Use of cook stoves, indoor air pollution, and the prevalence of respiratory morbidity and cardiovascular risk factors in three cohorts of women and children under-five years of age in rural Bangladesh

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Background

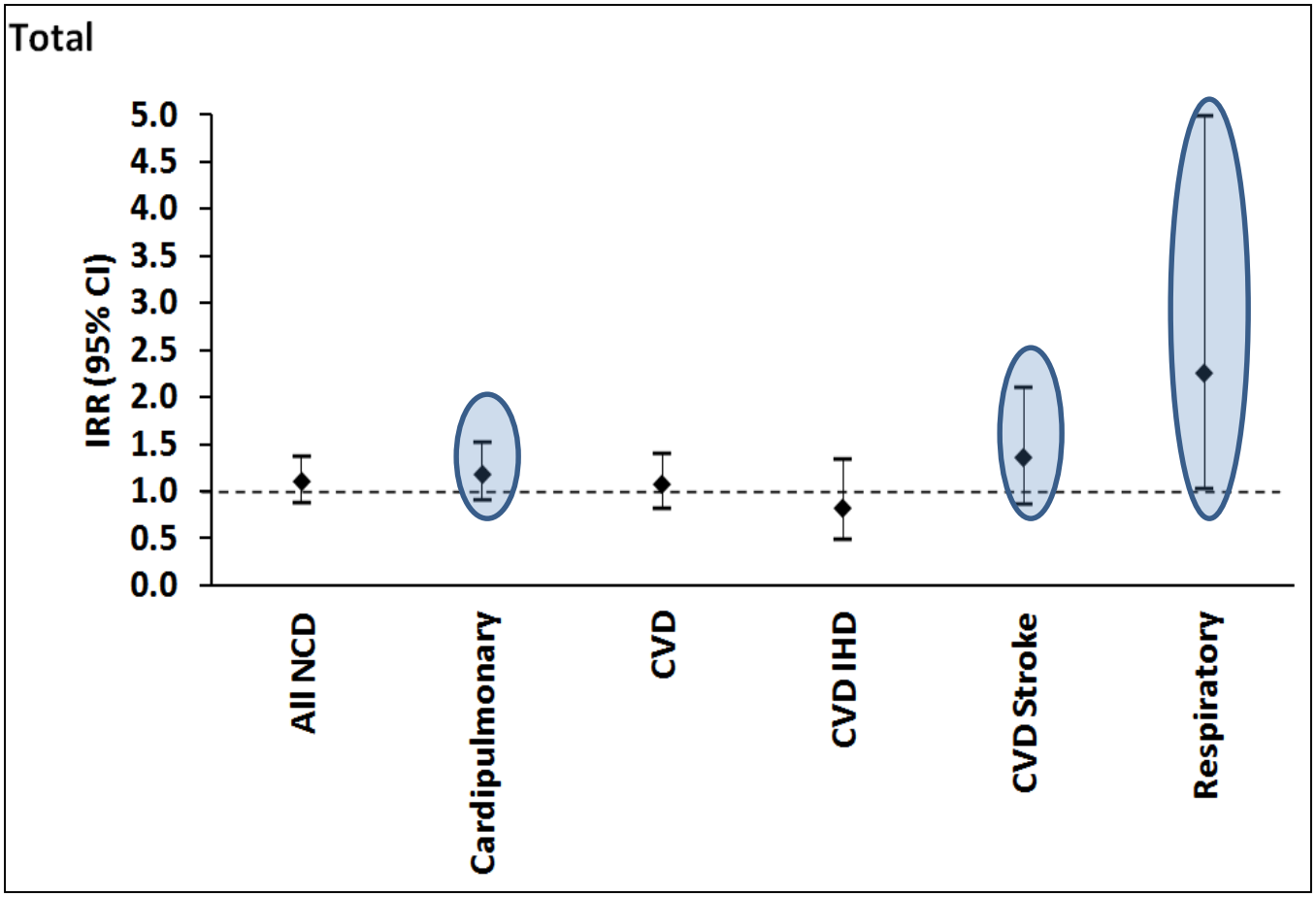
- More than 3 billion people worldwide depend on solid fuels for cooking and heating (N Bruce, 2000).

- Indoor air pollution (IAP) due to solid-fuel use is the second biggest risk factor for ill heath and is accountable for 2 million deaths annually and 2.7 percent global burden of disease (N Bruce, 2000).

- 89% of households in Bangladesh use solid fuel. (Rehfuess et al., 2006)

Background

Incidence rate ratio (IRR) of mortality due to solid fuel use as compared to natural gas use for different NCDs among adults in Matlab, Bangladesh



Alam DS et al., 2012

Objectives

- Explore the relationship of IAP level (PM2.5 and CO concentrations) with different type of cook stoves.
- To evaluate the potential cardiovascular respiratory benefits of reducing IAP by replacing traditional stoves with fuel-efficient, low emission improved cook stoves.

Methods

- Study Design: Prospective cohort study

We Compared IAP in three different groups:

a. Solid fuel user in traditional cook stove (100 HH)
b. Solid fuel user in improved cook stove (100 HH)
c. Clean fuel user (gas) (100 HH)

- Outcomes:

a. Cardiovascular risk factors (heart rate, BP, lipid profile & CRP)
b. Respiratory morbidity (ALRI & URTI, respiratory symptoms) and lung function.

Methods

- Study site and population:
  - Conducted in rural Matlab, Chandpur District.
  - The study population were female main cook (>=18 y) and children less than five years in the same household (HH).

Methods

- ***Assessment of Health Outcomes:***
  - Physical measurements : Weight, height, waist circumference, hip circumference, respiratory rate, pulse, blood pressure.
  - Blood specimen was collected from a subsample of 120 women (40 from each group) and 60 children (20 from each group)
  - Biomarker investigation include-lipid profile [serum total cholesterol, triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL)] and Level of C - reactive protein (CRP).
  - Lung function was measured using Spirometry

- ***Exposure Assessment:***
  - Monitoring for CO and PM2.5 at the kitchen

Changes in the cooking environment after cook stove installation

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Before Cook Stove installation

After Cook Stove Installation

Manufactured by Grameen Shakti (an NGO)

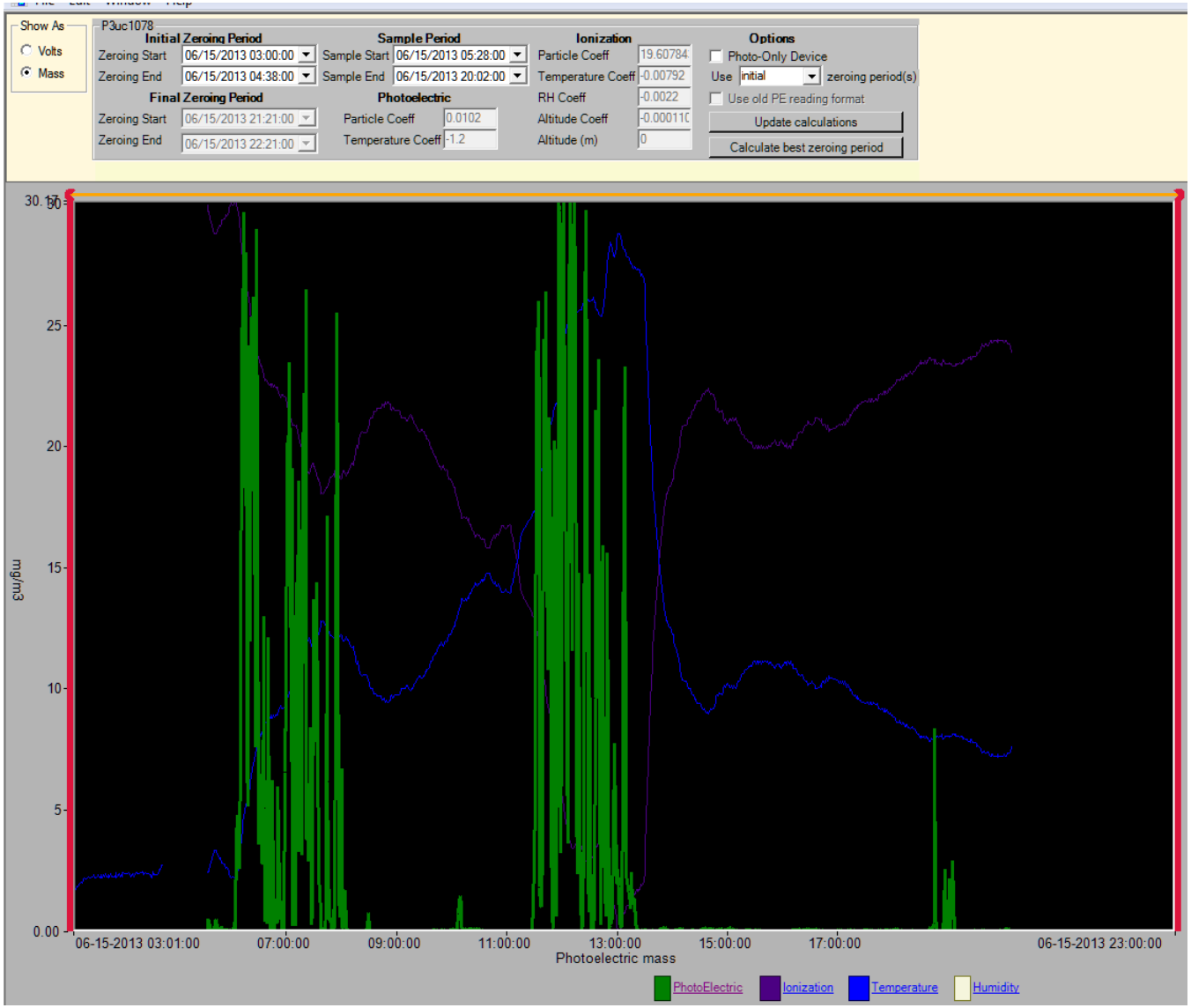
- Save 50-60% of traditional Fuel use.
- Reduce emission
- Cause less Blackening of utensils.

Measurement of PM 2.5 and CO

UCB Particle Monitor: photoelectric (light-scattering) detector

EasyLog CO Data Logger

PM2.5 Measurements



Photoelectric (mg/m^3)

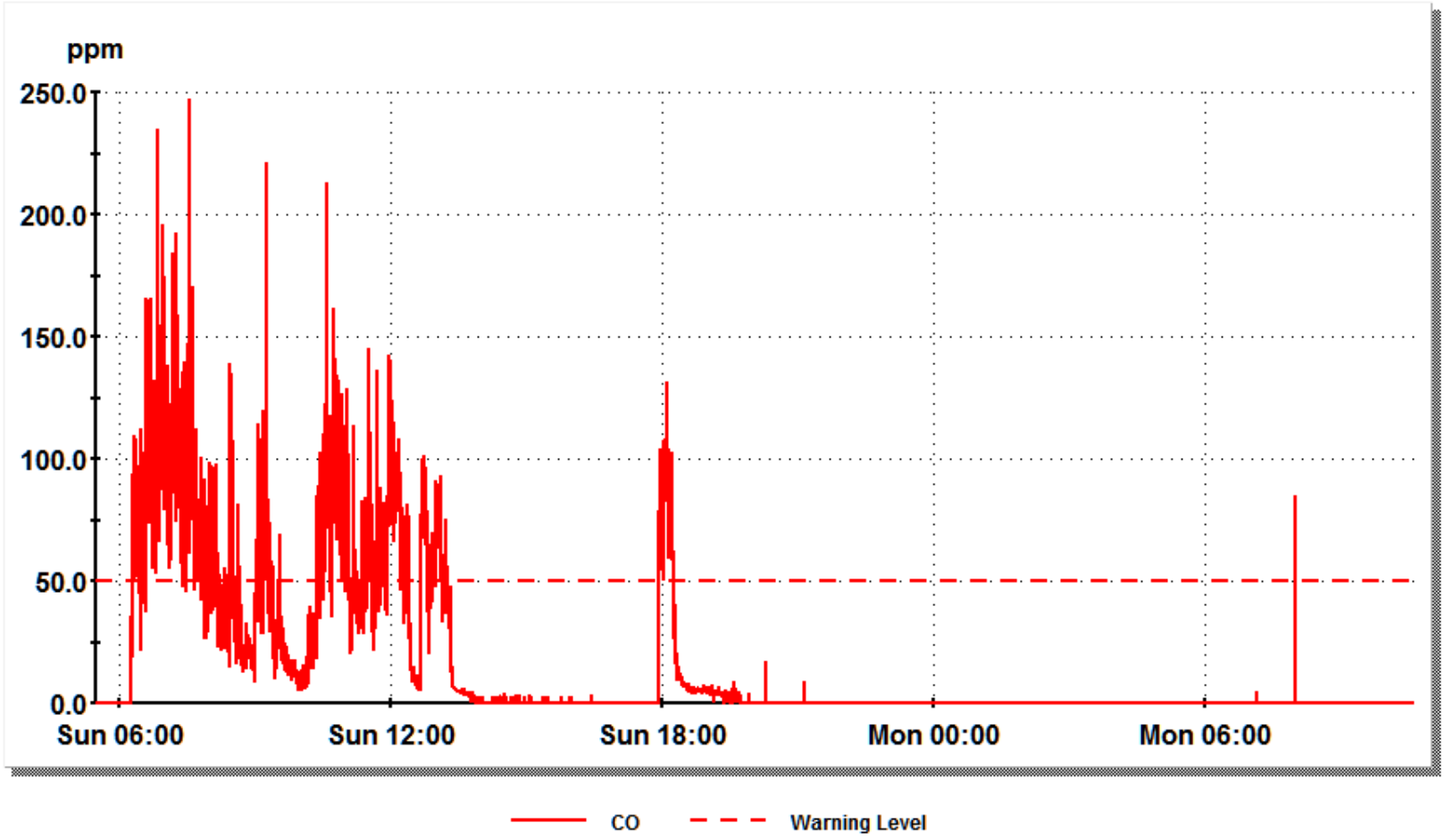
arith. mean	2.448
geo. mean	0.000
std. dev.	6.205
geo. std. dev.	NaN

median	0.049
75th %	0.322
95th %	19.295
min.	0.000
max.	30.174

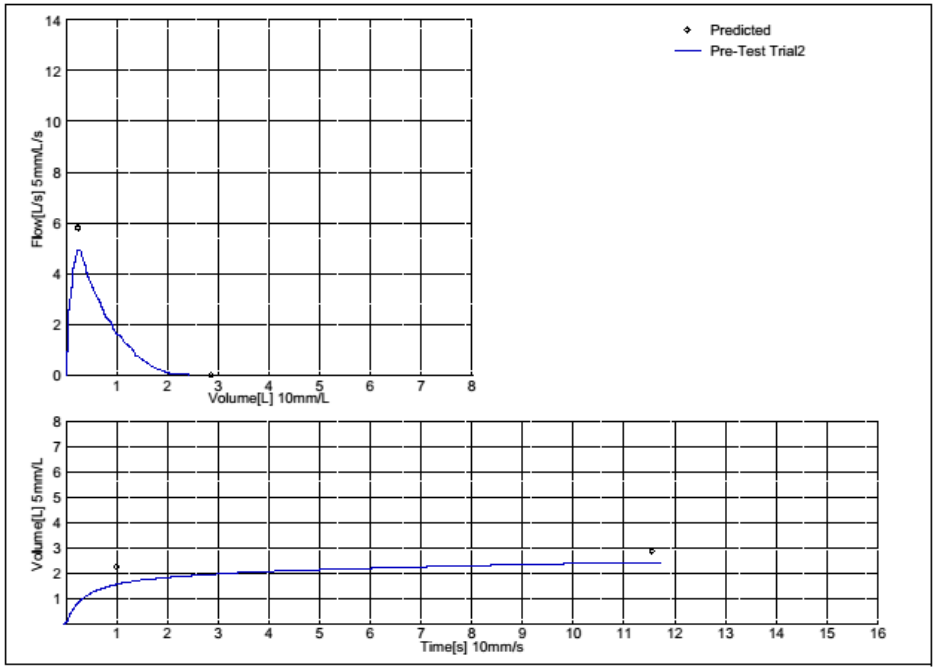
15 minute avg

highest	16.028
2nd highest	15.842
3rd highest	14.621

Carbon Monoxide (CO) Measurement



Spiromerty and Biochemical Analysis

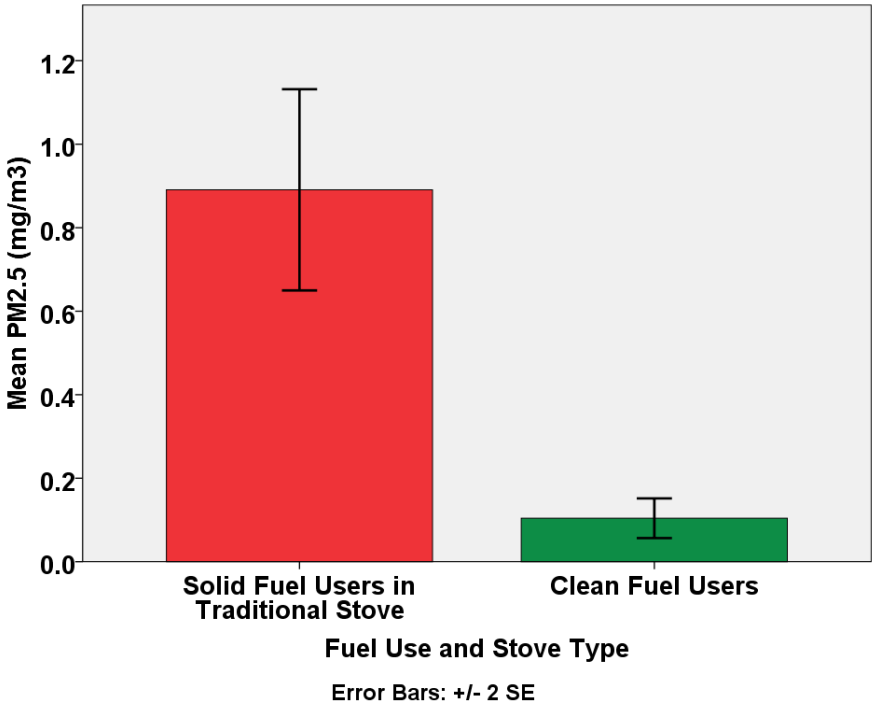


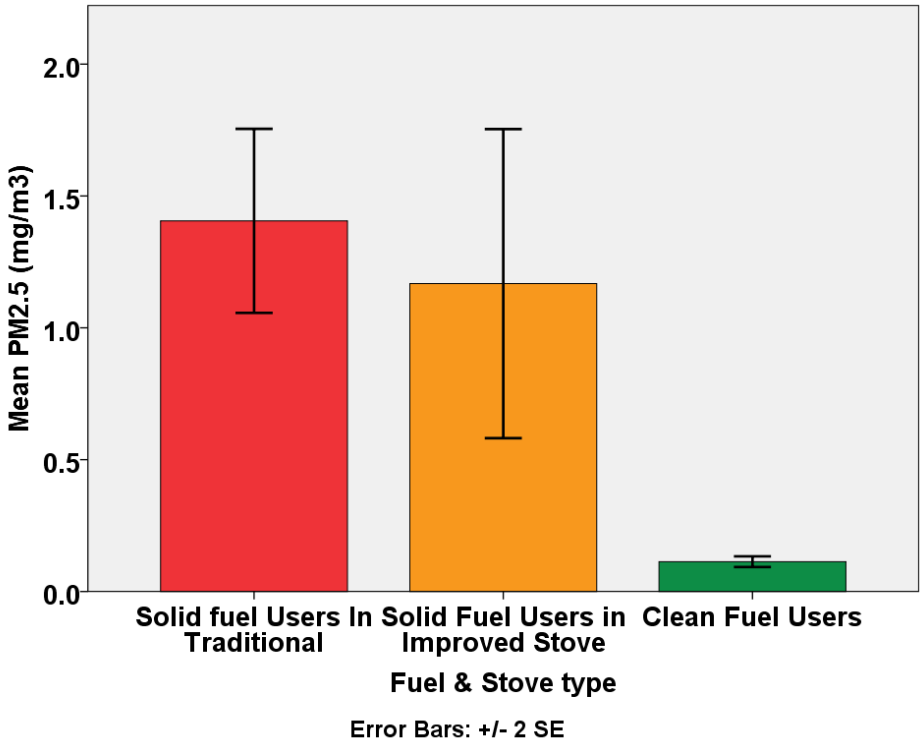
Results

Baseline Characteristics of the women before cook stove intervention

	Total N= 296	Solid Fuel Users Traditional Stove N=196	Clean Fuel N=100
Age in Year, mean (SD)	42 (12)	42 (13)	42 (9.3)
Age Group			
<30 Years, %	18.9	21.9	13.0
30-39 Years, %	19.9	18.9	22.0
40-49 Years, %	36.8	31.1	48.0
50-59 Years, %	19.6	22.4	14.0
>=60 Years, %	4.7	5.6	3.0
Education in Year , %	6 (5)	4 (4)	9 (4)
Income in '000 BDT, mean (SD)	18.2 (18.1)	12.7 (9.7)	28.9 (24.7)
Environmental Tobacco Smoke, %	38.5	47.4	21.0
Lung Function			
FEV1 in L, mean (SD)	2.53 (0.43)	2.53 (0.45)	2.54 (0.37)
FVC in L, mean (SD)	2.01 (0.43)	1.99 (0.46)	2.05 (0.37)
FEV1/FVC in %, mean (SD)	79 (9)	78 (10)	80 (7)
Exposure to Indoor Air Pollution			
PM2.5 in mg/m3, mean (SD)	0.625 (0.78)	0.891 (0.84)	0.104 (0.12)
CO in ppm , mean (SD)	9.6 (13.0)	13.02 (14.43)	2.3 (4.3)

$PM_{2.5}$

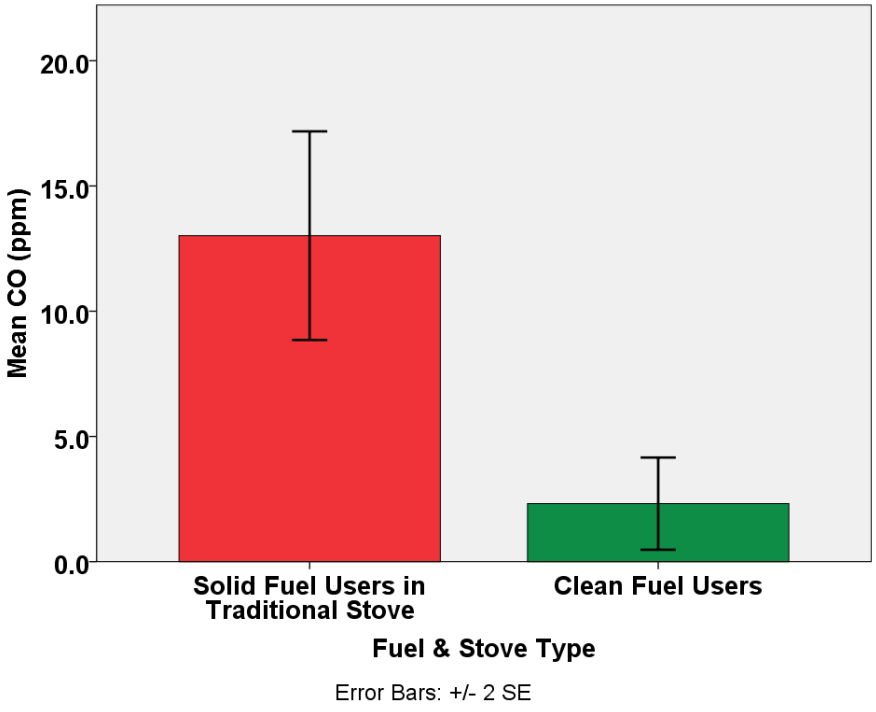


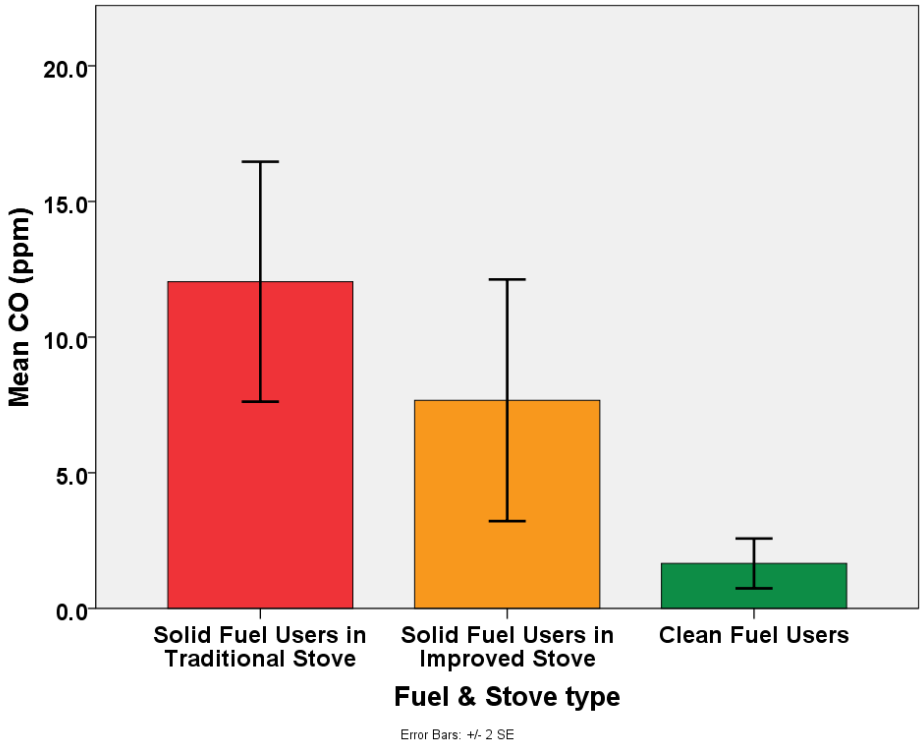


Before Intervention

After Intervention

Carbon Monoxide (CO)





Before Intervention

After Intervention

Risk factors of cardiovascular diseases in female after cook stove intervention among women

	Total	Traditional Stove	Improved stove	Clean Fuel	P value (ANOVA)
Heart Rate (bpm)	83 ± 13	83 ± 10	80 ± 10	84 ± 16	0.083
SBP (mmHg)	114 ± 19	113 ± 19	111 ± 19	119 ± 18	0.008
DBP (mmHg)	75 ± 11.2	74 ± 12	72 ± 11	78 ± 10	0.001
Biomarkers					
Total Cholesterol (mmol/L)	5.06 ± 0.97	4.99 ± 1.16	4.93 ± 0.98	5.22 ± 0.77	0.402
HDL (mmol/L)	1.10 ± 0.24	1.13 ± 0.27	1.08 ± 0.23	1.10 ± 0.21	0.609
LDL (mmol/L)	3.31 ± 0.85	3.22 ± 1.07	3.23 ± 0.77	3.46 ± 0.66	0.386
Triglyceride (mmol/L)	1.43 ± 0.98	1.29 ± 0.69	1.44 ± 1.15	1.53 ± 1.05	0.558
CRP (mg/dl)	0.44 ± 0.99	0.22 ± 0.18	0.19 ± 0.07	0.83 ± 1.54	0.006

Symptom Prevalence and Lung Function after cook stove intervention among women

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Symptom	Solid Fuel Users in Traditional Stove N=97	Solid Fuel Users in improves Stove N=95	Clean Fuel Users N=100
Cough	19.6	13.7	9.0
Phlegm	14.4	8.4	9.0
Wheezing	15.5	14.7	7.0
Breathing difficulty	14.4	18.9	18.0
FEV1 in L, mean (SD)†	2.11 (0.47)	1.98 (0.49)	2.04 (0.39)
FVC in L, mean (SD)	2.69 (0.44)	2.58 (0.51)	2.49 (0.40)
FEV1/FVC in %, mean (SD) †	79.20 (9.42)	76.87 (9.68)	81.83 (6.48)

† Significantly differ between the group in ANOVA

Respiratory Symptoms in under 5 children after cook stove intervention

Symptom	Solid Fuel Users in Traditional Stove N=29	Solid Fuel Users in improves Stove N=14	Clean Fuel Users N=17
Wheezing, n(%)	10 (35.7)	5 (38.5)	5 (29.4)
ARI or Pneumonia, n(%)	3 (10.7)	1 (7.7)	0

In summary

- Use of improved biomass cook stove has the potential to reduce pollutant emissions and therefore reduce the household exposure to pollution to some extent.
- Despite the reduction, the emissions are still much higher than the WHO recommended air quality guidelines.
- Long term follow up is needed to observe sustainability and health effects of improved cook stove.

Limitations

- Very short follow-up period.
- Lower than expected number of children were available for enrollment and follow up.

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THANK YOU