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Occupational Physical Activity Patterns and Cardiovascular Health

Cookey SN[1]*, Agbarakwe B[2].

[1]Senior Lecturer/Consultant Cardiologist. Department of Internal Medicine, Rivers State University / Department of Internal Medicine, Rivers State University Teaching Hospital

[2]Senior Registrar, Department of Internal Medicine, Rivers State University Teaching Hospital

***Corresponding Author**: Cookey SN

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Abstract

Background: *Physical activity is a very important component of cardiometabolic health, yet most evidence supporting its benefits is derived from leisure-time physical activity (LTPA). In low- and middle-income settings, occupational physical activity (OPA) constitutes the dominant source of daily exertion, but its cardiometabolic implications remain insufficiently characterized. It's clear that excessive occupational physical activity results in adverse cardiovascular activities: the physical activity health paradox, the more reason why this study becomes very important.*

Objective: *This study assessed the distribution of occupational physical activity levels and examined their associations with key cardiometabolic indicators: hypertension, body mass index and blood glucose among adults in Rivers State*

Methods: *A cross-sectional analysis was conducted among 1,116 adults aged 30–65 years using de-identified community health records. Sociodemographic data, body mass index (BMI), blood pressure, and blood glucose measurements were extracted. Occupational physical activity was classified into sedentary, moderate, and high levels using adapted public health criteria. Group differences in cardiometabolic parameters were evaluated using one-way ANOVA with Tukey post-hoc analysis.*

Results: *The mean age of participants was 43.30 ± 15.62 years, with females comprising 58.2% of the cohort. Sedentary occupations predominated (67.9%), while 21.1% engaged in high-intensity OPA. Hypertension was prevalent in 30.7% of participants, and 34.6% were overweight, with 20.9% obese. Mean BMI differed significantly across OPA categories ($p < 0.05$), with moderately active workers exhibiting the lowest BMI (24.72 kg/m²). Systolic blood pressure increased progressively with higher OPA levels, peaking in the high-activity group (138.93 mmHg; $p < 0.05$). No significant differences were observed for diastolic blood pressure or blood glucose.*

Conclusion: *Occupational physical activity demonstrated a complex, non-linear relationship with cardiometabolic health. Moderate OPA appeared most favorable, while high OPA was associated with elevated systolic blood pressure, supporting the physical activity paradox. These findings point to the need for context-specific physical activity guidelines that incorporate occupational workload, recovery, and leisure-time exercise in a population more involved in work related physical activity like in sub-Saharan African populations.*

Keywords: *Occupational Physical Activity (OPA), Cardiometabolic Risk Factors, Hypertension Prevalence, Body Mass Index (BMI), Physical Activity Health Paradox, Adult Population, Cross-Sectional Analysis, Rivers State, Nigeria.*

INTRODUCTION

Physical activity (PA) is defined as any set of bodily movement produced by skeletal muscles that results in energy expenditure and encompasses both structured exercise and unstructured movements embedded in daily living, particularly occupational activity[1] Physical inactivity is recognized as a major contributor to global mortality, ranking as the fourth most important risk factor worldwide and accounting for approximately 6% of all deaths. It is surpassed only by elevated blood pressure, which contributes about 13% of global deaths, tobacco use at 9%, and raised blood glucose at 6% [2] While leisure-time physical activity (LTPA) typically occupies a limited portion of the day, occupational physical activity (OPA) often spans several hours across most working days and therefore contributes substantially to total daily energy expenditure and long-term health outcomes. [3,4]

Extensive epidemiological and interventional evidence demonstrates that regular PA improves cardiometabolic health, reduces the burden of non-communicable diseases, and enhances overall well-being. Even modest physiological changes are clinically meaningful; for instance, a 1 kg reduction in body weight is associated with an approximate 1 mmHg reduction in systolic blood pressure. [5-7] Meta-analyses further show that structured aerobic exercise improves blood pressure control, insulin sensitivity, and glycaemic regulation in hypertensive and diabetic populations, independent of pharmacological therapy. Importantly, these protective effects are most consistently documented for LTPA, which is typically planned, rhythmic, time-limited, and of sufficient intensity to enhance cardiorespiratory fitness. [8-10]

While leisure-time physical activity (LTPA) is commonly incorporated into daily routines in many high-income countries, this pattern does not apply to a substantial proportion of adults in low- and middle-income settings. In these populations, daily physical activity is driven predominantly by occupational demands rather than planned or recreational exercise. Occupational physical activity (OPA) typically involves prolonged low-to-moderate intensity exertion, repetitive movements, sustained static postures, and limited control over work pace and rest periods. These characteristics contrast fundamentally with LTPA, which is usually voluntary, time-limited, and performed at intensities sufficient to improve cardiorespiratory fitness. Such differences have generated increasing concern regarding whether occupational activity provides health benefits comparable to those of leisure-time physical activity.[11-12]

This distinction has given rise to the Physical Activity Health Paradox, which emerges from accumulating epidemiological evidence showing that high levels of OPA frequently fail to confer the expected cardioprotective effects and may, paradoxically, increase the risk of cardiovascular disease (CVD) and all-cause mortality even after extensive adjustment for lifestyle, socioeconomic factors, and LTPA. Multiple studies have demonstrated that individuals engaged in high OPA, particularly when characterized by repetitive heavy lifting, sustained elevations in heart rate, and insufficient recovery, experience higher blood pressure, persistent low-grade inflammation, and increased cardiovascular strain.[13-16] These adverse associations appear particularly pronounced among men and individuals with low cardiorespiratory fitness or limited engagement in leisure-time physical activity (LTPA). Evidence from long-term prospective cohort data indicates that men exposed to high levels of occupational physical activity (OPA) experience a significantly increased risk of both all-cause mortality and myocardial infarction, even after adjustment for conventional cardiovascular risk factors. Importantly, this excess risk is not uniform across all workers but is strongly modified by LTPA. Men with high OPA combined with low or moderate levels of LTPA demonstrate the greatest vulnerability, whereas those who engage in high levels of LTPA do not exhibit a similar increase in mortality risk. This modifying effect of LTPA likely reflects exercise-induced cardiac preconditioning, whereby regular aerobic activity improves cardiorespiratory fitness, autonomic regulation, endothelial function, and myocardial ischemic tolerance, thereby buffering the cardiovascular strain imposed by sustained occupational exertion. [17-18]

In addition, activities involving heavy lifting, prolonged static postures, or repetitive movements lead to sustained elevation of 24-hour heart rate and blood pressure.[19] Furthermore, OPA is often performed under conditions of low worker control and inadequate recovery time, resulting in chronic stress, dysregulated autonomic balance, and systemic inflammation. Together, these processes adversely affect cardiometabolic regulation, providing a strong rationale for examining outcomes such as blood pressure, adiposity, and glucose homeostasis as markers of cumulative cardiovascular and metabolic strain.[12]

Accelerometers have been used as objective measurement tools, and have been instrumental in advancing this field by enabling accurate classification of occupational activity patterns. Accelerometer based studies have demonstrated that high OPA is not synonymous with health-enhancing activity and have reinforced the importance of differentiating physical activity by domain rather than volume alone. [4,20-21]

Despite growing evidence globally, significant gaps still remain. Much of the existing literature relies on single-

time-point assessments of physical activity, which fail to capture long-term exposure across the life-course, even though cardiometabolic risk accumulates over time. There is a particular scarcity of data from sub-Saharan Africa, where occupational structures, socioeconomic contexts, and access to structured LTPA differ markedly from high-income settings. A retrospective assessment of OPA offers an opportunity to better approximate cumulative exposure and address this limitation.

Accordingly, this study set out to evaluate the distribution of occupational physical activity and its associations with selected cardiometabolic indices among a cross-section of Nigerian adults. Specifically, the study aimed to classify occupations by physical activity level; assess the distribution of hypertension, blood glucose and body mass index (BMI) across OPA categories; examine associations between OPA and demographic factors such as sex, marital status, and community type; and derive public-health-relevant inferences for occupational health policy and cardiovascular risk prevention.

RESULTS:

Table 1: Descriptive Statistics (Mean ± SD)

Parameter	Mean ± SD
Age	43.30 ± 15.62 years
Body Mass Index (BMI)	26.16 ± 5.61 kg/m²
Systolic BP (SBP)	131.37 ± 24.40 mmHg
Diastolic BP (DBP)	80.30 ± 13.56 mmHg
Blood Sugar	6.51 ± 3.46 mmol/L

Table 2: Categorical Variables

Variable	Category	Frequency	Percent (%)
Sex	Female	649	58.2
	Male	467	41.8
Hypertension Status	Hypertension	343	30.7
	Prehypertension	301	27.0
	Normotensives	472	42.3
Community Type	Rural	508	45.5
	Urban	608	54.5
Marital Status	Married	878	78.7
	Single	226	20.3
	Widow	12	1.1
BMI Classification	Underweight	60	5.4
	Normal BMI	437	39.2
	Overweight	386	34.6
	Obese	133	20.9
	Morbid Obesity	72	6.5
Diabetes Status	Diabetic	140	12.5
	Hypoglycemia	20	1.8
	Impaired Glucose	206	18.5
	Normoglycemia	750	67.2

Table 3: Occupational Physical Activity Classification for Study population

Activity Level	Frequency	Percent (%)
Sedentary	758	67.9%
Moderate Activity	123	11.0%
High Activity	235	21.1%

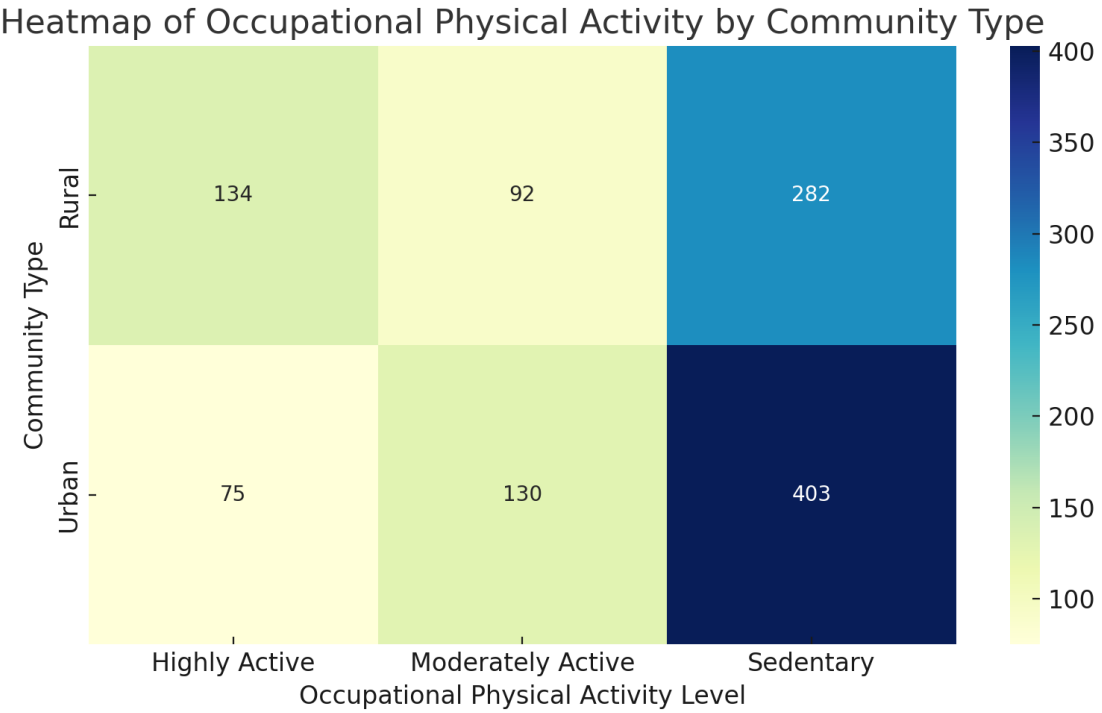

Figure 1 *HEAT MAP OF OPA AND COMMUNITY TYPE*

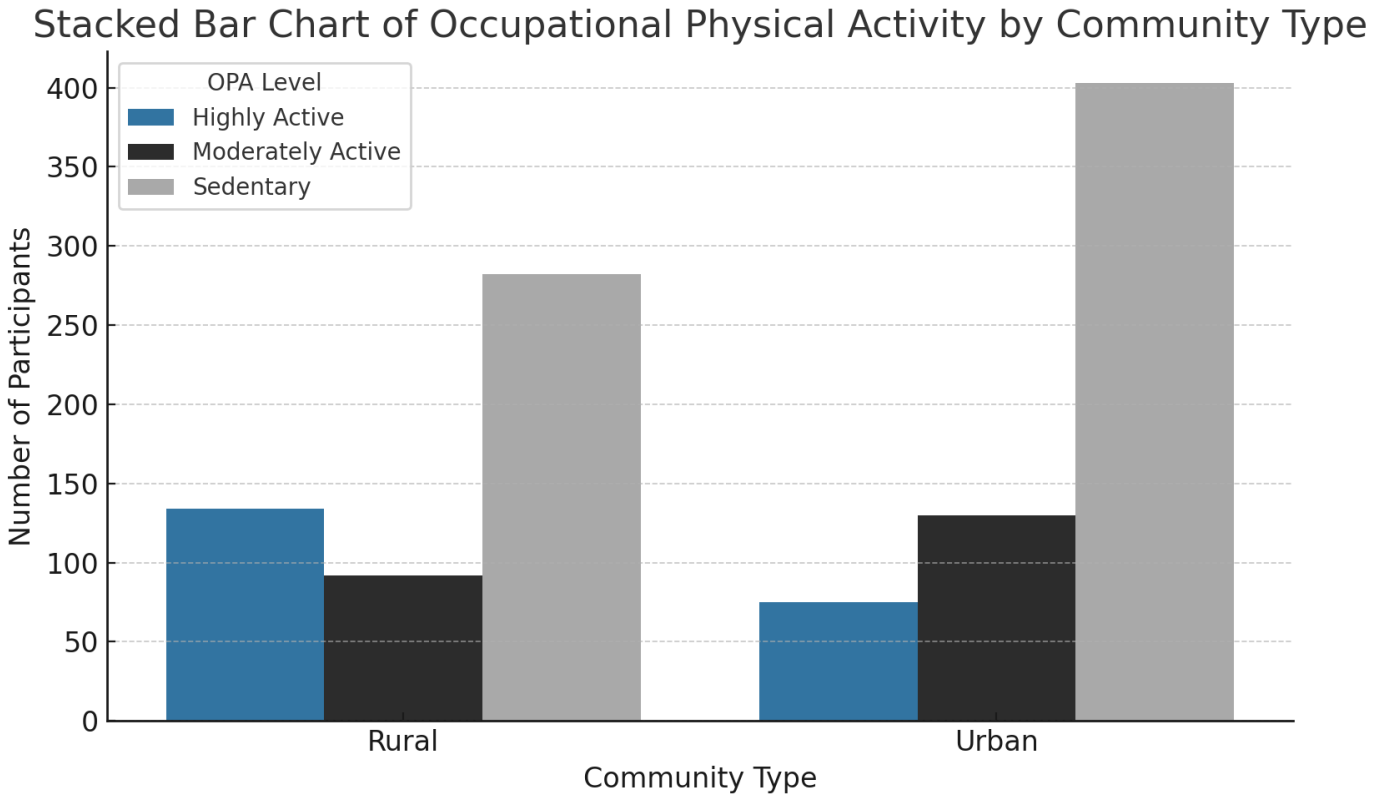

Figure 2: *STACED BAR CHART OF PARTICIPANTS and OPA LEVEL*

Table 4: Summary of Key Associations Between OPA and Cardiometabolic/Sociodemographic Variables

Variable	Key Finding	Statistical Evidence
BMI	Lowest in moderate OPA; no difference between sedentary and high OPA	ANOVA $p < 0.05$; Tukey's HSD
SBP	Progressive increase from sedentary → moderate → high OPA	ANOVA $p < 0.05$
DBP	No significant variation across OPA categories	$p = 0.566$
Blood glucose	No significant variation across OPA categories	$p = 0.974$
Sex	No association with OPA	χ^2 $p = 0.889$
Marital status	Trend but not significant	χ^2 $p = 0.095$
Community type	Strong predictor of OPA	χ^2 $p < 0.001$
Rural residence	Independent predictor of high OPA	OR = 2.8, $p < 0.001$

DISCUSSION

The study population reveals a dominant middle-aged cohort (mean age 43.30 ± 15.62 years) with a notable burden of cardiometabolic risk, consistent with patterns observed across sub-Saharan Africa. Adeloye et al and other authors have observed that the burden of hypertension was higher amongst the middle-aged population. This age group corresponds to the most economically active segment of the population and is increasingly affected by lifestyle-related non-communicable diseases. [22-25] This trend disproportionately affects the economically productive segment of the population and has the potential to significantly undermine workforce productivity, thereby imposing substantial economic strain on national development.

The mean BMI of 26.16 ± 5.61 kg/m² falls within the overweight range and is comparable to values reported in community-based studies from Nigeria, Ghana, and Sierra Leone, .[26-28] where mean BMI typically ranges between 24 and 27 kg/m². This reflects ongoing epidemiological transition driven by urbanization, dietary shifts, and declining leisure-time physical activity. The systolic blood pressure exceeds normal thresholds approaching stage 1 hypertension, aligning with findings from several West African population studies reporting mean SBP values between 128 and 135 mmHg.[22,29] The mean diastolic blood pressure (80.30 ± 13.56 mmHg) was at the upper limit of the normal range. This finding is consistent with evidence indicating that systolic blood pressure tends to be a more sensitive indicator of cumulative cardiovascular strain and vascular aging than diastolic pressure, particularly in adult populations exposed to chronic hemodynamic stressors.[30]

Females constituted a higher proportion of the study population (58.2%), a finding consistent with several community-based health surveys in Nigeria and other sub-Saharan African settings, where women are more likely to participate in screening programs and maintain contact with primary healthcare services. Similar sex distributions have been reported in occupational and community studies examining physical activity patterns, where women are often overrepresented in lower-intensity or sedentary occupations such as clerical, caregiving, and service roles. [29,31]

The prevalence of hypertension (30.7%), with an additional 27.0% classified as prehypertensive, points to a high burden of blood pressure-related morbidity. These figures are comparable to national and regional estimates from Nigeria, where hypertension prevalence in adult populations typically ranges from 28% to 35%.[29] Studies examining occupational activity have similarly reported high rates of hypertension among workers engaged in both sedentary and physically demanding jobs, reinforcing evidence that occupational exertion alone does not confer protection against elevated blood pressure.[32]

Urban residents constituted 54.5% of the cohort, reflecting increasing urbanization in southern Nigeria. Urban dominance has been associated with higher sedentary occupational exposure and increased cardiometabolic risk in multiple African studies.[29,33] Conversely, rural participants (45.5%) are more commonly engaged in physically active occupations, particularly agriculture and informal labor, a pattern frequently observed in OPA-focused research. However, rural residence has not consistently translated into lower cardiometabolic risk, supporting the concept of the occupational physical activity paradox.[34]

With regard to glycaemic status, 12.5% of participants were classified as diabetic, while 18.5% exhibited impaired glucose levels. These proportions fall within the range reported in a community-based studies in West Africa,[36] where adult diabetes prevalence typically ranges from approximately 8% to 15%, with a substantial proportion of

cases remaining undiagnosed Furthermore, evidence from occupational health research indicates that high levels of work-related physical activity do not consistently confer protection against dysglycaemia, particularly in populations where leisure-time physical activity is limited and broader lifestyle transitions such as dietary change and increasing adiposity are occurring.

The distribution of occupational physical activity (OPA) levels as seen in Table highlights a pronounced predominance of sedentary occupational patterns. Specifically, 67.9% of participants were classified within the sedentary category, while only 11.0% were engaged in moderately active occupations and 21.1% in highly physically demanding roles. This distribution indicates that the majority of individuals in the cohort are employed in occupations characterized by low energy expenditure and minimal dynamic physical movement.

The predominance of sedentary occupational activity observed in this study is consistent with global trends showing a progressive shift toward less physically demanding work environments, without adequate compensation with LTPA. Economic development, urbanization, and technological advancement have collectively reduced the need for manual labor while expanding administrative, clerical, and service-based occupations that require prolonged sitting and limited physical exertion. The relatively small proportion of participants engaged in moderate occupational activity (11.0%) is noteworthy. Moderate activity occupations often involve intermittent movement, walking, or light manual tasks and may represent a balance between physical exertion and adequate recovery. From a physiological perspective, this level of activity may provide more favorable metabolic conditions compared with both sedentary and excessively strenuous work. Indeed, several studies suggest that moderate levels of activity are more likely to support healthy body weight and metabolic regulation. Despite the dominance of sedentary occupations, a considerable proportion of the study population (21.1%) remained engaged in highly active occupations.[35-38] These roles typically involve prolonged standing, repetitive manual tasks, heavy lifting, or agricultural work. However, evidence increasingly suggests that high occupational physical activity does not necessarily confer the same cardioprotective benefits as structured leisure-time physical activity. Prolonged occupational exertion may instead impose sustained cardiovascular strain due to repetitive muscle loading, elevated heart rate, and limited recovery time.

One-way ANOVA demonstrated significant differences in mean BMI and systolic blood pressure (SBP) across OPA categories, whereas diastolic blood pressure (DBP) and blood glucose did not vary significantly. The BMI pattern is notable: participants in moderately active occupations had the lowest mean BMI, while sedentary and high-OPA groups showed similarly higher values. This non-linear pattern is compatible with the physical activity health paradox, which proposes that moderate occupational demands may support energy balance, whereas prolonged heavy or repetitive occupational work may fail to provide the metabolic advantages of structured leisure-time exercise.

The rise in SBP across OPA categories is particularly important and mirrors wider evidence that occupational exertion has a stronger and more consistent relationship with blood pressure than with other metabolic outcomes. Research on the physical activity paradox shows that heavy lifting, static loading, repetitive movement, and long work duration without sufficient recovery can sustain sympathetic activation, elevate 24-hour heart rate and blood pressure, and increase cardiovascular strain. By contrast, leisure-time physical activity is usually dynamic, time-limited, and intense enough to improve cardiorespiratory fitness, endothelial function, and autonomic recovery. That physiological difference helps explain why higher OPA in your study was associated with worse SBP rather than protection. Similar domain-specific findings have been reported in prospective studies showing that leisure-time, but not occupational, moderate-to-vigorous activity is associated with lower blood pressure and lower hypertension risk.

The absence of significant differences in DBP and blood glucose across OPA groups is also plausible biologically and is not out of keeping with the literature. DBP is often less sensitive than SBP to chronic occupational strain, particularly in middle-aged populations where systolic pressure more readily reflects arterial stiffness and cumulative hemodynamic load. Evidence on OPA and diabetes is more mixed than evidence on OPA and hypertension: some cohorts report no clear association, others report neutral findings, and some long-term studies, especially in Asian

Chi-square analysis were performed to explore the relationship between selected sociodemographic variables and levels of occupational physical activity (OPA). The results demonstrated no statistically significant association between sex and OPA ($\chi^2(2, n = 1116) = 0.236$, $p = 0.889$), indicating that men and women were similarly distributed across sedentary, moderately active, and highly active occupational categories. This suggests that in the present population, occupational activity patterns were not strongly determined by gender.

The association between marital status and OPA approached statistical significance ($\chi^2(4, n = 1116) = 7.896$,

p = 0.095), although it did not reach the conventional threshold for statistical significance. Nonetheless, a relatively higher proportion of single individuals were observed in moderately active occupations (25.7%). This trend may reflect underlying socioeconomic or behavioral factors such as occupational mobility, employment type, or stage of life, and may warrant further investigation using stratified or longitudinal analyses.

In contrast, community type showed a strong and statistically significant association with occupational physical activity ($\chi^2(2, n = 1116) = 35.861$, $p < 0.001$). Participants residing in rural areas were predominantly engaged in highly physically demanding occupations (64.1%), whereas urban residents were more frequently represented in sedentary (58.8%) and moderately active (58.6%) occupational categories. This clear urban–rural gradient likely reflects structural differences in economic activity, occupational structure, and infrastructural development, with rural settings typically characterized by agriculture and manual labor, while urban environments are increasingly dominated by service and administrative sectors.

Multinomial logistic regression analysis yielded findings consistent with the chi-square results. After adjusting for age, sex, systolic and diastolic blood pressure, blood glucose, and community type, rural residence remained the only significant independent predictor of high occupational physical activity, while marital status, sex, and blood glucose were not independently associated with OPA levels.

Conclusion: This analysis reinforces the need for context-specific occupational health strategies. While moderate occupational activity appears beneficial for body weight, high OPA is not cardioprotective and is associated with elevated systolic blood pressure. These findings emphasize that the quality, intensity, and recovery characteristics of occupational physical activity—rather than volume alone—must be central considerations in cardiovascular risk prevention and workplace health policy in southern Nigeria.

REFERENCES

1. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126–13
2. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT; Lancet Physical Activity Series Working Group. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet*. 2012;380(9838):219–229. doi:10.1016/S0140-6736(12)61031-9.
3. Holtermann A, Krause N, van der Beek AJ, Straker L. The physical activity paradox: six reasons why occupational physical activity does not confer the cardiovascular health benefits that leisure-time physical activity does. Br J Sports Med. 2018;52(3):149–150. doi:10.1136/bjsports-2017-097965.
4. Steeves JA, Tudor-Locke C, Murphy RA, King GA, Fitzhugh EC, Bassett DR. Classification of occupational activity categories using accelerometry: NHANES 2003–2004. J Phys Act Health. 2015;12(6):823–829. doi:10.1123/jpah.2013-048/
5. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. CMAJ. 2006;174(6):801–809. doi:10.1503/cmaj.051351.
6. Neter JE, Stam BE, Kok FJ, Grobbee DE, Geleijnse JM. Influence of weight reduction on blood pressure: a meta-analysis of randomized controlled trials. Hypertension. 2003;42(5):878–884. doi:10.1161/01.HYP.0000094221.86888.AE.
7. Pedersen BK, Saltin B. Exercise as medicine – evidence for prescribing exercise as therapy in 26 different chronic diseases. Scand J Med Sci Sports. 2015;25(Suppl 3):1–72. doi:10.1111/sms.12581.
8. Cornelissen VA, Fagard RH. Effects of endurance training on blood pressure, blood pressure–regulating mechanisms, and cardiovascular risk factors. Hypertension. 2005;46(4):667–675. doi:10.1161/01.HYP.0000184225.05629.51.
9. Umpierre D, Ribeiro PAB, Kramer CK, Leitão CB, Zucatti ATN, Azevedo MJ, et al. Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: a systematic review and meta-analysis. JAMA. 2011;305(17):1790–1799. doi:10.1001/jama.2011.576.
10. Hayashino Y, Jackson JL, Fukumori N, Nakamura F, Fukuhara S. Effects of supervised exercise on glycemic control in type 2 diabetes mellitus: a meta-analysis of randomized controlled trials. Diabetes Care. 2012;35(12):2393–2400. doi:10.2337/dc12-0784.
11. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U; Lancet Physical Activity

Series Working Group. Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet*. 2012;380(9838):247–257. doi:10.1016/S0140-6736(12)60646-1.

12. Holtermann A, Krause N, van der Beek AJ, Straker L. The physical activity paradox: six reasons why occupational physical activity does not confer the cardiovascular health benefits that leisure-time physical activity does. *Br J Sports Med*. 2018;52(3):149–150. doi:10.1136/bjsports-2017-097965.

13. Holtermann A, Hansen JV, Burr H, Søgaard K, Sjøgaard G. The health paradox of occupational and leisure-time physical activity. Br J Sports Med. 2012;46(4):291–295. doi:10.1136/bjsm.2010.079582.

14. Krause N, Brand RJ, Arah OA, Kauhanen J. Occupational physical activity, job strain, and cardiovascular disease mortality. Am J Ind Med. 2015;58(9):1002–1013. doi:10.1002/ajim.22485.

15. Li J, Siegrist J. Physical activity and risk of cardiovascular disease—a meta-analysis of prospective cohort studies. Int J Environ Res Public Health. 2012;9(2):391–407. doi:10.3390/ijerph9020391.

16. Coenen P, Huysmans MA, Holtermann A, Krause N, van Mechelen W, Straker LM, et al. Do highly physically active workers die early? A systematic review with meta-analysis of data from 193 696 participants. Br J Sports Med. 2018;52(20):1320–1326. doi:10.1136/bjsports-2017-098540.

17. Holtermann A, Marott JL, Gyntelberg F, Søgaard K, Mortensen OS, Prescott E, Schnohr P. Occupational and leisure time physical activity: risk of all-cause mortality and myocardial infarction in the Copenhagen City Heart Study. BMJ Open. 2012;2(1):e000556. doi:10.1136/bmjopen-2011-000556.

18. Lavie CJ, Ozemek C, Carbone S, Katzmarzyk PT, Blair SN. Sedentary behavior, exercise, and cardiovascular health. Circ Res. 2019;124(5):799–815. doi:10.1161/CIRCRESAHA.118.312669

19. Coenen P, Huysmans MA, Holtermann A, Krause N, van Mechelen W, Straker LM, et al. Do highly physically active workers die early? A systematic review with meta-analysis of data from 193,696 participants. Br J Sports Med. 2018;52(20):1320–1326. doi:10.1136/bjsports-2017-098540.

20. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc*. 2008;40(1):181–188. doi:10.1249/mss.0b013e31815a51b3.

21. Straker L, Coenen P, Dunstan D, Gilson N, Healy G. Sedentary work—evidence on an emergent work health and safety issue. *Safe Work Australia*. 2016;1–51.

22. Adeloye D, Basquill C. Estimating the prevalence and awareness rates of hypertension in Africa: a systematic analysis. *PLoS One*. 2014;9(8):e104300. doi:10.1371/journal.pone.0104300.

23. Ataklte F, Erqou S, Kaptoge S, Taye B, Echouffo-Tcheugui JB, Kengne AP. Burden of undiagnosed hypertension in sub-Saharan Africa: a systematic review and meta-analysis. *Hypertension*. 2015;65(2):291-298. doi:10.1161/HYPERTENSIONAHA.114.04394.

24. Gouda HN, Charlson F, Sorsdahl K, Ahmadzada S, Ferrari AJ, Erskine H, et al. Burden of non-communicable diseases in sub-Saharan Africa, 1990–2017: results from the Global Burden of Disease Study. *Lancet Glob Health*. 2019;7(10):e1375-e1387. doi:10.1016/S2214-109X(19)30374-2.

25. Agyemang C, Boatemaa S, Frempong GA, de-Graft Aikins A. Obesity in sub-Saharan Africa. *Metab Syndr Relat Disord*. 2016;14(3):106-116. doi:10.1089/met.2015.0100.

26. Ataklte F, Erqou S, Kaptoge S, Taye B, Echouffo-Tcheugui JB, Kengne AP. Burden of undiagnosed hypertension in sub-Saharan Africa: a systematic review and meta-analysis. *Hypertension*. 2015;65(2):291-298. doi:10.1161/HYPERTENSIONAHA.114.04394.

27. Agyemang C, Owusu-Dabo E, de Jonge A, Martins D, Ogedegbe G, Stronks K. Overweight and obesity among Ghanaian residents in Ghana and Ghanaian migrants in Europe: prevalence and determinants. *Public Health Nutr*. 2009;12(11):2031–2038. doi:10.1017/S1368980009004942.

28. Odland ML, Kamara MM, Sivaraman K, et al. Prevalence and socioeconomic factors associated with overweight and obesity among adults in Freetown, Sierra Leone. *BMJ Open*. 2017;7:e018309. doi:10.1136/bmjopen-2017-018309.

29. Oguoma VM, Nwose EU, Skinner TC, Richards RS, Bwititi PT. Prevalence of cardiovascular disease risk factors among a Nigerian adult population: relationship with income level and urbanization. *BMC Public Health*. 2015;15:743. doi:10.1186/s12889-015-2082-8.

30. Franklin SS, Larson MG, Khan SA, Wong ND, Leip EP, Kannel WB, Levy D. Does the relation of blood pressure to coronary heart disease risk change with aging? The Framingham Heart Study. *Circulation*. 2001;103(9):1245–1249. doi:10.1161/01.CIR.103.9.1245.

31. Luke A, Bovet P, Forrester TE, Lambert EV, Plange-Rhule J, Schoeller DA, et al. Protocol for the modeling the epidemiologic transition study: a longitudinal observational study of energy balance and change in body weight, diabetes and cardiovascular disease risk. *BMC Public Health*. 2011;11:927. doi:10.1186/1471-2458-11-927.

32. Sobngwi E, Mbanya JC, Unwin NC, Porcher R, Kengne AP, Fezeu L, Minkoulou EM, Tournoux C, Gautier JF, Aspray TJ. Physical activity and its relationship with obesity, hypertension and diabetes in urban and rural Cameroon. *Int J Obes Relat Metab Disord*. 2002;26(7):1009–1016. doi:10.1038/sj.ijo.0802008.

33. Addo J, Smeeth L, Leon DA. Hypertension in sub-Saharan Africa: a systematic review. *Hypertension*. 2007;50(6):1012–1018. doi:10.1161/HYPERTENSIONAHA.107.093336

34. Oyeyemi AL, Ishaku CM, Oyekola J, Wakawa HD, Lawan A, Yakubu S, Oyeyemi AY. Patterns and associated factors of physical activity among adolescents in Nigeria. *PLoS One*. 2016;11(2):e0150142. doi:10.1371/journal.pone.0150142.

35. Warburton DER, Nicol CW, Bredin SSD. Health benefits of physical activity: the evidence. *CMAJ*. 2006;174(6):801–809. doi:10.1503/cmaj.051351.

36. Swift DL, Johannsen NM, Lavie CJ, Earnest CP, Church TS. The role of exercise and physical activity in weight loss and maintenance. *Prog Cardiovasc Dis*. 2014;56(4):441–447. doi:10.1016/j.pcad.2013.09.012.

37. Ekelund U, Ward HA, Norat T, Luan J, May AM, Weiderpass E, et al. Physical activity and all-cause mortality across levels of overall and abdominal adiposity in European men and women: the EPIC study. *Am J Clin Nutr*. 2015;101(3):613–621. doi:10.3945/ajcn.114.100065.

38. Holtermann A, Hansen JV, Burr H, Søgaard K, Sjøgaard G. The health paradox of occupational and leisure-time physical activity. *Br J Sports Med*. 2012;46(4):291–295. doi:10.1136/bjsm.2010.079582.