

**ORIGINAL ARTICLE****Physical Activity Pattern and Its Association with Glycaemic and Blood Pressure Control among People Living with Diabetes (PLWD) In The Ho Municipality, Ghana****James Osei-Yeboah<sup>1\*</sup>, William Owiredu<sup>2,7</sup>, Gameli Norgbe<sup>3</sup>, Christian Obirikorang<sup>2</sup>, Sylvester Lokpo<sup>1</sup>, Evans Ashigbi<sup>4</sup>, Beatrice Johnson<sup>5</sup>, Francis Ussher<sup>6</sup>, John Deku<sup>1</sup>, Emmanuel Asiamah<sup>1</sup>, Roseline Avorkliyah<sup>1</sup>, Edward Boakye<sup>1</sup>, Tibemponi Ntoni<sup>1</sup>, Prince Nyamadi<sup>1</sup>****OPEN ACCESS**

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**ABSTRACT**

**BACKGROUND:** *Physical activity (PA) offers considerable health benefits for diabetic patients. However, extensive high levels of inactivity has been reported among diabetic patients. This study sought to assess the patterns of physical activity and its relationship with two management-relevant outcomes (glycaemic and blood pressure control) among people living with diabetes in the Ho Municipality, Ghana.*

**METHODS:** *A hospital-based cross-sectional study was carried out from January 2017 to April 2017 among 150 purposively recruited diabetic patients who were receiving care at the diabetes clinics of the Volta Regional Hospital and the Ho Municipal Hospital. A semi-structured questionnaire was used in capturing socio-demographic information. Physical activity was assessed using the International Physical Activity Questionnaire Short Form. Glycaemic and blood pressure control were evaluated within a three-month period from patients' records.*

**RESULTS:** *Physical activity estimates among participants were 21.33%, 48% and 30.67% for high, moderate and low PA respectively. Glycaemic control among the study participants was 33.33% and blood pressure control was 58.67%. Both glycaemic and blood pressure control were significantly associated with PA.*

**CONCLUSION:** *In this group of PLWD in the Ho Municipality, high levels of inactivity, uncontrolled glycaemia and blood pressure exist. However, glycaemic and blood pressure control may be modulated by moderate-intensity physical activity.*

**KEYWORDS:** *Diabetes, Physical Activity, Glycaemic Control, Blood Pressure Control*

## INRODUCTION

Urbanization and globalization with its attendant pronounced changes in the human environment, behaviour and life-style modification, have resulted in escalating rates of both obesity and diabetes, described as diabetes (1). Currently, the prevalence of Diabetes mellitus has been increasing in Ghana (2,3). Diabetes is a component cause of several other important and often lethal diseases, such as cardiovascular and renal diseases (4). Diabetic conditions, if not well managed, could lead to complications (2). The management of diabetes requires a lifelong intervention which includes frequent self-monitoring of blood glucose (SMBG), dietary modifications, physical activity and administration of medications as per schedule (5).

The adoption and maintenance of physical activity are critical foci for blood glucose management and overall health in individuals with diabetes (6). Practice guidelines consistently recommend that people with diabetes obtain at least 150 minutes of moderate to vigorous aerobic exercise per week (7). Acute bout of exercise increases glucose disposal into the contracting muscles, leading to clinically significant decreases in blood glucose concentrations (8). Evidence of the benefits of physical activity to diabetes management includes, but not limited to, reduction in weight, increased insulin sensitivity, improved cardiovascular fitness, muscle strength and overall improvement of well-being of people living with diabetes (6,9). Physical inactivity has been linked to increased risk of cardiovascular episodes and all-cause mortality among people living with diabetes (1,10).

Despite the evidence of substantial benefits of physical activity towards clinical management goals in diabetes, a high rate of physical inactivity has been reported among people living with diabetes (1,11,12). There is limited information on physical activity among people living with diabetes in the Ho Municipality. An important initial step for prioritizing, formulation and implementation of a successful intervention is the measuring of current levels of physical activity

(9). This study, sought to assess the patterns of physical activity and its relationship with two management-relevant outcomes, glycaemic and blood pressure control, among people living with diabetes in the Ho Municipality, Ghana.

## MATERIALS AND METHODS

**Study population and study design:** A hospital-based cross-sectional study was carried out from January 2017 to April 2017 among 150 purposively recruited patients with diabetes who were receiving medical care at the diabetes clinics of the Volta Regional Hospital and the Ho Municipal Hospital. The study participants were all consenting type 2 diabetes adult patients between the ages of 27 and 84 years, who were not deaf or mute and were not having physical disability or other chronic conditions which could influence physical activity such as stroke and cancer.

**Study area:** The Ho Municipality is located in the Volta Region. The Ho Municipality also serves as the capital of the Volta Region of Ghana. Ho is the capital of the municipality and the commercial hub of the entire region. The total land size covers 2,361 square kilometers representing 11.5 percent of the region's total land area (13). The total population is 192,871 with 94,951 males and 97,920 females and had a growth rate of 1.17% in the year 2010 (14).

**Sample size determination:** Using the average monthly attendance of diabetic patients which was sixty (60) for two previous months (November 2016 and December 2016), a total study population of 260 was generated for the four months study duration, using the Roasoft online sample size calculator (Roasoft Inc, 2004, <http://www.raosoft.com/samplesize.html>). The recommended minimum sample of 148 diabetic participants was calculated at 95% confidence level, 5% margin of error, and a response distribution of 50% based on the average number of diabetic patients that visited the clinic in the previous months.

**Socio-demographic and physical activity capture:** A self-reported, semi-structured questionnaire was used to collect information on

age, gender, marital status, educational background, employment status, duration of diabetes and type of medication. Physical activity was assessed using the pre-validated seven item International Physical Activity Questionnaire Short Form (IPAQ-SF)(15).

**International physical activity questionnaire (IPAQ):** The IPAQ-SF was administered by a face-to-face interview by the investigators in the participants' preferred language (English, Ewe or Twi) or self-administered by those who were literate. The IPAQ was developed as an instrument for cross national monitoring of physical activity and inactivity across diverse countries and populations (16). The IPAQ-SF consists of three physical activity components/domain (Walking activity, Moderate-intensity activity and Vigorous-intensity activity). The IPAQ-SF scoring mechanism allows for both categorical and continuous estimation of physical activity. The continuous scores are equivalent to weekly energy expenditure measured in Metabolic Equivalent of Task – minutes per week (MET minutes/week), while the categorical score rates the physical activity into Highly active, Moderately active and Low(inactive or sedentary) (17).

**Biochemical and haemodynamic parameters:** With a regular clinic attendance interval of 6 weeks, fasting blood glucose and blood pressure measurement as well as values for two previous visits within a 3 month period were recorded from patients' folders. Glycaemic control was defined as consistent fasting blood glucose levels of 4 to 7mmol/L for the three recorded readings. Controlled blood pressure was defined as consistent blood pressure reading of < 140/90mmHg systolic/diastolic blood pressure for the three recorded readings.

**Statistical analysis:** Categorical variables were expressed as frequency and proportion. Continuous non-parametric variables were presented as medians. Differences between proportions were tested with Fisher exact or chi square test where appropriate. Differences between medians were tested with Kolmogorov-Smirnov test. Association between continuous variables was assessed using Spearman correlation. A p-value of less than 0.05 was

considered as significant at all points of the analysis. Data analysis was done using IBM Statistical Package for the Social Sciences version 22.00. (SPSS Inc, Chicago, USA; www.spss.com).

**Psychometric properties of the IPAQ:** The internal consistency reliability for the IPAQ was tested using the Cronbach's alpha reliability method. The overall Cronbach alpha was 0.742 and the Cronbach's alpha based on standardized items was 0.776. The reliability for Walking activity was 0.709, for Moderate-intensity activity was 0.660 and Vigorous-intensity activity was 0.757.

**Ethical consideration:** Informed consent was obtained from all participants after the study procedure was clearly explained to them in a language they understood (English, Ewe or Twi). Approval for the study was obtained from the facilities at both the Volta Regional Hospital (VRH) and the Ho Municipal Hospital. Ethical Clearance for the study was granted by the Ethical Review and Scientific Committee of the School of Allied Health Sciences of the University of Health and Allied Sciences, Ho (UHAS-SAHS-ERSC:0016A/2017). No patient was denied the appropriate care for declining to participate in the study. Confidentiality of participant's data was ensured and analysis of data was anonymous and non-linked.

## RESULTS

The majority of the study respondents were females, 109(72.67%) and married, 106(70.67%). At the time of the study, 34% of the respondents had attained tertiary education, 11.33% had secondary and 43.33% had basic education. The majority of the participants (51.33%) were employed in the informal sector. With the exception of 8.67% who were on insulin and 2.66% who were on both insulin and oral medications, all the participants were on oral medications (Table 1).

Table 1: Socio-Demographic characteristics of Diabetes patients in Ho

Parameter	Frequency	Percentage
Total	150	100
<b>Facility</b>		
Municipal	96	64.00
Regional	54	36.00
<b>Gender</b>		
Male	41	27.33
Female	109	72.67
<b>Marital Status</b>		
Single	44	29.33
Married	106	70.67
<b>Educational Background</b>		
None	17	11.33
Basic	65	43.33
Secondary	17	11.33
Tertiary	51	34.00
<b>Employment Status</b>		
None	17	11.33
Formal	56	37.33
Informal	77	51.33
<b>Type of Treatment</b>		
Oral Drug	133	88.67
Insulin	13	8.67
Both	4	2.66

Data presented as frequency and percentage

Fifty (50) participants representing 33.33% presented with plasma glucose levels within the normal range, and 58.67% had their blood pressure controlled. Controlled blood pressure

was predominantly higher among patrons of the Municipal Hospital (64.58%) compared to those who attended clinic at the Regional Hospital (48.15%) (Table 2).

Table 2: Glycaemic and blood pressure control among people living with diabetes in the Ho Municipality stratified by gender and facility.

Gender	Total 150(100)	Male 41(27.33)	Female 109(72.67)	p-value
Glycaemic Control	50(33.33)	14(34.15)	36(33.03)	1
Controlled BP	88(58.67)	66(60.15)	22(53.66)	0.2807
Facility	Total 150(100)	Municipal 96(64.00)	Regional 54(36.00)	p-value
Glycaemic Control	50(33.33)	32(33.33)	18(33.33)	1
Controlled BP	88(58.67)	62(64.58)	26(48.15)	0.0370

Data presented as frequency with corresponding percentage in parenthesis; BP- Blood pressure; p- significant at 0.05

For most of the diabetic patients who engaged in physical activity (PA), walking was the physical activity of choice, 140(93.33%), followed by those who engaged in moderate physical activity, 101(67.33%), and 15(10.00%) participated in vigorous physical activity. Among participants that engaged in walking, 86 also do moderate PA, and 14 did vigorous PA and moderate PA in addition to the walking. Gender difference in terms of physical activity pattern was not

statistically significant. However, a slightly higher proportion of males were engaged in vigorous and moderate physical activities compared to females. Generally, respondents who had achieved glycaemic control were found to engage in more physical activity than those without glycaemic control. No significant difference in the patterns of physical activity was observed for respondents with controlled blood pressure and those without (Table 3).

Table 3: Physical activity patterns in people living with Diabetes in the Ho Municipality stratified by gender and clinical end-point

<b>Gender</b>	<b>Female</b>	<b>Male</b>	<b>p-value</b>
Vigorous PA	8(7.34)	7(17.07)	0.1222
Moderate PA	73(66.97)	28(68.29)	1
Walking PA	102(93.58)	38(92.68)	1
<b>Glycaemia</b>	<b>Controlled</b>	<b>Not Controlled</b>	
Vigorous PA	6(12.00)	9(9.00)	0.5733
Moderate PA	40(80.00)	61(61.00)	0.0261
Walking PA	50(100)	90(90.00)	0.0311
<b>Blood Pressure</b>	<b>Controlled</b>	<b>Not Controlled</b>	
Vigorous PA	6(6.82)	9(14.52)	0.1671
Moderate PA	64(72.73)	37(59.68)	0.1125
Walking PA	83(94.32)	57(91.94)	0.7415

Data presented as frequency with corresponding proportion in parenthesis; PA-Physical Activity; p- isignificant at 0.05

The median Total Metabolic Equivalent of Task (MET) was 1,603 (minutes/week) for the general population. The female and male study participants had MET of 1,599.5 (minutes/week) and 1,624 (minutes/week) respectively. The median MET for vigorous physical activity, moderate physical activity and walking were 0 (minutes/week), 700 (minutes/week) and 693 (minutes/week) respectively. No significant gender variation in median MET was observed. With the exception of the vigorous activity component, participants with glycaemic control presented a higher median MET in all the components of physical activity compared with their counterparts without glycaemic control. Participants with controlled blood pressure

presented a higher median MET for the walking component of physical activity than participants presenting with high blood pressure (Table 4).

Table 4: Median Metabolic Equivalent of Task per week among people living with diabetes in the Ho Municipality

<b>Gender</b>	<b>Total</b>	<b>Female</b>	<b>Male</b>	<b>p-value</b>
Total MET	1603.00	1599.50	1624.00	0.665
Vigorous MET	0.00	0.00	0.00	0.94
Moderate MET	700.00	700.00	840.00	0.65
Walking MET	693.00	693.00	693.00	0.99
<b>Glycaemia</b>	<b>Total</b>	<b>Controlled</b>	<b>Not Controlled</b>	<b>p-value</b>
Total MET	1603.00	2119.50	1186.50	0.005
Vigorous MET	0.00	0.00	0.00	1
Moderate MET	700.00	1080.00	560.00	0.01
Walking MET	693.00	693.00	462.00	0.002
<b>Blood Pressure</b>	<b>Total</b>	<b>Controlled</b>	<b>Not Controlled</b>	<b>p-value</b>
Total MET	1603.00	1879.50	1253.00	0.164
Vigorous MET	0.00	0.00	0.00	0.982
Moderate MET	700.00	840.00	560.00	0.525
Walking MET	693.00	693.00	462.00	0.014

Data presented as median metabolic equivalent task minutes per week; p-significant at 0.05; MET- Metabolic Equivalent Task = Minute scores equivalent to Kilocalories for a 60 Kilogram person

In general, aging was associated with decreasing physical activity among the general study population. Among the female respondents, glycaemic control was negatively associated with the total metabolic equivalent task representing

the overall physical activity and the walking component of physical activity. Blood pressure control was negatively associated with overall physical activity and the moderate physical activity component (Table 5).

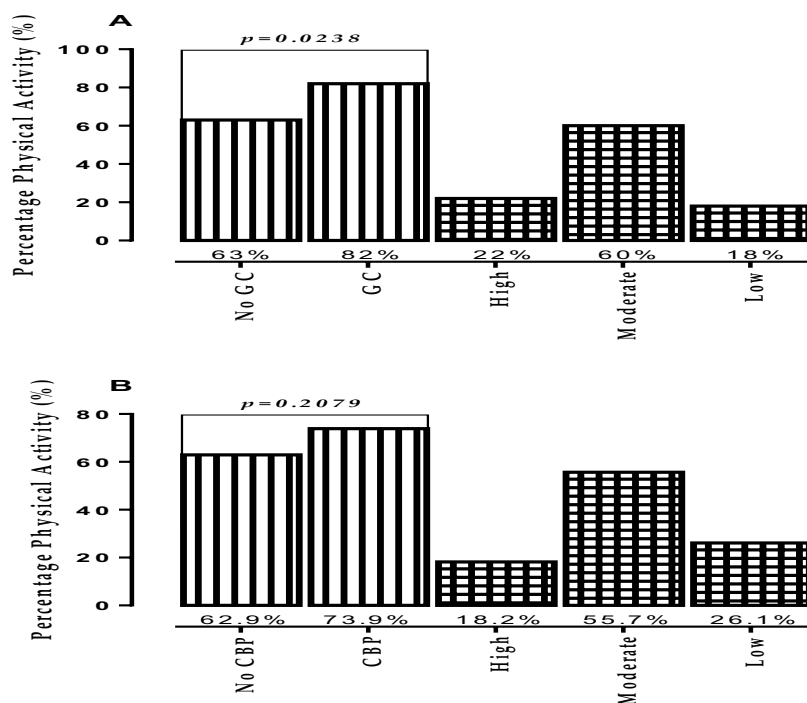
Table 5: Spearman correlation of clinical outcome variables and physical activity scores. Female subpopulation (Upper right-hand side) and Male subpopulation (Lower left-hand side)

<b>Parameter</b>	<b>Age</b>	<b>Duration</b>	<b>FBG</b>	<b>SBP</b>	<b>DBP</b>	<b>METW</b>	<b>METM</b>	<b>METV</b>	<b>TMET</b>
<b>Age</b>		.19*	-0.13	0.40**	0.19	-.22*	-.28**	-0.13	-0.31**
<b>Duration</b>	0.22		0.1	0.15	-0.06	-0.15	-0.12	-0.24*	-0.19*
<b>FBS</b>	0.17	0.04		0.01	0.04	-.32**	-0.19	-0.03	-0.22*
<b>SBP</b>	0.07	-0.25	0.2		0.55**	-0.19	-0.23*	-0.08	-0.23*
<b>DBP</b>	0.15	-0.14	0.18	0.42**		-0.18	-0.23*	0.08	-0.20*
<b>METW</b>	-0.63**	-0.22	-0.18	-0.06	-0.17		0.51**	0.21*	0.71**
<b>METM</b>	-0.44**	-0.22	0.02	0.22	-0.13	0.68**		0.30**	0.93**
<b>METV</b>	-0.15	0.05	0.05	0.28	0.25	0.24	.40**		0.44**
<b>TMET</b>	-0.51**	-0.2	-0.05	0.24	0.03	0.76**	0.89**	0.63**	

Data is presented as coefficient of spearman correlation; \*p- significant at 0.05; \*\*p- significant 0.01; FBG-Fasting blood glucose, SBP-Systolic blood pressure, DBP-Diastolic blood pressure, MET-Metabolic Equivalent Task –minutes/week; METW-Walking MET-minutes/week; METM-Moderate; MET-minutes/week; METV-Vigorous MET-minutes/week; TMET-Total physical activity; MET- minutes/week

Significantly higher percentage of patients, presenting with glycaemic control, were found to have engaged in physical activity in comparison to their counterparts whose glucose levels were higher than optimal ( $p= 0.0238$ ). In the continuum of physical activity, 22.00% of patients with glycaemic control engaged in high physical activity, 60.00% engaged in moderate physical activity and 18.00% in low physical activity compared to 37.00% of those without glycaemic control found to engage in low physical activity

(Figure 1A). Though not statistically significant, higher percentages of those with controlled blood pressure were engaged in physical activity (73.9%) compared to those without blood pressure control (62.9%). For those with controlled blood pressure, the majority were engaged in moderate physical activity (55.7%) while 26.1% were engaged in low physical activity compared to 37.1% of those presenting with high blood pressure engaging in low physical activity (Figure 1B).



**Figure 1:** Relation between physical activity, glycaemic and blood pressure control among people living with diabetes in the Ho Municipality; GC-Glycaemic Control; CBP- Controlled Blood Pressure;  $p$ -significant at 0.05

## DISCUSSION

The demographic characteristics of the study population compared well with that of similar researches conducted locally (18-20) and within the sub-region (21). However, the study participants in this study were comparatively more educated compared to those in the work of Awodele and Osuolale (21).

Poor glycaemic control is acknowledged as the major contributing factor to diabetes complications (22). Only one third of the current study population had their plasma glucose levels controlled. This finding compared favourably with that of Titty (23) in Tamale (40%), Chinenye, Uloko (24) in Nigeria (32.4%) and Musenge, Manankov (25) in Zambia (38.7%). However the rate of poor glycaemic control recorded in this study is higher than that reported

by Kamuhabwa and Charles (26) in Tanzania (23.9%) and BeLue, Ndiaye (27) in Senegal (24.8%).

In this study, the choice of physical activity among people living with diabetes was skewed, with participation in the order of walking, moderate physical activity and a few engaging in vigorous physical activities (Table 3). The pattern of physical activity observed in this study agrees with earlier reports in diabetic populations. Due to economic circumstances, populations in developing countries are more likely to walk longer distances because of lower ownership of vehicles and high transport fares (12).

As seen in Table 4, except for vigorous physical activity, the median energy expenditure in the current study was higher compared to those reported by Oyewole, Odusan (1). Metabolic equivalence of task scores are normally nonparametric data, and contrary to recommendations by the IPAQ Research Committee (15), other works cited in the literature presented the MET scores as means instead of medians. Therefore, making comparison with this study is not plausible (9,12,28,29).

Respondents' self-reported engagement in physical activity was classified as high physical activity (21.33%), moderate physical activity (48%) and low physical activity (inactive or sedentary, 30.67%). Among a cohort of Nigerian diabetics, Ojoawo and Ogunbeku (30) reported 33% high physical activity level, 41% moderate level of physical activity and 26% low physical activity level. Oyewole, Odusan (1) and Adeniyi, Ogwumike (31) also found that 31% and 68.7% respectively of diabetic patients in Nigeria were physically inactive. In Rwanda, Kabanda and Phillips (12) found that 39% of people living with diabetes were inactive. Similar findings have been reported in other non-African jurisdictions. Shazwani, Suzana (32) reported 20% high, 47% moderate and 33.33% low physical activity among people living with diabetes in Malaysia.

Gleaned correlates of physical inactivity from previous studies is skewed toward the older age group, and women living with diabetes (1,12,29,30,33). In conformity with earlier

findings, older age was negatively associated with physical activity (Table 5). Kabanda and Phillips (12) posited that the apparently low levels of physical activity among older patients is due to lack of self-esteem, poor health status and feelings of fatigue. In this study, no statistically significant gender variation in physical activity was observed, though in most cases, percentage and median scores of physical activity were higher in the males (Tables 3-4).

Significantly, participants with glycaemic control were found to engage in more moderate and walking components of physical activity, and this culminated into a significantly higher median total energy expenditure and component moderate and walking metabolic equivalents of tasks in this group (Tables 3 and 4). Overall, 20% of those inactive as compared to 39.4% of the active population had blood glucose levels within the control limit. Among the female respondents, the glucose level was negatively associated with the total metabolic equivalent of task for the overall and the walking component of physical activity.

The reducing effect of physical activity on glucose levels among people living with diabetes has been well acknowledged in literature over the years (6,8,32,34-41). Among postulations of the mechanism(s) of physical activity on glucose control in diabetes are normalization of impaired insulin-stimulated glucose transporter type 4 (GLUT4) translocation associated with people with type 2 diabetes with concomitant increased insulin sensitivity (8), increased glycogen synthase and hexokinase activity resulting in increased glycogen synthesis and increased non-oxidative disposal of glucose (33), increased messenger RNA, decreased release and increased clearance of free fatty acids, increased muscle glucose delivery due to increased muscle capillary density and changes in muscle composition favouring increased glucose disposal (34).

The antihypertensive effect of being physically active was apparent in this study. The median energy expenditure for walking was significantly higher among persons with controlled blood pressure. Increased blood pressure was also negatively associated with the



overall and the moderate physical activity component among female participants (Tables 4 and 5). The hypothesized mechanisms of the antihypertensive effect of physical activity include direct pathways such as neuro-humoral, vascular and structural adaptations (42). Though many stages of these mechanisms are yet to be elucidated, it is thought to function under the form of reflex arches composed of receptors, afferent pathways, integrator centers, efferent pathways and effectors (43). Specifically, the mechanical activation of the calcium-calmodulin controlled endothelial nitric oxide synthase (eNOS) (44), decrease in sympathetic nerve activity due to decreased circulating catecholamines (45) and genetic links to race-dependent responses to exercise stimuli (42,46), are said to be some of the attributes.

In the continuum of physical activity, glycaemic and blood pressure control peaked at moderate physical activity since the majority of patients with optimal outcomes were engaged in moderate physical activity (Figure 1). According to Tanasescu, Leitzmann (47), moderate-intensity activities are associated with improvement in lipoprotein profile and glucose control. Moderate physical activity like walking for at least 30 min per day has been shown to improve glycaemic control and reduce the risk of cardiovascular event in diabetics by approximately 50% (48). Tanasescu, Leitzmann (47), therefore, recommended an early initiation of moderate physical activity in the management strategy of diabetics to prevent macrovascular complications and death.

In conclusion, in this group of patients living with diabetes in the Ho Municipality, high levels of sedentariness, uncontrolled glycaemia and blood pressure exist. However, the two treatment outcomes (Glycaemic and Blood pressure control) may be modulated by moderate-intensity physical activity.

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