Impact of Ethanol Blended Fuel and Bharat Stage VI Emission Standards on Human Health and Ambient Air Quality Risk Assessment in India

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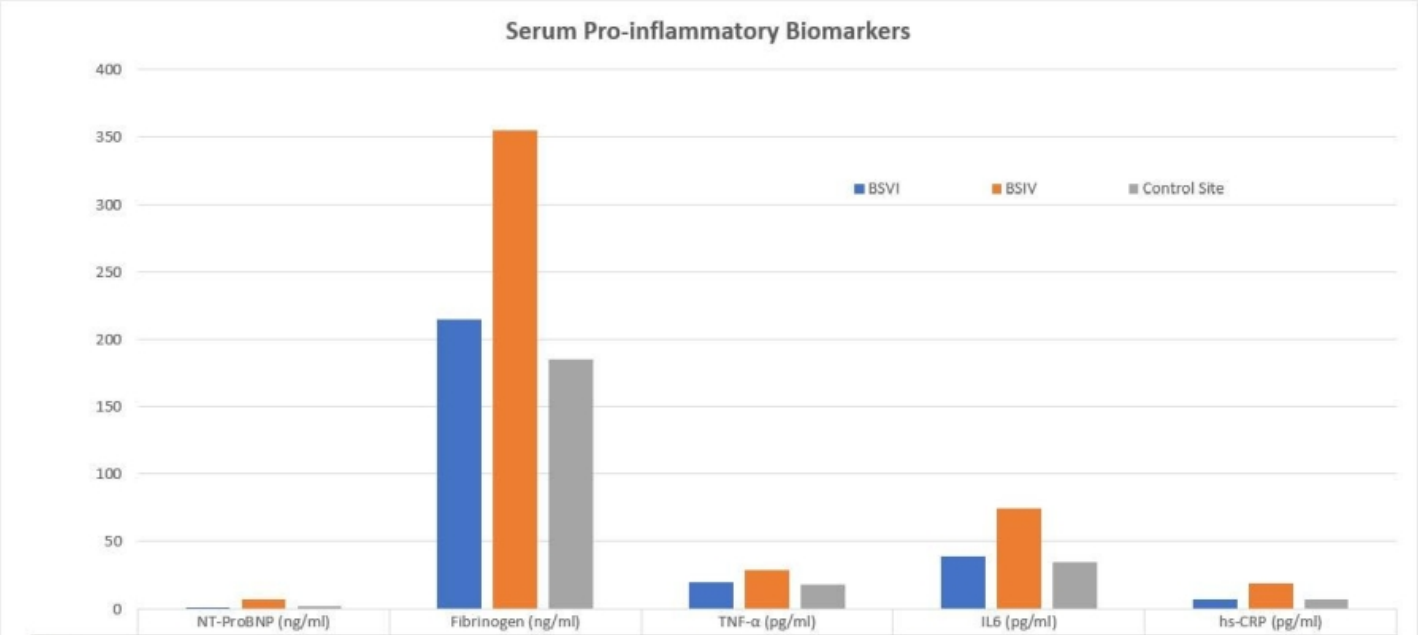
Rationale: Air pollution is one of the five leading risk factors for mortality worldwide. India has been dealing with serious environmental problems as its economy develops. The number of automobiles on the road has increased the risk of air pollution. Therefore, to reduce pollution levels, Government of India decided to leapfrog Bharat Stage V (BSV) (equivalent to Euro V) emission standards and directly implement the stricter and more comprehensive Bharat Stage VI (BSVI) (equivalent to Euro VI) emission regimen. One of the features of BSVI emission standard is E20 fuel i.e., 20% ethanol blending in fuel. This study aimed to correlate the levels of heavy metals and chemicals in urine as well as pro-inflammatory biomarkers in serum with air quality comparing BSVI and BSIV regions. **Methods:** A cross-sectional study involving 600 participants was conducted in Delhi (BSVI region), Narnaul (BSIV region) and Faridabad (control site). Blood samples were collected to measure pro-inflammatory biomarkers (NT-Pro-BNP, Fibrinogen, TNF-α, IL-6, and hs-CRP), and urine samples were analyzed for chemicals (Benzene, Nitrates, Sulphates, Toluene) and heavy metals (Arsenic, Cobalt, Iron, Aluminum, Copper, Cadmium, and lead). Also, air quality parameters like PM10, PM2.5, Carbon monoxide, Ammonia, Ozone, Benzene, oxides of sulphates and nitrates, and toluene of the regions was monitored during the study period. **Results:** Our data recorded a 70%, 50%, 40% and 10% overall drop in Benzene, Toluene, Ozone and $PM_{2.5}$ emissions respectively in the BSVI region when compared to the BSIV region. Urine heavy metal analysis recorded higher levels of arsenic, iron, and lead in BSIV region. Urine toluene and benzene levels were 60% and 40% lower in BSVI region respectively. Serum pro-inflammatory biomarkers levels were higher in Narnaul (BSIV region) as compared to Delhi (BSVI region) **(Figure 1)**. Overall, we recorded hazard index (HI) of Delhi (BSVI region) was 8.35 vs 10.01 in Narnaul (BSIV region) during the study period. **Conclusion:** We conclude from this study that the full switch from BSIV to BSVI emission standards will significantly enhance both human health and air quality. This will help in overall economic development and improvement in the quality of life.



	NT-ProBNP (ng/ml)	Fibrinogen (ng/ml)	TNF-α (pg/ml)	IL6 (pg/ml)	hs-CRP (pg/ml)
BSVI	1.21	214.9	20.08	38.5	7.75
BSIV	7.03	355.2	28.5	74.04	18.85
Control Site	1.95	185.78	18.13	34.41	7.28

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