

[Home](#) > [Journal](#) > [Earth & Environmental Sciences](#) > [JEP](#)
[Indexing](#) | [View Papers](#) | [Aims & Scope](#) | [Editorial Board](#) | [Guideline](#) | [Article Processing Charges](#)
[JEP](#) > Vol.3 No.10, October 2012



The Levels of Toxic Air Pollutants in Kitchens with Traditional Stoves in Rural Sierra Leone

PDF (Size: 1100KB) PP. 1353-1363 DOI: 10.4236/jep.2012.310154

Author(s)

Eldred Tunde Taylor, Satoshi Nakai

ABSTRACT

Wood and charcoal fuels, widely used in Sierra Leone for cooking, may impact indoor air quality. Until now, there is presently lack of data to quantify the extent of impact. In this study, concentrations of polycyclic aromatic hydrocarbons (PAHs), suspended particulate matter (SPM) and carbon monoxide (CO) were measured in kitchens with wood and charcoal stoves during cooking in rural areas. PAH contents of PM_{2.5} and PM_{2.5 - 10} fractions were analyzed using HPLC/FLD and SPM and CO were monitored in realtime. Mean \pm SD concentrations of PM_{2.5} related Σ_{11} PAHs, PM and CO were 2127 \pm 1173 ng/m³, 1686 \pm 973 μ g/m³ and 28 \pm 9 ppm for wood stoves; and 158 \pm 106 ng/m³, 315 \pm 205 μ g/m³ and 42 \pm 21 ppm for charcoal stoves, respectively. PAHs were largely associated with PM_{2.5} than PM_{2.5 - 10}. Maximum 1-hr time averaged \pm SD CO concentration for kitchens with wood and charcoal stoves were 44 \pm 21 ppm and 77 \pm 49 ppm, respectively. Generally, concentrations of PAHs, PM and CO were higher than the WHO recommended guidelines which raise concern with regards to health risks. Given the existing evidence of reduced emissions of PAHs, PM and CO from cleaner fuels, a transition from cooking with wood and charcoal to cleaner fuels would provide an improvement in indoor air quality, a requirement for good health.

KEYWORDS

Indoor Air; Biomass-Fuel; Polycyclic Aromatic Hydrocarbons; Suspended Particulate Matter; Carbon Monoxide

Cite this paper

 E. Taylor and S. Nakai, "The Levels of Toxic Air Pollutants in Kitchens with Traditional Stoves in Rural Sierra Leone," *Journal of Environmental Protection*, Vol. 3 No. 10, 2012, pp. 1353-1363. doi: 10.4236/jep.2012.310154.

References

- [1] WHO, "Indoor Air Pollution Takes Heavy Toll on Health," 2007. <http://www.who.int/mediacentre/news/notes/2007/np20/en/index.html>
- [2] WHO, "Fuel for Life: Household Energy and Health," 2006. <http://www.who.int/indoorair/publications/fuelforlife.pdf>
- [3] N. Bruce, R. Perez-Padilla and R. Albalak, "Indoor Air Pollution in Developing Countries: A Major Environmental and Public Health Challenge," *Bulletin of the World Health Organization*, Vol. 78, No. 9, 2000, pp. 1078-1092.
- [4] IARC, "Monographs on the Evaluations of Carcinogenic Risks to Humans, Volume 92. Some Non Heterocyclic Polycyclic Aromatic Hydrocarbons and Some Related Exposures, IARC, Lyon, 2010," 2010. <http://monographs.iarc.fr/Eng/Monographs/vol92/mono92.pdf>
- [5] T. T. Hien, P. P. Nam, Y. Sadanaga, T. Kameda, N. Takenaka and H. Bandow, "Comparison of Particle-Phase Polycyclic Aromatic Hydrocarbons and Their Variability Causes in the Ambient Air in Ho Chi Minh City, Vietnam and in Osaka, Japan, during 2005-2006," *Science of the Total Environment*, Vol. 382, No. 1, 2007, pp. 70-81.
- [6] S. Kong, X. Ding, Z. Bai, B. Han, L. Chen, J. Shi and Z. Li, "A Seasonal Study of Polycyclic Aromatic

- [Open Special Issues](#)
- [Published Special Issues](#)
- [Special Issues Guideline](#)

[JEP Subscription](#)
[Most popular papers in JEP](#)
[About JEP News](#)
[Frequently Asked Questions](#)
[Recommend to Peers](#)
[Recommend to Library](#)
[Contact Us](#)

Downloads:	301,518
------------	---------

Visits:	674,042
---------	---------

[Sponsors, Associates, and Links >>](#)

- [The International Conference on Pollution and Treatment Technology \(PTT 2013\)](#)

Hydrocarbons in PM_{2.5} and PM_{2.5} - 10 in Five Typical Cities of Liaoning Province, China," *Journal of Hazardous Materials*, Vol. 183, No. 1-3, 2010, pp. 70-80.

- [7] J. L. Mumford, R. S. Chapman, D. B. Harris, X. Z. He, S. R. Cao, Y. L. Xian and Z. M. Li, "Indoor Air Exposure to Coal and Wood Combustion Emissions Associated with High Lung Cancer Rate in Xuan Wei, China," *Environment International*, Vol. 15, No. 1-6, 1989, pp. 315-320.
- [8] C. Boman, A. B. Forsberg and B. G. Jarvholm, "Adverse Health Effects from Ambient Air Pollution in Relation to Residential Wood Combustion in Modern Society," *Scandinavian Journal of Work, Environment and Health*, Vol. 29, No. 4, 2003, pp. 251-260.
- [9] L. P. Naeher, M. Brauer, M. Lipsett, J. T. Zelikoff, C. D. Simpson, J. Q. Keoeing and K. R. Smith, "Woodsmoke Health Effects: A Review," *Inhalation Toxicology*, Vol. 19, No. 1, 2007, pp. 67-106.
- [10] B. C. Boman, A. B. Forsberg and T. Sandstrom, "Shedding New Light on Wood Smoke: A Risk Factor for Respiratory Health," *European Respiratory Journal*, Vol. 27, No. 3, 2006, pp. 446-447.
- [11] M. Ezzati and D. M. Kammen, "Indoor Air Pollution from Biomass Combustion and Acute Respiratory Infections in Kenya: An Exposure-Response Study," *The Lancet*, Vol. 358, No. 9282, 2001, pp. 619-624.
- [12] L. E. Bautista, A. Correa, J. Baumgartner, P. Breyse and G. M. Matanoski, "Indoor Charcoal Smoke and Acute Respiratory Infections in Young Children in the Dominican Republic," *American Journal of Epidemiology*, Vol. 169, No. 5, 2009, pp. 572-580.
- [13] J. Regalado, R. Perez-Padilla, R. Sansores, J. I. P. Ramirez, M. Brauer, P. Pare and S. Vedal, "The Effect of Biomass Burning on Respiratory Symptoms and Lung Function in Rural Mexican Women," *American Journal of Respiratory and Critical Care Medicine*, Vol. 174, No. 8, 2006, pp. 901-905.
- [14] J. R. Goldsmith, "Carbon Monoxide and Coronary Disease: A Review," *Environmental Research*, Vol. 10, No. 2, 1975, pp. 236-248.
- [15] K. R. Smith, S. Mehta and M. Maeusezahl-Feuz, "Indoor Air Pollution from Household Solid Fuels Use," In: M. Ezzati, A. D. Lopez, A. Rodgers and C. J. L. Murray, Eds., *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors*, World Health Organization, Geneva, 2004, pp. 1435-1493.
- [16] D. G. Fullerton, S. Semple, F. Kalambo, S. Suseno, R. Malamba, G. Henderson, J. G. Ayres and S. B. Gordon, "Biomass Fuel Use and Indoor Air Pollution in Homes in Malawi," *Occupational and Environmental Medicine*, Vol. 66, No. 11, 2009, pp. 777-783.
- [17] C. Viau, G. Hakizimana and M. Bouchard, "Indoor Exposure to Polycyclic Aromatic Hydrocarbons and Carbon Monoxide in Traditional Houses in Burundi," *International Archive of Occupational Environmental Health*, Vol. 73, No. 5, 2000, pp. 331-338.
- [18] M. Ezzati, M. B. Mbinda and M. D. Kammen, "Comparison of Emissions and Residential Exposure from Traditional and Improved Cookstoves in Kenya," *Environmental Science and Technology*, Vol. 34, No. 4, 2000, pp. 578-583.
- [19] M. E. Titcombe and M. Simcik, "Personal and Indoor Exposure to PM_{2.5} and Polycyclic Aromatic Hydrocarbons in the Southern Highlands of Tanzania: A Pilot-Scale Study," *Environmental Monitoring and Assessment*, Vol. 180, No. 1-4, 2010, pp. 461-476.
- [20] J. H. Kilabuko, H. Matsuki and S. Nakai, "Air Quality and Acute Respiratory Illness in Biomass Fuel Using Homes in Bagamoyo, Tanzania," *International Journal of Environmental Research and Public Health*, Vol. 4, No. 1, 2007, pp. 39-44.
- [21] A. Ellegard, "Cooking Fuel Smoke and Respiratory Symptoms among Women in Low Income Areas in Maputo," *Environmental Health Perspectives*, Vol. 104, No. 9, 1996, pp. 980-985.
- [22] J. S. M. Boleij, P. Ruigewaard, F. Heok, H. Thairu, E. Wafula, F. Onyango and H. de-Koning, "Domestic Air Pollution from Biomass Burning in Kenya," *Atmospheric Environment*, Vol. 23, No. 8, 1989, pp. 1677-1681.
- [23] E. T. Taylor and S. Nakai, "Prevalence of Acute Respiratory Infections in Women and Children in Western Sierra Leone Due to Smoke from Wood and Charcoal Stoves," *International Journal of Environmental Research and Public Health*, Vol. 9, No. 6, 2012, pp. 2252-2265.
- [24] F. A. Ansari, A. H. Khan, D. K. Patel, H. Siddiqui, S. Sharma, M. Ashquin and I. Ahmad, "Indoor Exposure to Respirable Particulate Matter and Particulate-Phase PAHs in Rural Homes in North

- [25] R. Jiang and M. L. Bell, " A Comparison of Particulate Matter from Biomass Burning Rural and Non Biomass Burning Urban Households in Northeastern China," Environmental Health Perspective, Vol. 116, No. 7, 2008, pp. 907-914.
- [26] E. T. Taylor and S. Nakai, " Monitoring the Levels of Toxic Air Pollutants in the Ambient Air of Freetown, Sierra Leone," African Journal of Environmental Science and Technology, Vol. 6, No. 7, 2012, pp. 283-292.
- [27] K. Hayakawa, N. Terai, P. G. Dinning, K. Akutsu, Y. Iwamoto, R. Etoh and T. Murahashi, " An Online Reduction HPLC/Chemiluminescence Detection for Nitropolycyclic Aromatic Hydrocarbons and Metabolites," Biomedical Chromatography, Vol. 10, No. 6, 1996, pp. 346- 350.
- [28] A. Bhargava, R. N. Khanna, S. K. Bhargava and S. Kumar, " Exposure Risk to Carcinogenic PAHs in Indoor-Air during Biomass Combustion Whilst Cooking in rural India," Atmospheric Environment, Vol. 38, No. 28, 2004, pp. 4761-4767.
- [29] N. R. Khalili, P. A. Scheff and T. M. Holsen, " PAH Source Fingerprints for Coke Ovens, Diesel and Gasoline Engines, Highway Tunnels, and Wood Combustion Emissions," Atmospheric Environment, Vol. 29, No. 4, 1995, pp. 533-542.
- [30] A. Violi, A. D' Anna and A. D' Alessio, " Modeling of Particulate Formation in Combustion and Pyrolysis," Chemical Engineering Science, Vol. 54, No. 15-16, 1999, pp. 3433-3442.
- [31] J. B. Kandpal, R. C. Maheshwari and T. C. Kandpal, " In- door Air Pollution from Combustion of Wood and Dung Cake and Their Processed Fuels in Domestic Cookstoves," Energy Conservation and Management, Vol. 36, No. 11, 1995, pp. 1073-1079.
- [32] N. T. K. Oanh, L. B. Reutergardh and N. T. Dung, " Emis- sion of Polycyclic Aromatic Hydrocarbons and Particulate Matter from Domestic Combustion of Selected Fuels," Environmental Science and Technology, Vol. 33, No. 16, 1999, pp. 2703-2709.
- [33] S. Gupta, S. Saksena, V. R. Shankar and V. Joshi, " Emission factors and Thermal Efficiencies of Cooking Biofuels from Five Countries," Biomass and Bioenergy, Vol. 14, No. 5-6, 1998, pp. 547-559.
- [34] M. D. Hays, C. D. Geron, K. J. Linna and N. D. Smith, " Speciation of Gas-Phase and Fine Particle Emissions from Burning of Foliar Fuels," Environmental Science and Technology, Vol. 36, No. 11, 2002, pp. 2281-2295.
- [35] M. J. Kleeman, J. J. Schauer and G. R. Cass, " Size and Composition Distribution of Fine Particulate Matter Emitted from Wood Burning, Meat Charbroiling, and Cigarettes," Environmental Science and Technology, Vol. 33, No. 20, 1999, pp. 3516-3523.
- [36] C. Venkataraman, G. Negi, S. B. Sardar and R. Rastogi, " Size Distributions of Polycyclic Aromatic Hydrocarbons in Aerosol Emissions from Biofuel Combustion," Journal of Aerosol Science, Vol. 33, No. 3, 2002, pp. 503-518.
- [37] E. Hedberg, A. Kristensson, M. Ohlsson, C. Johansson, P. A. Johansson, E. Swietlicki, V. Vesely, U. Wideqvist and R. Westerholm, " Chemical and Physical Characterization of Emissions from Birch Wood Combustion in a Wood Stove," Atmospheric Environment, Vol. 36, No. 30, 2002, pp. 4823-4837.
- [38] J. M. Barbosa, N. Re-Poppi and M. Santiago-Silva, " Poly- cyclic Aromatic Hydrocarbons from Wood Pyrolysis in Charcoal Production Furnaces," Environmental Research, Vol. 101, No. 3, 2006, pp. 304-311.
- [39] J. J. Schauer, M. J. Kleeman, G. R. Cass and B. R. T. Simo- neit, " Measurement of Emissions from Air Pollution Sources. 3 C1-C29 Organic Compounds from Fireplace Combustion of Wood," Environmental Science and Technology, Vol. 35, No. 9, 2001, pp. 1716-1728.
- [40] A. Bjorseth, O. Bjorseth and P. E. Fjeldstad, " Polycyclic Aromatic Hydrocarbons in the Work Atmospher. II. Determination in a Coke Plant," Scandenavian Journal of Work, Environment and Health, Vol. 4, No. 3, 1978, pp. 224-236.