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ERGONOMIC STUDY FOR INFORMAL WORKING PUESTS. SEWING CASE S IN CUBA

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Summary

Informal work in the clothing sector, especially among women who carry out sewing work from their unregulated homes or workshops, presents unique ergonomic challenges. In Cuba, this problem is exacerbated by economic limitations and the lack of access to adequate equipment, generating bodily illnesses among the majority of these workers. The objective of this study is to investigate the main ergonomic risk factors among informal seamstresses with regard to biomechanical and environmental aspects. An observational study is demonstrated, with a quantitative, descriptive and experimental focus of transectal type that evaluated a group of 15 seamstresses who performed their work independently in their home. To obtain information, the Corlett and Bishop diagram is used, the implementation of the Kinovea software to take angles and the RULA postural assessment method. Furthermore, environmental conditions were evaluated using digital applications previously calibrated with professional instruments: Luxometer and OpeNoise Meter sound meter. As a result, inappropriate postures and repetitive movements will be detected that can generate musculoskeletal disorders, especially in the hip, lumbar area and upper extremities. The lighting is lower than recommended, generating visual fatigue, while noise, even within safe limits, presents variations that affect the concentration. The investigation provided practical and economical solutions to improve the well-being of these seamstresses, highlighting the importance of adapting the work environment in this vulnerable sector.

Keywords: Ergonomics; postural assessment; lighting; noise; informal work

1. INTRODUCTION

In many activities dedicated to clothing, there are obvious risk factors such as cuts or falls; However, it is also possible that problems of lesser visibility, but equally harmful, arise from dysergonomic risks and poor work organization. Although less obvious, these factors can cause serious health problems, such as muscle pain, visual changes and work stress, contributing to the presence of physical and mental fatigue. (Guasch et al., 2024)

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These affects, often ignored or misattributed, are a direct consequence of specific operational practices. Long working hours in inappropriate positions, repetitive movements and inappropriate working conditions contribute to the development of bodily ailments and musculoskeletal disorders. However, many workers suffer from these conditions without recognizing their direct relationship with poor work environment design or poor organizational management. (Guasch et al.,2024)

Ergonomics is currently considered a consolidated scientific discipline, which is continually expanding at a global level, during its evolution, having been nourished by several scientific disciplines and has contributed to others, such as occupational health. The application of its principles in the design of work systems has helped to reduce discomfort, workload, injuries and chronic disorders that can be suffered by the working population. (Acosta et al., 2023). In general, Ergonomics has a preventive and proactive character, which can create tools, machines, work tools and methods that adapt to human capabilities and limitations.

Every day, many people come to offices or hospital centers due to pain on their backs, shoulders, rollers, among others, products from long days of repetitive work on a sewing machine. Sewing involves using the sewing machine to pick up cut pieces with edges and edges as required by customers. This class of operations can be subject to problems in postures of the hips, shoulders, back, torso and hands. (Reguera et al., 2018).

In Latin America, and specifically in Cuba, informal work in this sector is a reality that economically supports thousands of women, many of them heads of family, who work from their homes or small, unregulated workplaces. Unlike workers in the formal textile industry, these seamstresses face critical ergonomic conditions: inadequate furniture and tools, long working hours without rest and the absence of regulations that protect their health (Narváez & Erazo, 2022). This situation derives from the adoption of forced postures and exposure to an unfavorable environmental environment, factors directly linked to the high prevalence of musculoskeletal disorders and fatigue reported in this group. However, there is a lack of specific diagnoses that measure these risks in the context of Cuban informal work, limiting the development of effective and accessible solutions. To fill this gap and provide evidence that allows prioritizing interventions, the study's objective is defined as: investigating the main ergonomic risk factors among informal seamstresses with regard to biomechanical and environmental aspects.

2. Materials and methods

The study presented has a quantitative focus and is based on the measurement of the characteristics of the work task. Its scope is descriptive because it intends to specify the characteristics of the study object: Cuban sewing workers . Asimismo, is a non-experimental study of transectal type that describes the current situation of the characteristics of the sewing work force through evaluation with ergonomic methods.

The study was applied to a group of 15 workers, randomly selected from among those who expressed their voluntary willingness to participate. They also work on their own in the sewing sector, often from their homes carrying out processes such as designing and adapting patterns, cutting and assembling fabrics.

Ethical considerations are taken into account at all stages of the investigation. Participants received complete information about the conditions of the study and gave their informed consent before participating.

The procedure selected for the development of the investigation is explained by Ormaza (2017) with some modifications based on the particularities of the study case. The integral diagnosis and monitoring and control step is eliminated, instead a plan of preventive measures is proposed and only factors such as postural diagnosis and lighting and noise are treated through the diagnosis of working conditions. Next, the corresponding steps of the methodological procedure to follow are shown.

2.1.Stage I. Initial Preparation.

2.2.Step II. Ergonomic diagnosis

- Postural ergonomic diagnosis

The number of observations carried out was 32 hours of the working day during the month of May 2025, the observations will be carried out for convenience according to the time available for evaluations.

The BPD scale is also known as the Corlett and Bishop diagram, as shown in figure 1. It consists of carrying out a comfort test from which the parts of the human body are analyzed using an image and the worker selects those parts where pain or discomfort is present. The scale ranges from 1 to 5 and the level of discomfort is at 5 being the degree of greatest inconvenience. (Acosta et al. , 2024)

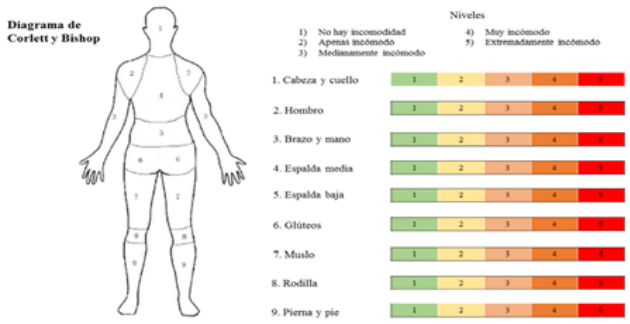


Figure 1. Corlett and Bishop diagram

Fuente: taken from (Acosta et al., 2024)

From the observation of the postures developed during the course of the working day, a total of 20 photographs and 2 videos were taken of those considered to have the greatest effects and prone to musculoskeletal disorders.

With the Kinovea software, angles are identified, given that its objective is to reduce subjectivity in measurements and guarantee greater safety and accuracy, resulting in usefulness in the ergonomic field and in the animation studio. (Palacios & Guzhñay, 2021)

For postural assessment, the RULA method was applied as it is the most feasible method to employ that allows the assessment of workers' exposure to risk factors that can cause disorders in the upper limbs of the body: postures, repetitiveness of movements, applied forces, static activity of the system musculoskeletal. (Carrillo,2018)

The method begins with the evaluation of the upper limbs organized in the so-called Group A. To determine the score to assign to that limb there are tables that demonstrate the different postures considered by the method and the value of the score assigned to each one. Once the evaluation of the upper limbs has been completed, the evaluation of the legs, torso and hips, limbs included in group B, are carried out. (Vargas & Iglesias, 2019)

Final Score: The score obtained from summing up to the group A, the score corresponding to muscle activity and the debt to applied strengths will be called C score. In the same way, the score obtained from summing up to the B group, the debt to muscular activity and applied strengths will be called D score. From the C and D scores, a final global score will be obtained for the task that will oscillate between 1 and 7, the greater the risk of injury. (Vargas & Iglesias, 2019)

- Ergonomic diagnosis of environmental working conditions: lighting and noise.

To carry out measurements in these studies, digital applications will be used Luxometer (illumination) and OpeNoise Meter (noise), previously calibrated by professional instruments to reduce the error margin of the measurements taken.

The lighting diagnosis requires, in the first place, to establish the existing lighting level (Eexist) from the measurement of the light intensity using a lux meter. (Pérez et al., 2023) Subsequently, the recommended lighting level (Erecom) is determined according to NC-ISO 8995/CIE S 008:2003 and these values are compared.

The measurement will be carried out at specific points where the worker's action occurs in the work area, as shown in figure 2.

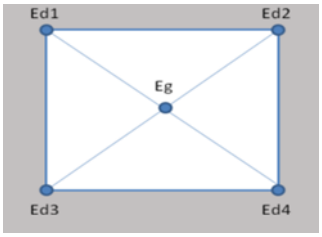


Figure 2. Lighting level measurement points

Fuente: taken from (Pérez et al., 2023)

The recording of point values takes place one day when the climatic conditions are optimal and the work area is unoccupied; with a frequency of three measurements during the working day at the times of morning (8am), midday (12pm) and afternoon (4pm) which are where there are significant differences in lighting.

Once the measurements are recorded for each work station, the existing lighting level is calculated with the energy: Existing E = 1/6MN*(ΣEd + 2Eg)

• Si Eexist < Erecom, incorrect.

To evaluate the noise level, the OpeNoise Meter digital sound level meter is used as a measuring instrument, a tool designed to measure the noise level in real time, with the aim of evaluating the sound pressure in the studio work environment. (Montenegro et al., 2021) The results obtained are compared with the limits established in the NC 871:2011 standard to guarantee compliance with the required acoustic standards.

2.3.Step III. Define a measurement plan

This stage is dedicated entirely to the elaboration of the plan of preventive measures regarding the results of the general ergonomic evaluation. The ergonomic diagnosis of different factors allows you to determine which elements need to be corrected.

3. Results

3.1.Application of Stage I.

It is important to learn about the objectives that are pursued with the study and that explains the need for their active participation, committing them to the activity.

The sewing work task is characterized by being highly manual, focused on precision tasks that require dexterity and sustained attention. The environment seems to be domestic, with reduced spaces adapted in an improvised way (eating tables, non-ergonomic chairs), where the worker alternates between prolonged static postures (sitting) and repetitive movements of arms and hands. There are no security protocols or protection equipment, and the work organization is self-managed, with irregular working hours that depend on demand.

3.2.Application of Stage II.

- Postural ergonomic diagnosis

Using the Corlett and Bishop Diagram (BPD), areas of the body with the greatest illnesses and their intensity were identified. Figure 3 shows the average results obtained from 15 workers in the most affected areas: head and hip, arms and hands (mainly in the neck) and lower back, all related to the postures and repetitive movements typical of this job.

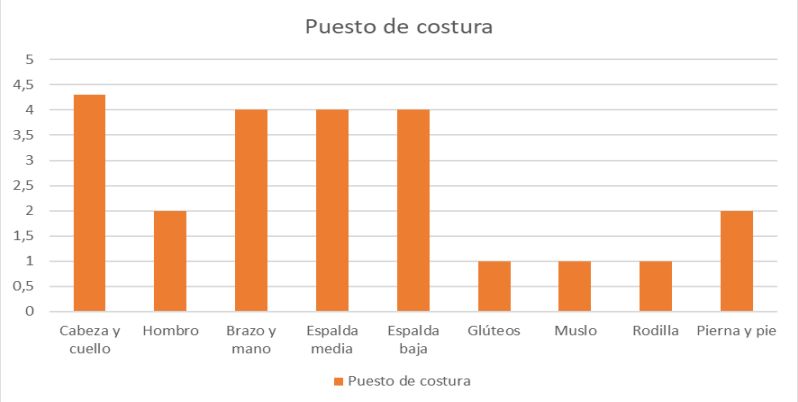


Figure 3. General scores of the Corlett and Bishop diagram among 15 sewing workers.

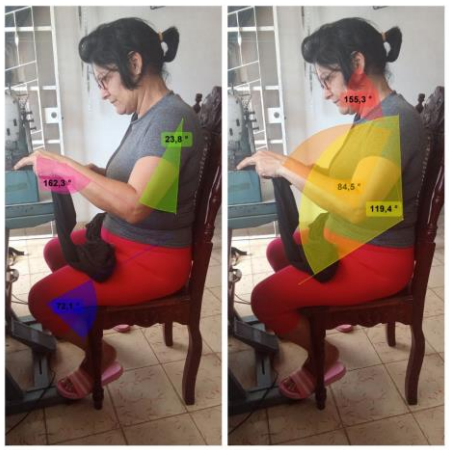
Source: own elaboration.

Postural evaluation is carried out with the seamstress of greater experience, disposition and knowledge of activity.

After identifying the most critical postures, the RULA method was applied according to the criteria described. To complement the analysis, body angles were determined using the Kinovea software. All results are recorded in Table 1.

Table 1. Definition of worker angles using Kinovea software.

Postures during activity development	Identification of angles	Body parts measurements	Corrected angle
1		-Brazo Forearm -Doll -Cuello -Stem -Piernas	56.2° 180° - 147.6° = 32.4° 180° - 116.9° = 63.1° 180° - 164.1° = 15.9° 180° - 88.4° = 91.6° (Worker seated) 109.7° Sitting Operator with both floors on the ground

2		-Brazo Forearm -Doll -Cuello -Stem -Piernas	23.8° 180° - 84.5° = 95.5° 180° - 162.3° = 17.7° 180° - 155.3° = 24.7° 180° - 119.4° = 60.6° Seated operator 72.1° Worker sitting with both feet on the floor
3		-Brazo Forearm -Doll -Cuello -Stem -Piernas	70.5° 180º - 161.9° = 18.1º 180° - 163° = 17° 180° - 161° = 19° 180° - 149.6° = 30.4° 173.1°
4		-Brazo Forearm -Doll -Cuello -Stem -Piernas	18.5° 180° - 139.5° = 40.5° 180° - 154.8° = 25.2° 180° - 128.4° = 51.6° 180° - 153° = 27° 177.6°

Source: output from Kinovea software.

Table 2 reflects the results obtained from the application of the postural assessment method applied to each of the critical postures that you perform.

Table 2. Postural assessment of the worker. RULA method

Posture	Punctuation A	Punctuation B	Muscular Strength	Final Score	Action Level	Intervention
1	6	4	0	6	3	Task redesign required
2	5	3	0	4	2	Changes or additional analysis may be necessary
3	4	5	0	5	3	Task redesign required
4	3	6	0	5	3	Task redesign required

Source: own elaboration.

Most postures require task redesign, so that, considering the results of the application of the Corlett and Bishop Diagram, posture 1 constitutes the most critical.

- Ergonomic diagnosis of working conditions

Ergonomic lighting diagnosis:

Table 3 shows measurements of the lighting level and lux obtained. Some of these values can be seen in figure 4.

Table 3. Lighting measurement at the work station

Distribution of points	Tomorrow (Lux)	Midday (Lux)	Afternoon (Lux)	Average (Lux)
Ed1	372	823	795	663.33
Ed2	119	215	144	159.33
Ed3	133	612	552	425.66
Ed4	277	1110	934	773.66
Eg	217	743	662	540.66

Source: own elaboration.

Figure 4. Samples of lighting level measurements at different times during the working day

Source: Luxometer output.

When calculating the existing lighting level, a value of 517.21 lux is obtained. La NC: ISO 8995:2003, depending on the activity that takes place at work, recommends a minimum of 750 lux. In comparison, the existing lighting level is lower than recommended for precision work, which results in eye fatigue.

- Ergonomic noise diagnosis

During the noise study during work, a maximum level (LA max) of 58.2 dBA was measured as shown in figure 5, which corresponds to non-constant noise, characterized by intermittent peaks that indicate irregular activity, typical of sewing machines that switch on/off the speed change. It is worth noting that, at the time of the measurement, there was no exchange of conversation between the worker and any person, which guarantees that the values recorded in the meter were influenced by external sources and only reflected the levels of sound pressure produced by the operations of the workplace.

Figure 5. Noise at the work station

Source: OpenNoise exit

According to the NC ISO 871:2011 standard, which establishes a maximum allowable limit of 85 dBA for 8-hour workdays, the measured level (58.2 dBA) is very below the risk threshold, which indicates that it does not represent a danger for the hearing health of employees. However, it could affect concentration or comfort.

3.3.Application of Stage III.

With the aim of correcting the level of risk present after carrying out the ergonomic diagnosis and considering that many seamstresses work from home as an extra income, the following plan of measures is proposed to minimize the risks associated with this work as shown in table 4.

Table 4. Measurement plan to minimize risks associated with sewing work.

Factor	Measures
Diagnosis Postural	1-Use chairs with easy-to-adjust ergonomic adjustments: -Height, seat inclination and position are easily adjustable. -Padded lumbar support with rounded ends for greater comfort

	-A gently sloping front edge prevents the edge of the lining from getting stuck on the back of the legs. -Place the silla at an appropriate distance to avoid separating the body's cores too much. -The work surface must be at the height of the sitting position, the feet completely supported on the floor and the wheels slightly higher than the seat
	2-Provide tables that are adjustable in height and inclination so that workers can carry out their tasks without adopting forced postures: -The ideal height of the table must coincide with the height of the worker and guarantee sufficient space below the table so that the legs do not touch the table, thus ensuring comfort and freedom of movement. -The edges of the surfaces must have a rounded design to support your arms with greater comfort -The space must be greater when using a pedal so that the movement of the legs is easier. -The machine pedal must adjust to the foot dimensions of the person using it. -When working seated, the table must be high enough to allow comfortable space for your legs. - Keep in mind the dimensions of minimum and maximum reach of the arm when organizing tools and materials that are needed for the activity, facilitating access without excessive effort and preventing injuries due to repetitive movements.
	3- Implement breaks every 30 minutes to stretch your hips, shoulders and muñecas (e.g.: gentle rotations, stretching of forearms)
Lighting	1-Install economical LED lamps with flexible support on each sewing machine, whenever possible, orienting them specifically towards the work area to improve visibility and prevent inappropriate postures 2- Avoid the use of electrical extension cords, as this could pose a risk of tripping or fire

Noise	1-Use of hearing aids during periods of increased activity to minimize possible discomfort and promote concentration.

Source: own elaboration.

4. Discussion

Mekonnen et al. (2019) observed a relationship between the lack of lighting and pain in the hips and shoulders, 58% of workers related the lack of lighting to the presence of musculoskeletal pain; data similar to those found by Okareh et al. (2021) to highlight how environmental conditions regarding lighting, ventilation and noise, correspond to physical risk factors that have an impact on the incidence of headache, thermal stress and auditory sensitivity.

In a study carried out by Joyce (2004), approximately 50% of workers who work in sewing areas feel less comfortable during their work day. Removing yourself from your workspace implies a postural change that benefits the worker, however, less than 20% of it is lost and more than 50% consider that the lighting in your workspace is regular.

Ortiz et al. (2022) proposed that the workers' seats should not be wheeled, in order to guarantee their stability, in addition the backrest should be padded, to reduce pressure in the contact areas and it should be possible to regulate the height of the seat and the inclination of the backrest.

It coincides with Sobrinho et al. (2020) that studies in the field of Ergonomics have a character of continued improvement. It develops according to the needs and demands of the areas, aiming at the comfort, health and well-being of employees. Furthermore, we demonstrated that the implementation of improved ergonomics allowed the reduction of pain issues reported by employees in different body segments. According to their reports, the physical sensations that manifested were: "less pain in the cervical spine, joints and upper and lower limbs"; "reduction of fatigue, ailments and muscular problems". Both in the current article, and in investigations that serve as a theoretical basis, it was demonstrated that Ergonomics in informal sewing work is an urgent need. Small changes in the work environment can significantly transform the health and quality of life of these women. It is crucial to promote educational campaigns and alliances with local organizations to implement sustainable solutions.

5. Conclusions

The study revealed that informal seamstresses in Cuba face significant ergonomic risks, resulting from inappropriate postures and repetitive movements that generate high levels of musculoskeletal disorders.

It was found that the critical stances, evaluated with the RULA method, required an immediate redesign. Simism, the lighting, with a value of 517.21 lux, is lower than recommended, which contributes to visual fatigue, even though noise, even within safe limits, presents variations that affect concentration, worsening precarious working conditions.

The limitations of the study include the reduced size of the sample, 15 workers and the evaluation in a specific period, May 2025, which could affect the generalization of results. Suggested for future investigations:

· Expand the museum to other regions of Cuba.

· Include longitudinal evaluations to monitor the effectiveness of proposed interventions.

· Incorporate the subjective perception of workers through satisfaction and well-being surveys.

Despite these limitations, the plan of measures I propose shows that simple and economical adaptations can significantly mitigate ergonomic risks, improving the health and productivity of this vulnerable sector.

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Bioethical aspects

This study was carried out based on ethical principles for investigations with human beings. Given the observational nature and low risk of investigation (postural observation, environmental measurements) without altering the working conditions or health of the participants, all workers will provide informed consent, which explains the objectives, methods and anonymous use of data. Your right to withdraw at any time and the confidentiality of the collected information is guaranteed.

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