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# Impact of Sudden Sit-Stand Postural Switch on Electroencephalogram

**Mayowa Jeremiah Adeniyi[1*], Awosika Ayoola[2], Anna Chika Idaguko[3]**
[1]Departments of Physiology, Federal University Health Sciences Otukpo, Nigeria
[2]College of Medicine, Illinois State University
[3]Department of Anatomy, Edo State University Uzairue, Edo State, Nigeria

**Abstract:** Postural changes are inevitable motor behavior and physiological phenomenon. The study recorded electroencephalographic findings characterizing sudden switch from sitting to standing posture. 15 young adult males who satisfied inclusion criteria were recruited for the study. Baseline electroencephalographic tracings were obtained using Powerlab 26T at sitting position using scalp electrodes and during sudden switch from sitting to standing. The results of the study revealed sudden switch from sitting had no significant effect on alpha wave amplitude, beta wave amplitude and beta wave frequency. However, both alpha wave frequency and alpha/beta ratio decreased with sudden switch from sitting to standing position. The findings of the study indicated that sudden sitting to standing posture caused reductions in alpha wave and alpha/beta ratio.

**Keywords:** Postural changes, Electroencephalography, Sitting, Standing, Alpha wave, Beta wave.

**Research Paper**

***Corresponding Author:**
*Mayowa Jeremiah Adeniyi*
Departments of Physiology, Federal University Health Sciences Otukpo, Nigeria

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## INTRODUCTION

Posture is the relative position of the body and body parts in space at any moment. Interestingly, vertebrates exhibit different static and dynamic postures (Adeniyi and Awosika, 2023; Adeniyi and Awosika, 2023; Adeniyi *et al*., 2023). Lying, sitting and standing are among the numerous examples of posture.

Just like lying, sitting is a resting posture. Sitting is a position in which the weight of the vertical axis of the body is transmitted via the buttock to a support (Oni and Adeniyi, 2017; Adeniyi, 2022). Sitting is a recovery position the body reflexly assumes after physical exertion, exhaustion and stress (Adeniyi, 2022). However, daily activities characterized largely by sitting positions are dangerous for health and wellbeing. Sedentary behaviour is described as spending majority of daily activities in non-exercising sitting position. Even though the average daily sitting time varies on the basis of occupation, gender and physical status (Healy *et al.*, 2011; Clemens *et al.*, 2014), single stretch sitting duration may provide more information about severity of sedentary behaviour. Sitting for long time has been reported to lead to an increase in muscle stiffness and increased risk of low back pain (Kett *et al.*, 2021; Awosika *et al.*, 2022). A Swedish study that involved 44978 participants indicated a high prevalence of self-reported back and neck pain (Kallings *et al.*, 2021).

Standing is an upright position of the body. During standing, the weight of the vertical axis of the body is transmitted via the feet to the earth surface. Unlike sitting, standing is an exertional posture (Adeniyi, 2022; Adeniyi *et al*., 2020; Adeniyi *et al*., 2023). Conversely, prolonged standing causes diversion of large amount of blood to lower extremities and depletes cerebral perfusion pressure (Adeniyi *et al*., 2020; Awosika *et al*., 2023). On the brain, right leg orthostasis was shown to increase alpha wave frequency when compared to left leg in males (Adeniyi *et al*., 2023). Post-exercise orthostasis reduced theta waves amplitude in males and females respectively and caused a decrease in alpha waves amplitude in males (Adeniyi *et al*., 2023). Kahya *et al*., (2022) reported that dual-tasking while standing when compared with quiet standing caused reduction in alpha-band power and increased theta/beta power ratio. This implies that quiet standing elicited an increase in alpha band and a decrease in theta/beta power ratio. Utilization of sit to stand workstations was reported to be safe for mental activities while causing no decline in cognitive performance by Russells *et al*., (2016). Profound changes in brain activities and delta waves were induced by change in body postures (Jung *et al*., 2020).

In 33 older adults, Ibitoye *et al*., (2021) showed that there was reduction in alpha wave power during orthostasis. Furthermore, standing significantly attenuated theta waves (John *et al*., 2003).

Postural change from sit to stand or stand to sit has long been known to be associated with hemodynamic changes in humans. Other studies have highlighted numerous benefits of sit to stand switch on mitigation of sedentary behaviour and health in general. Ma *et al*., (2021) claimed that sit-stand switch caused reduction in sitting time and alleviation of shoulder and neck pain. When compared with people with sedentary behaviour, triglyceride and insulin resistance were better in workers with sit-stand interventions (Bodker *et al*., 2021). Sit-stand switch is a potential approach for improving the mobility and function of patients with dementia (Slaughter *et al*., 2015). Besides hemodynamic changes, profound physiological changes are orchestrated by when there is a sudden sit to stand switch. The aim of the study was to investigate the electroencephalographical changes associated with sudden sit-stand switch.

# MATERIALS AND METHODS

**Study Design**

The study adopted experimental research design. The work was carried out in the Technologically Enhanced Laboratory unit of the Department of Physiology, College of Medical Sciences, Edo State University Uzairue, situated in Etsako West Local Government Area of Edo State, Nigeria.

**Participants**

15 apparently healthy young adult individuals (18.5years) were used for the study. Ethical clearance was obtained from the Ethical Committee, Edo State University Iyamho. Written consent was obtained from each subject and a well-structured questionnaire was administered to rule out those with medical history of musculoskeletal, respiratory, cardiovascular, kidney, hepatic and metabolic diseases or anatomical deformities. History of smoking, alcoholism and caffeine and any form of medication was also taken. Medical examination and physical activity status were also done.

**Inclusion Criteria**

25 young adult individuals were accommodated into the groups. Written consent was gotten from each subject and a well-structured questionnaire was administered to rule out those with medical history of respiratory diseases, cardiovascular, kidney, hepatic and metabolic diseases or anatomical deformities. History of smoking, alcoholism and caffeine and any form of medication was also taken. Medical examination and physical activity status evaluation were also done. Physical examinations were also done and those that were not medically fit were disqualified. For example those with musculoskeletal abnormalities, high blood pressure, among others were ruled out as was previously done (Okeke *et al*., 2023; Adeniyi *et al*., 2021; Adeniyi and Agoreyo, 2017).

***Measurement of Electroencephalographic Waves***

Electroencephalographic (EEG) waves were recorded using Powerlab 26T (Adinstruments PTY, Australia). As stipulated in the manual, both white and blue marked electrodes were connected to the left and right side of the frontal part of the skull while the black electrode was attached to the occiput. Electrodes were held in place by means of electrode pads. As part of the measures aimed at preventing artifacts, ambient noise interference was avoided.

Electroencephalographic recordings were conducted at baseline (sitting) posture and also with sudden switch from sitting to standing posture.

Baseline (EEG) readings were taken at sitting position. EEG recordings were also obtained during exercise and post-exercise orthostasis for both males and females.

Alpha/beta ratio was calculated by dividing alpha wave frequency by beta wave frequency.

**Statistical Analysis**

Statistical analysis was conducted using Statistical Package for Social Science Students (SPSS) 23. Statistical test was done using Analysis of Variance (ANOVA) and student t test. Statistically significant difference was accepted at $P<0.05$.

# RESULTS

Figure 1 showed that sudden sit-to-stand postural switch had no significant effect on alpha wave amplitude when compared with sitting posture.

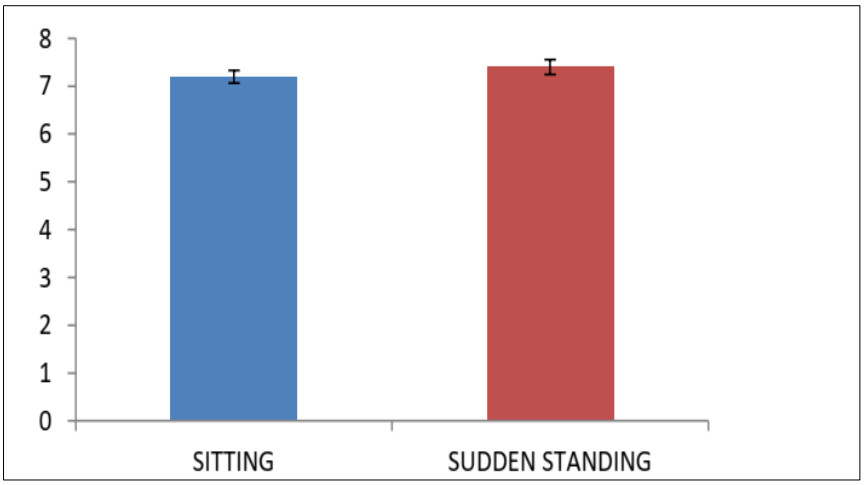


**Figure 1: Effect of sudden sit-to-stand postural switch on alpha wave amplitude**

Figure 2 showed that sudden sit-to-stand postural switch caused a significant decrease in alpha wave frequency when compared to sitting posture.

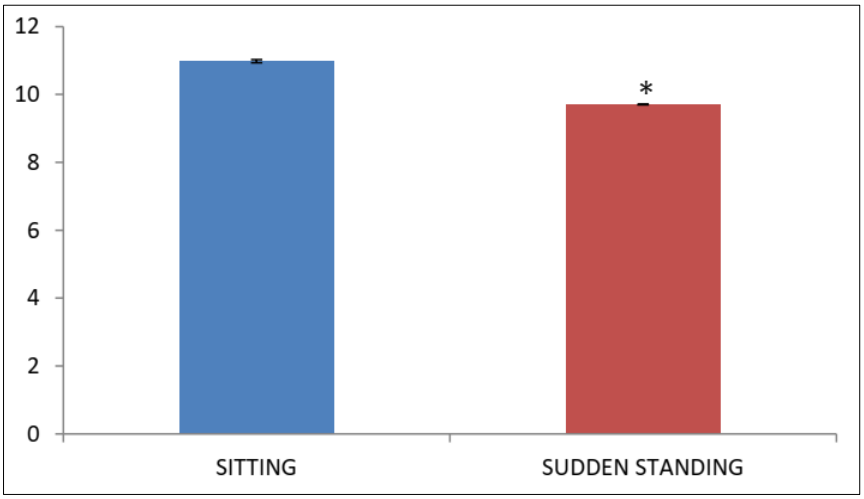


**Figure 2: Effect of sudden sit-to-stand postural switch on alpha wave frequency**

Figure 3 showed that sudden sit-to-stand postural switch caused a significant increase in beta wave amplitude when compared to sitting posture.

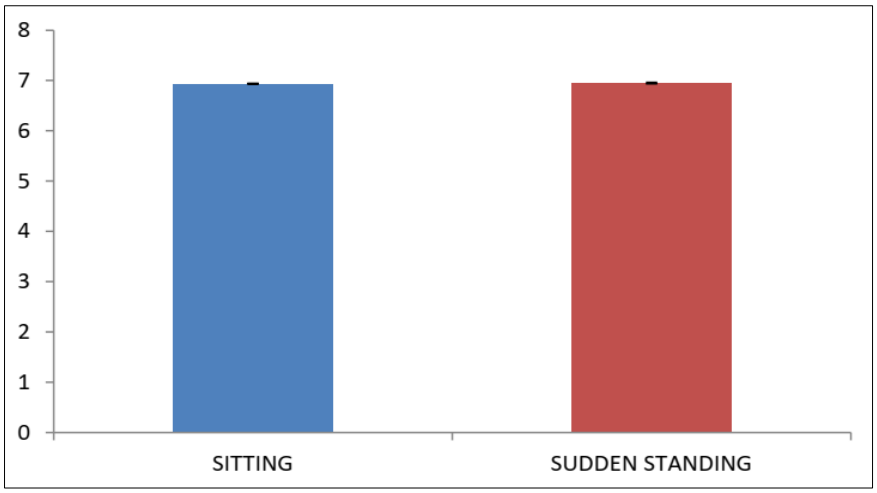


**Figure 3: Effect of sudden sit-to-stand postural switch on beta wave amplitude**

Figure 4 showed that sudden sit-to-stand postural switch caused no significant increase in beta wave frequency when compared to sitting posture.

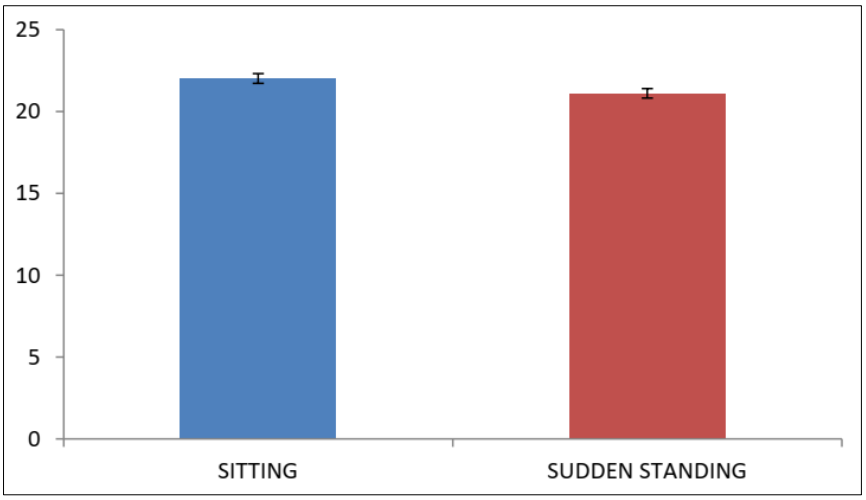


**Figure 4: Effect of sudden sit-to-stand postural switch on beta wave frequency**

Figure 5 showed that sudden sit-to-stand postural switch caused significant decrease in alpha/beta ratio when compared to sitting posture.

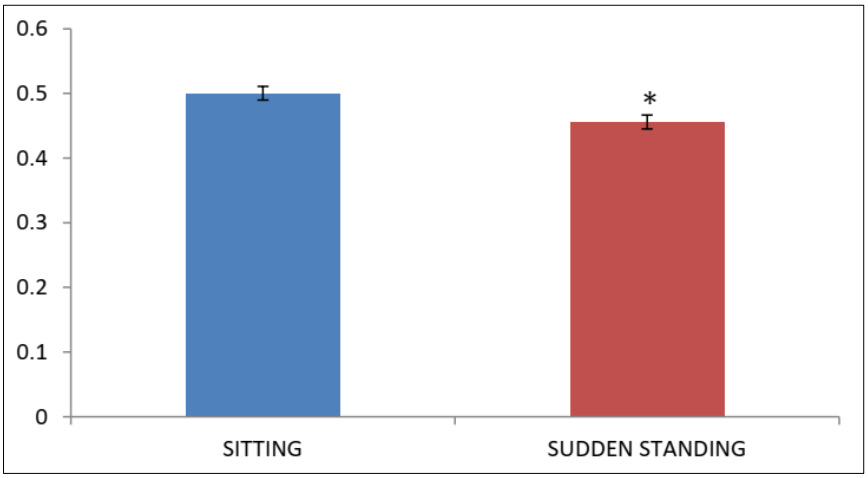


**Figure 5: Effect of sudden sit-to-stand postural switch on alpha/beta ratio**

## DISCUSSION AND CONCLUSION

Owing to needs, instincts and human peculiarities, postural changes are inevitable motor behavior and physiological phenomenon. In fact, inability to switch posture is an indication of structural and functional anomalies and a risk for sedentary behaviour and ambulation. Many works have identified the enormous benefits of sit to stand switch including reduction in sitting time and alleviation of back pain (Slaughter *et al*., 2015; Ma *et al*., 2021; Adeniyi *et al*., 2022). The aim of the study was to understand the electroencephalographic changes associated with sudden switch from sitting to standing postures.

The major finding of the study is that alpha wave frequency decreased during sudden sit to stand switch. Previous investigation has indicated that standing decreases alpha wave frequency (Ibitoye *et al*., 2021). John *et al*., (2003) reported that standing caused reduction in theta waves. However, despite this background knowledge, physiological changes that characterizing sudden switch to standing from sitting are quite different from that of standing. For instance, during sudden standing, acute effect of gravitational force causes diversion of blood from body parts that are above the heart level to the extremities thereby causing higher pressure baroreceptors to be inactivated and bringing about increases in blood pressure and heart rate. In addition to cardiovascular changes orchestrated by sudden sit to stand switch, activation of postural reflexes occurs. Contraction of extensor muscles of the lower limbs and trunk together with head and eye coordination takes place during rapid standing from sitting positions. Therefore, decrease in alpha wave observed during sudden switch from sitting to standing posture may be a result of changes in eye movements.

Alpha waves, though are spontaneous thalamic discharge, are generally known to indicate inactivity of visual cortex. They are typically produced during relaxed wakefulness with eyes closed.

Moreover, there was a reduction in alpha/beta ratio. Either relative decrease in alpha wave frequency or relative increase in beta wave frequency leads to decrease in alpha/beta ratio. Since there was insignificant difference between beta wave frequency during sitting and sudden standing, reduction in alpha/beta ratio in the study was due to relative reduction in alpha wave frequency. Decrease in alpha/beta ratio is a characteristic feature of rest, fatigue, dizziness, drowsiness and right leg orthostasis (Adeniyi *et al*., 2023).

Unlike alpha wave frequency and alpha/beta ratio, beta wave frequency, alpha wave amplitude and beta wave amplitude were not significantly altered by sudden standing from sitting position. It is known that muscular activities elicit changes in brain waves most especially increase in beta bands. However in the study, sudden standing did not affect beta waves.

In conclusion, the findings of the study indicated that sudden sitting to standing posture caused reductions in alpha wave and alpha/beta ratio.

**Conflict of Interest**: None declared.

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