AJMAS
https://journal.utripoli.edu.ly/index.php/Alqalam/index eISSN 2707-7179

Original article

Exposure to Fumes from Mosquito Coils Impairs Cardiac Function and Elevates Serum Markers of Inflammation

Ahmeed A. Idowu, Usman A. Adegoke, Bernard O. Adele, Abayomi O. Ige*

Applied and Environmental Physiology Unit, Department of Physiology, University of Ibadan, Ibadan, Nigeria

ARTICLE INFO

Corresponding Email. *ao.ige@mail1.edu.ng*

Received*: 17-09-2023*
Accepted*: 09-10-2023*
Published*: 11-10-2023*

Keywords*. Mosquito Coil, Cardiac Function, Inflammatory Markers, Malaria Prevention.*

ABSTRACT

Background and aims. *The use of fumes from mosquito coils has been recognized as a malaria preventive measure in rural to local areas in sub-Saharan Africa. The effects of these fumes on cardiac function and serum inflammatory indices are however not yet fully explored. Hence, this study in Wistar rats.* ***Methods.*** *Male animals (n = 40) weighing between 180- 200g were equally divided into 4 groups as follows; Group I was control and animals were not exposed to fumes from mosquito coils. Animals in group II, III and IV were exposed daily, to fumes from pyrethroid-based mosquito coils for 30, 60 and 90 minutes in a modified fume exposure chamber for 28 days, respectively. Thereafter, systolic, diastolic, and heart rate were assessed, while mean arterial and pulse pressure were calculated. Blood samples were also obtained for serum interleukin-6 (Il-6), interleukin-1β (Il-1β), tumor necrosis factor-∝ (TFN-∝), and C-reactive protein (CRP), respectively.* ***Results.*** *Cardiac function was impaired to varied extent in the exposure groups as groups II and IV exhibited reduced systolic blood pressure and heart rate while animals in group III had elevated systolic and diastolic blood pressures compared to controls, respectively. Serum markers of inflammation (Il-6, Il-1β and CRP) were elevated (P<0.05) in all exposure groups compared to controls, while TFN-∝ was unchanged across all groups.* ***Conclusions.*** *This study suggests that exposure to fumes from mosquito coil for prolonged periods may trigger episodes of cardiac dysfunction and upregulate systemic inflammation mediated mechanisms.*

Cite this article. *Idowu AA, Adegoke UA, Adele BO, Ige AO. Exposure to Fumes from Mosquito Coils Impairs Cardiac Function and Elevates Serum Markers of Inflammation. Alq J Med App Sci. 2023;6(2):593-602. https://doi.org/10.5281/zenodo.8432298*

INTRODUCTION

Malaria has been described as one of the most prevalent disease conditions plaguing sub-Saharan Africa [1]. However, following diverse therapeutic interventions, studies have shown that its rate of causing morbidity and mortality have been halved from about 30 to 13 per 100,000 population at risk between the year 2000 and 2019 [2]. The use of the mosquito coil as an antimalaria strategy, has gained widespread patronage in malaria-endemic countries, even though it is not a recommended preventive measure for avoiding mosquitoes [3]. Nevertheless, the use of these coils has come to occupy a certain niche in the control of mosquitoes in low-income areas of sub-Saharan Africa, Asia and South America due to its cheap cost and ready accessibility [3, 4].

These mosquito coils have been reported to contain heavy metals like aluminum, chromium, and tin, insecticide or pesticide (pyrethrin), aromatic substances, and organic fillers capable of burning with smouldering binders and additives [5, 6, 7]. The coils are formulated to allow approximately 6-8 hours of continuous smoldering, such that the insecticide vaporizes slowly to offer protection against the mosquito. The fumes from these coils are said to either repel or reduce the likelihood of being bitten by mosquitos and thus may constitute a malaria preventive measure [7].

Although these fumes are of great importance as a malaria preventive measure [8], they may cause emissions that constitute a potential source of indoor air pollutant [9]. Fumes from mosquito coils have been reported to contain pollutants like polycyclic aromatic hydrocarbons, aldehydes, ketones, carbon monoxide and volatile organic compounds [9]. The most common active ingredients in these mosquito coils are pyrethroids which have been shown to be effective against many genera of mosquitoes including Aedes, Anopheles and Mansonia [6]. These mosquito coils are often burnt overnight in sleeping quarters resulting in elevated exposure to the coil fumes by those sleeping in close proximity. Thus, these fumes are therefore likely to be inhaled, reach the alveolar region of the lung [10], enter the blood stream and reach other tissues and organs such as the heart [11]. The continuous use of fumes from these mosquito coils as a malaria preventive measure therefore, may raise serious environmental health concerns. Furthermore, epidemiologic studies have also shown that long term exposure to fumes from mosquito coils can induce asthma and persistent wheezing in children [12,13]. Toxicological studies following exposure to these fumes in rats have also showed focal deciliation of the tracheal epithelium, metaplasia of epithelial cells and morphologic alteration of the alveolar macrophages [14]. Lung damage which was evident by interstitial accumulations, pulmonary oedema and emphysema as well as intracellular accumulations and severe sinusoidal congestion of hepatic cells have also been observed in rats exposed to fumes from mosquito coils [4].

While many studies have investigated the elemental and organic chemical composition of fumes from mosquito coils [15, 16, 17], and their effects on lung vasculature and function [4, 12-14], very limited investigation have evaluated the effect of prolonged exposure to these fumes on cardiac function and general inflammatory processes in the body. This study was therefore designed to evaluate cardiac function and serum inflammatory markers in rats exposed to mosquito coil fumes for varying durations.

METHODS

Animals and groupings

Male Wistar rats (n = 40) weighing between 180- 200g housed in well-aerated plastic cages and exposed to room temperature with alternating natural day and night cycles. They were acclimatized to laboratory conditions prior to experimental procedures and were allowed free access to food (standard rat chow) and water. The rats were handled according to the ethics of animal handling and treated humanely in accordance with the Guide for the Care and Use of Laboratory Animals [18]. The animals were randomly grouped into 4 equal groups of 10 animals each as follows. Group I was control and was exposed to fresh air. Animals in group II, III and IV were exposed daily to fumes from mosquito coils.

Mosquito coil characteristics

A commercially available brand of mosquito repellent, Rambo Mosquito Coils (Black Big - RB140D10) ™ Gongoni Ltd, Kano, Nigeria), which was purchased from a retail outlet at a local market in Ibadan, Nigeria was used in this study. The spiral mosquito coils were declared to be unbreakable, perfumed, contain 0.02% pyrethroids as the main active ingredient and weigh 100g. Each coil was declared by the manufacturer as being capable of burning for up to 8 hours. However, in this study animals were exposed to fumes from this mosquito coil for 30, 60 and 90 minutes daily for 28 days respectively.

Design of the mosquito coil fume exposure chamber and duration of exposure

The fume exposure chamber was modified version of that described by Owonikoko et al, [19]. Briefly, the fume exposure chamber was a fabricated non-mobile apparatus designed to simulate mosquito coil fume dispersal in an aerated room as it is usually being used across rural Africa, South America and Asia. The exposure chamber was made up of transparent plexiglass arranged in a perfect square (45x50x45cm). An internal sub-chamber (10x13x13cm) is specifically designed to house the burning mosquito coil fumes. Made of plexiglass, the sub chamber is designed to contain the fumes and with its walls adequately perforated, it ensures constant effusion of the fume-laden air into the portion of the chamber housing the rats. This sub-chamber is completely isolated from the portion housing the rats save for the tiny perorations in its walls for the dispersal of fumes to the interior of the chamber. This sub-chamber also houses a miniature metallic quadri-bladded aerator situated anterodorsally. The aerator is a heavy-duty type of model CNS-3 20/620 (serial number S40141392) running on main alternating current of 220 V, power of 27 W, current of 0.25A, and frequency of 50/60 Hz. When connected to a power source the aerator is capable of moving with a speed of 2400/3400 rpm which is capable of delivering the mosquito coil fumes in inhalable form from the sub-chamber to the internal portion of the apparatus housing the experimental animals. Animals in groups II, III and IV were daily transported from their cages to this exposure chamber in batches (n=5) for 30, 60 and 90mins respectively. After each respective exposure period, animals in each group were removed from the exposure chamber and transferred back to

their cages, respectively. Animals in the control group were also placed into the exposure chamber in batches (n=5), the aerators were turned on for 90mins, however no burning mosquito coil was placed in the sub-chamber for dispersal. Thereafter, controls were also removed from the cage and transferred back to their laboratory cage. This exposure protocol was followed each day for the control and experimental animals for 28days, respectively.

Blood pressure analysis

At end of the exposure period, blood pressure in five randomly selected animals per group was evaluated as previously described [20]. Briefly, the systolic and diastolic blood pressure were measured simultaneously non-invasively by tail-cuff method using a CODA blood pressure machine (Kent Scientific Co., USA). The CODA tail-cuff system used volume pressure recording (VPR) to evaluate tail blood volume and hence blood pressure as its method of analysis. The animals were allowed to enter the holders on their own freewill and were maintained therein for at least 10-15 minutes for acclimatization test runs, prior to actual recording of blood pressures. The pulse and mean arterial blood pressures were estimated from the systolic and diastolic pressure measurements, respectively.

Blood collection and biochemical analysis

Blood samples were obtained by the retro-orbital sinus of animals in each group (n=5 / group) after light anesthesia (thiopentone sodium, 30mg/kg) into plain specimen bottles. The samples were allowed to coagulate and centrifuged at 3000 g for 10 min at 4 ◦C to obtain serum. Aliquot of the clear serum obtained was analysed, using commercially available ELISA kits (Elabscience, Houston, USA), for interleukin-6 (Il-6), interleukin-1β (Il-1β), tumor necrosis factor alpha (TFN-∝) and C-reactive protein (C-RP), respectively.

Data collection procedure

Data is presented as mean ± SEM and this was analyzed using one-way analysis of variance while Tukey's honest post-hoc test was used to establish the statistical significance between experimental groups and control at $p < 0.05$.

RESULTS

Systolic and diastolic blood pressure in control and experimental groups

Systolic blood pressure (mmHg) in groups II (124.2±1.9) and IV (118.2±1.5) were significantly reduced ($p<0.05$) while values obtained in group III was significantly increased compared with controls (136.8±1.5), respectively (Figure 1). Diastolic pressure in groups III (113.8±2.5) increased significantly ($p<0.05$) while values observed in group IV (75.5±3.9) were reduced compared with control (97.2±1.8), respectively. No significant differences were observed for diastolic pressure between the control group and animals in group II (Figure 2).

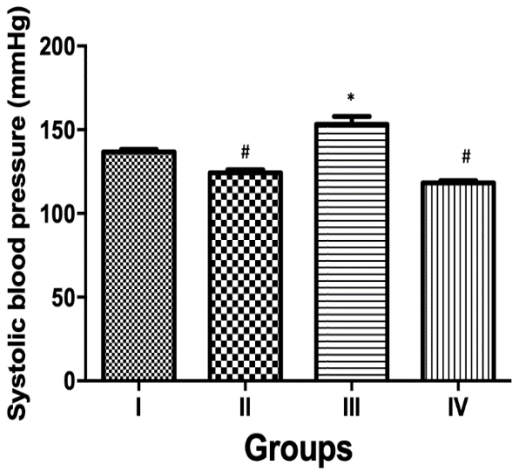

Figure 1. Systolic blood pressure in control and experimental animals exposed to mosquito coil fumes

*Values are mean±SEM and *indicates values that are significantly increased ($p<0.05$) compared with controls, while # indicates values that are significantly decreased ($p<0.05$) compared to controls. I – Controls i.e., animals not exposed to fumes from mosquito coils. II = Animals that were exposed to fumes from mosquito coils daily for 30 mins. III = Animals that were exposed to fumes from mosquito coils daily for 60 mins. IV = Animals that were exposed to fumes from mosquito coils daily for 90 mins.*

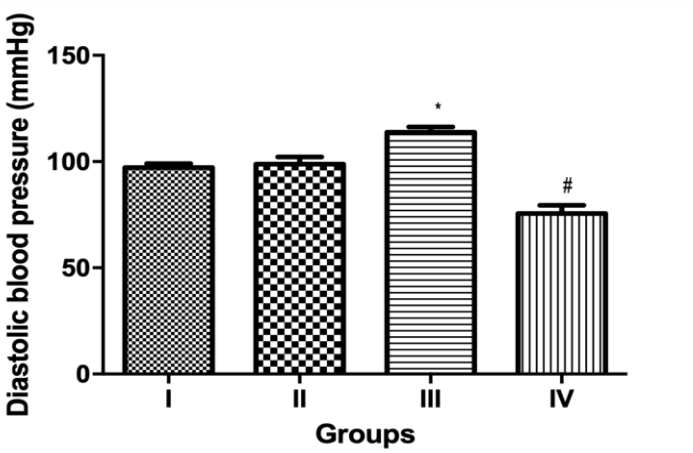

Figure 2. Diastolic blood pressure in control and experimental animals exposed to mosquito coil fumes
*Values are mean±SEM and *indicates values that are significantly increased (p<0.05) compared with controls, while # indicates values that are significantly decreased (p<0.05) compared to controls.*
I – Controls i.e., animals not exposed to fumes from mosquito coils. II = Animals that were exposed to fumes from mosquito coils daily for 30 mins. III = Animals that were exposed to fumes from mosquito coils daily for 60 mins. IV = Animals that were exposed to fumes from mosquito coils daily for 90 mins.

Pulse pressure, mean arterial pressure and heart rate in control and experimental groups

Pulse pressure (mmHg) in group II (25.4±3.6) was reduced (p<0.05) by 35.9%, while values in groups III (39.4±2.6) and IV 42.0±3.5 were comparable with that seen in the control group (39.6±1.7) (Table 1). Compared to controls, mean arterial pressure (mmHg) increased (p<0.05) in group III, reduced (p<0.05) in group IV and were comparable in group II, respectively (Table 1). The heart rate (bpm) in groups II and IV were significantly reduced, while values in group III was comparable with control (Figure 3).

Table 1. Pulse pressure and mean arterial pressure in control and experimental groups

Groups	Pulse pressure (mmHg)	Mean arterial pressure (mmHg)
I	39.6±1.7	110.4±1.5
II	25.4±3.6*	107.3±2.4
III	39.4±2.6	126.9±3.2*
IV	42.0±3.5	89.5±2.9*

*Values are mean±SEM and *indicates values that are significantly different (p<0.05) compared with controls. I – Controls i.e., animals not exposed to fumes from mosquito coils. II = Animals that were exposed to fumes from mosquito coils daily for 30 mins. III = Animals that were exposed to fumes from mosquito coils daily for 60 mins. IV = Animals that were exposed to fumes from mosquito coils daily for 90 mins.*

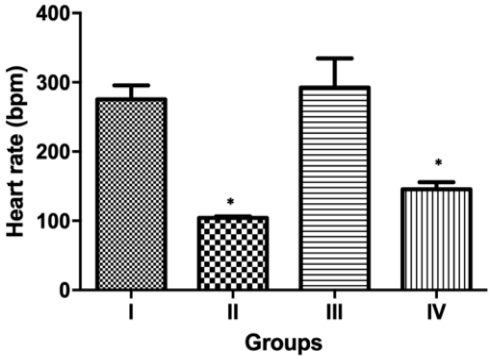

Figure 3. Heart rate in control and experimental animals exposed to mosquito coil fumes
*Values are mean±SEM and *indicates values that are significantly decreased (p<0.05) compared with controls*
I – Controls i.e., animals not exposed to fumes from mosquito coils. II = Animals that were exposed to fumes from mosquito coils daily for 30 mins. III = Animals that were exposed to fumes from mosquito coils daily for 60 mins. IV = Animals that were exposed to fumes from mosquito coils daily for 90 mins.

Selected serum inflammation biomarkers in control and experimental groups

Interleukin-6 values (pg/mL) observed in groups II (0.25±0.02), III (0.19±0.01), and IV (0.20±0.01) were elevated by 56.3%, 18.8%, and 25.0% when compared with control (group I) values (0.16±0.01), respectively (Figure 4). Compared to controls, interleukin-1β (pg/mL) was significantly ($p<0.05$) increased in groups II and IV while values in group III were comparable statistically (Figure 5). No significant difference was observed for tumour necrosis factor-∝ across the different groups (Figure 6). The values for C-reactive protein (ng/mL) observed in groups III (0.13±0.03) and IV (0.33±0.07) were significantly increased ($p<0.05$), while values in group II (0.05±0.01) were comparable with the values in the control group (0.06±0.01), respectively (Figure 7).

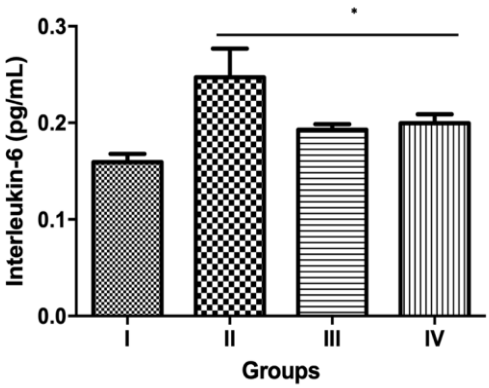

Figure 4. Interleukin-6 in control and animals exposed to mosquito coil fumes *Values are mean±SEM and *indicates values that are significantly increased (p<0.05) compared with controls*
I – Controls i.e., animals not exposed to fumes from mosquito coils. II = Animals that were exposed to fumes from mosquito coils daily for 30 mins. III = Animals that were exposed to fumes from mosquito coils daily for 60 mins. IV = Animals that were exposed to fumes from mosquito coils daily for 90 mins.

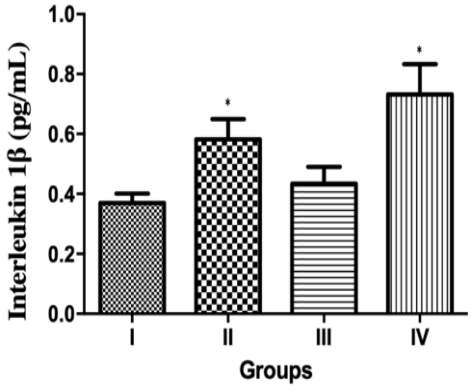

Figure 5. Interleukin-1β in control and animals exposed to mosquito coil fumes

*Values are mean±SEM and *indicates values that are significantly increased (p<0.05) compared with controls I – Controls i.e., animals not exposed to fumes from mosquito coils. II = Animals that were exposed to fumes from mosquito coils daily for 30 mins. III = Animals that were exposed to fumes from mosquito coils daily for 60 mins. IV = Animals that were exposed to fumes from mosquito coils daily for 90 mins.*

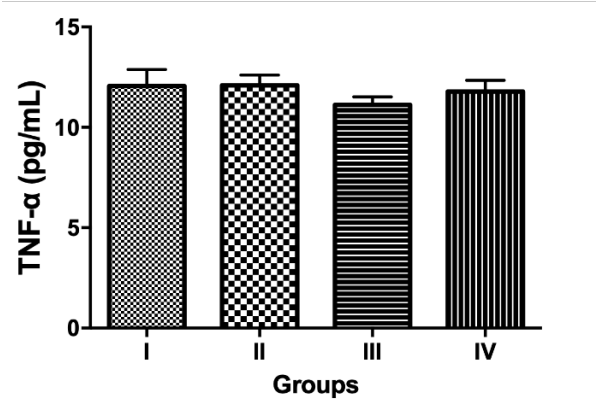

Figure 6: Tumor necrosis factor-alpha (TNF-∝) in control and animals exposed to mosquito coil fumes

Values are mean±SEM.

I – Controls i.e., animals not exposed to fumes from mosquito coils. II = Animals that were exposed to fumes from mosquito coils daily for 30 mins. III = Animals that were exposed to fumes from mosquito coils daily for 60 mins. IV = Animals that were exposed to fumes from mosquito coils daily for 90 mins.

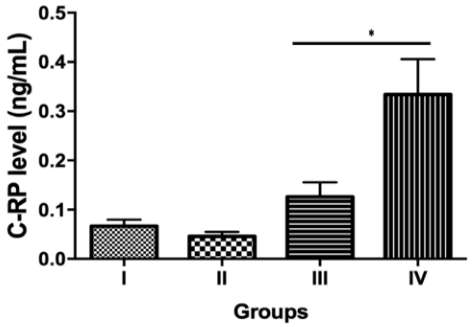

Figure 7. C-reactive protein (C-RP) in control and animals exposed to mosquito coil fumes

*Values are mean±SEM and *indicates values that are significantly increased (p<0.05) compared with controls*

I – Controls i.e., animals not exposed to fumes from mosquito coils. II = Animals that were exposed to fumes from mosquito coils daily for 30 mins. III = Animals that were exposed to fumes from mosquito coils daily for 60 mins. IV = Animals that were exposed to fumes from mosquito coils daily for 90 mins.

DISCUSSION

There are several preventive measures that have been adopted as malaria preventive measure in low-income malaria endemic regions worldwide. Some of these measures include the use aerosols, mosquito coils, liquid vaporizers and vaporizing units which have been reported to reduce the likelihood of being bitten by mosquitos [21]. However, studies highlighting the health risk associated with the continuous exposure to fumes from mosquito coils, has continued to raise some public health concerns [9, 22]. In this study, systolic pressure, the driving force for movement of blood out of the heart, was impaired in the mosquito coil exposure groups in varying degrees (Figure 1). While exposure of experimental animals to fumes from the mosquito coil for short (30minutes) and long term (90mins) daily durations (groups I and III) exerted a suppressive effect on systolic blood pressure, exposure for an intermediate duration (60minutes) daily (group II) exerted a stimulatory effect on the systolic pressure. Furthermore, diastolic blood pressure, the pressure during the resting phase of the heart, was also impaired, with elevations observed in group II and suppression observed in group III (Figure 2). These observations suggest that exposure to fumes from mosquito coils for short and long durations daily, may induce hypotensive conditions while exposure daily for intermediate durations of one hour, may induce hypertensive conditions.

The heart, a highly active pump that has a high metabolic rate which is required to meet its high-energy demand, has been reported to possess reduced amounts of superoxide dismutase, catalase, and glutathione peroxidase which makes it therefore prone to oxidative injury [23, 24]. It has also been observed to be the first recipient of the lung drainage. Hence, fumes from mosquito coils which have been reported to contain the pyrethroids, and toxic substances such carbon monoxide, volatile organic compounds, sulphur dioxide, nitrogen dioxide and particulate matter [7], may enter the blood stream and exert direct cardiotoxic effects on the heart.

In most common mosquito coils, pyrethroids have been have been identified as the most active ingredient as it has been observed to be effective against many genera of mosquitoes [25]. According to the manufacturer details, the mosquito coil used in this study contained pyrethroids (0.2%). Pyrethroids have been reported to impair the activities of voltage-gated sodium channels [26]. It is said to act on the α subunit of the channel causing its permanent opening and preventing the closure of the channel [27]. Within excitable cells, this has been reported to result in sustained influx of sodium ions and hence persistent depolarization of the cell [26]. Studies have also reported that exposure to pyrethroid-based insecticides in the early stages of life can result in cardiac hypertension, elevated calcium levels, and increased systemic oxidative at elderly age [28]. It is therefore not unlikely that the impairment in cardiac function observed in this study maybe due to oxidative injury to and impaired signaling of the cardiomyocytes and autorhythmic cells caused by the inhaled pollutants from the mosquito coil (especially pyrethroids) resulting in impaired signaling and contractile activity in these cells.

The pulse pressure represents the force that the heart generates each time it contracts and is often evaluated clinically as a risk factor for the development of heart disease [29]. While a narrow (reduced) pulse pressure has been reported to suggest the likely presence of several heart diseases such as heart failure, blood loss, aortic stenosis, and decreased cardiac filling time, a high pulse pressure is said to be indicative of valve regurgitation, disorders of heart rhythms, and stroke [30]. This study shows a reduction in pulse pressure (Table1) and heart rate (Figure 3) in group II which aligns with the reduced systolic blood pressure also observed in this group (Figure 1) and suggests the likely presence of cardiac diseases in this group (30minutes mosquito coil-fume exposure group). The pulse pressure in groups III (60minutes mosquito coil-fume exposure group) and IV (90minutes mosquito coil-fume exposure group) were not significantly different from controls (Table 1). The authors speculate that this latter observation may be ascribed to vascular vasodilation which might have occurred in response to elevated systolic and diastolic pressures in the case of animals in group III (Figure 1) and reflex vasoconstriction in some arterial vessels in an attempt to compensate for reduced systolic pressure, diastolic pressure and heart rate (Figure 1-3) which was observed in group IV.

Furthermore, animals in group III also exhibited an increase in mean arterial pressure which is consistent with the previously observed increased systolic pressure in the group, while animals in group IV showed reduced mean arterial pressure which also aligns with the reduced blood pressures (systolic and diastolic) and heart rate which was also observed in this group. Interestingly, animals in group II which also exhibited reduced systolic and heart rate did not show significant variations in mean arterial pressure compared to controls.

The blood pressure is said to be primarily a function of the pumping action of the heart. However, the regulation of blood pressure in circulation, rests in the activities of cardiac baroreceptors, vascular resistance within the arterioles, and renal control of blood volume [31]. The blood pressure regulatory activities may be broadly divided into short-term mechanism, which are mediated through the baroreceptor reflex, and long-term regulatory mechanisms, which involve the activities of the kidney in regulating the blood volume via the renin-angiotensin-aldosterone system (RAAS) mediated mechanisms. The effects of exposure to pyrethroids, which come in two main classes- type I and II [32], on mammals have been reported to include changes in the conformation of sodium channels, chloride channels and GABA-

aminergic mediated channels in excitable tissues which result in persistent depolarization and hence excitation [32, 33]. It is therefore likely, aside from impairment to the electrical and contractile functions of the myocardial cells, fumes (which contain pyrethroids and other pollutants) from the mosquito coils may also impair the RAAS mediated control of blood pressure and hence maybe responsible for the alterations in heart rate, pulse pressure and mean arterial pressure observed in the fume exposed animals. Moreso that impaired renal function have also been associated with exposure to fumes from mosquito coils [34]. The indices of cardiac function assessed in this study also appear to depict a stimulation of cardiac function in the intermediate term daily duration (60minutes) and suppression of cardiac function in the short-term (30minutes) and long-term (90minutes) daily exposure groups, respectively, suggesting an exposure-duration dependent effect.

This study also shows that exposure to fumes from mosquito coils for durations ranging from 30-90 minutes per day also exert downstream effects other than in the lungs [4] as some serum inflammation markers (Il-6, Il-1β, C-RP) were observed to be elevated in varying degrees in the exposure groups. The highest levels of these serum inflammation markers were observed in the 90miuntes per day mosquito fume exposure group suggesting that prolonged exposure may activate systemic inflammatory processes. These observations are consistent with that of Vadhana et al. [28], who also reported elevated levels in serum markers of oxidative stress and inflammation following exposure to pyrethroid-based insecticides. However, TNF-$\propto$, an inflammatory cytokine produced by macrophages/monocytes during acute inflammation and is responsible for a diverse range of cellular signaling events leading to necrosis or apoptosis, was not different between control and experimental groups. It is likely, the systemic inflammation caused by exposure to fumes from the pyrethroid-based mosquito coils may not be very severe as at the time samples were collected. Perhaps for if exposure periods had been extended to 6-8 hours daily as it is mostly used in rural areas in sub-Saharan Africa, South America and Asia, it might have resulted in the triggering of a more severe systemic inflammatory response.

CONCLUSION

This study has demonstrated that exposure to fumes from mosquito coils, especially pyrethroid based mosquito coils, exerts deleterious downstream effects, (other than pulmonary impairment and function), on cardiac function as well as upregulates systemic inflammatory processes. The severity of these observed dysfunctions may be exposure-duration dependent with longer exposure periods per day exerting greater deleterious effects.

Acknowledgments

The authors would like the acknowledge the assistance of Dr. M.W. Owonikoko, Department of Physiology, Igbinedion University, Okada for technical support while constructing the fume exposure chamber utilized in this study.

Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

REFERENCES

1. Badmos AO, Alaran AJ, Adebisi YA, Bouaddi O, Onibon Z, Dada A, Lin X, Lucero-Prisno III DE. What sub-Saharan African countries can learn from malaria elimination in China. Trop Med Health 2021; 49:86. doi.org/10.1186/s41182-021-00379-z
2. World Health Organization (WHO). World malaria report 2020: 20 years of global progress and challenges. Geneva: World Health Organization; 2020.
3. Hogarh JN, Antwi-Agyei P, Obiri-Danso K. Application of mosquito repellent coils and associated self-reported health issues in Ghana. Malar J 2016; 15:61. doi.org/10.1186/s12936-016-1126-8
4. Taiwo Idowu E, Aimufua OJ, Yomi-Onilude E, Akinsanya B, Adetoro Otubanjo O. Toxicological effects of prolonged and intense use of mosquito coil emission in rats and its implications on malaria control. Revista de Biología Tropical, 2013; 61(3): 1463-1473.
5. McEween FL, Stephenson GR. The use and significance of pesticides on environment. 2nd edition, John Wiley and Sons Publishers, New York. 120 – 126, 1979.
6. Krieger RL, Dinoff M, Zhang X. Octachlorodiphenyl ether. Mosquito coils are inadequately studied for residential use in Asia and illegal in the United States. Environmental Health Perspective, (2003); 3:12-15.
7. Hogarh JN, Agyekum TP, Bempah CK, Owusu-Ansah EDJ, Avicor SW, Awandare GA, Fobil JN, Obiri-Danso K. Environmental health risks and benefits of the use of mosquito coils as malaria prevention and control strategy. Malar J 2018;17: 265. doi.org/10.1186/s12936-018-2412-4
8. Syed M, Balowria KS, Tousia S, Jabeen N, Faruqi NA. Histopathological and Haematological Effects of Mosquito Coil Smoke on Lungs - An Experimental Study on Albino Rats. Academia Anatomica International, 2019, 5(1): 54-58.

9. Liu W, Zhang J, Hashim JH, Jalaludin J, Hashim Z, Goldstein BD. Mosquito coil emissions and health implications. Environ Health Perspect. 2003; 111(12):1454-60. doi: 10.1289/ehp.6286.
10. Cheng V, Lee HR, Chen CS. Morphological changes in the respiratory system of mice after inhalation of mosquito-coil smoke. Toxicol. Lett., 1992; 62: 163-177.
11. Ahmad S, Ahmad A, Hendry-Hofer TB, Loader JE, Claycomb WC, Mozziconacci O, Schöneich C, Reisdorph N, Powell RL, Chandler JD, Day BJ, Veress LA, White CW. Sarcoendoplasmic reticulum Ca (2+) ATPase. A critical target in chlorine inhalation-induced cardiotoxicity. Am J Respir Cell Mol Biol. 2015; 52(4):492-502. doi: 10.1165/rcmb.2014-0005OC. Erratum in: Am J Respir Cell Mol Biol. 2021 Jan;64(1):149.
12. Azizi BH, Henry RL. The effects of indoor environmental factors on respiratory illness in primary school children in Kuala Lumpur. Int J Epidemiol 1991; 20: 144-50. 10.1093/ije/20.1.144
13. Fagbule D, Ekanem EE. Some environmental risk factors for childhood asthma: a case-control study. Ann Trop Paediatr 1994; 14: 15-9.
14. Liu WK and Sun SE. Ultrastructural Changes of Tracheal Epithelium and Alveolar Macrophages of Rats Exposed to Mosquito Coil Smoke. Toxicol Lett. 1988; 41(2):145-157.
15. Kasumba J, Hettick B, French A. Wickliffe JK, Lichtveld MY, Hawkins WB, van Sauers-Muller A, Klein D Wickliffe JK, Lichtveld MY, Hawkins WB, van Sauers-Muller A, Klein D. Analysis of Pesticides and Toxic Heavy Metals Contained in Mosquito Coils. Bull Environ Contam Toxicol 2016; 97, 614–618. doi.org/10.1007/s00128-016-1938-9
16. Dubey J, Banerjee A, Meena RK, Kumari KM, Lakhani A. Characterization of polycyclic aromatic hydrocarbons in emissions of different mosquito coils. Bull Environ Contam Toxicol 2014; 92(6):650–654
17. Yang TT, Lin ST, Lin TS, Chung HY. Characterization of polycyclic aromatic hydrocarbon emissions in the particulate and gas phase from smoldering mosquito coils containing various atomic hydrogen/carbon ratios. Science of The Total. Environment, 2015; 506–507:391–400.
18. National Research Council. Guide for the Care and Use of Laboratory Animals, National Academy Press, Washington, DC, 1996.
19. Owonikoko MW, Emikpe BO, Olaleye SB. Standardized experimental model for cement dust exposure; tissue heavy metal bioaccumulation and pulmonary pathological changes in rats. Toxicol Rep. 2021; 3(8):1169-1178. doi: 10.1016/j.toxrep.2021.06.001.
20. Ige AO, Olaoye MO, Oluwole DT, Ayeni GT, Adewoye EO. Route of exposure influences the cardiovascular effects of Cannabis sativain salt-induced hypertensive male Wistar rats. J. Afr. Ass. Physiol. Sci. 2021; 9(2): 74-88.
21. Khadijah AA, Gamide SM, Hauwa K, Perede A, Musa AA, Aisha A, Dansy AG, Amina G. Some nephrotoxic effects of commonly used mosquito repellents in Sokoto State, Nigeria. East African Scholars Journal of Medical Sciences (2020); 3(6): 212-217.
22. Anyabolu AE, Ezejindu DN, Obinwa BN. Evaluation of toxic effect of d-alletrin based mosquito's coil on the lungs and selected haematological parameters of adult Wistar rats. J Adv Med Pharmac Sci 2021; 23(4):9–19
23. Damiani RM, Piva MO, Petry MR, Saldiva PH, Tavares Duarte de Oliveira A, Rhoden CR. Is cardiac tissue more susceptible than lung to oxidative effects induced by chronic nasotropic instillation of residual oil fly ash (ROFA)? Toxicol Mech Methods. 2012; 22:533–539.
24. Costa VM, Carvalho F, Duarte JA, Bastos Mde L, Remiao F. The heart as a target for xenobiotic toxicity: the cardiac susceptibility to oxidative stress. Chem Res Toxicol. 2013; 26:1285–1311.
25. Lukwa N and Chandiwana SK. Efficacy of Mosquito Coil Containing 0.3% and 0.4% Pyrethrin Against An. Gambiae Sensu Lato Mosquitoes. Cent Afr J Med.1998; 44(4):104-107.
26. Bradberry SM, Cage SA, Proudfoot AT, Vale JA. Poisoning due to Pyrethroids. Toxicol. Rev. 2005; 24: 93–106.
27. Soderlund DM. Molecular mechanisms of pyrethroid insecticide neurotoxicity: Recent advances. Arch. Toxicol. 2012; 86: 165–181.
28. Vadhana MS, Arumugam SS, Carloni M, Nasuti C, Gabbianelli R. Early life permethrin treatment leads to long-term cardiotoxicity. Chemosphere 2013; 93: 1029–1034.
29. Domanski M, Norman J, Wolz M, Mitchell G, Pfeffer M. Cardiovascular Risk Assessment Using Pulse Pressure in the First National Health and Nutrition Examination Survey (NHANES I). Hypertension, 2001; 38(4); 793-797. doi.org/10.1161/hy1001.092966
30. Homan TD, Bordes SJ, Cichowski E. Physiology, Pulse Pressure. [Updated 2022 Jul 12]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482408/
31. Izzo JL, Taylor AA. The sympathetic nervous system and baroreflexes in hypertension and hypotension. Current Science Inc, 1999; 1: 254–263. doi.org/10.1007/s11906-999-0030-9
32. Chrustek A, Hołyn´ska-Iwan I, Dziembowska I, Bogusiewicz J, Wróblewski M, Cwynar A, Olszewska-Słonina D. Current Research on the Safety of Pyrethroids Used as Insecticides. Medicina 2018; 54: 61.
33. Costa LG. The neurotoxicity of organochlorine and pyrethroid pesticides. Handb. Clin. Neurol. 2015; 131: 135–148.
34. Abdrabouh AE. Susceptibility of young and adult rat kidneys to impacts of mosquito coil fumes, Egyptian Journal of Basic and Applied Sciences, 2021; 8:1, 1-11, doi: 10.1080/2314808X.2020.1839850

AJMAS
https://journal.utripoli.edu.ly/index.php/Alqalam/index eISSN 2707-7179

التعرض للأبخرة المنبعثة من لفائف البعوض يضعف وظيفة القلب ويرفع علامات الالتهاب في الدم

أحمد أ. إيدو، عثمان أ. أديجوكي، برنارد أو. أديل، أبايومي أو. إيجي

وحدة علم وظائف الأعضاء التطبيقية والبيئية، قسم علم وظائف الأعضاء، جامعة إبادان، إبادان، نيجيريا

المستخلص

الخلفية والاهداف. تم الاعتراف باستخدام الأبخرة المنبعثة من لفائف البعوض كإجراء وقائي ضد الملاريا في المناطق الريفية والمحلية في أفريقيا جنوب الصحراء الكبرى. ومع ذلك، فإن تأثيرات هذه الأبخرة على وظيفة القلب ومؤشرات الالتهاب في الدم لم يتم استكشافها بالكامل بعد. ومن هنا جاءت هذه الدراسة على فئران ويستار. **طُرق الدراسة**. تم تقسيم الحيوانات الذكور (ن = 40) التي يتراوح وزنها بين 180-200 جرام بالتساوي إلى 4 مجموعات على النحو التالي؛ المجموعة الأولى كانت مسيطرة ولم تتعرض الحيوانات للأبخرة المنبعثة من لفائف البعوض. تم تعريض الحيوانات في المجموعة الثانية والثالثة والرابعة يوميًا للأبخرة المنبعثة من لفائف البعوض القائمة على البيرثرويد لمدة 30 و60 و90 دقيقة في غرفة التعرض للدخان المعدل لمدة 28 يومًا على التوالي. بعد ذلك، تم تقييم معدل ضربات القلب الانقباضي والانبساطي، في حين تم حساب متوسط الضغط الشرياني والنبض. تم الحصول على عينات دم أيضًا للإنترلوكين -6 (Il-6)في الدم، والإنترلوكين -1(Il-1β) β، وعامل نخر الورم(TFN-∝) ∝-، والبروتين التفاعلي(CRP) C ، على التوالي. **النتائج**. وتعرضت وظيفة القلب للضعف بدرجات متفاوتة في مجموعات التعرض، حيث أظهرت المجموعتان الثانية والرابعة انخفاضًا في ضغط الدم الانقباضي ومعدل ضربات القلب بينما كانت المجموعة الثالثة للحيوانات تعاني من ارتفاع ضغط الدم الانقباضي والانبساطي مقارنة بالمجموعة الضابطة، على التوالي. كانت علامات الالتهاب المصلية6-Il) ، وβ-Il1، و (CRPمرتفعة (P<0.05) في جميع مجموعات التعرض مقارنة بالضوابط، في حين لم يتغير TFN-∝ في جميع المجموعات. **الاستنتاجات**. تشير هذه الدراسة إلى أن التعرض للأبخرة المنبعثة من لفائف البعوض لفترات طويلة قد يؤدي إلى حدوث نوبات من خلل وظيفي في القلب وينظم آليات الالتهاب الجهازي.

الكلمات الدالة. لفائف البعوض، وظيفة القلب، علامات الالتهاب، الوقاية من الملاريا.