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A student-centred design approach for reducing musculoskeletal disorders in India through Six Sigma methodology with ergonomics concatenation

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ABSTRACT

Classroom-related musculoskeletal disorders (CMSDs) rates in low- and middle-income countries (LMICs) are increasing despite the ever-collective interest in occupational health and safety (OHS) and succeeding developments over time. To explore the problem (i.e., OHS) with its proposed solutions, this study integrated the Six Sigma methodology with ergonomics principles to eliminate the CMSDs. Participants were 478 students from India as a country amongst the LMICs. The age range, mean, and standard deviation were 17–37, 20.28, and 2.348 for male students and 17–26, 19.57, and 2.163 for female students, respectively (units in years). The study found that students are prone to high risks of getting CMSDs due to prolonged usage of poorly designed furniture. The CMSDs results are as follows: fatigue joint and muscle pain (71%), shoulder and neck tension (70%), headache (63%), neck pain (53%), back pain (51%), legs' joints pain (46%), shoulders and muscles pain (42%), elbow pain (42%), sleeplessness (insomnia) (40%) and hand pain (39%). The proposed solutions include the two ergonomically designed students' desks; students' requirements and anthropometric measurements consideration; occupational health and safety workshops and/or seminars preparation; administration interventions; behavioural (personal) interventions, and other engineering interventions.

1. Introduction

The prevalence or incidence of classroom musculoskeletal disorders (CMSDs) worldwide is high. For example, students reported musculoskeletal pains and discomfort in India due to the mismatch between classroom furniture and students' anthropometric measurements (Esht and Singh, 2021; Savanur et al., 2007; Taifa and Desai, 2017). This is possible because all schools, colleges, and/or universities require furniture. Some of the commonly used furniture includes chairs, students' desks, teachers' desks, exam desks, tables, bookcases, folding tables, lab stools, metal storage and cupboards, plan chests, storages, study booths, cloakroom furniture, lunchboxes trolleys, lockers, swivel chairs, staging, staff room chairs as well as teachers wall. Several schools in India comprise desks and benches with higher desk and bench heights than the recommended Bureau of Indian Standards (BIS) and students' body dimensions (Esht and Singh, 2021). Similarly, buttock-popliteal length (seat depth) and the depth of desks are less than the recommended dimensions according to the BIS (IS 4837: 1990) and the collected students' body dimensions (Esht and Singh, 2021). Students sometimes are not comfortable, probably due to mismatches of their dimensions with the available classroom furniture. The discomforts reported in knee regions (27.14%), back (38.51%), neck (40.8%), wrist (74.9%), shoulder (52.45%) and other discomforts (12.28%) (Esht and Singh, 2021). Savanur et al.'s (2007) study also found that the major complaint was headache (44.5%), discomfort due to sitting (12.3%), left lower leg (6.2%), neck (6.5%), right hand (9.2%), right shoulder (9.2%), right lower leg (10.3%), and writing discomfort (17.1%). Their study did not establish the reasons for having a large percentage of headache complaints (44.5%) (Savanur et al., 2007). That needs further assessment. However, the discomfort felt by students in their shoulders, neck and leg suggests that there is a mismatch between the students' body dimensions (elbow rest and sitting height) and classroom furniture (desk and bench height).

Other studies, including Madaan and Chaudhari (2012) for 230 Indian students, showed a high prevalence of musculoskeletal pain by 81%. Melis et al. (2004) found that students had musculoskeletal symptoms and suggested the inclusion of ergonomics concepts in an educational system to lessen the risks of CMSDs to students.

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