The Effects of Workspace Ergonomics on Programmers

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Abstract— **Ergonomics, positioning and posture of body and design of workstations in offices are considered key research areas in recent times. There is a wide gap in practice and theory of ergonomics. The goal of this study is to evaluate the musculoskeletal health of the employees with relevance to ergonomics and workstation design in practical environment of software houses.**

Keywords-ergonomics, productivity, code quality, software development, workspace.

I. INTRODUCTION

Students from the Faculty of Automation and Computers (ACS) and professionals in the programming field are often exposed to specific working conditions, such as extended programming hours and interaction with advanced technologies. Ergonomic assessment may include aspects such as the organization of study or workspaces, lighting conditions, noise level, and health and safety aspects, including the use of protective equipment. This case study focuses on the impact of working conditions and ergonomic factors on ACS students and programming professionals.

The motivation for choosing this research topic stems from the desire to understand the impact of working conditions and ergonomics on the productivity of students and professionals in the programming field. Given the intensive nature of work in the technology industry, improving the work environment can significantly contribute to comfort, health, and performance. The global trend of remote work highlights the importance of creating an optimal work environment, and the research aims to provide empirical evidence on how the sound, temperature, and the overall work environment, as well as the static or dynamic position of the human body in this environment, can influence the subject's performance in the workplace.

The objective of the article is not only to better understand these aspects but also to provide specific solutions tailored to the needs of students and employees in the programming field, benefiting both organizations and educational institutions. Recommendations to universities and companies could focus on improving study and work conditions, supporting the balance between professional and personal life, as well as promoting safe and healthy workplace practices.

In accordance with previous research, factors influencing productivity and performance can be divided into two main categories: leadership factors, such as organizational planning and administrative support, and factors related to the work environment, such as workspace design and well-being facilities.

II. STATE OF THE ART

The Knowledge of Computer Ergonomics study analyzes knowledge regarding ergonomics through a questionnaire administered to 177 students from a private software engineering faculty. The data used in conducting the study will be diverse as it examines: participants' personal characteristics (age, weight, height, and BMI), the extent of computer usage (in study[1], interval of time when pain/discomfort occurs is analyzed based on the time spent in front of the computer weekly; it is observed that individuals spending more than 10 hours in front of the computer per week experience desk-related pain in less than an hour), as well as the use of specialized equipment to promote an ergonomic environment (external mouse, keyboard - in another study[2], differences in musculoskeletal load on the hand between men and women are observed, with women being more affected by prolonged use of a non-ergonomic mouse).

In addition to the mentioned aspects, this questionnaire also includes a set of questions addressing knowledge in the ergonomic field. Studies [3-4] (conducted in an IT company in Karnataka) suggest that the existence of an educational program related to ergonomics is necessary for maintaining a productive and healthy work environment. These studies indicate that maintaining a consistent educational program for 2-3 weeks yields observable results in the work environment.

In the current study, it will be observed that the theoretical results are quite low, as the questionnaire subjects are not aware of the risks of poor positions and the diseases that can be caused by them (referred to as MSDs).(Figure 1)

Living in an era of the digital revolution, computers are not only used for educational purposes but also for recreational activities. Thus, in a study conducted on students in India [3], it is observed that the majority are not aware of the risks of MSD (Musculoskeletal Disorders).

Further analyzing two other studies[5-6], it is noted that maintaining the body in a neutral and natural position reduces stress on muscles, tendons, and joints, thereby decreasing the risk of MSD occurrence. Most participants in the study were able to

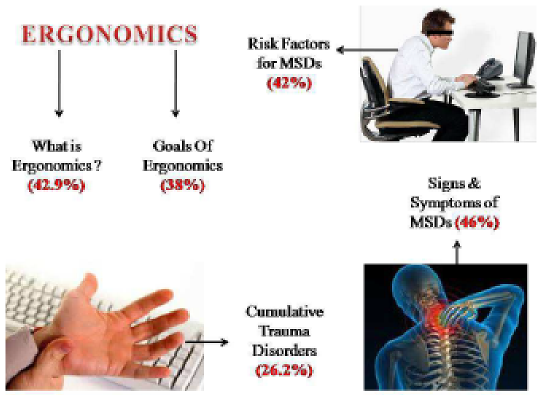

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Fig. 1. Knowledge about musculoskeletal disorders and its risk factors - Knowledge of Computer Ergonomics among Computer Science Engineering and Information Technology Students in Karnataka, India.

answer questions in the questionnaire regarding correct body positions during desk work, with the exception of the ideal posture for arms and shoulders. These studies also provide an analysis of how participants responded: the chair is the basis for a comfortable computer workstation (most participants correctly answered questions about the functionalities that an ergonomically efficient chair should have, except for the part where it is necessary for its base to consist of 5 rotating legs, where only 47.6 percent answered correctly. The necessity of this number for the chair's base is presented in a specific study.[7]

The keyboard should allow a 90-degree flexion of the elbow (discused in a specific study[8]), with only 59.9 answering correctly to this question. For the correct position of the mouse, which should be at the same height as the keyboard and close to the body, 69.8 percent answered correctly. Results for the remaining questions from the presented case study will be described in the following images.

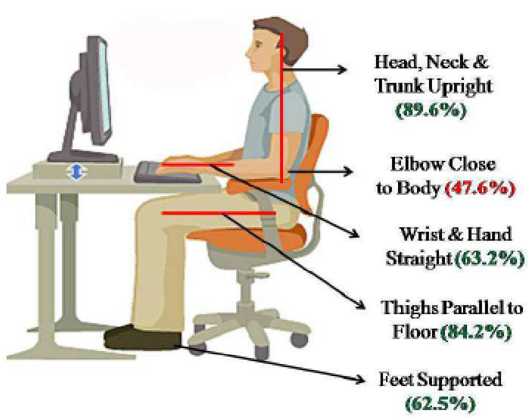

Fig. 2. Ergonomic knowledge related to working postures - Knowledge of Computer Ergonomics among Computer Science Engineering and Information Technology Students in Karnataka, India.

Majority of the subjects 102 (57.6percent) scored in the

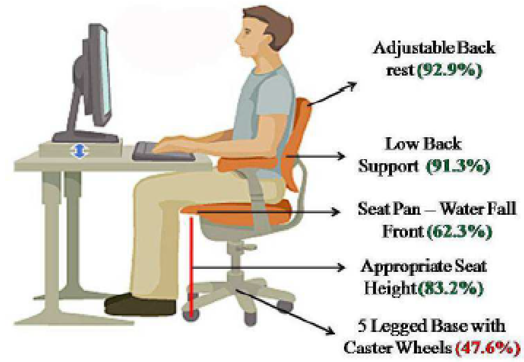

Fig. 3. Ergonomic knowledge related to seating. - Knowledge of Computer Ergonomics among Computer Science Engineering and Information Technology Students in Karnataka, India

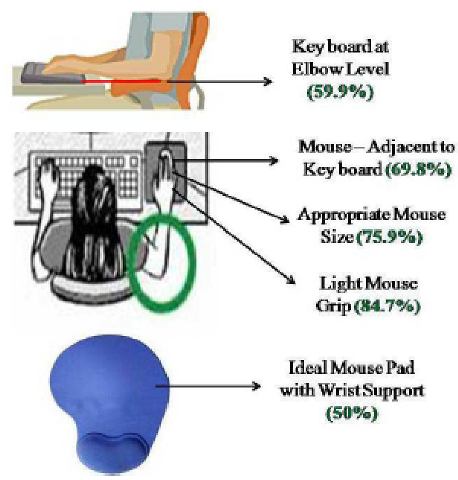

Fig. 4. Ergonomic knowledge related to key board/ mouse. - Knowledge of Computer Ergonomics among Computer Science Engineering and Information Technology Students in Karnataka, India

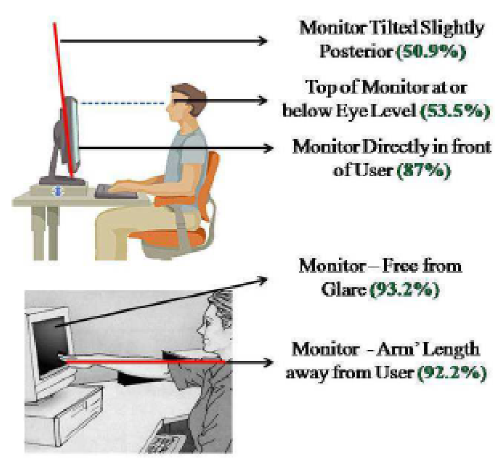

Fig. 5. Ergonomic knowledge related to monitor. - Knowledge of Computer Ergonomics among Computer Science Engineering and Information Technology Students in Karnataka, India

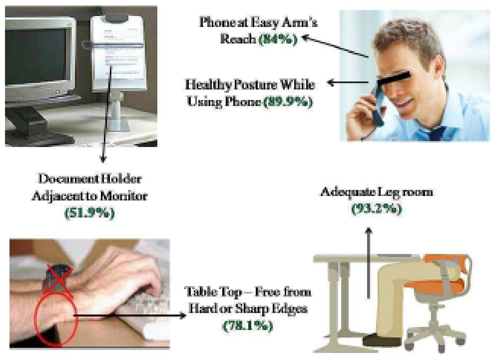

Fig. 6. Ergonomic knowledge related to table and accessories. - Knowledge of Computer Ergonomics among Computer Science Engineering and Information Technology Students in Karnataka, India

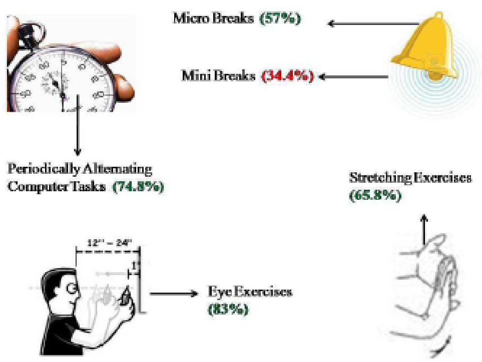

Fig. 7. Ergonomic knowledge related to rest breaks and exercises. - Knowledge of Computer Ergonomics among Computer Science Engineering and Information Technology Students in Karnataka, India

range of 60-79 percent, 64 subjects (36.2percent) scored in the range of 40- 59 percent, 11 subjects (6.2 percent) scored 80 percent or above and no one was below 40 percent.

These robust findings indicate not only the relevance of initial knowledge about ergonomics but also the significant impact on individual development and adaptation. By promoting and encouraging proper ergonomic practices, a tangible impact can be observed in the progression of individual performance within a working environment. Therefore, these results underscore not only the importance of acquiring knowledge but also the necessity of continuous and consistent application in the specific context of the workplace.

III. Study Methodology and Socio-demographic Characteristics of Participants

Our study unfolds in two distinct stages, each addressing specific aspects of the working environment and ergonomic practices. In the first stage, we focus on assessing the impressions and overall experiences of individuals in the programming field at the Polytechnic University, as well as those of their colleagues. To achieve this, we will employ a set of questionnaires aimed at collecting feedback regarding the comfort of the work environment, employee satisfaction, and their perception of existing ergonomic practices.

In the second stage, we extend the research to the direct evaluation of performance in a deficient ergonomic environment, followed by an assessment in an optimally ergonomic working environment. The initial tests will involve a series of programming problems in the deficient ergonomic environment. Subsequently, we will invite participants who completed the initial tests to redo them in an environment designed to provide an efficiently ergonomic workspace. This process will help us identify any differences in performance and comfort between the current working environment and an enhanced ergonomic one. Thus, we will obtain a comprehensive understanding of the impact of the working environment and ergonomic practices on employee performance and satisfaction. It is important to note that the period between these two tests will resemble what we observed in the study (test-retest), as even with a correctly arranged space, a brief instructional period is needed for proper utilization.

The questionnaire consists of 17 questions addressing themes similar to the previously discussed study, such as comfort regarding the chair, lighting, temperature, and desk organization. The questions are rated on a scale from 1 to 5 and reflect the participants' opinions on how they carry out their activities in the workspace (in our case, the office). This questionnaire will be confirmed or refuted through the practical tests that we will conduct, aiming to truly observe whether the work environment is efficient or not.

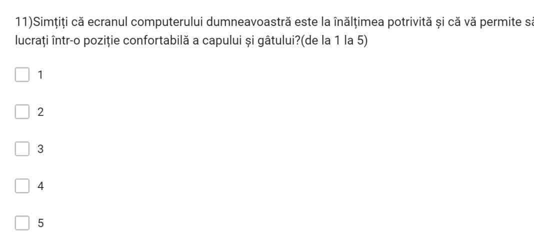

Fig. 8. Example of a questionnare section.

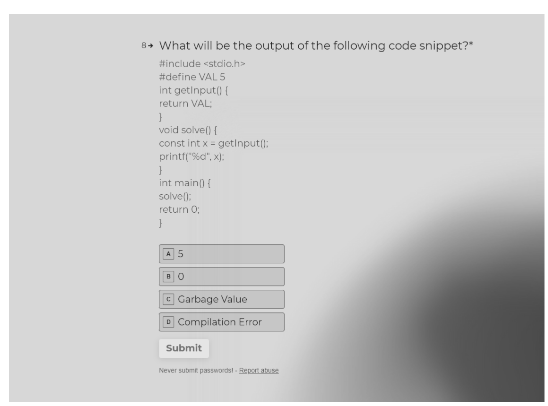

Fig. 9. Example of a test question.

This mixed approach, combining subjective assessments with objective performance measurements, will provide relevant and valuable data for the continuous improvement of working conditions and ergonomic practices within our academic institution.

IV. Socio-demographic Characteristics of Participants

4.1. Gender Distribution of Participants

The study included participants from both students at Politehnica University and professionals in the programming field, including acquaintances and colleagues of those surveyed. The gender distribution of participants reflects a relatively balanced presence, with 52 percent male and 48 percent female.

4.2. Age Distribution of Participants

Participants spanned a diverse range of ages, encompassing both students in the early stages of academic formation and professionals with significant experience in programming. The age distribution showed an average around 28 years, highlighting diversity in terms of professional development stages.

4.3. Educational Level of Participants

The analysis of participants' education level highlighted a predominant presence of students in the final years of study, alongside professionals with various postgraduate education degrees. Approximately 70 percent of participants were students, and the remaining 30 percent had varying levels of higher education.

4.4. Experience in the Programming Field

The duration of service varied significantly, ranging from 1 year to 15 years of experience in the programming field. This allowed for a detailed analysis of how different experience levels could influence perceptions of the work environment and ergonomic practices.

By outlining these fictional socio-demographic characteristics, the study aims to provide a detailed and engaging picture of the community of students and professionals in the programming field at Politehnica University, emphasizing the diversity and specificities that can play a significant role in evaluating the work environment.

V. Results Collection and Comparison with Existing Ones

Following the questionnaire used, we can observe results similar to those in the case study, namely that participants are aware of the term ”ergonomics” and certain practices necessary for maintaining an optimal ergonomic space. However, to validate the questionnaire data, the second stage of measurements is needed—testing. The questionnaire included individuals aged between 19 and 55, with varying weights ranging from 53 kg to 90 kg. The majority, 9 out of 23, spend between 30-40 hours per week in front of a laptop, followed by 7 out of 23 with 20-30 hours per week. Four of them spend between 40-50 hours, and the remaining three fall within the 10-20 hour range. Thus, we can observe a favorable context for the onset of MSD.

What could be alarming is that the average responses regarding the level of comfort while sitting at the desk tend to be around 4 out of 5. Therefore, there might be a data conflict: Does the advancement of technology and education propose efficient ergonomic equipment and practices without the need for specialized intervention? Or is it a matter of a perception of correctness, with participants not having sufficient information about correct ergonomic practices but considering their work habits to be optimal? The answer to this question can be revealed through practical tests.

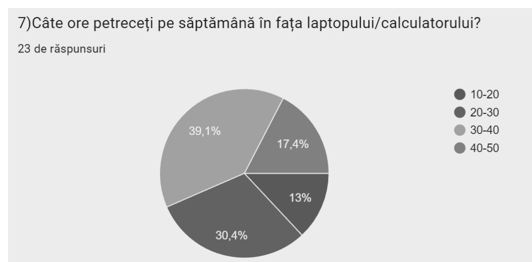

Fig. 10. Hours spent in front of the laptop - The standard deviation is approximately 11.233 hours.

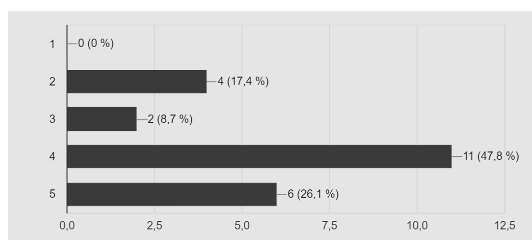

Fig. 11. Opinions regarding mentaining a correct posture - The standard deviation is approximately 1.165.

Following the double testing, the results were as follows: in the first test, which had a lower difficulty level (this aspect was not communicated to the participants), the total score was 108 correct answers out of 184 possible (58.15 percent), with an average solving time of 10 minutes and 12 seconds. After two weeks, during which participants received instructions regarding correct ergonomic practices (participants were not informed about the difficulty level), the results for the second test were as follows: the total score was 127 out of 184 correct answers (69.02 percent), with an average solving time of 9 minutes and 23 seconds. Therefore, the percentage of correct answers improved by 10.87 percent, and the average test-solving time decreased by 49 seconds. In the following graphs, individual analysis of the obtained results can be observed.

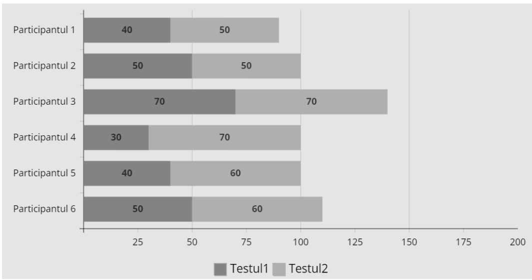

Fig. 12. Compartive results for participants 1-6 - The standard deviation is approximately around 12.797.

VI. Conclusions

The results indicate a significant improvement in participants' performance between the two tests. The percentage of correct answers increased by 10.87 percent, suggesting a positive impact of the ergonomic instructions provided during the two-week period.

The second test, conducted after participants received instructions on correct ergonomic practices, demonstrated a higher level of performance. This highlights the potential effectiveness of ergonomic education in enhancing participants' understanding and application of ergonomic principles.

Alongside the improvement in correctness, there was a notable enhancement in time efficiency. The average solving time for the test decreased by 49 seconds, indicating that participants not only performed better but also did so more quickly.

The mention of individual analysis in the graphs suggests that there may be variations in how participants responded to ergonomic guidance. Exploring these individual differences could provide insights into the effectiveness of educational interventions for specific participants.

The participants were not informed about the difficulty levels of the tests. This could be a crucial factor, as it reflects a real-world scenario where individuals may encounter tasks without prior knowledge of the challenge level. The observed improvement underlines the adaptability of participants when equipped with ergonomic knowledge.

Overall, the results suggest that providing ergonomic education positively influences both correctness and efficiency in task performance, emphasizing the potential benefits of incorporating ergonomic practices into educational programs, which also was the main objective of this article.

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