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RESEARCH ARTICLE

Relationships between Hand Grip Strength, Upper Limb Anthropometric Characteristics and Hand Disability in Middle-Aged and Older Adults with Type-2 Diabetes Mellitus

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Abstract

Background: Progressive decline in muscular strength at middle age coupled with the presence of Type-2 Diabetes Mellitus (T2DM) may define hand disability (HdD) as age progresses. However, there is paucity of information on the link between hand grip strength (HGS), upper limb anthropometric characteristics (ULAC) and hand disability (HdD) in patients with T2DM. This study investigated the relationships between HGS, ULAC and HdD as well as factors associated with HdD in middle-aged and older people with T2DM.

Methods: This cross-sectional study involved 150 patients with T2DM (male: n = 83; female: n = 67) receiving treatment at a Nigerian tertiary Hospital using purposive sampling method. Socio-demographic and physical characteristics data were recorded. HGS was measured using an electronic hand dynamometer while ULAC including right and left arm girth, forearm girth, wrist circumference, hand length, hand span and palm length were measured using a non-elastic tape measure. HdD was assessed using the upper extremity functional index. Data were analyzed using descriptive and inferential statistics. Alpha level was set at $p < 0.05$.

Results: The mean age of participants was 59.10 ± 12.13 years. There were significant correlations between dominant, non-dominant HGS and selected ULAC ($p < 0.05$). Older adult; OR = 3.34, (95%CI = 1.08-10.27; $p = 0.001$) and above 5 years diagnosis of T2DM; OR = 2.83, (95%CI = 2.58-3.12; $p = 0.032$) showed significant associations with HdD.

Conclusion: People with T2DM exhibited poor HGS with moderate level of HdD but there were significant relationships between HGS and selected ULAC. However, being older and above 5 years since diagnosis of T2DM are possible risk factors for HdD. The study has implication for disability prevention and designing appropriate rehabilitation regimens for people with T2DM. Regular assessments of hand grip strength, hand anthropometric characteristics and hand disability level are recommended as part of routine examinations in order to identify level of physical disability with the view to preventing disability and institute an appropriate rehabilitation regimen for people with T2DM.

Keywords

Hand disability, Hand anthropometric characteristics, Hand grip strength, Type-2 diabetes, Middle-aged, Older adult

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Abbreviations

T2DM: Type-2 Diabetes Mellitus; HdD: Hand Disability; HGS: Hand Grip Strength; ULAC: Upper Limb Anthropometric Characteristics; HGS-D: Dominant Hand Grip Strength; HGS-ND: Non-Dominant Hand Grip Strength

Introduction

The last four decades have witnessed an unprecedented increase in the prevalence of Diabetes Mellitus especially Type-2 Diabetes Mellitus (T2DM) due to series of lifestyle changes globally [1]. Risk factors contributing to high preponderance of T2DM include but not limited to increasing prevalence of obesity, poor dietary habit, rapid urbanization, cigarette smoking, aging population and physical inactivity [2,3]. According to the International Diabetic Federation (IDF), diabetes is becoming increasingly endemic globally with more than 194 million people reported to have suffered the disease in 2003 [4]. By projection, it is estimated that this figure may rise to 625.6 million people amounting to 9.9% of the world population by 2045 [5]. Furthermore, an estimated 15.5 million adults in Africa aged 20-79 years have diabetes representing a regional prevalence of 2.1 (6.0%). Undeniably, Africa as a continent has the highest proportion of undiagnosed diabetes with over two-thirds (69.2%) of people unaware of their diabetes status [5].

T2DM usually presents with characteristic symptoms such as excessive thirst, polyuria, hyperglycemia, weight loss, fatigue, muscle weakness and exercise intolerance [6,7]. Individuals with long-standing T2DM have been reported to have an increased risk of developing functional disabilities due to progressive uncontrolled hyperglycemia, insulin resistance and poor muscle function [8]. Besides, it has been established that the maximum peak power starts to decline by the third to fourth decade of life leading to poor physical functioning as age advances [9]. Hence, rate of functional disability as regards hand function may be more pronounced among individuals with chronic diseases especially patients with T2DM.

Hand dexterity plays important role in the activity of daily living, thus corroborating the extent of self-care and independent physical function in many chronic diseases such as T2DM [10]. Hand function as regards hand grip strength (HGS) is fundamental to physical performance in adult population. More importantly, HGS is a measure of overall body strength [11], a reliable measurement of disability index [12] and a strong predictor of health status in adult population [13]. Although HGS may be affected by a wide array of factors including body size and hand anthropometric characteristics; hand length, body surface area and arm girth, it is not known whether presence of T2DM may also contribute to rapid acceleration of hand disability and poor physical function as age advances.

In a previous study conducted by Fallahi and Jadidian [14], it was reported that there was good correlation between upper limb anthropometric characteristics and HGS of athletes. However, the influence of hand anthropometric characteristics including hand shape, forearm, upper arm girth, and HGS on HdD of patients with T2DM remains poorly understood. Though several studies have reported poorer upper limb muscle strength and quality in patients with T2DM, it is not clear whether upper limb anthropometric characteristics (ULAC) and HGS contribute to HdD in patients with T2DM. Similar, factors that may be associated with HdD in people with T2DM have not been objectively explored. Moreover, few studies have investigated the relationships among HGS, ULAC and HFS in patients with T2DM and associated factors for hand disability [15]. Hence, the aim of this study was to assess HGS, ULAC and HdD and their relations and also examine factors that may be associated with HdD in middle-aged individuals and older adults with T2DM.

Material and Methods

Study design and participants

This cross-sectional study involved patients with T2DM whose ages ranged between 40 and older. They were receiving treatment at the Endocrinology and Metabolism Unit, Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC), Ile - Ife, Nigeria. Participants were selected using purposive sampling technique.

Inclusion criteria

Inclusion criteria into the study were:

i. Individuals with T2DM.

ii. Ages ranged between 40 years and above.

iii. With no previous history of upper limb fracture, no restriction to upper limb range of motion (ROM) and inflammatory joint diseases or neurological conditions.

Exclusion criteria

They were excluded from the study if presented with

i. Co-morbidities that affect gross weight loss such as cancer or other chronic diseases.

Sample size for the study

The sample size for the study was based on a sample size formula for cross-sectional study assessing functional disability in elderly individual: $n = Z^2p(1-p)/e^2$ [16]. Where n = sample size, Z = 1.96 at 95% confidence level, p = assumed proportion of persons with T2DM, 50% (0.50) in middle age, q = 1.0-p = 0.5, the z-value (z-value for 95% confidence level [1.96]), p the estimated proportion of an attribute present in the population, and e the desired level of precision (i.e., confidence level, expressed as a decimal [0.05]). It has been previously established that the prevalence (p) of any functional disability (defined as an inability to independently perform any function) is 9.2% [17]. Hence, a minimum sample size of 150 people with T2DM was needed for this study.

Procedures

Ethical approval for this study was obtained from the Ethics and Research Committee of the Obafemi Awolowo University Teaching Hospitals Complex (OAU-THC) (ERC/2020/01/04), Ile - Ife, Osun State, Nigeria. Age, socio-demographic and physical characteristics were recorded. The objectives of the study were explained to each participant and an informed consent was obtained. HGS was assessed using an electronic hand grip dynamometer (Model EH 101, Taiwan). Upper limb anthropometric characteristics were measured using a non-elastic tape measure (Butterfly type) to the nearest 0.1 cm, while HdD was assessed using the upper extremity functional index.

Assessment of handgrip strength: Hand grip strength (HGS) was measured using an electronic handgrip dynamometer according to the American Society of Hand Therapists recommendations [18]. HGS was measured with the subject in a sitting position with shoulder adducted and neutrally rotated with elbow joint flex at 90 degrees without radio-ulnar deviation. Participant was asked to squeeze the handle maximally and sustain this for 3-5 seconds. All measurements were performed for both hands, and handedness (dominance and non-dominance) was determined based on self-report. Participants performed at least two maximum attempts for each grip strength measurement, and the mean value of the trials was recorded. Thirty seconds rests was given between each attempt, and hands were alternated to minimize fatigue effects. Results were recorded in Kilogram-force (Kgf). Furthermore, grip strength was classified as less than 25^{th} (poor grip strength), 25^{th}-75^{th} (moderate grip strength), and > 75^{th} (good grip strength) percentile were < 29.0 Kgf, 29.0 - 34.0 Kgf and > 34.0 Kgf, respectively [11].

Assessment of hand shape and upper limb anthropometric indices: The procedures for assessing hand dimension and upper limb anthropometric indices in this study were adopted from the work of Fallahi and Jadidian, [14]. Participant was allowed to relax for about three minutes while the upper limb under examination was placed on a table in supination with appropriate support. A standard non-elastic tape measure was used to take the upper limb dimension measurements to the nearest centimeter.

Hand span: Measurement was taken from the tip of the thumb to the tip of the small finger having opened the hand as wide as possible [14].

Palm length: Measurement was taken from the distal wrist crease to the base of the middle finger.

Hand length: Measurement was taken from the distal wrist crease to the tip of the middle finger.

Arm girth: The circumference of the bulkiest part of the muscles of the arm (4 cm above elbow joint) was recorded.

Forearm girth: The circumference of the bulkiest part of the common extensor group muscles of the forearm (3 cm below elbow joint).

Wrist circumference: Circumferential measurement at the level of the radial styloid of the forearm [14].

Assessment of hand disability: The functional disability index was used to assess level of hand disability among participants. The upper extremity functional index (UEFI) consists of a 20 item questions on a 5-point Likert rating scale assessing level of difficulty in performing activities of daily living using the upper extremities such as household and work activities, hobbies, lifting a bag of groceries, washing scalp, driving etc. [19]. Participant responded to each item by circling a number that best describes their level of difficulty. Item scores range from 0 to 4 whereby 0 indicates extreme difficulty and 4 indicates no difficulty with a task and the total score is a total of the item scores. The score on the UEFI 20 - item ranges from 0-80; 0 indicating lowest and 80 indicating highest functional status. The minimum amount of change that is considered to be clinically significant is 9 points [19]. Minimum level of detectable change (90% Confidence Interval) is 9 points. The lower the score on the UEFI, the worse is the hand disability. HnD was classified as < 25^{th} (poor), 25^{th}-75^{th} (moderate), and > 75^{th} (good) percentile were < 20.0 points, 20.0-60.0 points and > 60.0 points, respectively. The instrument was translated to Yoruba language, back translated to English language by language experts before subjecting it to psychometric evaluations. The psychometric properties of the instrument were r = 0.72 and ICC = 0.462-6.84 for reliability and validity respectively.

Data Analysis

Data are presented as frequency (%) and mean ± S. D. Student t-test was used to compare physical, upper limb anthropometric characteristics, dominant and non-dominants HGS, HdD between male and female participants. Similarly, middle-aged individuals and older adults with T2DM were compared. Pearson's Moment Correlation Coefficient (r) was used to determine the relations between dominant and non-dominants HGS and upper limb anthropometric characteristics. Logistic regression analysis was used to determine factors associated with HdD using socio-demographic factors and time since diagnosis of T2DM among participants with poor HGS. P < 0.05 was considered statistically significant. Statistical Package for Social Sciences (Version 20.0) software was used for the analysis.

Table 1: Socio-demographic characteristics and hand grip strength of participants (n = 150).

Variable	n	%
Sex		
Male	82	54.6
Female	68	45.4
Age group		
Middle age	93	62.0
Older adult	57	48.0
Marital status		
Single/divorced	45	30.0
Married	86	57.3
Widow/widower	19	12.7
Occupation		
Artisan/ Farmer	48	32.0
Civil servant	53	35.3
Retiree	37	24.7
Unemployed	12	8.0
Educational level		
Non formal/primary	46	30.7
Secondary	59	39.3
Postsecondary	45	30.0
Monthly income		
< ₦100,000	85	56.7
₦100,000-₦200,000	36	24.0
> ₦200,000	29	19.3
Time since diagnosis of T2DM		
< 5 years	98	65.3
> 5 years	52	34.7
Hand dominance		
Right hand	113	75.3
Left hand	37	24.7
Hand grip strength		
Poor (< 29.0 Kgf)	82	54.7
Moderate (29.0-34.0 Kgf)	68	45.3
Hand disability		
Poor (< 25th percentile)†	85	56.7
Moderate (25th -75th percentile)	65	43.3
Medication‡		
Metformin	80	53.3
Diabinese	60	40.0
Miglitol	20	13.3
Liraglutide	15	10

Data are n (%); †: upper extremity functional index; ‡: summation is greater than 100% due to combinations of medications.

Results

Table 1 shows the socio-demographic characteristics and hand grip strength of participants. More than half, (54.7%) were males and less than half, (48.0%) were older adults. Table 2 shows comparison of age, physical, upper limb anthropometric characteristics, HdD, dominant and non-dominant HGS between male and female participants. The means of age, HdD level and dominant HGS of participants were 59.10 ± 12.13 years, 58.05 ± 10.14 and 26.35 ± 9.10 Kgf, respectively. Participants were comparable in age and other physical characteristics except in height (t = 3.624; P = 0.048) and body mass index (t = 4.729; p = 0.021). There were significant differences in both right and left upper limb anthropometric characteristics (p < 0.05), except in right arm girth (t = -0.743; p = 0.459), left arm girth (t = 0.217; p = 0.828), and left palm length (t = 1.706; p = 0.090), between males and females. Table 3 shows comparison of age, upper limb anthropometric characteristics, HFS, dominant and non-dominant HGS between middle-aged individuals and older adults. Significant difference was found in age (t = 1.257; p = 0.025) and all upper limb anthropometric characteristics (p < 0.05), except in right arm girth and left palm length (t = -0.743; p = 0.459) and (t = 1.442; p = 0.062), respectively.

Table 4 presents the correlations between dominant, non-dominant HGS and upper limb anthropometric characteristics of participants. There were significant correlations between dominant and non-dominants HGS and all upper limb anthropometric characteristics of participants (P < 0.05), except in right arm girth (t = 0.105; p = 0.200) and left arm girth (t = 0.1161; P = 0.156). Table 5 shows the Logistic regression analysis examining the association between HdD and each of age category, socio-demographic characteristics and time since diagnosis of T2DM among participants with poor HGS. Significant association was found between HdD and older adults category; OR = 3.34, (95%CI = 1.08-10.27; p = 0.001). Additionally, significant association was found between HdD and time since diagnosis of T2DM; OR = 2.83, (95%CI = 2.58-3.12; p = 0.032).

Discussion

This study was carried out to assess handgrip strength (HGS), upper limb anthropometric characteristics (ULAC) and hand disability (HdD) and their relations in middle-aged and older adults patients with T2DM recruited from a Nigerian university teaching hospital. Findings from this study showed that the HGS of the people with T2DM were lower than that in healthy populations. Previously, Cetinus, et al. [10] reported that the HGS of people with T2DM was lower than in normal population. In their case-control study, HGS and pinch strength were compared between people with T2DM and age-matched healthy control subjects; it was observed that the HGS in the T2DM group was lower than the control subjects. Similarly, Awotidebe, et al. [20], reported lower HGS in people with T2DM compared with healthy control. Also, the same trend was observed in a study by Peterson, et al. [21]. The reasons for the reduced HGS among people with T2DM may be due to insu-

Table 2: Comparison of age, physical, upper limb anthropometric characteristics, hand functional status, dominant and non-dominant hand grip strength between male and female participants.

Variable	All (n = 150) Mean ± SD	Male (n = 82) Mean ± SD	Female (n = 68) Mean ± SD	t-cal.	p-value[a]
Age (year)	59.10 ± 12.13	60.72 ± 12.72	58.24 ± 11.31	1.257	0.211
Weight (Kg)	78.82 ± 9.75	78.24 ± 8.62	84.66 ± 8.62	2.466	0.624
Height (m)	1.63 ± 3.44	1.69 ± 1.12	1.54 ± 0.74	3.624	0.048*
BMI (Kg/m²)	30.84 ± 2.62	27.93 ± 3.29	35.70 ± 2.26	4.729	0.021*
RArG (cm)	30.32 ± 4.87	30.05 ± 4.73	30.64 ± 5.37	-0.743	0.459
RFaG (cm)	26.60 ± 3.13	27.46 ± 3.21	25.58 ± 2.72	2.934	0.001**
RHLg (cm)	19.33 ± 1.22	19.75 ± 1.11	18.68 ± 1.07	5.989	0.001*
RHSp (cm)	19.33 ± 1.57	20.00 ± 1.51	18.51 ± 1.24	6.538	0.001*
RPLg (cm)	11.17 ± 0.72	11.45 ± 0.67	10.82 ± 0.62	6.001	0.001**
RWrC (cm)	16.55 ± 1.81	17.10 ± 1.79	15.88 ± 1.59	4.380	0.001**
LArG (cm)	30.10 ± 4.49	30.17 ± 4.50	30.01 ± 4.51	0.217	0.828
LFaG (cm)	26.33 ± 3.14	26.95 ± 4.052	25.12 ± 2.99	3.012	0.003*
LHLg (cm)	19.51 ± 1.23	20.05 ± 1.13	18.85 ± 1.15	6.432	0.001**
LHSp (cm)	19.52 ± 1.49	20.53 ± 2.17	18.89 ± 1.20	5.582	0.001**
LPLg (cm)	11.23 ± 0.81	11.53 ± 0.74	11.10 ± 2.15	1.706	0.090
LWrC (cm)	16.64 ± 1.74	17.01 ± 1.77	16.15 ± 1.64	3.102	0.002*
FBS (mmol⁻¹)	6.72 ± 2.18	6.68 ± 2.32	7.14 ± 2.14	-0.509	0.466
HFS	58.05 ± 10.14	65.22 ± 8.35	42.22 ± 8.35	2.442	0.021*
HGS-D (Kgf)	26.35 ± 9.10	30.42 ± 8.74	21.37 ± 6.80	7.153	0.001**
HGS-ND (Kgf)	24.65 ± 8.60	28.40 ± 8.39	20.08 ± 6.394	6.913	0.001*

*$p < 0.05$; **$p < 0.001$; Data are mean ± SD.

RArG: Right arm girth; RFaG: Right forearm girth; RHLg: Right hand length; RHSp: Right hand span; RPLg: Right palm length; RWrC: Right wrist circumference; LArG: Left arm girth; LFaG: Left forearm girth; LHLg: Left hand length; LHSp: Left hand span; LPLg: Left palm length; LWrC: Left wrist circumference; FBS: Fasting blood sugar; HFS: Hand functional status; HGS-D: Dominant hand grip strength; HGS-ND: Non-dominant hand grip strength; [a]Comparing males and females.

Table 3: Comparison of age, upper limb anthropometric characteristics, hand functional status, dominant and non-dominant hand grip strength between middle age and older adult participants.

Variable	All (n = 150) Mean ± SD	Middle age (n = 93) Mean ± SD	Older adult (n = 57) Mean ± SD	t-cal.	p-value[a]
Age (year)	61.10 ± 12.13	45.24 ± 11.31	71.72 ± 12.72	1.257	0.025*
RArG (cm)	30.32 ± 4.87	30.05 ± 4.73	28.22 ± 7.12	-0.743	0.459
RFaG (cm)	23.72 ± 1.18	25.40 ± 2.16	22.74 ± 2.69	2.338	0.004*
RHLg (cm)	18.14 ± 1.40	18.44 ± 1.01	16.68 ± 1.07	3.252	0.022*
RHSp (cm)	19.93 ± 1.62	20.24 ± 1.59	18.11 ± 1.56	4.812	0.001*
RPLg (cm)	10.41 ± 0.16	10.52 ± 0.48	9.56 ± 0.78	4.281	0.041*
RWrC (cm)	15.94 ± 1.62	16.18 ± 1.35	14.70 ± 1.68	2.992	0.023*
LArG (cm)	29.64 ± 3.58	29.40 ± 3.00	28.26 ± 5.22	1.327	0.614
LFaG (cm)	24.18 ± 3.25	25.82 ± 4.68	23.05 ± 2.48	3.012	0.015*
LHLg (cm)	19.51 ± 1.23	19.22 ± 1.06	18.14 ± 1.21	6.432	0.041*
LHSp (cm)	19.68 ± 1.39	20.53 ± 2.17	18.89 ± 1.20	5.582	0.036*
LPLg (cm)	10.63 ± 0.48	10.66 ± 0.82	10.60 ± 2.61	1.442	0.062
LWrC (cm)	15.86 ± 1.62	17.58 ± 1.48	14.15 ± 1.45	2.648	0.004*
FBS (mmol⁻¹)	6.89 ± 2.72	6.27 ± 2.49	7.26 ± 2.24	-0.429	0.069
HFS	46.18 ± 10.52	52.26 ± 8.15	28.37 ± 2.70	2.648	0.004*
HGS-D (Kgf)	25.16 ± 8.40	32.61 ± 6.85	23.84 ± 5.92	5.195	0.001**
HGS-ND (Kgf)	23.72 ± 6.38	26.82 ± 6.12	21.81 ± 5.46	3.118	0.001**

*$p < 0.05$; **$p < 0.001$; Data are mean ± SD

RArG: Right arm girth; RFaG: Right forearm girth; RHLg: Right hand length; RHSp: Right hand span; RPLg: Right palm length; RWrC: Right wrist circumference; LArG: Left arm girth; LFaG: Left forearm girth; LHLg: Left hand length; LHSp: Left hand span; LPLg: Left palm length; LWrC: Left wrist circumference; FBS: Fasting blood sugar; HFS: Hand functional status; HGS-D: dominant hand grip strength; HGS-ND: Non-dominant hand grip strength; [a]Comparing middle-aged and older adults.

Table 4: Correlation between dominant, non-dominant hand grip strength and upper limb anthropometric characteristics of participants (n = 150).

Variable	HGS-D		HGS-ND	
	r[a]	p-value	r[a]	p-value
RArG	0.128	0.118	0.105	0.200
RFaG	0.442	0.001**	0.411	0.001**
RHLg	0.498	0.001**	0.500	0.001**
RHSp	0.465	0.001**	0.479	0.001**
RPLg	0.427	0.001**	0.447	0.001**
RWrC	0.437	0.001**	0.395	0.001**
LArG	0.157	0.054	0.116	0.156
LFaG	0.427	0.001**	0.417	0.001**
LHLg	0.500	0.001**	0.509	0.001**
LHSp	0.427	0.001**	0.451	0.001**
LPLg	0.403	0.013*	0.420	0.001**
LWrC	0.399	0.001**	0.357	0.001**

*$p < 0.05$; **$p < 0.001$

RArG: Right arm girth; RFaG: Right forearm girth; RHLg: Right hand length; RHSp: Right hand span; RPLg: Right palm length; RWrC: Right wrist circumference; LArG: Left arm girth; LFaG: Left forearm girth; LHLg: Left hand length; LHSp: Left hand span; LPLg: Left palm length; LWrC: Left wrist circumference; HFS: Hand functional status; HGSD: dominant hand grip strength; HGSND: non-dominant hand grip strength; [a]Pearson's product-moment correlation.

Table 5: Logistic regression analysis of associations between hand disability, age group, socio-demographic characteristics and time since diagnosis among participants with poor hand grip strength (n = 82).

Variable	Hand Disability		
	OR[a]	95% CI	p-value
Age category			
Middle age	1.00 (Ref)		
Older Adult	3.34	1.08-10.27	0.001**
Gender			
Female	1.00 (Ref)		
Male	0.58	0.15-2.17	0.462
Marital status			
Single/divorced	1.00 (Ref)		
Married	0.94	0.31-2.82	
Widow/widower	1.52	1.30-1.77	0.121
Occupation			
Unemployed	1.00 (Ref)		
Civil servant	1.13	0.95-1.34	
Artisan/ Farmer	0.84	0.27-2.49	
Retiree	2.17	1.12-4.14	0.206
Time since diagnosis of T2DM (year)			
< 5	1.00 (Ref)		
> 5	2.83	2.58-3.12	0.032*

*$p < 0.05$; **$p < 0.001$; OR[a]: Adjusted Odd Ratio; CI: Confidence Interval.

lin resistance and hyperglycemia causing a reduction in the number of mitochondria in the muscle cells, decrease in glycogen synthesis and increased concentration of circulating systemic inflammatory cytokines [8,22,23]. Moreover, it could be due to peripheral and motor neuropathy affecting the muscle function owing to persistent hyperglycemia.

Finding from this study also showed that male participants had higher HGS than their female counterparts in both dominant and non-dominant hands. This is consistent with the findings of previous studies on HGS among healthy population [11,13,24]. Likewise, among individuals with T2DM, the trends remain the same as male individuals have higher HGS than their female counterparts. The possible explanation for this could be due to the type of activity each sex engages in. While males are more adept to activities that involve increased muscle strength and hypertrophy, females are more involved in endurance type of activities that do not require increased muscle strength and hypertrophy. Also, higher percentage of lean body mass which induces protein deposition and development, thus causing an increase in muscle strength in males than the females could be a possible explanation. However, dominant HGS was higher than the non-dominant HGS without any sex bias. The reason for the difference may not be difficult to identify as regular use of a particular limb increases the chance of greater muscular strength and endurance; hence, dominant hands are usually stronger than non-dominant hands. Considering the age group of participants, findings from this study showed that individuals in middle age demonstrated higher HGS than older adults. This is similar to findings of previous studies that older adults had reduced HGS than younger individuals [9,25,26]. The possible explanation for the difference may be due to age related issues as muscle fibres begin to degenerate with advances in age, and thus becomes thinner with progressive reduction in muscle strength. Moreover, nerve conduction is slower in older adults and may result to poor response to external stimuli.

The relationships between HGS and upper limb anthropometric characteristics showed that there were significant correlations. Positive correlations were found between dominant, non-dominant HGS and most of the upper limb anthropometric characteristics including arm girth, forearm girth, hand span, wrist circumference and palm length. This is in line with previous studies on hand grip strength in healthy populations which reported significant correlations between HGS and several hand anthropometric variables [14,27,28]. These relationships may not be unconnected with hand dexterity as activities of daily living involves regular use of upper limbs could eventually have multiply effects on the anthropometric characteristics of the upper limb muscles and subsequently impact the HGS.

In the present study, hand disability (HdD) of more than half of people with T2DM is poor. This is in line with findings of previous studies that hand functions in people with T2DM is usually compromised [20,29,30]. This may be due to persistent hyperglycemia impacting negatively on the skeletal muscle mass, strength, and function, potentially leading to the development of disability. In the present study, the association between HdD and socio-demographic characteristics were also explored. HdD was significantly associated with age category as older adults were more than thrice susceptible to HdD. As age increases, many physiological changes, wear and tear may result in poor physical function leading to progressive physical disability. Besides, presence of metabolic disorder such as T2DM may accelerate and augment poor functions due to series of negative impact of hyperglycemia on nerve cell and development of peripheral neuropathy. It is also possible that conditions such as carpal tunnel syndrome and Dupuytren's contracture commonly seen in people with T2DM may complicate the development of HdD. Hence, hand function may not only be impaired but could hasten gross physical disability. T2DM is a lifelong ailment and disease progression over the years may have negative impact on physical functions. It is now evident that presence of chronic disease such as T2DM and aging are potential contributors for rapid hand and physical disability [31,32].

Findings from this study show that there was significant association between HdD and greater than five years since time of diagnosis of T2DM. This is similar to findings of previous studies that upper limb muscle quality and good hand function were consistently lower in adults with duration of greater than 6 years of T2DM regardless of sex [23,33]. T2DM is associated with chronic, low-grade systemic inflammation which may negatively affect glucose and muscle homeostasis [34]. This may perhaps disrupt normal functioning of the hand and consequent HdD in people with T2DM. Furthermore, multifactorial effects of aging on musculoskeletal and neurological systems coupled with occasional hyperglycemia over long period of time may heighten HdD in people with T2DM. Although regular medications help to control plasma glucose level, episodes of hyperglycemia and habitual physical inactivity commonly seen in people with T2DM may result into possible risk factors for rapid hand and physical disability.

Conclusions

People with T2DM demonstrated poor and hand grip strength and moderate to high hand disability. Furthermore, selected upper limb anthropometric characteristics were significantly correlated with handgrip strength. However, older adults and greater than 5 years since diagnosis of T2DM were possible risk factors associated with hand disability. Consequently, people with T2DM are possibly at greater risk of physical disability than their age-matched healthy counterparts.

Limitations

The results of this study should be interpreted with cautions due to some limitations. The study design is a cross-sectional one in nature and causal relationship could not lead to the generalizability of this finding. Nevertheless, participants were carefully recruited into the study without bias as participants were selected in the same hospitals setting; hence, they appeared to be homogeneous group. Furthermore, time since diagnosis of T2DM varied among the participants but clinical and laboratory assessment of T2DM provided an evidence of T2DM is under proper control of hyperglycemia. Therefore, the results of this study may not be applied to individuals with poor glycemic control.

Recommendations

Regular assessments of hand grip strength, hand anthropometric characteristics and hand disability level are recommended as part of routine examinations in order to identify level of physical disability with the view to designing an appropriate rehabilitation regimen for people with T2DM.

Disclosure of Interest

The authors declare that they have no competing interest.

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