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Ergonomic Risk in Nurses and Caregivers due to Patient Care and Mobilization in Senior Centers

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ABSTRACT

This paper contains a study related to the risk and ergonomic conditions in nurses and caregivers, who are involved in care and mobilization of patients in senior centers. The results were obtained trought: mixed approach methodology and descriptive scope. Pragmatic techniques and data collection instruments were utilized too, including documentary analysis of work procedures, direct observation, photographic records, and cards adapted to senior centers of the Assistance mobilization of hospitalized patients methodology (MAPO). Among the findings, the critical activities and tasks in the care and mobilization of dependent or non-cooperative patients (NC) and semi-dependent or partially cooperative (PC) have been identified. In addition, other determinations have been made, including: lifting factors, minor aids, wheelchairs, environment and training in the facilities or wards of the senior center, and the calculation of ergonomic risk level, both for nursing staff and caregivers.

Keywords: Ergonomics, Nurses, Caregivers, Occupational hazards, Ergonomic risk, Senior center, Mapo, Musculoskeletal disorders

INTRODUCTION

Research on ergonomic conditions in work environments continues advancing at a global level, especially those carried out in the economic sectors of production and logistics, where the influence in the gross domestic product is enormous. Nevertheless, there are others work environments that usually, don't receive the same attention from the scientifics, for example, the senior centers in which nurses and caregivers suffer from ergonomic risks. This exposure affects their health and, their welfare due to the following issues: intrinsic characteristics of their labor, the exhausting work shifts, the lack of aids or tools to facilitate the tasks and, even the contractual conditions under they work.

Among the services performed by nursing staff or caregivers in senior centers are: medical and personal care and recreation. These duties involve manual handling tasks, mobilization, and the lifting of heavyweight. According to Cheung et al. (2018), the risk factor related to these activities lies in the tendency of the worker or person to continue working despite feeling persistent musculoskeletal pain during the workday, which over time leads to chronic pathologies that are difficult to manage medically. Similarly, other

conditions affect the performance of the mencioned situations. The manual task without mechanical assistance. Also the speed required for them, which combined with the lack of specialized knowledge and experience, increases the degree of vulnerability in workers (Cheung et al., 2018).

Therefore, this research becomes important. It examines the conditions and ergonomic risk for nurses and caregivers at a senior center in Bogotá DC – Colombia. The study defines their critical activities and tasks, stipulating the impact of daily lifting heavyweight, the presence or lack of minor aids, wheelchairs, proper training, etcetera. This study is accompanied by an evaluation and analysis of the risk to which these nurses and caregivers are exposed. It is important to mention that this inquiry process is related to the Goals for Sustainable Development No. 3 and 8, Health, Well Being and Decent Work and, Economic Growth, which seek to promote safe and risk-free work environments for national and global health (United Nations Development Program, n.d.)

METHODOLOGY

This study was developed at a private senior center, where the physical limitations of the patiens make them dependant or non-cooperative (NC) and, semi-dependent or partially cooperative (PC). Following Hernández et al. (2014), this study employed a mixed approach, which allows a collection, analysis and, linking of qualitative and quantitative data that respond to the problem statement within the same study. The scope was descriptive. It is characterized by identification of facts, situations, and detailed features of the parts, by categories, or classes of an object of inquiry (Bernal, 2010). In this case, the focus was on conditions and ergonomic risks associated with the care and mobilization of patients.

Within the total population studied who directly attend to, or mobilize the patients are the nursing staff (composed of 1 head nurse and 12 assistants) and 12 caregivers, who were prepped and duly informed before the start of the study, guaranteeing reliability in the handling of the information and data received. It should be noted that the nurses have an employment contract directly with the institution, while the caregivers only have an unwritten agreement with the patients' relatives. In addition, the nurses work in 8-hour shifts, while the caregivers work in 12-hour shifts, either all day or all night, depending on the needs of the older adult and the agreement with the relatives.

Among the techniques and instruments used for data collection, initially, there was a review and documentary analysis of 11 protocols or procedures used in the senior center for patient care, then direct observation by filling out 20 field diaries and 50 photographic records of the tasks performed by the nursing staff and caregivers. Next, the methodology chosen for the mobilization of hospitalized patients (MAPO) – (authored by the Center for Applied Ergonomics – CENEA) was employed, also was adapted to senior institutions. For CENEA (2012), this tool provides the ergonomic risk assessment for the manual handling of patients or users, emphasizing the biomechanical

overload of the lumbar area and the level of ergonomic inadequacy of those assessed.

The adapted MAPO methodology is composed of 4 records: explanation sheet, checklist sheet, inspection sheet and conclusion sheet. The first one, explains in each of its chapters how to fill in the boxes of the other cards. It provides examples and describes some concepts, such as assistance equipment, minor aids, among others. The second one helps to recognize the main organizational aspects of the senior institution. The third sheet evaluates characteristics of the equipment and physical facilities required for patient care. The fourth sheet assesses quantity of workers and users into the institution, the lifting factor, the minor aids factor, the wheelchair factor, the environment factor, and the training factor, all based in the evidence collected in the two previous checklists and inspection sheets. Finally, according to the following formula, the MAPO index is obtained to identify the level of exposure for the nursing staff and caregivers (CENEA, 2012).

$$\text{Mapo index} = \left[\frac{\text{NC}}{\text{TW}} * \text{LF} + \frac{\text{PC}}{\text{TW}} * \text{AF} \right] * \text{WF} * \text{Fenv} * \text{TF} \quad (1)$$

Where,
NC = Number of "non-cooperating" users.
TW= Total number of workers in 24 hours.
LF = Lifting factor.
PC = Number of "partially collaborating" users.
AF = Factor of minor aids.
WF = Wheelchair factor.
Fenv = Environment/environment factor.
TF = Training factor.

RESULTS

Critical Activities and Tasks in the Care of Patients in a Senior Center

It was established that the critical activities and tasks are associated with the patient's health and mobility condition, that is, whether they are partially cooperative (PC) or non-collaborative (NC) during the care provided by the nursing staff. This analysis was carried out based on the procedures or protocols used in the institution, the field diaries and the photographic records. Table 1 lists those activities and tasks that are performed by people when the patient partially collaborates, as well as a brief ergonomic description of it.

These are critical activities and tasks which involve lifting and moving semi-dependent or partially collaborating patients. it is significant to point out that both, nursing assistants and caregivers maintain postures outside the comfort angles. This increases the risk of injury due to the difference between the height of the beds and chairs available in the institution. Table 2 also presents the critical activities and tasks performed by nurses and caregivers for dependent or non-cooperative patients, together with their ergonomic description.

Table 1. Critical activities and tasks in the care of semi-dependent patients (PC).

Activity	Tasks	Ergonomic description
Shower assistance.	Assist with patient hygiene during showering.	Tasks involve cervical flexion with torso flexion of approximately 45°, dominant shoulder flexion, with adduction and wrist flexion/extension movements to assist in rinsing, non-dominant shoulder abduction to 90° horizontal to support the patient, pelvis anteversion, hip and knee flexion with an increase polygon of support.
	Assist with complete drying of the patient after showering.	
Wardrobe assistance.	Changing the patient's diaper.	Tasks involve, in bipedal position, neck flexion with torso flexion up to 90°, shoulder and elbow flexion, prone/supination movements of wrists and hand pincers, hip and knee flexion. -adoption of squatting posture at times.
	Position the gown on the patient.	
Diaper change.	Place the patient in a lateral decubitus position.	The tasks involve the adoption of a squatting position on the bed. Then it generates neck and torso flexion, shoulder flexion/extension movements with shoulder abduction, wrist pronation/supination with full hand, or penta-digital grip of the patient, and tenar diaper pinch.
	Remove diaper from the patient.	
	Put a new diaper on the patient.	

These critical activities and tasks that involve lifting and moving dependent or uncooperative patients (NC). In these activities both, nursing assistants and caregivers, besides they perform postures outside the confort angles, they are exposed to overextertion and manual handling of loads. Due this they present a greater risk for injury relative to the critical pathological level of the patient.

Analysis of Ergonomic Conditions in a Senior Center

Based on the application of the adapted MAPO methodology sheets, the following factors or ergonomic conditions of the senior center were established that influence the level of exposure to the ergonomic risk of nursing staff and caregivers in the care and mobilization of patients. These include the lifting factor (LF), the minor aids factor (AF), the wheelchair factor (WF), the environment factor (Feng), and the training factor (TF). It should be noted that the institution has four zones or wards (Madre Marcelina, San Pedro Claver, Inmaculada, and San José) where semi-dependent or partially collaborating patients (PC) and dependent or non-cooperating patients (NC) are cared. It should also be noted that the nursing staff is assigned in 3 shifts of 8 hours a day, which are rotated weekly.

Lifting Factor (LF)

For CENEA (2012) the LF is the availability of cranes available at institution for the transfer of patients. Also that they respond to the needs of the

Table 2. Critical activities and tasks in the care of dependent patients (NC).

Activity	Tasks	Ergonomic description
Full lift from bed to wheelchair.	Seat the patient on the edge of the bed. Hold the patient's forearms and legs. Perform transfer of the patient, lifting them to the wheelchair. Position the patient in the wheelchair.	Activity performed by two nursing assistants or caregivers, for which one of them holds the resident's upper body and the other the lower body. Subsequently, the patient is seated on the edge of the bed with neck and torso flexion movements, moving on the knees on the bed of the assistant holding the upper body. Once the patient is seated on the bed, is lifted, and transferred, for which each assistant is positioned on either side of the patient, holding the patient's upper and lower limb with neck flexion, torso inclination and rotation, hip and knee flexion movements. During the activity, the patient is lifted, held, pulled, moved, and unloaded.
Changes of position in bed	Position in supine lateral decubitus position. Change to seated or supine to sleep.	Tasks involve squatting on the bed and pushing the patient's torso with neck and torso flexion movements, shoulder and elbow flexion with wrist extension and palmar grip, followed by shoulder and elbow flexion/extension, as well as torso inclination and twisting for lower limb accommodation. To change to supine decubitus position, the same movements are performed, but instead of pushing, the patient's torso is pulled to lay them on the bed.

Table 3. Elevation factor rating.

The Situation in the Senior center	Value
Crane absent or present but never used	4
Lack of crane or inadequate and insufficient crane	4
Insufficient or inadequate crane	2
Crane present, adequate and sufficient	0.5

site where they will be used, and their use by the staff. Its qualification is composed of four values depending on the situation, see Table 3.

In the case of the senior center evaluated, the value of the lifting factor is 4 in all the wards, considering that the institutions do not have cranes for lifting people in any of the areas indicated.

Minor Aids Factor (AF)

For CENEA (2012) the AF is assesses the existence of little aids in the institution, such as a sheet or sliding board, roller, ergonomic belt, and, in addition,

Table 4. Wheelchair factor assignment.

Average insufficiency score	0 – 1.33		1.34 – 2.66		2.67 – 4	
Numerical sufficiency	NO	YES	NO	YES	NO	YES
Wheelchair factor	1	0.75	1.5	1.12	2	1.5

Table 5. Average Wheelchair Factor Score – AWFS.

Pavilion	AWFS
Madre Marcelina	1.5
San Pedro Claver	0
Inmaculada	0
San Jose	0

if these are combined with height-adjustable stretchers. Its rating comprises two values: Absent or inadequate and insufficient (1) and Adequate and sufficient (0.5).

In the institution evaluated, it could be observed that the use of minor aids to reduce manipulations or biomechanical overload in patient handling operations is minimal. And in some wards, is completely absent. Therefore, this factor is evaluated as 1.

Wheelchair Factor (WF)

For CENEA (2012) the WF is assesses the presence of wheelchairs in an institution, their condition, ergonomic inadequacies, and their use for transporting non-autonomically independent or non-cooperative patients. Its rating depends on two variables such as the average score of inadequacy and the numerical sufficiency of wheelchairs in the senior center. See Table 4.

Average Insufficiency Score

For CENEA (2012) the value of this variable depends on the result of the calculation of the average wheelchair factor score (AWFS). At the same time, it evaluates the typology, and number of wheelchairs in use, and the characteristics of ergonomic inadequacy, such as, brake operation, non-removable or folding armrests, inadequate backrest and maximum width, non-removable or non-reclining footrests, and maintenance. In the case of the senior institution, each of the wards was evaluated, with the results shown in Table 5.

It indicates that the Madre Marcelina ward had an average AWFS or insufficiency within the average range for this factor, in contrast the other communities had a score of zero since there are no wheelchairs in use and no non-autonomous or non-cooperative patients who require their service.

Numerical Sufficiency

For CENEA (2012) it means the presence of several wheelchairs in the institution that exceeds 80% of the dependent or non-cooperative patients. In the senior institution, all the wards comply with the numerical sufficiency of

Table 6. Wheelchair factor results.

Pavilion	Madre Marcelina	San Pedro Claver	Inmaculada	San Jose
Average insufficiency score	1.5	0	0	0
Numerical sufficiency	YES	YES	YES	YES
Wheelchair factor	1.12	0.75	0.75	0.75

Table 7. Assignment of the environment – surroundings factor.

Average ergonomic inefficiency score	0 – 5.8	5.9 – 11.6	11.7 – 17.5
Environment factor values	0.75	1.25	1.5

Table 8. The Average score of the environment – surroundings.

Ward	APBS	AEIB	AIR	AFamb
Madre Marcelina	3	5	0.39	8.39
San Pedro Claver	0.33	5	4.34	9.67
Inmaculada	1	0	1	2
San Jose	0.14	0.14	1	1.28

wheelchairs by exceeding the indicated percentage. Based on the above and crossing the two variables, Table 6 shows the results of the wheelchair factors for each pavilion.

The above means that the wheelchair factor is in the low range for the San Pedro Claver, Inmaculada, and San José wards. In contrast for the Madre Marcelina ward, the coverage is medium, which directly influenced the level of exposure to ergonomic risk.

Environment - Environment Factor (Fenv)

I For CENEA (2012) it estimates the spaces for mobilization of patients within the senior center. These spaces could be bathrooms for hygiene, bathrooms with toilet use, and the room. For each of them, the number, presence of side rails, door width, bed and chair height, among other environmental relationships, are evaluated. In this factor, the ergonomic inadequacies are considered by relating the non-use of assistive equipment due to the limitation of spaces, causing the adoption of forced postures by the nursing staff or the caregiver. The final rating depends on the average ergonomic inefficiency score variable from Table 7.

Average Ergonomic Inefficiency Score

For CENEA (2012) this variable, in turn, depends on the average environment/surroundings score (AFamb), which is obtained from the sum of the independent ratings of the average patient hygiene bathrooms score (APBS). The average ergonomic inadequacy of bathrooms (AEIB), and of The inadequacy average of rooms (AIR), the results of the assessment in the Senior center are described in Table 8.

Table 9. Results of the background factor.

Ward	Madre Marcelina	San Pedro Claver	Inmaculada	San Jose
Average ergonomic inefficiency score	8.39	9.67	2	1.28
Environment factor values	1.25	1.25	0.75	0.75

Table 10. Assignment of the training factor.

Type of training	Training factor values
Adequate training	0.75
Partially adequate training	1
Training not carried out or wholly inadequate	2

Table 11. Results of the training factor.

Ward	Training factor values	
	Nursing assistants	Caregivers
Madre Marcelina	1	1
San Pedro Claver	1	1
Inmaculada	1	2
San Jose	2	N/A

This means that the Madre Marcelina and San Pedro Claver wards are the senior center sites with the highest average environment or ergonomic inefficiency score. There are more inadequacies in the background, affecting the mobilization of patients and the risk of ergonomic injury to workers. Based on the values in Table 8, Table 9 shows the results of the environment factor for each ward.

According to this, the environment factor of the first two wards is in the high range and for the last two wards in the low range.

Training Factor (TF)

For CENEA (2012) it is to the theoretical-practical training that the personnel has to receive before the handling of patients. It must be organized by the senior institution itself and with a total duration of at least 6 hours. However, for the caregivers, since they are not contractually dependent on the institution, their evaluation was based on their independent training, taking into account the values in Table 10.

In the case of the senior center studied, the results of this factor are detailed in Table 11. Highlighting that in the San José ward it does not apply - N/A, because there are no caregivers in that area.

The above table shows that both, nursing assistants and caregivers do not have adequate training for handling patients. Even the nursing staff in the San José ward and the caregivers in the Inmaculada ward, according to the

Table 12. Ergonomic risk exposure level results.

Type of worker	Ward	NC	TW	LF	PC	FA	FC	Fenv	TF	MAPO Index	Exposure level
Nursing Assistant	Madre Marcelina	3	5	4	11	1	1.12	1.25	1	6.44	High
	San Pedro Claver	0	5	4	19	1	0.75	1.25	1	3.56	Medium
	Inmaculada	0	6	4	15	1	0.75	0.75	1	1.41	Irrelevant
	San Jose	0	7	4	21	1	0.75	0.75	2	3.38	Medium
Caregivers	Madre Marcelina	3	7	4	4	1	1.12	1.25	1	3.20	Medium
	San Pedro Claver	0	1	4	1	1	0.75	1.25	1	0.94	Irrelevant
	Inmaculada	0	3	4	3	1	0.75	0.75	2	1.13	Irrelevant
	San Jose	0	0	4	1	1	0.75	0.75	0	0.00	Absent

evaluation, have wholly inadequate training, which is a danger factor not only for the patient. but also for the physical well-being of the worker.

Level of Exposure to Ergonomic Risk

From the MAPO index formula, the results obtained previously for the lifting factor (LF), minor aids factor (FA), wheelchair factor (WF), environment factor (Fenv), and training factor (TF), as well as the quantity of non-cooperative users (NC), the total quantity of workers in 24 hours (TW) and the quantity of partially cooperative users (PC), the following results are presented in Table 12 for each type of worker and ward.

According to the above, for nursing personnel, the high and medium level of exposure to ergonomic risk is found in the Madre Marcelina, San Pedro Claver and San José wards, respectively. For caregivers, the level of exposure is only medium in the Madre Marcelina ward. In the rest of the workspaces, the risk is usually negligible or absent, considering their characteristics and the absence of patients.

CONCLUSIONS AND DISCUSSIONS

From the results presented above, several conclusions can be stated. First, the activities related to the physiological needs and hygiene of patients, such as assistance in the shower, dressing, diaper change, change of posture in bed, lifting for the provision of medicines and their displacement, generate more significant exposure to ergonomic risk, both to nursing staff and caregivers. King et al. (2019), supports this information, who states that the weight of the elderly patient becomes a risk when assisting in the performance of physiological needs, whose process is something routine, continuous, and of daily execution, therefore with a high probability of increasing risk of bodily injury to the worker.

In this same sense, the study was able to determine the repetitive biomechanical situations and the most affected limbs in nursing staff and caregivers during critical tasks, including bending of the neck, shoulders, elbows, hips, and knees, flexing of the upper limbs, and torso, improper postures, and lifting and shifting of excessive weight. These tasks primarily impact the upper body and torso, such as the back, neck, shoulders, and lower back (Rasmussen et al., 2019; Karstad et al., 2018). Secondarily, the upper and lower

extremities such as the hands, wrists, elbows, and knees are impacted (Ching et al., 2018). Because of the above, several musculoskeletal areas are exposed, reducing overtime muscle strength and therefore the ability of people to perform their functions, mainly when, according to Pelissier et al. (2014), the number of daily tasks are performed by a single nurse or caregiver.

On the other hand, it is also possible to conclude that the administrative management of senior institutions directly influences the ergonomic exposure of workers. For example, the absence of cranes, sheets, or sliding boards for lifting patients, and as the availability and technical condition of wheelchairs for their transport, hamper the performance of caregivers. This is consistent with Muthukrishnan and Maqbool (2020). They argue that, at the hospital level, the lack of equipment for moving or transferring patients, the lack of rest during the working day, and the insufficient quantity of workers contribute significantly to overall insufficiency. Similarly, and to the same extent, they infer the ergonomic inadequacies of the bathrooms and rooms used by patients and nursing staff and caregivers, including the absence of handrails, the inappropriate width of doors, the incorrect height of beds and chairs, which together with the types of movements and efforts performed during critical activities and tasks, increase the correlation between the probability of occurrence and consequence of the materialization of ergonomic risk in people.

Finally, the risk levels obtained according to the MAPO methodology adapted and applied to the target population of this study corroborate the bellow conclutions. Risk levels were between medium and high in the wards with more inadequate ergonomic conditions and absent and irrelevant. There is less exposure on the part of caregivers and nursing staff of the senior center. Allowing in turn, the formulation of mitigation proposals, such as engineering controls in senior institutions: use of pull sheets, sliding board, ceiling lifts, adjustable bed, and mechanical lifts, by means of which, according to Hwang et al. (2019) significantly reduce hand traction force, shoulder flexion and muscle activity in the upper extremities and lower back. Likewise, an organizational intervention measure should be held to reinforce the constant theoretical and practical training of workers on the risks and the safe way to perform the activities. This proposal is consistent with what has been proposed by Richardson et al. (2018) and Stevens et al. (2019) who propose respectively, a safe patient handling program and physical, cognitive and behavioral training for the prevention of pain and related symptoms.

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