Effects of biomass smoke on women's cardiovascular health in rural Lumbini, Nepal

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Background

With around three billion people across the world cooking and heating their homes using open fires or traditional stoves, indoor air pollution remains a significant health threat. The use of solid fuels, including biomass fuels (wood, dung, and agricultural residues) and coal, to meet energy needs generates a substantial amount of pollutants. In developing and rural areas, women and young children are disproportionately affected by biomass smoke as women are generally tasked with cooking and children often spend time with their mothers. Despite the importance of understanding and addressing indoor air pollution, several gaps in knowledge still exist. Few studies have conducted quantitative research on the emission levels of indoor air pollution and its impacts on women's cardiovascular health, while simultaneously studying socioeconomic factors and fuel consumption patterns that contribute to this health hazard.

Objectives

Our study aimed to investigate the effects of long-term biomass smoke produced during cooking (compared with the impacts of clean fuels such as LPG) on the cardiovascular health of women in rural households in Lumbini, Nepal.

Methodology

- A household health questionnaire was administered to understand socio-demographic characteristics, prevalence of cardiovascular symptoms and diseases, house and kitchen characteristics, and lifestyle and dietary patterns.

- A cross-sectional study was conducted on healthy, non-smoking women (aged 25–45 years) who were not diagnosed with any cardiovascular disease in the last six months. The women needed to be cooking using biomass fuels and LPG for at least five years.

- A portable electrocardiogram, oximetry, and sphygmomanometer were used to assess cardiovascular risk.

- The study was conducted over a period from April to May 2018 in villages in Lumbini.

Questionnaire interview

Questionnaire interview

Blood pressure measurement

Electrocardiogram test

Health impact mechanism

When PM2.5 enters the respiratory system, it causes pulmonary and systemic inflammation and oxidative stress, affects the coagulation system, changes autonomic nerve function, injures the vascular endothelium, and affects vasomotor function.

The above reaction could also occur through other routes, such as through the circulatory system via the digestive tract.
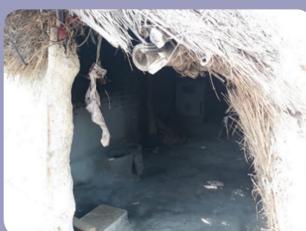
Acknowledgement

Conclusion

- The probability of cardiovascular disease symptoms were higher in biomass fuel users in comparison to LPG users, although the measurements of both groups are within the normal ranges.

- The higher body mass index and waist–hip ratio among clean fuel users may be attributable to their lifestyle and better economic condition.

- There is an urgent need to adopt various strategies to improve indoor air quality. Moreover, the advancement in research tools, particularly measuring techniques, is critical for researchers in developing countries to improve their capability to study emissions and address growing public health concerns.

Summary of findings

Biomass users had slightly lower mean values of body mass index, waist–hip circumference, and oxygen saturation and higher heart rate than LPG users. This indicated increased risk for hypertension (Fig. 1). Intervals of various heart waves were slightly increased in biomass users, which indicated increased risk for cardiovascular diseases like atrial fibrillation, left ventricular hypertrophy, and myocardial ischemia (Fig. 2).
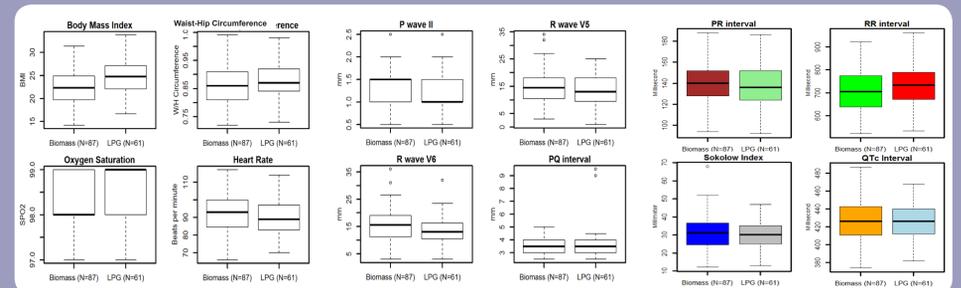
Fig. 1: **Comparison of physical measurements**   Fig. 2: **Different heart waves recorded by electrocardiogram**

Preliminary results

Table 1: Socio-demographic characteristics (population, N = 148)

Socio-demographic characteristics		Biomass (N = 87)	LPG (N = 61)
Variables		N (%)	N (%)
Marital status	Married	86 (98.85)	59 (96.72)
	Single	1 (1.15)	2 (3.27)
Level of education	Primary school	17 (19.54)	11 (18.03)
	Middle school	5 (5.75)	16 (26.23)
	High school	2 (2.30)	5 (8.20)
	University	0	3 (4.92)
	None	63 (72.41)	26 (42.62)
Level of Father's education	Primary school	9 (10.34)	9 (14.75)
	Middle school	11 (12.64)	10 (16.39)
	High school	4 (4.60)	4 (6.56)
	None	63 (72.41)	38 (62.29)
Monthly income	NPR. 10,000	77 (88.51)	25 (40.98)
	NPR. 20,000	8 (9.20)	24 (39.34)
	> NPR. 30,000	2 (2.30)	12 (19.67)
Psychological factors	Depression	19 (21.84)	21 (34.43)
	Anxiety	28 (32.18)	20 (32.78)
	Depression and anxiety	2 (2.30)	4 (6.56)
	Lack of social support	21 (24.14)	12 (19.67)
	Social isolation	12 (13.79)	2 (3.28)
	Stress at work	5 (5.75)	1 (1.64)

Table 2: Physical measurements (population, N = 148)

Physical measurement	Biomass users (N = 87)			LPG users (N = 61)			Normal range (as per WHO)
Variables	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	
Age (years)	35.97±6.99	24	47	36.44±7.17	24	50	
Height (cm)	147.6±5.31	130	158	148.9±5.006	138	160	
Weight (kg)	49.22±9.88	30	86	55.51±10.63	37	88	
Body mass index (BMI)	22.58±4.24	14.22	38.22	24.99±4.43	16.67	40.72	18.5-24.9
Waist–hip ratio	0.85±0.06	0.72	1.04	0.87±0.06	0.73	1.06	< 0.85
Systolic blood pressure	114.6±13.52	89	150	117.2±17.01	90	140	120 mm Hg
Diastolic blood pressure	77.15±9.01	60	110	77.58±10.49	60	110	80 mm Hg
Heart rate (per minute)	86.36±12.41	60	115	83.39±11.94	62	122	60–100
SpO2 (%)	98.07±1.62	88	99	98.26±1.4	89	99	

Table 3: Cardiovascular risk assessment (population, N = 148)

Cardiovascular risk assessment		Biomass	LPG
Variables		N (%)	N (%)
Chest pain	Yes	33(37.93)	10(16.39)
	No	54(62.07)	51(83.61)
Shortness of breath	Yes	21(24.14)	7(11.48)
	No	66(75.86)	54(88.52)
Pain, numbness, weakness, or coldness in legs and arms	Yes	44(50.57)	11(18.03)
	No	43(49.53)	50(81.97)
Sharp pain (neck, jaw, throat, abdomen, back)	Yes	20(22.99)	3(4.92)
	No	67(77.01)	58(95.08)
Dizziness, fainting, or loss of balance	Yes	8(9.20)	6(9.84)
	No	79(90.80)	55(90.16)
Palpitations or fluttering in the chest	Yes	24(27.59)	7(11.48)
	No	63(72.41)	54(88.52)
Swelling in the legs, abdomen, or around the eyes	Yes	17(19.54)	8(13.11)
	No	70(80.46)	53(86.89)
Fatigue or difficulty in breathing during physical activity	Yes	56(64.37)	19(31.15)
	No	31(35.63)	42(68.85)
Skin rashes or skin color changes	Yes	9(10.34)	3(4.92)
	No	78(89.66)	58(95.08)
Tingling in the fingers and toes	Yes	47(54.02)	9(14.75)
	No	40(45.98)	52(85.25)
Nocturia	Yes	16(18.39)	9(14.75)
	No	71(80.46)	52(85.25)
Physical activity	Yes	68(78.16)	55(90.16)
	No	19(21.84)	6(9.84)
Fruits and vegetables consumption	Not so often	26(29.89)	5(8.20)
	Daily	40(45.98)	39(63.93)
	≥ Twice a week	21(24.14)	17(27.87)
Fatty and salty foods consumption	Not so often	15(17.24)	30(49.18)
	Daily	69(79.31)	30(49.18)
	≥ Twice a week	3(3.45)	1(1.64)
Meat and milk products consumption	Not so often	29(33.33)	30(49.18)
	Daily	2(2.30)	4(6.56)
	≥ Twice a week	56(64.37)	27(44.26)