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Analysis of Somatosensory Impairment Among Teaching Professionals

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Abstract: Somatosensation refers to the body's ability to sense and perceive physical sensations like touch, pain, pressure, temperature, and body position. The present study examined somatosensory deficits among teaching professionals, a population frequently subjected to prolonged standing and recurrent postural stresses. Thirty healthy university faculty members aged between 28-40 years participated in the study. The vibration, pressure, proprioception, and graphesthesia components of somatosensation were evaluated by Cumulative Somatosensory Impairment Scale (CSIS). The results indicated that the absence of vibration sensation was found to be the highest (63.30%) among teachers, followed by graphesthesia (43.30%), pressure (46.60%), and proprioception (30%) sensation. On contrary, the maximum percentage of normal responses (36.60%) was observed in graphesthesia, indicating a higher-level sensory processing. The results suggest a differential susceptibility of somatosensory modalities, indicating that pressure and vibration sensations are more vulnerable to occupational stress. These, in turn can affect the fine motor performance and postural regulation among teachers making them prone to musculoskeletal diseases and fatigue. The findings emphasize the importance of regular sensory assessments among teachers for preventing long-term functional loss. Overall, this study addresses a critical gap by highlighting somatosensory variability in teaching professionals and its implications for motor control and work-related functional efficiency.

Keywords: Cumulative Somatosensory Impairment Scale (CSIS), Somatosensation, Teaching professionals, Vibration.

I. Introduction

Perceiving and reacting to physical sensations including touch, pressure, pain, temperature, and proprioception is made possible by the somatosensory system, a sophisticated network of peripheral receptors, ascending neuronal routes, and cerebral representations. It is one of the most important sensory systems for engaging with the world , supporting not only perception but also proper posture, balance, and mobility [1]. Specialized receptors mediate somatosensory modalities such as proprioceptors in muscles and joints give feedback on limb position and movement, mechanoreceptors detect touch and vibration, nociceptors react to painful stimuli, and thermoreceptors sense temperature changes. These receptors send data to the somatosensory cortex, where integration and conscious perception take place, via the spinothalamic and dorsal column–medial lemniscus pathways [2].

A key component of motor control is somatosensation, particularly, proprioceptive feedback offers real-time data for limb coordination and postural alignment, enabling accurate actions even when visual cues are not present. Loss of somatosensory input results in decreased dexterity, ineffective motor learning, and worse balance, as suggested by studies conducted in both clinical and healthy populations [2]. By updating internal models in the central nervous system, somatosensory feedback also aids in motor learning by gradually improving movement precision and flexibility [3].

Continuous sensory feedback is essential for accurate motor execution as it allows for the modification of movement amplitude, direction, and force [4]. Recent advances in neuroscience have highlighted the dynamic and adaptable nature of somatosensory processing. Cortical representations are affected by learning, injury, and exposure to the environment that allows for reconfiguration in response to variations in sensory input [1]. In people with neurological or occupational impairments, sensorimotor training and rehabilitation can alter cortical maps, enhancing sensory discrimination and functional recovery. This flexibility makes somatosensation a flexible, experience-dependent system which is necessary for functioning behaviour rather than a passive process [3].

The integration of the somatosensory and motor systems becomes essential for maintaining performance and avoiding fatigue or injury in occupational settings, especially in professions requiring repetitive or static postures such as teaching. Teachers often engage in prolonged standing and

conduct repetitive upper-limb tasks, such as writing on boards, and perform fine motor skills requiring tactile precision [5]. Continuous exposure to these occupational demands can lead to proprioceptive dysfunction, sensory adaptation, or musculoskeletal strain, thus lowering productivity and increasing the risk of cumulative trauma disorders. Research has shown that impaired somatosensory feedback contributes to altered muscle activation patterns and postural instability, which may exacerbate pain and functional limitations in working populations [5]. Accurate processing of somatic sensory data, or somatosensory integrity, is essential for efficient motor control and day-to-day functioning. Teaching activities such as use of digital gadgets, writing on boards, and controlling classroom dynamics require fine motor coordination and sensory feedback. Disruptions in these processes can compromise performance, elevate the risk of musculoskeletal issues, and hinder occupational efficiency.

Sensory feedback plays an important role in preparation, performance, and modification of motions. Evidence shows that somatosensory input helps to construct and consolidate internal models used during skill acquisition [4]. Fine motor skills performed by teachers such as writing, object manipulation, and adapting to challenging or repetitive work postures, rely heavily on intact somatosensory function. Impairments in somatosensation can adversely affect these skills, thereby impacting overall occupational performance. [5].

Teachers are an appropriate group for somatosensory impairment research since their jobs frequently require physical duties that can affect their sensory and motor systems. Although musculoskeletal disorders are increasingly recognized among teaching professionals, very little research has specifically examined somatosensory deficits within this occupational group. Most existing studies have primarily focused on musculoskeletal complaints, occupational hazards, and pain prevalence, while only a few have comprehensively assessed sensory modalities such as touch, proprioception, vibration sense, and fine motor sensory integration [4, 5].

Moreover, comparative studies assessing the differences in somatosensory function, gender, age, years of teaching experience, or type of instructional activity are very limited. Although somatosensory deficiencies are known to affect functional efficiency and motor performance in clinical populations, their impact on teachers' occupational performance has not been sufficiently studied. This knowledge gap restricts the development of focused treatments to enhance functional performance, avoid disability, and improve occupational health in educators. Thus, the present study was undertaken to compare the somatosensation among teaching professionals, hence bridging the gap.

II. Methodology

The current observational study was conducted at a private university. A total of thirty healthy teaching professionals aged between 28-40 years, having atleast one year of teaching experience were included using purposive sampling. Exclusion criteria comprised of acute injury, skin laceration, musculoskeletal, neurological and metabolic conditions [6]. All participants were informed about the entire process prior to the study, and their written consent was acquired. The study received institutional ethical committee approval (Ref. No.SU/SMS&R/76-A/2023/182). Cumulative somatosensory impairment scale was used as an outcome measure to analyse the variability of somatosensation among teaching professionals.

Procedure

After selecting the participants, their somatosensation was assessed using the cumulative somatosensory impairment scale. For measuring proprioception, ankle dorsiflexion was set at 10 degrees and plantarflexion at 20 degrees. The participant was asked to actively recreate each posture. Pressure sensation was tested by applying 2.01 g and 3.63 g of force using the Semmes-Weinstein monofilaments with the numbers 4.31 and 4.56 respectively. To assess graphesthesia, three basic symbols i.e. plus, line, and circle were drawn on the subject's skin. Vibration sense was assessed using a 128 Hz tuning fork placed over the bony prominences of the first metatarsal and first metacarpal bones [6]. Scoring was done as given below:

0: Normal

1: Reduced

2: Absent

III. Results

Upon analysis it was found that, when compared to other sensory modalities (pressure, graphesthesia, and proprioception), vibration had the largest percentage of "absent" responses (63.30%) indicating that vibration sensation was most affected among the teaching professionals, followed by pressure (46.60%), graphesthesia (43.30%) and proprioception (30%). In contrast, graphesthesia had the largest percentage of "normal" responses (36.60%) followed by pressure (30%), proprioception (26.60%) and vibration (13.30%) as shown in Table I. These results show a differential vulnerability of somatosensory modalities, which may be significantly related to the function of somatosensation in postural control and limb/postural sensory function as reflected in Fig. 1.

Table I: Variation in Somatosensation Among Teaching Professionals

Somatosensation	*Normal*	*Reduced*	*Absent*
Vibration	13.30%	23.30%	63.30%
Pressure	30%	23.30%	46.60%
Graphesthesia	36.60%	20%	43.30%
Proprioception	26.60%	43.30%	30%

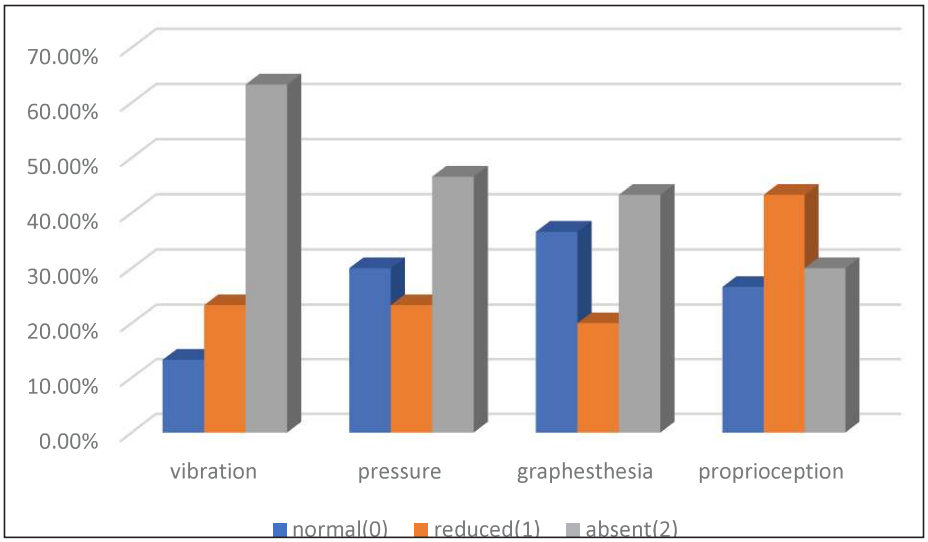

Fig. 1: Percentage of Individuals with Change in Somatosensation

IV. Discussion

The present study was undertaken to compare the somatosensation among teaching professionals. Results indicated that vibration sense was most affected in comparison to other sensations as it had the largest percentage of "absent" responses (63.30%). Graphesthesia, on the other hand, had the largest percentage of "normal" responses (36.60%%). Total number of reduced responses were almost equal for all sensations. These results show the differences among somatosensory modalities, which may be significantly related to the function of somatosensation for various sensory functions.

Maintaining an upright posture and precisely correcting disturbances depend on somatosensory information such as vibration, pressure, and proprioception [7]. The central nervous system integrates bottom-up sensory inputs, particularly proprioceptive and mechanoreceptive feedback from the foot, ankle, and shank, to accurately estimate body position relative to the base of support. Increased postural sway or instability may result from the system having to re-weigh other inputs (visual, vestibular) when this input is impaired [7].

Large-diameter mechanoreceptive afferents, such those that respond to vibration, may be among the first to exhibit impairments, as evidenced by the fact that vibration sensation is the most affected. This is consistent with the discovery that in lower-limb populations, vibration sensitivity is substantially linked to functional balance results [8, 9].

The body's ability to sense minute changes in weight distribution or ground contact may be compromised when vibration and pressure afferents are diminished or non-existent. This can manifest as a diminished capacity to correct micro-postural disturbances, such as while standing on uneven terrain, changing positions, or when in presence of lower limb fatigue. Decreased vibration perception may also be a result of early brain alterations that, despite being asymptomatic, lower the fidelity of sensory input (e.g., peripheral nerve damage, receptor desensitization, microvascular abnormalities). Due to neural redundancy and higher-order integration, which reflects higher "normal" responses for graphesthesia, proprioception (joint/position sense) and discriminative sensations (like graphesthesia) may initially remain largely maintained [10-13].

In present study, proprioception and pressure both experienced moderate impairment (either absent or decreased). There is evidence that postural control deficiencies are substantially linked to proprioceptive deficiencies in the lower limb. For instance, during postural sway testing, patients with low back pain demonstrated decreased somatosensory acuity and impaired ankle, knee, and hip proprioception [14-16].

These sensory impairments become even more functionally significant for people who are also subjected to sustained postural demands such as standing and repetitive posture common in teaching or related activities. Reliable somatosensory feedback must be provided by the lower limbs when standing still and moving slowly. Subtle postural modifications may become less effective if vibration and pressure modalities are impaired. This could eventually result in compensatory muscle recruitment, increased fatigue, or changed alignment, which could further affect proprioception and joint loading. Although the peripheral input pathway may be under stress, the relative preservation of graphesthesia suggests that cortical-level somatosensory discrimination remains functionally intact at this stage [17-19].

Although present data offers valuable cross-sectional information, causality cannot be inferred i.e., whether sensory impairments lead to postural dysfunction or occupational/ postural strain causes sensory impairment due to absence of longitudinal component. Future research could compare sensory modality scores with functional balance tests (e.g., single-leg stance, timed up & go), include dynamic postural assessment (e.g., sway measures, reactive balance), and investigate whether specific interventions (sensory retraining) reverse or mitigate these findings. Consideration should be given to interventions such neural mobilization, proprioceptive training, sensory retraining, and lower-limb sensory enhancement (via vibration, tactile stimulation, and balancing training) [20-22].

V. Conclusion

Vibration sense was found to be most affected among teaching professionals. Other sensory modalities such as pressure, proprioception and graphesthesia were also affected in different percentage of individuals. The pattern of the findings indicates that even in teaching population that are not often thought of as high-risk for neuropathy, screening for lower-limb sensory impairments, particularly vibration/pressure, may be helpful.

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