

# **The Linkage of Age, Muscle Strength and Body Composition with Functional Limitations in Patients with Type 2 Diabetes Mellitus**

**Kayode I. Oke<sup>1</sup>, Elias O. Agwubike<sup>2</sup> and Andrew C. Ugwu<sup>3</sup>**

## **Abstract**

Reduced functional physical performance capacity (FPPC) is one of the complications patients with type 2 diabetes (T2D) mellitus suffer. The purpose of this study was to investigate the relationship of age, muscle strength (MS) and body composition (BC) parameters of patients with (T2D) with their physical functional capacity.

Sixty- two (62) adult patients with T2D comprising 32 males and 30 females, with age ranged between 30- 65 years and have been diagnosed for at least 2 years duration participated in the study. Participants were those purposively selected from endocrine patients without any other physician diagnosed health problem. The FPPC of the participants were measured using the validated Short Physical Performance Battery. All the data collected were fed into SPSS software package for statistical analyses. Mean and standard deviation were obtained and the Pearson's Product Moment Correlation coefficient was used to test the hypothesis at 0.05 significant level.

The results showed an insignificant correlation between extremities MS and flexibility, BC parameters of body weight, percentage fat per height and body mass index; and FPPC in patients with T2D mellitus.

The study therefore concludes that age, more than MS and BC parameters is more linked to FPPC in with T2D patients.

**Keywords:** Functional performance, T2DM, Age, Muscle strength

---

<sup>1</sup>Ph.D, PT, Chief Physiotherapist, Department of Physiotherapy, University of Benin Teaching Hospital, Benin City, Edo State, Nigeria.

<sup>2</sup>Professor, Department of Health, Environmental Education and Human kinetics, University of Benin, Benin City, Edo State, Nigeria.

<sup>3</sup>Professor, Department of Physiology, University of Benin, Benin City, Edo State, Nigeria.

## **1 Introduction**

A burning question in many people's minds is whether functional limitations in patients with type 2 diabetes mellitus are more linked to age than muscle strength and body composition. A growing body of literature however indicates that there is limitation of functional physical performance capacity in patients with type 2 diabetes mellitus [1,2,3]. The causes of reduced exercise capacity in type 2 diabetes are unknown [4]. Physical functioning refers to the ability to perform activities (walking, climbing stairs, bending and stretching, lifting and carrying objects) without limitation. Role limitation (physical) refers to the limitations that reduced physical health has on the range and extent of physical activities that one is able to perform [5]. Impairment of any one or more of the body systems and subsequent impairment of any aspect of physical function, separately or jointly, can result in functional limitation and disability [6].

Diabetes is a major contributor to the global burden of chronic disease, and it is estimated that its prevalence may increase by as much as 80% in some regions over the next 10 years [7]. Type 2 diabetes is a worldwide cause of morbidity and mortality [8].

Clinical and observational studies have shown that exercise capacity is a strong predictor of cardiovascular and overall mortality [4]. Functional impairment and physical disability directly attributable to diabetes have been studied and reported, and their direct threats to personal independence and quality of life still continue to be of interest to researchers. Functional physical performance is closely related to an individual quality of life and total well-being. Obesity, physical fitness and inactivity have been implicated in the risk factors in the development of type 2 diabetes [7]. Researches over time have not studied level of functional physical performance in individuals affected by type 2 diabetes and determined the relationship of physical characteristic of age, health-related physical fitness component of muscle strength and or body composition parameters have on it. The purpose of this research therefore was to determine the relationship between age, muscle strength and body composition and functional physical performance capacity of patients with type 2 diabetes mellitus.

## **2 Methods**

The study involved sixty-two (62) adult patients with type 2 diabetes comprising thirty-two (32) males and thirty (30) females with age ranged between 30- 65 years who volunteered to partake and filled informed consent forms. They were those who have been diagnosed of type 2 diabetes for at least 2 years duration. Their mean body weight, height and body mass index were  $79.26\pm 7.96$ ,  $1.66\pm 0.07$  and  $29.02\pm 3.98$  respectively. Participants were purposively selected from patients attending the Endocrine Clinic of the University of Benin Teaching Hospital, Benin City, Nigeria, and who did not have any other physician diagnosed health problem. The functional physical performance capacities of the participants were measured using the validated Short Physical Performance Battery (SPPB). The battery has three components of assessment regarding gait speed, chair rise and balance tests. The participants' health-related and body composition characteristics were assessed and recorded using instruments of standard hydraulic Jamar hand-held dynamometer (Sammons Preston, Nottinghamshire, UK), leg dynamometer (Adapted hybrid pocket weight balance, Germany) and OMRON body fat monitor (Omron Co. Ltd., Japan). All the data collected were fed into SPSS software (version 16.0; SPSS Inc.,

USA) package for statistical analyses. Pearson's Product Moment Correlation co-efficient was used to test the strength of association of the parameters with the functional physical performance capacities of the participants. Alpha level was set at 0.05 significant level.

### 3 Results

The descriptive statistics of the subjects' physical characteristics, body composition and extremities muscle strengths parameters are shown in Table 1. As indicated in Table 2, a positive significant correlation was found between age and physical functional performance capacity of patients with type 2 diabetes mellitus at  $p < 0.05$ . However, a positive but non-significant statistical correlation was found to exist between physical functional performance and right upper limb muscle extremity strength, right and left lower extremities muscle strengths and spinal flexibility. Meanwhile, there was a negative insignificant correlation between physical functional performance capacity between functional performance capacity and body weight, body mass index, percentage fat per height, fat mass per weight and right hand grip strength in the study.

Table 1: Physical, extremities muscle strength and body composition characteristics of adult patients with type 2 DM. Table 1: Physical, extremities muscle strength and body composition characteristics of adult patients with type 2 DM.

<b>Variables</b>	<b>N</b>	<b>Mean±SD</b>
<b>Age (years)</b>	62	61.23±10.27
<b>Weight (Kg)</b>	62	79.14±6.84
<b>Height (m)</b>	62	1.68±0.06
<b>BMI (Kg/m<sup>2</sup>)</b>	62	29.44±3.62
<b>%Fat/Ht (%)</b>	62	31.23±5.34
<b>FM/Wt (Kg)</b>	62	26.56±4.98
<b>WHR</b>	62	1.08±0.55
<b>RTHNDS (Kg)</b>	62	31.54±5.43
<b>LTHNDS (Kg)</b>	62	30.45±5.86
<b>RTLES (Kg)</b>	62	28.45±7.26
<b>LTLES (Kg)</b>	62	27.53±7.59
<b>Flexibility (cm)</b>	62	0.08±0.07
<b>FPPerFTS</b>	62	10.64±0.42

SD=Standard deviation; Kg= Kilogram; m= meter; T2DM= Type 2 diabetes mellitus; N= number of subjects; BMI=Body Mass Index; %Fat/Ht= Percentage fat per height; FM/Wt= Fat Mass per weight; WHR= Waist-to-hip ratio; RTHNDS= Right hand grip strength; Kg/m<sup>2</sup>= Kilograms per meter square; %= Percentage.

Table 2: Pearson's correlation coefficient values of parameters with functional physical performance.

<b>Variables</b>	<b>R</b>	<b>P</b>
<b>Age</b>	0.725*	0.008
<b>Weight (Kg)</b>	-0.438	0.079
<b>Height (m)</b>	0.096	0.805
<b>BMI (Kg/m<sup>2</sup>)</b>	-0.428	0.202
<b>%Fat/Ht (%)</b>	-0.285	0.369
<b>FM/Wt (Kg)</b>	-0.412	0.206
<b>WHR</b>	0.068	0.812
<b>RTHNDS (Kg)</b>	-0.035	0.916
<b>LTHNDS (Kg)</b>	0.366	0.218
<b>RTLES (Kg)</b>	0.094	0.712
<b>LTLES (Kg)</b>	0.426	0.189
<b>Flexibility (cm)</b>	0.087	0.642

r= Pearson's correlation value; p= significant value; RTHNDGS= Right hand grip strength; LTHNDGS=Left hand grip strength; RTLES= Right lower extremity strength; LTLES= Left lower extremity strength.

\*Significant @ 0.05 alpha level

#### 4 Discussion

Studies have established reduced functional physical performance capacity in patients with type 2 diabetes mellitus when compared with the general population of age and sex matched counterparts without type 2 diabetes, and even when compared with those with some other chronic conditions [3, 9, 10]. The result of this study has further confirmed the fact that patients with type 2 diabetes mellitus have reduced functional performance capacity when compared with non diabetic persons.

Type 2 diabetes mellitus are believed to constitute major health burdens of global significance, and also constitute risk factors for many other medical problems and complications as confirmed by research studies [11, 12, 13].

The study has also revealed type 2 diabetic patients in this study to possess higher than normal values of body mass index, percentage body fat and waist-to-hip ratio. This observation is in agreement with previous report which stated that most patients with type 2 diabetes are obese and have high waist-to-hip ratio [14]. Studies have also indicated that changes in waist circumference and hip circumference with the corresponding ratio are associated with conditions such as type 2 diabetes, hypertension and stroke as well as dislipidemias, and benign prostatic hypertrophy [15, 16].

Age in this study has been found to have a significant positive correlation with physical performance capacity in patients with type 2 diabetes. This finding is in agreement with the observation of a recent study which stated that older patients with type 2 diabetes show an accelerated decline in leg lean mass, muscle strength, and functional capacity when compared with normoglycemic controls [17]. Age as well as other physical characteristics like sex and body mass index has also been demonstrated to be associated

with impaired exercise capacity in type 2 diabetes [4].

Body weight, body mass index, percentage fat mass per height and fat mass per weight were found to have negative insignificant correlation with physical functional performance capacity in this study. However, waist to hip ratio was found to have a positive though insignificant correlation with physical functional performance in these patients. This outcome is similar to the result of the study which investigated the association of strengths of different measures of adiposity and glucose levels and diabetes among the Thai adults aged 35 and above which concluded that waist circumference and waist-to-hip ratio (WHR) were more strongly associated with fasting plasma glucose and diabetes than were weight and BMI, adding that these measures of abdominal adiposity are likely to be more useful for assessing the obesity-related risk of cardiovascular diseases in Asian populations [18].

Extremities muscle strengths have not shown significant positive correlation with the functional physical performance in the present study. Evidence in literature has not established a direct relationship between muscle strength and functional physical performance among patients with diabetes. Type 2 diabetes in older adults does not necessarily result in poor muscle strength and quality [2]. Nevertheless, research reports have showed that there is reduced muscle strength in patients with type 2 diabetes [2,3] and that structured strengthening exercises can improve physical functional performance capacity in patients with type 2 diabetes [3]. It was also discovered that combined flexibility and resistance training caused significant strength gains in older adults with type 2 diabetes [19].

The present study has revealed that functional physical performance capacity has a positive though insignificant relationship with flexibility. There is paucity of literature on the relationship between flexibility and physical functional performance among patients with type 2 diabetes. However, it has been reported that patients with type 2 diabetes may experience limited joint mobility due to glycation of joint structures and can benefit from flexibility exercises [19]. Prevalence of limited joint mobility among type 2 diabetic mellitus patients when compared with non-diabetic controls matched for age and gender has been reported in many studies [20,21,22], and more especially those with long duration of diabetes [23].

## **5 Conclusion**

This study has concluded that though age, extremities muscle strengths and spinal flexibility are associated with functional physical performance capacity in patients with type 2 diabetes, age is more linked with performance capacity. However, structured muscle strength and flexibility exercises may help to keep these patients in good functional status even in old age.

**ACKNOWLEDGEMENTS:** The authors acknowledge and appreciate the cooperation of the physicians and patients of the endocrine clinic where the participants were sourced from.

## References

- [1] M. Ozdirenc, S. Biberoglu, A. Ozcan, Evaluation of physical fitness in patients with Type 2 diabetes mellitus. *Diabetes Res Clin Pract.*, 60 (3), (2003), 171-6.
- [2] S.W. Park, B.H. Goodpaster, E.S. Strotmeyer, N. de Rekeneire, T.B. Harris, A.V. Schwartz, Tylavsky, F.A & Newman, A.B (2006). Decreased muscle strength and quality in older adults with Type 2 diabetes. *Diabetes* 55(6), (2006), 1813-1818
- [3] K.I. Oke, E.O. Agwubike and A. Eregie, Effects of structured exercise therapy on physical functional indices of patients with type 2 diabetes in a Nigerian tertiary hospital. *Ozean Journal of Applied Sciences*; 4(3), (2011<sup>b</sup>), 351- 362.
- [4] Z.Y. Fang, J. Sharman, J.B. Prins and Marwicks, Determinants of Exercise Capacity in Patients With Type 2 Diabetes. *Diabetes Care*, 28(7), (2005), 1643- 1648
- [5] I.M. Kamarul, A.A.A. Ismail, L. Naing, and W.B. Wan Mohamad, Type 2 diabetes mellitus patients with poor glycaemic control have lower quality of life scores as measured by the Short-form-36. *Singapore Med J.* 51 (2), (2010), 157-162
- [6] C. Kisner, and L.A. Colby. *Therapeutic exercise: Foundations and techniques.* (5<sup>th</sup> Ed). Philadelphia:F.A.Davies Company, (2007).
- [7] P.T. Katzmarzyk, C.L. Craig, and L. Gauvin, Adiposity, physical fitness and incident diabetes: The physical activity longitudinal study. *Diabetologia.* 50, (2007). 538–544.
- [8] L. Qin, E. Corpeleijn, C. Jiang, G.N. Thomas, C.M. Schooling, W. Zhang, K.K. Cheng, et al., Physical Activity, Adiposity, and Diabetes Risk in Middle-Aged and Older Chinese Population. *Diabetes Care.* 33(11), (2010), 2342–2348.
- [9] W.J.C. de Grauw, E.H. van de Lisdonk, R.R.A. Behr, W.H.E.M. van Gerwen, H.J.M van den Hoogen, and C. van Weel, The impact of type 2 diabetes mellitus on daily functioning. *Family Practice.* 16 (2), (1999), 133 – 139
- [10] R.L. Marcus, S. Smith, G. Morrell, O. Addison, L.E. Dibble, D. Wahoff-Stice, and P.C. LaStayo, Comparison of combined aerobic and high-force eccentric resistance exercise with aerobic exercise only for people with type 2 diabetic mellitus. *Phys Ther.* 88: (2008), 1345-1354.
- [11] S.T. Sutbeyaz, N. Sezer, B.F. Koseoglu, F. Ibrahimoglu, and D. Tekin, Influence of Knee osteoarthritis on exercise capacity and quality of life in obese adults. *Obesity,* 15, (2007), 2071–2076.
- [12] S.O. Wi-Young and C. Dai-Hyuk, Differences in physical fitness and cardiovascular function depend on BMI in Korean men. *J. Sports Sc. Med;* 9, (2010), 239- 244.
- [13] T.N. Hilton, L.J. Tuttle, K.L. Bohnert, M.J. Mueller and D.R. Sinacore, Excessive adipose Tissue infiltration in skeletal muscle in individuals with obesity, diabetes mellitus, and peripheral neuropathy: association with performance and function. *Phys Ther.* 88: (2008), 1336- 1344.
- [14] J. Gormley, and J. Hussey, *Exercise therapy: Prevention and treatment of disease.* (1<sup>st</sup> ed.) MA, USA: Black well Publishing Inc. (2005)
- [15] A. Trichopoulou, C. Gnardellis, A. Lagiou, V. Benetou, A. Naska, and D. Trichopoulos, Physical activity and energy intake selectively predict the waist-to-hip ratio in men but not in women' *American Journal of Clinical Nutrition.* 74(5), (2001), 574-578.
- [16] G. Vazquez, S. Duval, D.R. Jacobs Jr., and K. Silventoinen, Comparison of Body Mass Index, Waist Circumference, and Waist/Hip Ratio in Predicting Incident Diabetes: A Meta- Analysis. *Epidemiol Rev.*, 29 (1), (2007), 115-128.

- [17] M. Leenders, L.B. Verdijk, L. van der Hoeven, et al., Patients with Type 2 Diabetes Show a Greater Decline in Muscle Mass, Muscle Strength, and Functional Capacity With Aging. *J Am Med Dir Assoc.* (2013).  
<http://dx.doi: 10.1016/j.jamda.2013.02.006>.
- [18] R.P. Stolk, P. Suriyawongpaisal, W. Aekplakorn, M. Woodward and B. Neal, Fat distribution is strongly associated with plasma glucose levels and diabetes in Thai adults-the InterASIA study. *Diabetologia*; 48(4): (2005), 657-60
- [19] M.T. Herriot, S.R. Colberg, H.K. Parson, T. Nunnold, and A.I. Vinik, Effects of 8 Weeks of Flexibility and Resistance Training in Older Adults with Type 2 Diabetes. *Diabetes Care*, 27 (12), (2004), 2988-2989doi: 10.2337/diacare.27.12.2988
- [20] I.C. Ikem, R.T. Ikem, M.O.B. Olaogun, A. Owoyemi and B.A. Ola, Assessment of limited joint mobility of the hand in Black Africans with diabetes mellitus and in non-diabetics. *West Indian Med J.*; 58 (6), (2009), 506- 511.
- [21] D.J. Fernando, D.J. Masson, E.A. A. Veves, A.J. Boulton, Relationship of limited joint mobility to abnormal foot pressures and diabetic foot ulceration. *Diabetes Care*. 14 (1), (1991), 8.
- [22] N.I. Shinabarger, Limited joint mobility in adults with diabetes mellitus. *Phys. Ther.* 67(2), (1987), 215-8.
- [23] P.G. Fitzgibbons, and A.C. Weiss, Hand manifestations in diabetic mellitus. *J. Hand Surgery*; 33A: (2008), 771 - 775.