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Prevalence and Distribution of Anterior Segment Ocular Diseases among Commercial Biomass Fuel Users in Isuikwuato Local Government Area, Abia State, Nigeria.

Samuel O. Ndukuba[1], Augustine U. Akujobi[2], James Nweke[3], Nnenne U. Onu[4], Amarachi Ezeigbo[5].
[1,3,4,5] Department of Optometry, Abia State University, Uturu, Nigeria.
[2] Department of Optometry, Imo State University, Owerri, Nigeria.
Email: samuel.ndukuba@abiastateuniversity.edu.ng
Phone: +2347035203374

Abstract

Food vendors who use biomass fuel are exposed to the toxic free radicals released from the combustion of wood, gaseous aromatic hydrocarbons, gaseous chemicals and the particulate solid irritants that are airborne. Therefore, the prevalence and distribution of anterior segment ocular diseases among commercial biomass fuel users in Isuikwuato Local Government Area, Abia State, Nigeria was investigated. One hundred (100) consenting participants were interviewed and subsequently subjected to clinical examinations which included external examinations with pen torch, Rose Bengal staining and ophthalmoscopy. Statistical analyses were performed using the chi-squared statistical method at 0.05 level of significance. It was observed that conjunctivitis was the most prevalent anterior segment disease in biomass fuel users occurring in 39 persons (29.32%), followed by cataract 33 (24.81%), dry eye disease 30 (22.56%), pterygium 21 (15.79%), and pinguecula 10 (7.52%). It was also observed that age and duration in business did not significantly affect the incidence of these diseases ($p>0.05$). While further studies on the relationship between biomass and ocular morbidities are encouraged, calls to make liquefied petroleum gas (LPG) more affordable for domestic cooking might be helpful especially for the protection of women and children who are primarily exposed.

Key words: Prevalence; Distribution; Biomass; Ocular Diseases; Anterior Segment

Introduction

Biomass is a group of biological materials (living organisms, both animal and vegetable, and their derivatives) present in a specific area, collectively considered; some of these materials are used as fuels for cooking and a source of heat energy (Smith *et al.,* 1999). The most efficient fuels like the liquefied petroleum gas (LPG), generate more heat and lower pollution particles

per unit of fuel used but are more expensive, while more polluting fuels are inexpensive, this is known as 'household fuel ladder' (Smith, 2013). Two categories of biomass fuels exist, namely; wood fuels and animal waste fuels. Generally, biomass fuels have lower density of energy compared to the fossil fuels. 25% of energy produced by biomass fuel is used in industrial countries and the other 75% is used in third world countries (Parrika, 2004).
Globally, about half of all households and 90% of rural households use biomass fuel, especially wood domestically. This constitutes a major source of indoor pollution, which exposes 50% of the world's population, which is approximately 3 billion people, to the harmful effects of the combustion of these fuels (World Health Organization, 2002; Torres-Duque *et al*., 2008).

There is a wide variation in the emission of pollutants produced when biomass is burned. More than 200 chemicals and compound groups have been identified from the combustion of wood in which 90% are aerodynamic particulate matters with diameter less than 10*um* (PM_{10}) (Zelikoff *et al*., 2002). According to a study by the U.S. Environmental Protection Agency(1998) a significant number of wood smoke constituents are known to be toxic or irritants including; carbon monoxide(CO), nitrogen and sulphur oxide (NO_2, SO_2), aldehydes (e.g. formaldehyde), polycyclic aromatic hydrocarbon(e.g. benzopyrene), volatile organic compounds, chlorinated dioxins and free radicals. Critically the contributions of some of these gases in global warming have been well documented (Parikka, 2004; Smith, 3013). However, many of these substances can act as primary pollutants, irritants, and carcinogenic or cocarcinogenic compounds (Naeher *et al,* 2007). In developing countries, air pollution resulting from the inefficient burning of biomass for cooking and heating has been linked to a number of negative health outcomes, mostly respiratory diseases and cancers (West *et al.* 2013). There have also been links of these fuels to low birth weights and cardiovascular diseases (Fullerton *et al.*, 2008).

The anterior segment includes the crystalline lens and structures anterior to it, namely; iris, cornea and two aqueous humor-filled spaces: anterior and posterior chambers (Khurana, 2012). Furthermore, some studies have shown how the anterior segment of the eye is affected by emissions in the atmosphere. The inefficient combustion of wood releases naphthalene, which is

well known for its cataractogenic potential and has been used to induce cataract in animal models *(*Nagata *et al.,* 1999). Biomass smoke condensates also contain metal ions such as lead, and lead exposure is associated with protein aggregation in diseases like cataract (Susaya *et al*., 2010; Schaumburg *et al.*, 2004).

Another effect of biomass combustion to the anterior segment is dry eye disease (DED) which, although not a major cause of blindness, is associated with substantial ocular pain, discomfort and can lead to fluctuating visual disturbances (Miljanovic *et al.,* 2007). The class of keratitis often associated with biomass fuel users is called traumatic keratitis which occurs due to mechanical trauma, chemical trauma, thermal burns and/or radiation, the injury may become secondarily infected or remain non-infected (Dahl, 2017).

Women, who are typically responsible for cooking in households are the most exposed to these pollutants, along with their children. In addition to exposure to smoke from the combusted wood, the food itself that is cooked, either fried or grilled at high temperature, can emit smoke and volatile organic compounds like formaldehyde (Kabir & Kim, 2011). A study by Thulasiraj *et al.* (2015) highlights how exposure to biomass fuels co-relates with cataract predominantly in women. Food vendors who use biomass fuel are exposed to the toxic free radical released from the combustion of wood, gaseous aromatic hydrocarbons, gaseous chemicals and the particulate solid irritants that are airborne. The study therefore, examines the prevalence and distribution of anterior segment ocular diseases among commercial biomass fuel users in Isuikwuato Local Government Area, Abia state, Nigeria.

Methodology

This research was carried out in Isuikwuato Local Governement Area, Abia state, Nigeria. A large proportion of the families in this area use biomass fuel domestically and commercially as a source of heat energy. A total of 100 randomly selected females of different ages who have worked as food vendors for at least 12 months were recruited into the study. Most subjects were recruited during a one week community eye care outreach in town halls of the area. Some other

subjects were met at their business premises at appointed days and times. Individuals with significant retinal conditions such as glaucoma, optic atrophy and macular degenerations were excluded from this study. Through oral interview, case history was taken to document information regarding age, ocular complaints, ocular health history, general health history, history of cooking with biomass fuel (location, duration and frequency) and known ocular complaints experienced during cooking. Testing procedures involved external eye examination with the aid of a pen torch and internal examination using a direct keeler ophthalmoscope, to detect and analyze the different anterior segment ocular diseases among these commercial biomass fuel users. Additionally, all participants were stained with the Rose-bengal strip, and the eyes observed under white light and a +10.00Ds (plus 10 convex lens). The dye stains damaged conjunctival and corneal cells and has been used to identify damages to the ocular surface. It has been believed that 1% Rose-bengal does not stain normal, healthy cells and mucous strands. The Rose-bengal staining of live, as well as detergent treated cells could be blocked by tear components like mucin and albumin, suggesting that normally negative Rose-bengal staining is due to the protective function of the preocular tear film. These indicate that Rose-bengal staining ensues whenever there is poor protection of surface epithelium by the precorneal tear film; this represents an interpretation for Rose-bengal stains seen in various ocular surface disorders (Feenstra & Tseng 1992). The data collected were presented in tables and figures while chi-square statistical distribution test was used to analyze them.

Results

Table 1: Age distribution of participants in the study area.

The lowest frequency among the subjects was between the 71 – 75 years age range (zero participant). The highest frequency was between the 41 – 45 years group (16 subjects) which form the bulk of the work force in the study area. The mean age of participants was 48 ± 15 years.

Age(years)	Age boundaries	n	Frequency	Cumulative frequency	Mean deviation
16-20	15.5-20.5	18	3	3	-30
21-25	20.5-25.5	23	12	15	-25
26-30	25.5-30.5	28	12	27	-20
31-35	30.5-35.5	33	5	32	-15
36-40	35.5-40.5	38	11	43	-10
41-45	40.5-45.5	43	16	59	-5
46-50	45.5-50.5	48	10	69	0
51-55	50.5-55.5	53	14	83	5
56-60	55.5-60.5	58	8	91	10
61-65	60.5-65.5	63	5	96	15
66-70	65.5-70.5	68	2	98	20
71-75	70.5-75.5	73	0	98	25
76-80	75.5-80.5	78	2	100	30
TOTAL			**100**		0

Table 2: Distribution of participants according to duration-in-business

Most participants were within the 1 – 5 years duration-in-business. The mean duration was 30.5± 21.90 years.

Duration (years)	n	Frequency	Cumulative frequency	Mean deviation
1-5	3	35	35	-27.5
6-10	8	30	65	-22.5
11-15	13	13	78	-17.5
16-20	18	6	84	-12.5
21-25	23	6	90	-7.5
26-30	28	2	92	-2.5
31-35	33	6	98	2.5
36-40	38	0	98	7.5
41-45	43	1	99	12.5
46-50	48	0	99	17.5
51-55	53	0	99	22.5
56-60	58	1	100	27.5
TOTAL		**100**		

Table 3: Age distribution of anterior segment ocular diseases in the study area.

Eighty (89) of the respondents had at least one anterior segment disease, while 11 subjects had no disease at all, and were tagged normal. Amongst these 89 subjects some had more than one anterior segment diseases, giving an incidence of 133 diseases. Conjunctivitis had the highest occurrence- 39 accounting for 27.08% prevalence rate; followed by cataract 33 (22.92%) and dry eye disease (DED) 30 (20.83%). The subjects without any ASD were 11 accounting for 7.64% of prevalence rate. The highest prevalence of diseases occurred within the 51–55 age group, with 25 diseases, while the least prevalence was within the age group 16–20, with 2 disease.

Age (years)	Conjunctivitis	Pterygium	Pinguecula	DED	Cataract	Normal
16-20	1	0	0	1	0	1
21-25	7	0	0	2	0	4
26-30	8	0	0	3	0	1
31-35	3	0	1	1	0	0
36-40	7	3	0	1	0	1
41-45	5	3	3	5	1	2
46-50	2	3	3	2	6	2
51-55	1	5	3	6	10	0
56-60	1	4	0	5	7	0
61-65	2	1	0	1	5	0
66-70	1	1	0	2	2	0
71-75	0	0	0	0	0	0
76-80	1	1	0	1	2	0
TOTAL	**39**	**21**	**10**	**30**	**33**	**11**
%	**27.08**	**14.58**	**6.95**	**20.83**	**22.92**	**7.64**

Table 4: Distribution of anterior segment diseases based on duration-in-business.

The highest prevalence of the diseases was seen among those that have been in the business for 6–10 years. Participants within the ranges of 36-40, 46-50 and 51-55 years had no anterior segment disease.

Duration (years)	conjunctivitis	pterygium	pinguecula	DED	cataract	normal	% with ASD
1-5	16	4	1	8	5	9	74.3
6-10	14	7	5	6	7	0	100
11-15	0	5	4	6	6	1	92.3
16-20	1	0	0	3	3	1	93.8
21-25	3	0	0	3	4	0	100
26-30	1	1	0	1	1	0	100
31-35	2	4	0	1	5	0	100
36-40	0	0	0	0	0	0	NA
41-45	1	0	0	1	1	0	100
46-50	0	0	0	0	0	0	NA
51-55	0	0	0	0	0	0	NA
56-60	1	0	0	1	1	0	100
TOTAL	**39**	**21**	**10**	**30**	**33**	**11**	**89**

Table 5: Distribution of ocular symptoms among subjects in the study area.

All the participants reported at least one ocular symptom. Itching was most prevalent (52%), followed by tearing (40%) and blurring of vision (36%) then redness (24%), sandy sensation (17%) and pain (11%).

Age (years)	Itching	Tearing	Pain	Redness	Sandy sensation	Blurred vision
16-20	2	1	0	1	0	1
21-25	7	2	1	2	1	1
26-30	6	4	1	3	1	3
31-35	3	2	1	1	0	2
36-40	7	7	0	1	0	4
41-45	10	5	2	4	1	4
46-50	2	6	2	3	2	6
51-55	8	5	1	3	3	4
56-60	2	4	1	2	3	5
61-65	2	2	0	1	3	3
66-70	1	1	1	2	2	1
71-75	0	0	0	0	0	0
76-80	2	1	1	1	1	2
TOTAL	**52**	**40**	**11**	**24**	**17**	**36**
%	**52%**	**40%**	**11%**	**24%**	**17%**	**36%**

Discussion

A total of 100 subjects between the ages of 19-80 years were examined. The duration in business ranged between 1- 60 years. The mean age of the participants was 48$\pm$ 15 years, while the mean duration of business was 30.5 $\pm$ 21.90 years. This age range compares relatively to the biomass fuel users assessed in Kenya by Wafula *et al*. (2000) which was from 15- 60 years. It was observed that some subjects had more than one anterior segment ocular disease, giving a total of 133 occurrences of anterior segment ocular diseases in 89 persons and 11 persons without any anterior segment ocular disease. More of the commercial biomass fuel users were between 21-55 years accounting for 80% of the population. This could most likely be because this age bracket forms the bulk of the labour force in Isuikwuato Local Government Area, Abia state, Nigeria.

Conjunctivitis was the most prevalent anterior segment disease in biomass fuel users (29.32%), followed by cataract 33 (24.81%), dry eye disease(DED) 30 (22.56%), pterygium 21 (15.79%), pinguecula 10 (7.52%). These findings are similar to a study carried out by Wafula *et al*. (2000)

where there was a significant prevalence of conjunctivitis among women between ages 15 and 60 and children below 5 years of age who use traditional three-stone stoves in a rural community in Kenya, compared with women who used improved stoves. However in a study by Saha *et al*. (2005) eye irritation was most prevalent amongst biomass fuel users, followed by cataract. This finding is not too different as eye irritation is a feature of most ocular surface morbidities. Since the study of Saha (2005) did not report other ocular morbidities besides cataract and eye irritation, most persons with eye irritation might have had any of the ocular surface diseases.

Wood Smoke components such as formaldehyde, acrolein and particulate matter can induce oxidative stress and alter the cytokine content of tears and ocular surface, leading to inflammation and development of dry eye disease (Uchino *et al.*, 2012; Wakamatru *et al.*, 2013).There are also suggestive data that increase in levels of particulate matter and carbon monoxide (CO_2) in air pollution may be associated with Meibomian gland dysfunction (Malerbi *et al.*, 2012). Smoke induced conjunctivitis is a form of allergic inflammatory response and when these allergens come in contact with the conjunctiva and mucus membranes lining the eyes, the

body releases histamine triggering the allergy symptoms. Chronic smoke irritation of the conjunctival surface could also make people rub their eyes more frequently, increasing the risk of infective conjunctivitis and/or transmission of Chlamydia trachromatis (Sahlu & Larson, 1992). Dry eye disease is among the top most reported symptoms in air pollution (Lukcso *et al.*, 2016; Reijula & Sundman-Digert, 2004). The tear film that protect the ocular surface is a multilayer fluid that is exposed directly to the air and hence affected by air quality, as has been demonstrated in many studies as summarized by Wolkoff (2010); it can be altered by physical process that increase tear evaporation and decrease tear film stability for example; heat, blowing air, humidity, as well as by aerosols and combination products that alter its biochemical composition and structure.

The prevalence of anterior surface ocular diseases did not co-relate significantly with age ($p>0.05$) among commercial biomass fuel users. However, anterior segment diseases like conjunctivitis, dry eye disease and pinguecula were seen almost in all age groups, while cataract

seemed to be present only in the middle aged and the aged, that is, between 41 – 80 years. Noor (2003) strengthened this finding when stated that pterygium, which is commonly seen in people from 20 years and above, is now found in children. Conjunctivitis and dry eye disease have no definite age range, therefore, age is not a risk factor for them (Khurana 2012). This however differs in the case of cataract which is commonly seen amongst the aged (Truscott, 2005). More so, there is no statistically significant relationship between the occurrence of anterior segment ocular diseases and the duration in business ($p>0.05$). However, with individuals who had been in business for the least duration (1-5 years) showing the lowest percentage of individuals with at least one disease- 74.3% and all others with 100% (except 11-15 and 16-20 years duration, who still had more than 90% respectively), it could be suggestive that there is a risk posed by duration in business. With over 65% of our respondents having not more than 10 years exposure in the food vendor business in this study, we may not have had a sufficient range of subjects in our study to analyze this parameter. Future study seeking a more reliable statistical outcome would need to get more respondents with a vast range of duration in business.

All the participants reported the occurrence of at least one ocular sign/ symptom within one month of their being examined. This was identified during cooking activities, namely; itching (52%), tearing (40%), blurring of vision (36%), redness (24%), sandy sensation (17%) and pain (11%) of the population respectively. Many of the studies regarding hazards of air pollution as a result of biomass fuel have reported ocular irritation as a complaint and it appears to be a consistent finding when symptoms are elicited (Diaz *et al*., 2007).

Conclusion

Conjunctivitis (29.32%) was found to be the most prevalent anterior segment ocular disease amongst commercial biomass fuel users, followed by cataract and dry eye disease which accounted for 24.81% and 22.56% respectively. There was no statistically significant relationship between the occurrence of anterior segment diseases and duration of use of biomass

fuel among the subjects. The frequencies of ocular complaints among the subjects is significant and warrants further investigation

In view of the findings, protective goggles should be recommended to all persons using biomass fuels to protect them from the airborne irritants as they cook. According to Pagan-Duran (2016) 90% of ocular injuries are preventable by protective eye wears. Further researches can compare the prevalence of ocular morbidities among biomass users and users of LPGs which may strengthen calls to make LPGs more affordable for domestic cooking, especially for the protection of women and children who are primarily exposed.

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