

## **Bilateral Hemodynamic Responses on Prefrontal Cortex during Voluntary Regulated Breathing (Pranayama) Practices: A Near Infrared Spectroscopy Study**

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**Abstract :** Similar to neuroimaging findings through functional magnetic resonance imaging (fMRI) assessing regional cerebral blood oxygenation, the functional near infrared spectroscopy (fNIRS) has also been used to assess hemodynamic responses in the imaged region of the brain. The present study assessed hemodynamic responses in terms of changes in oxygenation ( $\Delta$ HbO), deoxygenation ( $\Delta$ HbR) and total hemoglobin ( $\Delta$ THb) on the prefrontal cortex (PFC), bilaterally, using fNIRS in 10 participants who performed three voluntary regulated breathing (pranayama) practices viz. (i) Left nostril breathing (LNB), (ii) Right nostril breathing (RNB); and (iii) Alternating nostril breathing (ANB) and compared with normal breathing as baseline (BS). For this, we used 64 channel NIRS system covering left and the right prefrontal cortex. The normal breathing kept as baseline (BS) measures as regressors in the investigation of hemodynamic responses when compared with LNB, RNB and ANB. In the results, we found greater oxygenation in contralateral side i.e., higher activation on the left prefrontal cortex (lPFC) during RNB, and right prefrontal cortex (rPFC) during LNB, whereas ANB showed greater deoxygenation responses on both sides of PFC. Interestingly, LNB showed increased oxygenation on ipsilateral side i.e., lPFC but not during RNB. This suggests that voluntary regulated breathing produced an immediate effect not only on contralateral but ipsilateral sides of the brain as well. In conclusion, breathing practices are tightly coupled to cerebral rhythms of alternating cerebral hemispheric activity during particular nostril breathing. These results of the specific nostril breathing do not support previous findings of contralateral hemispheric improvement while left or right nostril breathing only.

**Keywords :** hemodynamic responses, brain, pranayama, voluntary regulated breathing practices, prefrontal cortex

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