Use of the Finnish method to quantify the ergonomic properties in an office environment among the workplaces in an Electricity Distribution Company in West Tehran Province

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Abstract
Background: The workplace plays an important role in workers’ performances, but most workplaces have not been designed and equipped in keeping with primary ergonomic principles. Ignoring these principles can cause ergonomic risk factors, difficulties for workers, and damage to workers’ health. The aim of this study was to identify acceptable ergonomic properties in workplaces in order to determine and investigate the aspects of workstations that cause occupational discomfort. To accomplish this aim, we used the Finnish method to evaluate workstations in an electricity distribution company in Tehran.

Methods: This cross sectional study was conducted for all of the workstations in an electrical power distribution company using the census method. The desired information was collected through objective observation using the Finish checklist of ergonomic issues in the workplace. Then, we used SPSS version 16 to analyze the information.

Results: In 11.2% of the workstations, none of the ergonomic principles was considered, so workers’ bodied were not situated appropriately while they were working. In 31% of the cases, lighting ranged between 10% and 50% of the recommended amount, and some of the workers appeared to be in a slight daze. In 42.3% of the cases, the temperature in the workplace was in the range of 25 to 27°C. In 42.3 and 52.3% of the cases, ratings of noise were 2 and 3, respectively, indicating that the noise levels were 60-70 dB and 70-80 dB, respectively.

Conclusion: The findings of this study can be used to determine ergonomic deficiencies in workstations so they can be resolved. Based on our investigation, it was found that the workstations, first and foremost, had significant defects in terms of work components. Furthermore, there were some irritating problems concerning noise and concerning comfort levels related to the high temperature.

Keywords: workplace, occupational injuries, questionnaires

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1. Introduction
Work environment is an important factor that has a direct effect on employees’ efficiency. Most workplaces do not adhere to basic principles of ergonomics, and this lack of attention to the basic principles causes ergonomic risk factors, problems for the employees, damage to the health of employees, increased errors, accidents, and different maladies, including headaches, visual discomfort, back pain, chronic musculoskeletal discomfort, and other disorders. These complications reduce the workers’ efficiency and accuracy, and they also increase marginal costs by reducing productivity (1-4). Unfortunately, today, the issue of the compliance of the work environment with the needs and requirements of the workers has not been dealt with in a scientific manner. One reason is that the people who are in charge of workplaces have inadequate knowledge concerning the principles of ergonomics in the workplace. The aim of this study was to use the Finnish method to quantify the ergonomic characteristics of the work environment that cause occupational ailments.

2. Material and Methods
This was a cross-sectional study that was conducted in all office workstations of an Electricity Distribution Company in West Tehran in 2011. The statistical population of the study included all employees of the electricity company in West Tehran, which consisted of 116 people employed by the company. Information was gathered using the census method through objective observations, interviews, measuring devices, and completion of the standard Finnish checklist among 116 of the 150 employees of the West Tehran Electricity Company.

The general checklist for evaluating and quantifying ergonomic features was designed by the Finnish Institute of Occupational Health, and it has international accreditation (5, 6). The checklist was used in this study to gather data in three dimensions, i.e.: 1. Work type: The type of work is divided into its components and analyzed. If the work components are much different from each other, each one is evaluated and analyzed separately.
   2. Work description: The work description is prepared by an analyst who prepares a list of activities and tasks that comprise the work and draws a design of the work environment.
   3. Analysis: After the work type, work description, and design of the work environment have been prepared, the analyst conducts an analysis to determine areas in which ergonomic improvements should be made. The basic principles of ranking the status and work conditions were established by studying the difference between the actual workplace conditions and the optimal or recommended conditions. Approaches for adjusting the workplace so that it is in closer alignment with optimal conditions also were investigated. Grades 4 and 5 suggest the existence of dangerous condition in the workplace that could threaten the health or safety of the workers. Based on the results of her or his analysis, the analyst can list some recommendations to improve the conditions in the workplace.

The corresponding ranks of different cases are not comparable with each other. In the evaluation of the workplace by the workers, the analyst specifies the workers’ assessments by signs, i.e., (+++) as good, (+) as appropriate, (-) as poor, and (--) as very poor. Also, to evaluate how well the workplace measured up to the existing standards related to lighting rate, heat stress, and sound levels, a Hagner Digital Luxmeter (EC1 Model), a Thermo-Anemometer (KIMO VT50 Model), and digital sound level meter (CEL – 254) were used, respectively.

In this study, the workplace conditions were assessed based on 12 items given in the Finnish checklist. Each item represents a measurable factor that can be used to design a safe, healthy, and productive workplace. The basis of this review was a regular and useful description of the duties of the job duties or of the workplace. In this analysis method, we examined the workers’ physical environment in the workplace, including its dimensions and the arrangement of all of the office equipment, including tables, chairs, copiers, printers, and other devices. The influence of each factor on the worker was examined. We investigated many factors and their impacts on the workers, including the places at which specific work duties were performed; the repetitive physical activities involved; the positions and movements of the worker’s body when performing the required activities; the components the worker had to use to get the job done; the limitations imposed by the work and the workplace; communications with co-workers and supervisors; the level of accuracy the work required; and environmental conditions, including the amount of lighting provided, temperature, and noise levels. In addition, the repetitive movements section was only studied in 121 systems (A system is responsible for response to incidents and events...[electronicphysician@gmail.com]
that occur in the public power network). The other sectors that did not require repetitive movements were not studied. Lighting, temperature, and sound were measured at 71 stations. Lighting measurements were made by placing the Hagner Digital Luxmeter in front of the keyboard; noise measurements were conducted by locating the digital sound meter in front of the desktop; and temperatures were measured placing the Thermo-Anemometer beside the worker’s chair. Also, due to the company’s lack of adverse incidents in the last few years, the incident parameter was removed from the procedure. It should be noted that 34 of the company’s 150 employees were not studied for various reasons, such as constant presence at the workplace, lack of cooperation, or the type of work they performed. Therefore, 116 employees in the company were evaluated. The study included all recent figures published by the American Conference of Governmental Industrial Hygienists (ACGIH) and the Institute of Standards & Industrial Research of Iran (7, 8). All experiments and procedures were conducted in the presence of staff and with their full consent, and there was no obligation to participate at any level. Eight people chose not to continue, so they were excluded from the study. After the data were collected, they were analyzed by SPSS version 16.

3. Results
3.1. The status of work components and body postures and movements
Regarding work components, in 5.2% of cases, the employees were responsible for most of the work process. In 26.7% of cases, the employees only performed a part of the work. In 57.8% of cases, employees were responsible for a small portion of the work, and in 10.3% of cases, the employees only were responsible for doing a simple task. However, in the employees’ assessment, 19.8% and 3.4% of them reported that the status of the work components was poor and very poor, respectively. In 12.1% of cases, instructional information about the work components was clear. In 72.4% of cases, information related to work components consisted of possible instructions and strategies for facilitating the selection of activity models. In 15.5% of cases, there was no way to make a comparison because the tasks consisted of complex components with different solutions. Regarding the status of body postures and movements, mode 3 was dominant in 11.2% of the cases (Table 1).

### Table 1. Overview check

|                          | Analyst ratings | Employee Evaluation |
|--------------------------|-----------------|---------------------|
|                          | 1   | 2  | 3   | 4 | 5 | ++ | + | - | -- |
| **Work location**        | 6   | 82.8 | 11.2 | - | - | 11.2 | 65.5 | 15.5 | 7.8 |
| **Regular physical activity** | 94 | 6   | -   | - | - | 6   | 64.7 | 20.7 | 7.8 |
| **Body positions when working** | 2.6 | 86.2 | 11.2 | - | - | 6   | 48.3 | 35.3 | 10.3 |
| **Completing work**      | -   | 5.2 | 26.7 | 57.8 | 10.3 | 6.9 | 69  | 19.8 | 3.4 |
| **Restrictions on labor and workplace** | 10.3 | 81.9 | 7.8 | - | - | 10.3 | 62.1 | 21.6 | 5.2 |
| **Communicate with others** | 84.5 | 14.7 | 0.8 | - | - | 63.8 | 32.8 | 2.6 | - |
| **Decision making**      | 12.1 | 72.4 | 15.2 | - | - | 23.3 | 62.1 | 12.1 | 2.6 |
| **Accuracy**             | 42.2 | 41.4 | 4.3 | 12.1 | - | 10.3 | 72.4 | 13.8 | 2.6 |
| **Lighting**             | 8.5 | 60.6 | 31 | - | - | 30.2 | 48.3 | 19 | 2.6 |
| **Thermal conditions**   | -   | 57.7 | 42 | - | - | 8.6 | 44.8 | 36.2 | 10.3 |
| **Noise**                | 5.6 | 42.3 | 52.1 | - | - | 9.5 | 25.9 | 24.1 | 40.5 |

**By percentage**

|                          | Analyst ratings | Employee Evaluation |
|--------------------------|-----------------|---------------------|
| **Work location**        | 7   | 96  | 13 | - | - | 13 | 76  | 18  | 9 |
| **Regular physical activity** | 109 | 7   | -  | - | - | 7  | 75  | 24  | 9 |
| **Body positions when working** | 3  | 100 | 13 | - | - | 7  | 56  | 41  | 12 |
| **Completing work**      | -   | 6   | 31 | 67 | 12 | 8  | 80  | 23  | 4 |
| **Restrictions on labor and workplace** | 12 | 95  | 9  | - | - | 12 | 72  | 25  | 6 |
| **Communicate with others** | 98 | 17  | 1  | - | - | 74 | 38  | 3   | - |
| **Decision making**      | 14  | 84  | 18 | - | - | 27 | 72  | 14  | 3 |
| **Accuracy**             | 49  | 48  | 5  | 14 | - | 12 | 84  | 16  | 3 |
| **Lighting**             | 6   | 43  | 22 | - | - | 35 | 56  | 22  | 3 |
| **Thermal conditions**   | -   | 41  | 30 | - | - | 10 | 52  | 42  | 12 |
| **Noise**                | 4   | 30  | 37 | - | - | 11 | 30  | 28  | 47 |
3.2. Repetitive movements and accuracy cycle
The findings showed that in all cases regarding repetitive movements, the timing of the repeat cycle was between 10 and 30 minutes. Given that working with electrical equipment and heeding warnings provided by electrical equipment require significant accuracy, the findings showed that in 42.2% of cases, the accuracy cycle rate was less than 30% of the entire job, and, in 44.4% of cases, the length of the accuracy cycle ranged from 30 to 60% of the entire job. In 4.3% of the cases, the length of the cycle was between 60 and 80%, and, in 12.1% of the cases, the length of cycle was greater than 80%.

3.3. Communicating with others
The findings on communicating with others showed that in 84.5% of the cases, no problems were associated with the communication and possible contact between employees and others. In 14.7% of the cases, there was minimal restriction in connection with other people. Investigation of limitations due to work indicated that, in 10.3% of the cases, the task or its methodology was not limited by requirements associated with a system or device, a process, a production method, or the speed of the work. In 81.9% of the cases, there were few restrictions placed on them in doing the job. In 7.8% of cases, the task or its methodology had limitations, and its characteristics had to be considered in certain cases and specific time periods.

3.4. Lighting
The results showed that, in 8.5% of the cases, lighting was 100% or more of the suggested value, and, in 60.6% of the cases, lighting was in the range of 50 to 100% of the suggested value. Also, in 31% of the cases, lighting was in the range of 10 to 50% of the suggested value, or there was a slight daze at work.

3.5. Temperature
After measuring the weather conditions at 71 environmental stations in the offices using a Thermo-Anemometer (KIMO VT50 Model), the results showed that air flow was not optimal in all areas of the offices and that there was inappropriate air flow in some parts of the offices. In 57.7% of the cases, the ambient temperature was between 21 and 21°C, and, in 42.3% of the cases, the ambient temperature was between 25 and 27°C.

3.6. Sound
According to our measurements, the level of sound in the offices and the permitted sound level within the buildings were 45 dB in the office environment based on the National Housing Provisions in Iran (8, 12). The results showed that noise levels in all workstations were above the limit, so that in 5.6%, 42.3%, and 52.1% of the cases, the analyst’s ratings were 1, 2, and 3, respectively.

4. Discussion
The aim of this study was to quantify the ergonomic characteristics in the office environment at the Electricity Distribution Company in West Tehran Province using the Finnish methodology. Using the results of this study, the shortcomings of the workstations from an ergonomic perspective were identified for use in solving emerging problems and shortcomings. According to the surveys, it was concluded that the office primarily had some shortcomings regarding work components and accuracy. There also was discomfort due to noise and temperature.

4.1. Work components and body posture and movement
In 12.1% of the cases, the manual information on work components was clear. In 72.4% of the cases, data related to work components were composed of possible instructions and solutions, which facilitated the selected activity models. The results of our study were not fully consistent with the findings reported by Hassanzadeh & Yousefi that the employees’ physical activity was ergonomically moderate (9). The difference between the two studies could be due to differences in the two populations or differences in the educational levels of the populations. Consideration of ergonomic principles and correct and appropriate body posture and movements at work help maintain the health of workers and are effective in reducing the costs incurred by the company and its workers. For example, using office designs based on ergonomic principles can avoid many costs and unpleasant issues, including the costs of disablement, costs due to accidents, costs of lost production time, and the costs of production waste. Also, other advantages can be achieved, such as reduced work time, the elimination of excess movements in the process, improved communication with the outside environment, balanced supply and demand, optimized work efficiency, and energy savings, all of which can be achieved by developing a comprehensive understanding of the principles of ergonomics and incorporating them in the workplace. Therefore, people’s workplaces, which are actually their second ‘home,’ can be designed in a way to improve both the physical and mental health of employees (10).
4.2. Repetitive movements and accuracy cycle
Regarding repetitiveness, in all cases, the time of the repeat cycle was between 10 and 30 minutes, which is more than the standard rate and can lead to musculoskeletal disorders (11). Methods of preventing such disorders also were reported in Nussbaum & Torres’ surveys (12). Training workers about correct movements, using the principles of body mechanics correctly, and proper training of body mechanics while doing a job can help solve many ergonomic problems (12).

4.3. Communicating with others
In our study, in 84.5% of the cases, there were no problems regarding communication with and having possible contact with others; however, Hassanzadeh & Yousefi’s study indicated that the status of communication among individuals was poor (9). The difference in the results of the two studies could be due to differences in the educational levels of the workers or differences in the dominant system in the two communities. To increase employees’ incentive to work cooperatively and be productive, maximum communication and contact between staff are essential.

4.4. Lighting
Lighting can have a significant effect on comfort and performance. Working with monitors, dazzling light leads to glaring and visual discomfort. In reading and writing tasks, low light causes eye discomfort and creates a depressing atmosphere in the workplace (13). According to our findings, the lighting situation in the workplace was generally viewed negatively by the workers and did not conform to standards (7, 8). Therefore, it is recommended that the relevant authorities take action to improve the lighting in the workplaces. The poor working conditions that result from inappropriate lighting may have a causal effect on many of the employees’ disorders and negative attitudes.

4.5. Temperature
In 42.3% of the cases in this study, the ambient temperature was between 25 and 27 °C. Standard values are the conditions in which all employees can work and perform their activities repeatedly without any harmful effects on their health in the work environment. The results of this study indicated that the measured factors were less than standard levels; however there was no heat stress that did not comply with workplace standards (8-7). Therefore, it is recommended that the relevant authorities implement the necessary measures in order to improve employees’ comfort and thermal conditions, since not paying attention to temperature issues creates problems in meeting the goals.

4.6. Sound
In this study, the sound levels in all workstations were above the permissible limits and created nuisances, such as interfering with conversations and making it difficult to concentrate, conditions that can occur even at relatively low sound levels. This situation is almost certain to be reflected in high levels of employees’ dissatisfaction about the noise status. By applying appropriate limitations on volume levels, damage to workers’ ability to hear can be prevented (14). Unfortunately, workers’ adaptation to their workplaces is an issue that is not dealt with scientifically at the current time, so important ergonomic principles are often ignored in the workplace. As a result of the findings of this study, the authors recommend the standardization of the physical factors that affect workers in their work environments, especially the sound factor. Our results indicated that a poorly-designed, inappropriate workplace can have negative effects on employees’ health and motivation, resulting in negative impacts on the company's goals, productivity, and financial status.

5. Conclusion
The findings of this study showed the office environment was in good condition with respect to the physical activities required of the workers and that there were no extraneous factors that increased the workers’ workloads. Regarding work components, the workplace did not meet some of the standards, and it is essential that the appropriate officials and managers make the necessary improvements to maintain their workers’ occupational health and efficiency. The status of lighting in the workplace did not comply with the standards. Also, the sound levels at all workstations exceeded permissible limits. All studies and investigations in this regard should be done in order to prevent physical and psychological damages to the employees, which would, in turn, improve the efficiency and productivity of the company. Therefore, it is recommended that studies such as this one be performed throughout our society.
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Conflict of Interest:
There is no conflict of interest to be declared.

Authors' contributions:
All of authors contributed to this project and article equally. All authors read and approved the final manuscript.
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