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# Neck Biomechanics for Ergonomics: Lessons Learned and Challenges Ahead

**Anita Vasavada, Ph.D.**
Associate Professor
Voiland School of Chemical Engineering and Bioengineering
Department of Integrative Physiology and Neuroscience
Washington State University, Pullman, WA

**Abstract:** Neck pain is a significant health and socioeconomic problem in the workforce. It affects 30 – 50% of the general population and is the fourth leading cause of disability globally. The prevalence is up to 2 – 3 times higher in females compared to males. Certain occupations, such as office workers, dental practitioners, manual laborers, healthcare workers and armed service members, have a higher incidence of neck pain. Risk factors for neck pain include individual factors such as age, sex, and body mass index; psychosocial factors such as stress, low job satisfaction, and depression; and biomechanical factors such as posture, muscle activity, and muscle endurance. In particular, postures in which the head and neck are flexed are becoming more common in the workplace and also in the general population, with the increasing use of laptops and mobile devices. We have been examining the biomechanical consequences of flexed head and neck postures, one of the identified risk factors for neck pain.

Mechanistically, spinal posture is a determinant of tissue loads and deformation, which are related to pain. Our goal is to estimate tissue loads from posture using biomechanical models and experimental data. However, the predictions of these biomechanical models are influenced by inter-individual differences in size, vertebral posture and muscle activation. We have found sex differences in the neck vertebral column and muscles, indicating that biomechanical models should be sex-specific. Using subject-specific models, we calculated that the demand on the neck musculoskeletal system during tablet computer use was 3–5 times greater than in neutral postures. However, these models used x-rays to document subject-specific vertebral posture, which is not feasible in the workplace. Models developed using photographs instead of x-rays predicted significantly different neck musculoskeletal demand. Thus, the prediction of vertebral postures from external measures is a significant challenge in using musculoskeletal models for better estimation of neck loads and potential for pain.

Future directions for neck biomechanics research in ergonomics include evaluating the dynamic characteristics of posture (e.g., short-term and long-term variations) as modifiable risk factors, and developing interventions that improve attention to posture and reduce postural exposure appropriately. Examining the relationships among posture, neck loads, psychosocial factors and neck pain using both empirical and mechanistic approaches will provide the scientific foundation for evidence-based guidelines, interventions and technologies to reduce the incidence of neck pain.

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