Original Article

Evaluation of Cardiovascular Risk among Carpenter Cabinetmakers in the Dakar Region: Study of Vascular Function and Heart Rate Variability

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Abstract

Background: Contemporary concerns recognize atmospheric air pollution as a significant contributor to cardiovascular diseases. Notably, wood dust, colloquially known as sawdust, emerges as a source of air pollution. Our investigation sought to assess the impact of wood dust on the cardiovascular health of carpenters in the Dakar region.

Methods: This cross-sectional study encompassed one hundred (100) carpenters in the Dakar region. A comprehensive questionnaire gathered data on socio-demographic features, professional experience, medical history, preventive measures, and lifestyle habits. Vascular function assessment involved determining finger-toe pulse wave velocity (ft-PWV) using a popmeter. Additionally, we screened for obliterative arteriopathy of the lower limbs (OALL). Heart rate variability measurement provided insights into the sympatho-vagal balance of nervous control over cardiac activity.

Results: The average age in our population was 38 ±7.2 years, with a body mass index of 22.7 ±2.8 kg/m2. A majority (69%) worked an average of 10.2 hours per day for six days per week. Approximately 73% of the shops were observed to be enclosed. Respiratory and ocular symptoms were prevalent among participants. Analysis using the Pop meter revealed arterial stiffness (ft-PWV>10 m/s) in 3% of participants, and 11% exhibited arterial hypertension. OALL was present in 8% of participants. Furthermore, a positive correlation (P=0.003; r=0.581) between ft-PWVV and mean arterial pressure was noted. Data on cardiac variability indicated a substantial proportion of participants displaying decreased tone in the cardiac-parasympathetic nervous system in the supine position (94.73% had RMSSD values above norms). Notably, abnormal activation of the parasympathetic system (HF) and decreased sympathetic system activity (low values for HF, LF, and LF/HF compared with norms) were observed in the orthostatic position.

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Conclusion: Carpentry work in environments with elevated air pollution, potentially emanating from wood dust, poses inhalation risks for workers. The inhalation of wood dust appears linked to an increased risk and exacerbation of cardiovascular complications.

Keywords: Air pollution, Wood dust, Cardiovascular system, Finger-to-eye pulse wave velocity, Heart rate variability

Introduction

Woodworking, a craft deeply intertwined with human history, serves as the foundation for countless structures and artifacts. However, the very nature of this craft exposes artisans, particularly carpenters and cabinetmakers, to potential health risks associated with their occupational environment[1]. This study delves into the cardiovascular health of carpenter and cabinetmaker populations in the Dakar region, shedding light on the intricate interplay between occupational exposure, vascular function, and heart rate variability.

Occupational hazards in woodworking extend beyond the immediate concerns of cuts and splinters. The inhalation of wood dust, a ubiquitous byproduct of carpentry, has long been identified as a potential health risk, with respiratory and cardiovascular implications[1]. Additionally, the physical demands of the profession, characterized by prolonged periods of standing, lifting, and manual labor, may contribute to cardiovascular strain over time[2].

The current research emerges against the backdrop of a global surge in awareness regarding occupational health. While the focus has often been on respiratory effects, this study aims to unravel the intricate cardiovascular dynamics that may be influenced by the occupational milieu of carpenters and cabinetmakers in the Dakar region.

The assessment of cardiovascular risk in this population involves a multifaceted approach, incorporating an exploration of vascular function and heart rate variability. Vascular function, encompassing parameters such as arterial stiffness and pulse wave velocity, provides insights into the structural integrity and elasticity of blood vessels[3]. Simultaneously, heart rate variability serves as a window into the intricate balance of the autonomic nervous system, reflecting the adaptability and responsiveness of the cardiovascular system to various stressors[4].

The correlation between woodworking, cardiovascular health, and autonomic regulation has been a subject of limited exploration. Our study endeavors to bridge this gap by comprehensively evaluating the cardiovascular risk profile of carpenter and cabinetmaker populations in Dakar. The inclusion of both vascular function and heart rate variability metrics ensures a holistic understanding of the cardiovascular implications associated with this occupation.

As we navigate the intricate tapestry of occupational health, this research not only contributes to the scientific discourse on the cardiovascular effects of woodworking but also holds potential implications for occupational safety guidelines and health interventions tailored to this specific artisanal community. Through rigorous examination and correlation of data, we aspire to illuminate the nuanced relationship between woodworking occupations and cardiovascular well-being, providing valuable insights for both practitioners and policymakers alike.

Methods

Study Design and Participants:

This cross-sectional study aims to evaluate the cardiovascular risk among carpenters and cabinetmakers in the Dakar region, focusing on vascular function and heart rate variability. The research adheres to ethical principles and has received approval from the ethics committee of the Dakar Faculty of Medicine. Informed consent was obtained from all participants.

The study population included male carpenters and cabinetmakers aged 25 to 60 years, with at least five years of professional exposure. Individuals with pre-existing cardiovascular conditions, respiratory disorders, or those on medications affecting cardiovascular function were excluded.

Data Collection:

Demographic and Occupational Data:For each participant, information was collected on age, smoking status, and duration of woodworking exposure. Occupational history, including specific tasks performed and the type of wood commonly worked with, was documented.

Anthropometric and cardiovascular Measurements Height, weight, waist circumference, and blood pressure (systolic, diastolic arterial pressures) were measured using standardized procedures. Mean arterial pressure (MAP) was calculated as follows: SAP + 2 x DAP) / 3

Vascular Function Assessment: :was evaluated by finger-toe pulse wave velocity (ft-PWV) using non-invasive tonometry (popmetry). The Arterial Stiffness was revealed when ft-PWV>10 m/s. The pop meter software indicated also the index for obliterative arteriopathy of the lower limbs (OALL).

Heart Rate Variability (HRV) Measurement:

- Participants underwent continuous electrocardiogram (ECG) monitoring for at least 10 minutes under controlled conditions.

HRV parameters, including time-domain (SDNN, RMSSD) and frequency-domain (LF, HF, LF/HF ratio) measures, were analyzed using dedicated software.

Statistical Analysis:

Descriptive statistics summarized demographic, occupational, and clinical characteristics. Continuous variables were expressed as means ± standard deviations or medians (interquartile ranges) based on data distribution. Categorical variables were presented as percentages.

Associations between woodworking exposure, vascular function parameters, and HRV measures were assessed using regression models. Subgroup analyses based on age, and duration of exposure were performed.

Statistical significance was set at $p < 0.05$. Data analysis was conducted using R software, and the results were reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Results

The investigation involved a cohort of one hundred carpenters in the Dakar region, revealing pertinent insights into the interplay between wood dust exposure and cardiovascular health.

Demographic and Work Characteristics: The participants, with an average age of 38 ± 7.2 years and a mean body mass index of 22.7 ± 2.8 kg/m², engaged in demanding work routines. A majority, 69%, toiled for an average of 10.2 hours daily, six days a week, within often enclosed shops.

Symptoms and Working Conditions: A noteworthy finding was the prevalence of respiratory and ocular symptoms reported by the carpenters. This underscores the potential health impact of prolonged exposure to wood dust within the working environment.

Table 1outlines the prevalence of working conditions and protective measures. Notably, 73% of carpentry shops were closed, and 51% of participants reported using masks for protection.

Table 1: Working Conditions and Protective Measures

Variables	Numbers (n)	Pourcentage (%)
Farm workshops	73	73
Open workshops	27	27
Wearing a mask	52	51
Wearing glasses	3	3
Wearing gloves	1	1

Clinical Manifestations: The study identified various clinical manifestations among carpenters. Respiratory and ENT (Ear, Nose, and Throat) issues accounted for 30.65%, cardiovascular problems for 27.10%, ocular and cutaneous concerns for 24.84%, and neurological complications for 17.42%. Table 2 represents the different categories of clinical manifestations noted among carpenters.

Among respiratory and ENT disorders, sneezing was the most common symptom, reported by 19.02% of participants.

Cardiovascular disorders were dominated by palpitations affecting 57.58% of participants followed by heart cramps with 29.55%.

The eye and skin symptoms reported were predominated by eye irritation 26.49% and itchy skin (25.83%).

Regarding neurological symptoms, memory disorders were predominant at 27.42% followed by headaches (24.87%).

Table 2: clinical manifestations among carpenters

Signs	Numbers (n)	Pourcentages (%)
Respiratory and ENT Troubles		
Sneeze	70	19.02
Cough	49	13.32
Nasal obstruction	51	13.86
Chest pain	29	7.88
Dyspnea	19	5.16
Chronicphlegm	29	7.88
Pneumonia	35	9.51
Rhinitis	18	4.89
Expectoration	34	9.24
Throat irritation	34	9.24
Cardiovascular Troubles		
High blood pressure	15	11.36
Palpitation	76	57.58
Cardiacarrythmia	2	1.51
Heartcramp	39	29.55
Ocular and Cutaneous Symptoms		
Eye irritation	40	26.49
Itching	39	25.83
Dermatitis	33	21.85
Tearing	20	13.85
Rashes	14	9.27
conjonctivitis	5	3.31
Neurological Symptoms		
Memory problems	54	27.42
Headache	49	24.87
Dizziness	40	20.30
Behavioraldisorders	8	4.06
Sleepdisorder	46	23.35

Vascular Function Assessment: Utilizing popmeter technology, the study identified 3% of participants with elevated finger-to-toe pulse wave velocity (ft-PWV>10 m/s), signifying arterial stiffness. Concomitantly, 11% of the cohort exhibited arterial hypertension, indicating a potential association between wood dust exposure and adverse cardiovascular effects.Table 3 presents the results of vascular function parameters.

Table 3: ft-PWVand OALL Results

Variables	Mean± Standard deviation	[min-max]	Frequency
ft-PWV	6, 6 ± 1	[4,3-9, 7]	97 %
ft-PWV>10m/s	12,5 ± 1,1	[11,6-14,2]	3 %
OALL	—	—	8 %

Arterial Obstructive Disease: Obliterative arteriopathy of the lower limbs (OALL)was observed in 8% of participants. This finding suggests that the vascular system, particularly in the lower limbs, may be adversely affected by the nature of carpentry work and associated wood dust exposure.

Correlation Analysis: A statistically significant positive correlation (P=0.003; r=0.581) between finger-to-toe pulse wave velocity (ft-PWV and mean arterial pressure was discerned. This correlation underscores a potential link between wood dust exposure and alterations in cardiovascular parameters.

Heart Rate Variability (HRV) Analysis: Assessment of heart rate variability unveiled intriguing patterns. In the supine position, 94.73% of participants exhibited decreased tone of the cardiac-parasympathetic nervous system, as indicated by RMSSD values above norms (table 4). In the orthostatic position, abnormal activation of the parasympathetic system (HF) coupled with decreased sympathetic system activity (low values for HF, LF, and LF/HF compared with norms) was observed (table 5).

These findings underscore the complex relationship between wood dust exposure and cardiovascular health among carpenters in the Dakar region.

Table 4: Results of the overall activity of the Autonomic Nervous System in decubitus

Parameters	Age group (years)	Low values (%)	Normal values (%)	High values (%)
SDNN (ms)	20-30	100	0	0
	30-40	97.73	0	2.27
	40-50	100	0	0
	50-60	100	0	0
RMSSD (ms)	20-30	5.27	0	94.73
	30-40	11.37	2.27	86.36
	40-50	14.81	0	85.19
	50-60	30	0	70
PNN_{50} (%)	20-30	5.27	0	94.73
	30-40	0	2.27	97.73
	40-50	25.92	0	74.08
	50-60	10	0	90

SDNN: Standard deviation of all normal RR intervals;

RMSSD: The root mean square of successive differences between normal heartbeats R-R intervals;

PNN50: percentage of R-R intervals for which there is a difference of more than 50 ms from the previous R-R interval.

Table 5: Results of sympathetic-vagal balance activity in decubitus

Parameters	Age group (years)	Low values (%)	Normal values (%)	High values (%)
LF (ms) ²	20-30	21.05	0	78.95
	30-40	40.90	0	59.10
	40-50	25.92	0	74.08
	50-60	40	0	60
HF (ms) ²	20-30	5.26	0	94.74
	30-40	11.36	0	88.64
	40-50	7.40	0	92.60
	50-60	30	0	70
LF/HF	20-30	15.79	0	84.21
	30-40	34.10	0	65.90
	40-50	40.74	0	59.26
	50-60	30	0	70

LF: Low Frequency; **HF:** High Frequency

Discussion

The findings of our study shed light on the multifaceted impact of wood dust exposure on the cardiovascular health of carpenters in the Dakar region. The observed prevalence of respiratory, cardiovascular, ocular, and neurological symptoms underscores the occupational health risks associated with carpentry, particularly in environments where wood dust is a prominent factor.

Respiratory and ENT Manifestations: The high prevalence of respiratory and ENT symptoms, including sneezing, cough, and nasal obstruction, suggests a substantial burden on the respiratory system among carpenters. These findings align with previous research linking wood dust exposure to respiratory issues, emphasizing the need for adequate respiratory protection measures [7–10]. As evidenced by the low utilization of masks (51%) among participants, there is a clear need for improved adherence to safety measures[11,12].

Cardiovascular Implications: Cardiovascular concerns, such as palpitations and cardiac cramps, were notably prevalent among the carpenters in our study. The correlation between arterial stiffness (ft-PWV>10 m/s) and mean arterial pressure underscores the potential impact of wood dust exposure on vascular function [2,13]. The association between occupational wood dust exposure and arterial hypertension has been recognized [14], emphasizing the importance of cardiovascular assessments in carpentry occupational health. Tanko et al, in Nigeria found that the effect of wood dust on carpenters increases the arterial blood pressure, decreases the forced vital capacity, forced expiratory volume in 1 sec and peak expiratory flow rate[2].

Ocular and Cutaneous Effects: The ocular and cutaneous symptoms reported including eye irritation and dermatitis, align with the irritant nature of wood dust. The low usage of goggles (3%) indicates a potential gap in protective measures against ocular exposures. Occupational safety measures should emphasize the importance of eye protection to prevent these symptoms[15].

Neurological Implications: Neurological symptoms, particularly memory troubles and headaches, were prevalent in our study cohort. While the exact mechanisms linking wood dust exposure to neurological effects warrant further investigation[16,17], these findings highlight the need for comprehensive neurological assessments and monitoring among carpenters.

Vascular Function Parameters: The majority of participants exhibited a ft-PWV below 10 m/s, indicating normal vascular function. However, the 3% with arterial stiffness and 8% with lower limb arteriopathy (OALL) emphasize the need for cardiovascular screening in carpentry occupational health programs[2,3]. The positive correlation between ft-PWV and mean arterial pressure further supports the potential cardiovascular implications of wood dust exposure[9,10,12,18].

The observed correlations and prevalence of arterial stiffness, hypertension, and OALL highlight the need for comprehensive occupational health measures and further research in this field.

These detailed findings provide a comprehensive understanding of the health implications of wood dust exposure among carpenters in the Dakar region. The reported symptoms and vascular function parameters underscore the need for targeted interventions and occupational health initiatives within this profession. Figures and detailed prevalence tables contribute valuable insights for further research and policy development.

Study Strengths and Limitations:

Strengths: Firstly. our study provides a thorough examination of the cardiovascular health of carpenters. encompassing respiratory. cardiovascular. ocular. and neurological aspects. This comprehensive approach contributes to a more nuanced understanding of the health implications associated with wood dust exposure. Secondly **t**he use of finger-to-toe pulse wave velocity (ft-PWV) as an indicator of vascular function adds an objective dimension to our cardiovascular assessments. This measure enhances the precision and reliability of our findings. particularly in evaluating the impact of wood dust on arterial stiffness. **Thirdly with** a sample size of one hundred carpenters. our study achieves a robust representation of the carpentry workforce in the Dakar region. This large sample size enhances the generalizability of our findings to the broader population of carpenters exposed to wood dust.

Limitations: The cross-sectional nature of our study limits our ability to establish causal relationships between wood dust exposure and cardiovascular outcomes. Future longitudinal studies are essential to explore the temporal dynamics of these associations. Furthermore, the reliance on self-reported symptoms introduces the potential for recall bias. Participants may not accurately recall or report all symptoms.

impacting the precision of our findings. Future research could benefit from incorporating objective measures to complement self-reported data. Thirdly **o**ur study focuses on carpenters in the Dakar region. and while this provides valuable insights into a specific population. it may limit the generalizability of our findings to carpenters in other geographic locations with potentially different environmental conditions. Lastly, although our study identifies neurological symptoms. the assessment is exploratory. Future research should employ more in-depth neurological evaluations to better understand the nature and extent of neurological effects associated with wood dust exposure.

Longitudinal studies are warranted to explore the cumulative effects of wood dust exposure on cardiovascular health. Additionally, future research should consider objective measures and biomarkers to enhance the accuracy of health assessments.

Conclusion

In conclusion. our study provides comprehensive insights into the cardiovascular implications of wood dust exposure among carpenters in the Dakar region. The high prevalence of respiratory. cardiovascular. ocular. and neurological symptoms. coupled with vascular function parameters. underscores the need for targeted occupational health interventions. Initiatives promoting respiratory protection. cardiovascular monitoring. and neurological assessments can contribute to mitigating the health risks associated with carpentry. Occupational health programs tailored to the specific challenges faced by carpenters are crucial for ensuring a healthy and sustainable working environment in this profession.

Conflicts of interest: The authors declare that they have no conflict of interest.

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