. J., Smith, D. R., Cockrell, D., *An international review of musculoskeletal disorders in the dental hygiene profession*, International dental journal, 60(5), pp. 343-352, 2010.

[13] Draghici, A., *Ergonomie*, Editura Politehnica ISBN 973-625-270-1, Timisoara, 2007.

[14] Cofaru, I. I., *Cercetari privind biomecanica deviatiilor axiale ale membrului inferior uman si dezvoltarea unor echipamente chirurgicale aferente*, PhD thesis, Universitatea Lucian Blaga, Sibiu, 2013.

[15] Sacco, M., *Some reserch results regarding teh virtual and augment reality*, pp. 55-65, Editura Politehnica, Timisoara, 2007.

[16] Benedelic, A., *Anatomia functionala a coloanei vertebrale*, Universitatea de Stat de Medicină şi Farmacie Nicolae Testemiţeanu, Chisinau, 2018, https://pdfcoffee.com/anatomia-coloanei-vertebrale-5-pdf-free.html.

[17] Dragan, F., *Cercetări privind valorificarea analizei instrumentale cuantificate a sprijinului plantar, ca ansamblu parametrial aferent evaluării funcţionale şi evolutive în scolioze, la copii și adolescenți fără patologie podală primară*., PhD thesis, Universitatea de Medicina si Farmacie Carol Davila, Bucuresti, 2020.

[18] World Dental Federation, *Ergonomics and posture guidelines for oral health professionals*, Morita, Geneve, 2021.

[19] Al-Eisa, E., Egan, D., Deluzio, K., Wassersug, R., *Effects of pelvic asymmetry and low back pain on trunk kinematics during sitting: a comparison with standing*, Spine, 31(5), pp. E135-E143, 2006.

[20] Calafeteanu, D. M., *Cercetari privind biomecanica articulatiei genunchiului uman cu aplicatii in protezare*, PhD thesis, Universitatea din Craiova, 2017.

[21] Gajšek, B., Draghici, A., Boatca, M. E., Gaureanu, A., Robescu, D. (2022). *Linking the Use of Ergonomics Methods to Workplace Social Sustainability: The Ovako Working Posture Assessment System and Rapid Entire Body Assessment Method*, Sustainability, 14(7), 4301, 2022.

[22] Gogan, M. L., Sirbu, R., Draghici, A., *Aspects concerning the use of the Moodle platform–case study*, Procedia Technology, 19, 1142-1148, 2015.

[23] Draghici, A., Mocan, M., & Draghici, G., *On-line training and certification solution for business process managers*, Proceedings of International conference on enterprise information systems (pp. 380-389). Springer, Berlin, Heidelberg, ISBN 978-3-642-24357-8, 2011.

Ergonomia și evaluarea posturală a dentistilor, pentru prevenirea tulburărilor musculoscheletice, proiectarea unui scaun ergonomic

Bolile profesionale sunt o categorie de afecțiuni întâlnite la nivelul organismului și dobândite ca urmare a implicării în realizarea unui proces de muncă. In domeniul stomatologic, sistemul musculo-scheletic care include mușchi, tendoane, teci de tendoane, nervi, vase de sânge, articulații/discuri spinale și ligamente sunt unele dintre cele mai afectate părți ale corpului omenesc, în timpul procesului de munca. Poziția corpului trebuie să fie simetrică și dreaptă, iar liniile imaginare (de referență) care trec prin ochi, umeri, coate, talie, genunchi și glezne, trebuie să fie paralele cu linia pământului pentru a nu se înregistra deformații și deteriorări ale sistemului osteo-artcular și a celui muscolu-scheletic. Din punct de vedere ergonomic, pornind de la cererea existentă pentru formatele de scaune destinate medicilor stomatologi și prin analiza scaunului existent utilizat de aceștia, în articolul de față se prezintă demersul de analiză și concepție a unui nou scaun mai ergonomic.

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