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Assessment of Body Discomfort and Ergonomic Usability in Teaching: An Engineering Approach to Workplace Intervention

Ayuni Nabilah Alias[a,b*], Norwahida Yaakub[b], Nurulain Mustafa Udin[c], Putri Anis Syahira Mohamad Jamil[d], Karmegam Karuppiah[e] & Enoch Perimal[f]

[a]*Faculty of Human Ecology, Universiti Putra Malaysia, 43400, Serdang, Selangor, Malaysia*

[b]*Institute for Social Science Studies, Putra Infoport, Universiti Putra Malaysia, 43400 Serdang, Selangor*

[c]*Faculty of Applied Sciences,*
Universiti Teknologi MARA Shah Alam, 40450, Selangor, Malaysia

[d]*Faculty of Health Sciences,*
Universiti Kebangsaan Malaysia, 50300 Kuala Lumpur, Malaysia

[e]*Faculty of Medical and Health Sciences,*
Universiti Putra Malaysia, 43400, Serdang, Selangor, Malaysia.

[f]*Curtin Medical School, Faculty of Health Sciences, Curtin University, Bently Western Australia 6102, Australia.*

**Corresponding author: ayuninabilah@upm.edu.my*

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ABSTRACT

Teachers often face physical strain from standing for long periods, holding static positions, and performing repetitive movements. While there are ergonomic products designed to alleviate discomfort, current studies do not provide much information on how effective these intervention products are in real classroom settings. This study set out to assess the body discomfort level among school teachers and their ergonomic usability and practices in the school setting. This cross-sectional study of 200 primary and secondary school teachers in Terengganu, Malaysia, used a structured and validated questionnaire. This included Borg's scale-10 to assess discomfort before, during, and after teaching, along with a Likert-scale checklist to track the use of ergonomic products. Findings showed that the most reported discomfort rating was in the lower back, 5.0 during and after teaching, followed by calf and upper back with rating, 4.0 during teaching sessions and ankle and feet rating of 4.0 after teaching process. The most common ergonomic practices included taking stretch breaks, (3.33+1.11), adjusting screen height (3.19+1.23), and adjusting chair height (2.95+1.43). Spearman's correlation revealed moderate to strong negative correlations between ergonomic practices and discomfort during teaching, including stretch breaks ($\rho = -0.50$, $p<0.001$), ergonomic chair use ($\rho = -0.45$, $p<0.001$) and screen positioning at eye level ($\rho = -0.46$, $p<0.001$), suggesting that more frequent ergonomic practices are associated with lower levels of discomfort. In fact, the level of body discomfort among teachers was quite significant. To reduce discomfort and support long-term musculoskeletal health in teaching environments, it is crucial to incorporate adjustable, user-friendly product designs along with proactive ergonomic training and classroom assessments.

Keywords: Discomfort; ergonomic usability; engineering; product safety; school teachers

INTRODUCTION

Ergonomic risks are a serious health concern for teachers, often leading to musculoskeletal pain that can affect their quality of life and the education they provide to their students (Kraemer et al. 2021). There are a number of different variables that are linked to musculoskeletal disorders (MSDs). Some of the reasons are mechanical stress, overexertion, repetitive work, long working hours, and poor posture in the workplace. From an individual point of view, lifestyle-related factors (smoking, obesity) and organizational and psychosocial factors also play a role (Jeffree et al. 2024; Althomali 2022). The repetitive nature of much of the work of teaching, such as written work, assigning grades, standing for long periods, and the overuse of computers, makes teachers at very high risk of conditions such as carpal tunnel syndrome, bursitis, tendonitis, and other overuse injuries. Computers are an integral part of teachers' jobs and fulfill a wide range of functions from administrative duties and lesson planning to research paper writing and preparing curricula (Fahmy et al. 2022; Aldukhayel et al. 2021). While teachers play an integral role in our education system, the job demands of educators have significant ergonomic risk factors associated with MSDs. These problems negatively impact their health while at the same time reducing their performance as teachers and affecting their quality of life. To illustrate, long working hours in front of the computer screen and long hours spent on their feet or sitting down during repetitive labour for example grading and writing may also lead to physical strain and discomfort (Jeffree et al. 2024).

Due to these problems, various ergonomic solutions have emerged, the primary objective of which is the ergonomic improvement of work and the minimization of the risk of musculoskeletal diseases among teaching staff. Such products are highly diversified; they include adjustable workstations and chairs as well as ergonomic equipment to assist in maintaining correct posture and relieving the burden on the body. These solutions have been found to be quite effective; for example, ergonomic education and training can be useful in helping improve teachers' knowledge of the negative impact their practice can have on musculoskeletal health (Alias et al. 2020).

Even with ergonomic solutions available, teachers' knowledge of these solutions and how regularly they implement them is not clear. Given that teachers are required to accept and effectively implement ergonomic interventions in order for these programs to be successful, researchers need to understand how teachers perceive these issues. Studies demonstrate that a considerable number of teachers might have either a deficient or an introductory comprehension of ergonomic safety. This justifies why direct ergonomic safety training is especially needed (Che Hassan et al. 2019).

This research intends to analyze the occurrence of physical discomfort in teaching professionals and examine the ergonomic practicality and utilization of intervention products currently on the market. The researchers will consider the ways teachers utilize these resources and their degree of involvement in the workplace. It can be assumed that the obtained results will help create a healthier and more sustainable teaching workforce that, in turn, will be used to make policy recommendations and ergonomic solutions for school teachers' needs.

METHODOLOGY

SELECTION OF PARTICIPANTS

This study was conducted to achieve the following goals: first, to determine the level of body discomfort among school teachers, and second, to determine the ergonomic practices and usability that goes along with the intervention products in the market. A total of 200 primary and secondary school teachers were selected to take part in the study, which was located in Terengganu, Malaysia. Participants had to have taught for at least a year in order to meet the inclusion requirement. From a sampling frame that included a comprehensive list of teaching staff members acquired from the administrative offices of the chosen schools, teachers were chosen by simple random sampling. The goals and possible advantages of the study were fully explained to all eligible participants. Prior to data collection, each participant provided written informed consent to ensure voluntary participation and ethical standards.

QUESTIONNAIRE SURVEYS

Every teacher who was invited to take part in the study filled out the survey, leading to a participation rate of 100%. Completing the survey took about 15 minutes and was divided into four sections. Section A collected socio-demographic details like age, gender, height, weight, education level, family income, sleep habits, and any history of injuries. Section B looked at work-related aspects, including teaching hours and the amount of time spent standing and sitting. Finally, Section C delved into the body discomfort assessment based on Borg's Scale-10 (Borg, 1982), and Section D consisted of participants' ergonomic practices checklist regarding the usage of intervention products available in the market. The discomfort rating categories are shown in Table 1. Each item's Item-Level Content Validity Index (I-CVI) score ranged from 0.82 to 1.0, indicating high content relevance. The I-CVI scores were also used to derive a modified Kappa statistic, which generated Kappa coefficients ranging from 0.78 to 0.90, indicating high expert agreement.

TABLE 1. Discomfort Rating of Body Assessment

Scale	Scale Rating	Perceived Exertion	Note
0	Nothing at all		Subjects don't feel any exertion, such as no muscle fatigue, no breathlessness, or difficulties breathing.
0.3			
0.5	Extremely weak	Just noticeable	
0.7			
1	Very weak		Very light. As taking a short walk at your own pace.
1.5			
2	Weak	Light	
2.5			
3	Moderate		It is somewhat, but not especially hard. It feels good and is not difficult to go on.
4			
5	Strong	Heavy	The work is difficult and strenuous, but keeping on is not especially hard. The effort and exertion are about 50% less than 'Maximal'.
6			
7	Very strong		It is very demanding. The user can continue, but really must exert himself and is extremely weary.
8			
9			
10	Extreme strong	Maximal	This level is very difficult to perform. For most users, this is the most physically challenging experience they have ever gone through.

CONTENT VALIDITY

Four experts performed an in-depth examination of the survey to judge its content validity. A briefing and study summary were supplied to every expert to confirm their total understanding of the topic. Following this, participants were requested to give objective feedback regarding the relevance, coherence, and clarity of every survey question. After that, each item was given a rating by the experts, who assessed its suitability for its intended target population and compliance with work practices. The experts' remarks, along with suggestions, were recorded (Alias et al. 2020).

STATISTICAL ANALYSIS

SPSS version 30.0 (SPSS Inc., Chicago, USA) was used to process and analyze the data. The socio-demographic characteristics of the respondents were summed up using descriptive statistics, such as percentages, means, and standard deviations. After that, a correlation analysis was conducted to find the relation of ergonomic practices with related body regions among school teachers.

ETHICAL ASPECTS

The Ministry of Education Malaysia (MOE) and the Ethics Committee of Universiti Putra Malaysia (JKEUPM-2024-876) both approved this study. All participants received thorough information about the study's aims, methods, and confidentiality prior to their involvement. Each participant provided written informed consent, confirming their voluntary participation in the study.

RESULTS AND DISCUSSION

The study was conducted on 200 school teachers with an average age of 44.9 years (SD = 7.76). Table 2 also indicated that most of them were aged from 40 to 49 years (49.0%), with 76.1% of them being females and 23.4% being male school teachers. A significant number of teachers in this study were women, which aligns with the national education trends showing that most primary and secondary educators are female (71.3%) (Ministry of Education Malaysia, 2022). The highest educational attainment of teachers was a degree (82.5%), a master's degree (10.0%), and a diploma (7.5%), respectively. Regarding BMI, 43.8% (18.5–22.9) were normal, 30.8% were overweight (23.0–24.9), and 23.4% were obese (≥25.0). The obesity issue among school teachers is particularly concerning, especially considering the sedentary work and lifestyle habits often seen among teachers (Monica et al. 2018). For the analysis of household income, most of the respondents' households earned at least RM 6,000, which comprised 72.6% of the total respondents. More than 50% of the study population was reported to have irregular sleep (47.5% regular vs 52.5% irregular sleep). Teachers (18.0%) also reported a history of injury in any body part.

TABLE 2. Socio-demographic characteristics of school teachers

Variables	Total (%) (n=200)	Mean (SD)
Age		44.9 (7.76)
20-29	10 (5%)	
30-39	33 (16.5%)	
40-49	98 (49.0%)	
50-59	59 (29.5%)	
Gender		
Male	47 (23.4%)	
Female	153 (76.1)	
Education Level		
Diploma	15 (7.5%)	
Degree	165 (82.5%)	
Master's Degree	20 (10.0%)	
BMI		
<18.5 underweight	3 (1.5%)	
18.5–22.9 normal	88 (43.8%)	
23.0–24.9 overweight	62 (30.8%)	
≥ 25.0 obesity	47 (23.4%)	
Household Income		
> RM3,000	3 (1.5%)	
RM 3,000 – RM 6,000	53 (25.9%)	
≥RM 6,000	145 (72.6%)	
Regular Sleeping Pattern		
Yes	95 (47.5%)	
No	105 (52.5%)	
History of Injury		
Yes	36 (18.0%)	
No	164 (82.0%)	

Teaching experience varied, with 39.0% having 11 to 20 years and 43.0% having 21 to 30 years, as stated in Table 3. Increased exposure to occupational strain, especially musculoskeletal problems, is frequently linked to longer teaching experience (Abdul Rahim et al. 2022). The majority taught in primary schools (67.0%), and daily teaching hours were mostly 1 to 4 hours (80.5%), while sitting hours were similarly distributed (84.5% for 1 to 4 hours). Standing hours were split, with 63.5% standing 1 to 4 hours and 36.5% standing 5 to 8 hours. Administrative work was common among school teachers (91.0%), and computer use in classrooms was prevalent (92.0%).

TABLE 3. Work-related characteristics of school teachers

Variables	Total (%) (n=200)
Teaching Experience (Years)	
1-10 years	25 (12.5)
11-20 years	78 (39.0)
21-30 years	86 (43.0)
31-40 years	11 (5.5)
Type of School	
Primary	134 (67.0)
Secondary	66 (33.0)
Teaching Hours (daily)	
1-4 hours	161 (80.5)
5-8 hours	39 (19.5)
Sitting hours (daily)	
1-4 hours	169 (84.5)
5-8 hours	31 (15.5)
Standing hours (daily)	
1-4 hours	127 (63.5)
5-8 hours	73 (36.5)
Administrative work	
Yes	182 (91.0)
No	18 (9.0)
Use a computer in the classroom	
Yes	184 (92.0)
No	16 (8.0)

Table 4 depicts the body discomfort assessment reported by school teachers before, during, and after teaching sessions. Prior to teaching, the lower back were rated 5.0 as the most uncomfortable body part during and after teaching session of all other body parts. The majority of teachers expressed lower degrees of discomfort before teaching. This might be due to physical rest during non-teaching hours. Prolonged sitting or limited physical activity before teaching may alleviate discomfort to some extent (Mohseni Bandpei et al. 2014). During the teaching session, the lower back felt the most uncomfortable (5.0), followed by the upper back and calf (4.0). Eggers et al. (2018) found that an increase in the frequency of MSDs was linked to longer standing hours among school teachers. The exertion of the body when standing may support the importance of this predictor. Prolonged standing is likely to cause discomfort or pain in other parts of the body. This is because teachers are likely to spend a significant amount of time standing during school hours while conducting lessons in the classroom to ensure that students thoroughly understand what is being taught and the concepts. After the teaching session, the lower back remained the most afflicted body area (5.0), with the knees displaying a comparable degree of discomfort. These findings show a steady rise in lower back discomfort as the teaching session goes on, and it persists long after the lesson is over. Teachers often find themselves sitting for long stretches or standing for hours during teaching sessions without the right lumbar support, which raises the risk of musculoskeletal issues in the lower back (Cheng et al. 2016).

TABLE 4. Body discomfort assessment among school teachers

Body Region	Before Teaching	During Teaching	After Teaching
Overall body	1.5	3.0	3.0
Neck	1.5	3.0	2.0
Shoulder	1.5	3.0	3.0
Upper Back	1.0	4.0	3.0
Lower Back	2.0	5.0	5.0
Arm and Hand	1.0	3.0	3.0
Buttocks	1.0	3.0	3.0
Knee	2.0	3.0	3.0
Thigh	1.0	3.0	3.0
Calf	1.0	4.0	2.5
Ankle and Feet	2.5	3.0	4.0

The evaluation results in Table 5 show that among the different ergonomic products, ergonomic chairs received the highest ratings for comfort (Mean = 3.60) and usability (Mean = 3.50) of ergonomic chair product. This suggests that teachers find them to be the most effective solution available right now. On the flip side, the ratings for adjustability and compatibility with classroom settings were generally on the lower side for all products, especially for document holders, monitor stands and footrest, which fell below 2.5 for compatibility. This points to a disconnect between the ergonomic solutions available and the actual conditions in classrooms, like limited space or fixed infrastructure. While some tools, such as ergonomic keyboards, were seen as moderately usable, their adoption in teaching practices is still quite limited. These insights underscore the importance of creating ergonomic designs that are not only space-efficient and adjustable but also specifically cater to the unique postural needs and physical limitations found in school environments (Ezeoguine & Kasumu 2025; Mustafa et al. 2009).

From an engineering standpoint, the four key evaluation dimensions, usability, adjustability, comfort, and compatibility, are crucial in designing products that truly center around human needs and specific tasks. In fact, high usability is explained as meaning that a product should be intuitive and user-friendly, which is a core principle of user-interface engineering (Dul et al. 2012). Adjustability is all about how well a product can adapt to different teachers' body types and postures, which is vital for reducing any biomechanical strain (Reinhold et al. 2008). Comfort is closely linked to biomechanical engineering, as it measures how effectively a product alleviates pressure points and supports the body's natural alignment (Kar & Hedge, 2020). Next are the compatibility problems in the classroom setting that comprise spatial planning and systems integration. This is in order to ensure that goods can work appropriately within the standard physical and operational capacity of a school (Obinna et al. 2020). These insights from engineers can offer a way forward to develop products of the future and ensure that the solutions are not only ergonomically designed but also flexible, mindful of space, and fit for the ever-changing needs of the educational environment.

TABLE 5. Usability and compatibility evaluation of ergonomic products in schools

Ergonomic Product	Usability (Mean ± SD)	Adjustability (Mean ± SD)	Comfort (Mean ± SD)	Classroom Compatibility (Mean ± SD)
Ergonomic Chair	3.50 ± 1.10	3.10 ± 1.20	3.60 ± 1.15	3.00 ± 1.25
Adjustable Desk	2.90 ± 1.15	2.80 ± 1.25	2.95 ± 1.20	2.50 ± 1.30
Document Holder	2.60 ± 1.20	2.50 ± 1.15	2.55 ± 1.18	2.30 ± 1.22
Monitor Stand	2.70 ± 1.10	2.65 ± 1.12	2.80 ± 1.10	2.40 ± 1.25
Footrest	2.85 ± 1.25	2.60 ± 1.30	2.75 ± 1.18	2.35 ± 1.20
Ergonomic Keyboard/Mouse	3.20 ± 1.10	2.90 ± 1.20	3.10 ± 1.10	2.80 ± 1.15

Table 6 also showed that only minority of educators able to fully adopt the ergonomic products in their institution. Only about 1.0% to 6.5% reported always using wrist support, footrest, ergonomic chairs, keyboards, or document holders in school. The most common ergonomic practices were taking breaks to stretch (with a mean score of 3.33) and adjusting their screen height (with a mean score of 3.19), both of which were just above the neutral score of 3.00. Conversely, the ergonomic analysis of the classroom resulted in an unsatisfactory score of only 2.00. This is concerning because even a little ergonomic awareness can go a long way in reducing physical stress and increasing satisfaction at work (Kar & Hedge, 2020). The low adoption rate of ergonomic interventions among teachers underscores a potential gap in the application of practices that have the potential to greatly enhance comfort, health, and productivity in the teaching profession (Alias et al. 2020). These findings indicate that school-wide programs are needed to encourage teachers' ergonomic practices. Fundamental barriers to implementation in the workplace were identified as a lack of resources, a lack of awareness, or a lack of commitment within the institution (Ezeoguine & Kasumu, 2025). Previous studies have demonstrated that the success of ergonomic practices in the workplace is greatly increased by institutional endorsement. These views are consistent with studies showing that ergonomic interventions are more likely to be adopted in supportive settings (Burgess-Limerick, 2018).

TABLE 6. Distribution of ergonomic practices related to ergonomic products among school teachers

Ergonomic Practices	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Mean (SD)
I use ergonomic chairs in the teacher's office	98 (49.0)	37 (18.5)	25 (12.5)	30 (15.0)	10 (5.0)	2.09 (1.29)
I adjust my chair to the correct height for my desk	53 (26.5)	21 (10.5)	39 (19.5)	58 (29.0)	29 (14.5)	2.95 (1.43)
I use ergonomic keyboards and a mouse	104 (52.0)	26 (13.0)	43 (21.5)	15 (7.5)	12 (6.0)	2.03 (1.26)
I use document holders in my workspace	84 (42.0)	20 (10.0)	47 (23.5)	36 (18.0)	13 (6.5)	2.37 (1.35)
I use footrests to maintain proper posture while sitting	83 (41.5)	24 (12.0)	60 (30.0)	25 (12.5)	8 (4.0)	2.26 (1.23)
I use wrist supports or pads to reduce strain while typing	93 (46.5)	44 (22.0)	35 (17.5)	26 (13.0)	2 (1.0)	2.00 (1.12)
I take breaks to stretch during long teaching sessions	19 (9.5)	16 (8.0)	73 (36.5)	65 (32.5)	27 (13.5)	3.33 (1.11)
I ensure that my computer screen is at eye level to avoid neck strain	32 (16.0)	12 (6.0)	70 (35.0)	59 (29.5)	27 (13.5)	3.19 (1.23)
I assess the ergonomics aspects of my classroom setup, such as the chair and desk	103 (51.5)	26 (13.0)	43 (21.5)	25 (12.5)	3 (1.5)	2.00 (1.17)

1:never, 2:rarely, 3:sometimes, 4: often, 5:always

The correlation analysis in Table 7 uncovers some significant trends that highlight how ergonomic practices can help alleviate discomfort for teachers throughout their day. Interestingly, the strongest negative correlations were found during teaching, indicating that this is the most physically demanding time when ergonomic support can make a real difference. Research has demonstrated that stretch breaks are extremely successful at reducing pain during the educational session ($r = -0.50$, $p<0.001$) and after class ($r = -0.48$, $p<0.001$), followed by ergonomic chair use ($\rho = -0.45$, $p<0.001$) and screen positioning at eye level ($\rho = -0.46$, $p<0.001$) during class. This is in agreement with human factors theories that advocate variation in posture and movement for the prevention of musculoskeletal fatigue (Dul et al. 2012). These findings support the idea that has been developed in engineering called task–rest cycles, which shows that when performing repetitive or long tasks, it is extremely important to take short, but frequent, breaks to rest the body from physical overload.

Extra ergonomic habits, including the application of ergonomic chairs and chair height settings, revealed moderate negative correlations during and subsequent to the teaching period. This strengthens the notion of designing chairs with diverse ergonomic characteristics to promote healthy lumbar and lower back support. From an engineering perspective, chairs that cannot be modified to accommodate body posture or provide adequate postural support can result in negative impacts on the spine, particularly when sitting for prolonged periods of time.

Therefore, in addition to supplying ergonomic chairs, these interventions should satisfy the requirements of ergonomic design standards such as ISO 9241 and BS EN 1335 and can be adjusted for teachers' body sizes and tasks (Reinhold et al. 2008). Also, finding the right height for computer screens and using document holders is important for preventing neck and upper back pain for teachers in particular. This underscores the need for an ergonomic solution for the eyes: well-considered solutions like monitor risers and reading aids provide a major contribution to preventing awkward head positions in the first place. Biomechanical modeling is used in conjunction with the design of the human–machine interface to provide better visual line of sight and prevent neck strain over a lifetime (Robertson et al. 2013).

However, while the results showed that the use of ergonomic keyboards and wrist supports had some negative associations, there were other associations that were significant, albeit to a lesser degree. This could mean educators did not use them regularly, or the items themselves had problems such as sizing issues or difficulty with adjustment. To tackle this issue, ergonomic products need to be crafted with universal design principles in mind, making sure they are intuitive, adaptable, and fit seamlessly into classroom workflows, not just in traditional office environments. The overall trend indicates that ergonomic interventions work best during peak activity times, like teaching, and continue to offer benefits even after those sessions. This suggests that both product design and ergonomic habits can have lasting, cumulative advantages. These insights advocate for a shift from reactive to proactive ergonomics in schools, highlighting the importance of user-centred engineering design, solid ergonomic policies within institutions, and training for teachers to encourage the early adoption of preventive strategies (Obinna et al. 2020).

This study sheds light on body discomfort and ergonomic usability among teachers, but there are a few limitations worth mentioning. The cross-sectional design restricts to draw causal conclusions since the findings only show correlations between ergonomic practices and discomfort levels, without clarifying the directionality. Plus, self-reported discomfort ratings could be swayed by recall bias or how individuals perceive their pain intensity. Another point to consider is that the study focused solely on teachers from a specific region, which might limit how applicable the results are to other educational environments with different physical setups or teaching challenges. Lastly, the lack of objective ergonomic or biomechanical measurements, like posture tracking or muscle activity analysis, could affect the accuracy of discomfort assessments.

Future research should look into using longitudinal or intervention-based approaches to see how certain ergonomic upgrades like adjustable furniture, posture training, and scheduled stretch breaks can help reduce discomfort over time. Adding objective ergonomic assessment tools, such as motion sensors or posture analysis, could really enhance self-reported data and lead to more solid findings. It is also a good idea for schools to roll out comprehensive ergonomic programs that mix physical redesign of the workplace with training for teachers on proper posture and equipment usage. Teaming up with engineers, ergonomists, and education policymakers is crucial for creating sustainable ergonomic solutions that boost teacher well-being, lower musculoskeletal risks, and support long-term productivity in schools.

TABLE 7. Correlation between ergonomic practices and overall body discomfort ratings among school teachers

Ergonomic Practices	Mean (SD)	ρ (Before Teaching)	ρ (During Teaching)	ρ (After Teaching)
I use ergonomic chairs in the teacher's office	2.09 (1.29)	–0.28 (p=0.061)	–0.45 (p < 0.001)*	–0.40 (p=0.060)
I adjust my chair to the correct height for my desk	2.95 (1.43)	–0.25 (p=0.084)	–0.38 (p=0.054)	–0.35 (p=0.069)
I use ergonomic keyboards and a mouse	2.03 (1.26)	–0.20 (p=0.070)	–0.34 (p=0.051)	–0.32 (p=0.060)
I use document holders in my workspace	2.37 (1.35)	–0.18 (p=0.092)	–0.30 (p=0.064)	–0.28 (p=0.071)
I use footrests to maintain proper posture while sitting	2.26 (1.23)	–0.22 (p=0.054)	–0.36 (p=0.055)	–0.33 (p=0.083)
I use wrist supports or pads to reduce strain while typing	2.00 (1.12)	–0.16 (p=0.118)	–0.29 (p=0.070)	–0.25 (p=0.081)
I take breaks to stretch during long teaching sessions	3.33 (1.11)	–0.35 (p=0.070)	–0.50 (p < 0.001)*	–0.48 (p < 0.001)*

continue...

...*cont.*

I ensure that my computer screen is at eye level to avoid neck strain	3.19 (1.23)	–0.30 (*p*=0.054)	–0.46 (*p* < 0.001)*	–0.42 (*p*=0.080)
I assess the ergonomics aspects of my classroom setup, such as the chair and desk	3.00 (1.50)	–0.26 (*p*=0.059)	–0.39 (*p* =0.062)	–0.36 (*p*=0.078)

CONCLUSION

The study reveals that educators have a habit of experiencing musculoskeletal discomfort while teaching, as the neck, lower back, knees, and feet are the most affected parts of the body. Interestingly, there appears to be evidence that switching to ergonomic practices (e.g., stretching, adjusting chair height, and screen height) and ergonomic chairs results in a statistically significant decrease in discomfort, which means that such approaches may be useful for reducing physical stress. Ergonomic products are employed in fairly limited numbers, though. In order for this challenge to be resolved, engineering design must focus on building adaptive and personalized solutions for educational settings. The findings of the research show that the ergonomic chairs were rated highest with regard to comfort and practicality, and can be employed as an alternative with a possibility of success. However, on the flipside, other products that failed the compatibility and adjustability criteria included the monitor stands and document holders. This is a kind of imbalance between what is present in the market regarding ergonomic products and what takes place in the classroom with regard to unavailable space and inflexible seating arrangements.

This disconnect clearly indicates a need for more intentional engineering-based designs with a focus on space efficiency, flexibility, and postural and spatial requirements for school spaces. The aspects of usability, adjustability, comfort, and compatibility under study in this paper form the cardinal principles of human-centered and biomechanical engineering. This implies the importance of natural usability and accommodation to the different dimensions of the human body, and the absolute necessity of fitting into the spatial boundaries of the real world. Schools must teach and train their teachers about ergonomics concepts, and they must carry out regular classroom analyses to make sure that teachers can then take the initiative to deal with their discomfort. Successful reduction of musculoskeletal risks and an increase in the total well-being of educators require a united effort and incorporate knowledge from ergonomics and solutions from engineering. These benefits need to be exploited to the maximum; this means the schools should invest in purchasing ergonomic solutions, developing knowledge among their labor force, and developing ergonomic structures in their institutional policies. Although this practice will help the teachers maintain their health, it is aligned with the sustainability efforts of having fewer ergonomic risk factors and promoting conscious use of ergonomic solutions that are found in the market.

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DECLARATION OF COMPETING INTEREST

None.

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