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Adequate Management of type two diabetes creates minor complications in Cardio-Postural Profile in Latinx-Hispanic People

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Abstract: Diabetes is recognized to lead to a series of metabolic abnormalities in the body. These alterations will affect balance, body composition, and cardiovascular performance, heightening the risk of various medical complications. The problem is that the primary instruction for those with diabetes is to monitor glucose levels, paying very insufficient consideration to other fundamental factors and health profiles that could influence the quality of life in these individuals. Identify body composition, balance, and cardiovascular components in controlled type two diabetics compared to an age-matched control group. 15 participants with controlled type II diabetes without peripheral neuropathy (CT2DM) and 18 non-diabetic subjects control (CG) were recruited. Both groups had an age average of roughly 56 years old. The CT2DM subjects had an average A1c level of 6.7+/-0.5%. Body composition, cardiovascular, and balance data were collected, analyzed, and compared among groups. Minimal alterations in balance components, body composition and cardiovascular factors were identified in the CT2DM group aside from higher SBP values and decreased BBS scores contrasted to the CG group. We can attribute the analogous outcomes in both groups to CT2DM participants managing their diabetes effectively. Our examination has prompted us to establish that the cardiovascular and balance components in middle-aged Latinx-Hispanic participants with CT2DM are proportionate to CG subjects because of effectiveness in dealing with diabetes. Further, we encourage establishing more age appropriate and complex assessment tools to identify early adaptations caused by diabetes.

Keywords: Controlled Diabetes, Balance, Health Profile, Diabetes Management

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1. Introduction

Diabetes is a continuously evolving diagnosis of a progressive disease that has invoked the conduction of a plethora of research studies to investigate its extensive characteristics and requirements for medical management. Despite the effective treatment options available for type 2 diabetes (T2DM), the disease remains widespread with 34.2 million active cases and an estimated 7.3 million undiagnosed cases in the United States alone [1]. The increase in cases of individuals living with this disease continues to be directly proportional to aging, as well as with those of specific races and ethnicities. While the average, older, non-Hispanic Americans are at great risk for developing T2DM, the probability of Latinx-Hispanic Americans developing T2DM is greater than 50% and occurs at ages far younger than their white counterparts [2]. Researchers from the CDC have recently recorded landmark statistics in the current prevalence of T2DM in Latinx Americans, which far exceeds the morbidity rate in non-Hispanic whites at 22% and 12%, respectively [3-4]. Although the correlation between the components remains uncertain, genetics significantly contributes to those of Latinx-Hispanic descent being 1.7 times more likely to develop T2DM, along with having higher incidence rates of 2.6 for hospitalization and 1.4 for mortality in comparison to non-Hispanic whites [2,5].

It has been thoroughly established that T2DM causes impairments to gait and balance, contributing to profound impacts on the quality of life in patients with this disease [6]. For instance, recent research incorporating the modified clinical test of sensory interaction in balance (mCTSIB) has recognized that as the complexity of the balance tasks increases, older adults with T2DM fail in performance in relation to those without the disease [7]. Other studies have identified that elderly adults with diabetic neuropathy have increased functional imbalance in tasks linked to healthy control participants [8], and while T2DM alone can be an intrinsic factor for enhanced fall risk, this risk is vastly enhanced due to being accompanied by the known correlation between lower extremity strength and higher risk of fall risk as age increases [9,10].

The most frequent complication of diabetes is peripheral neuropathy (PN) [11], along with many other gait deficiencies that come into play, such as diminished ankle range of motion, slower gait speed, and shorter stride and step, all of which are modifications characterized by stability alterations [12]. The issue at hand is that diabetes itself can provoke fall-related gait and balance difficulties in those living with the illness; therefore, upon T2DM patients incurring PN, their fall risk is profoundly amplified [13, 14].

Diabetes and diabetes-related PN impact multiple areas that ultimately jeopardize patients' functionality and autonomy [15, 16] by disturbing their balance [17] and gait [12]. Inquiries have previously established that upon being compared to healthy control groups, diabetes in the initial or controlled stages of the disease can show early manifestations of altered morphology and movement patterns [18, 19]; however, some underlying variations might not be as easily detectable in those who are in the early stages of T2DM. Thus, there is a clear justification for further investigations to examine whether outcome measures alone can differentiate activity performances in patients with controlled T2DM.

As mentioned above, investigations that focus on T2DM typically focus on the later stages of the illness, such as uncontrolled diabetes measured by glucose levels and peripheral neuropathy, because the further the condition progresses, the more obvious the exacerbations of diabetes-related complications become. Contrarily, we dare to ask, are early balance and cardiovascular alterations distinguishable in individuals with controlled T2DM without a history of peripheral neuropathy?.

As a result of the limited inquiries conducted to comprehensively understand balance and fitness among Latino adults with T2DM, the proposal of this current investigation is to compare performance characteristics across various fitness and balance tasks in Latinx-Hispanic subjects, both with and without T2DM. To the best of our knowledge, research involving identifying physical activity performance using various outcome measures in patients with and without T2DM remains scarce, particularly in the Latinx population who are in either initial or controlled stages of T2DM. Accordingly, to answer the above question, this study aimed to identify whether middle-aged Latinx adults with T2DM demonstrate any deviations in cardiovascular and balance factors in comparison to healthy participants.

2. Methods

2.1. Participants

All research participants were recruited from medical offices and the medical sciences center through flyers and word of mouth. Thirty-three

participants (19 women and 14 men) were successfully recruited, signed the informed consent, and partook in this inquiry; 18 healthy participants without diabetes were placed in the control group (CG) and 15 participants with controlled type 2 diabetes were placed diabetes group (CT2DM). The average age was 56.0 +.-4.7 for those in the CG and 57.7+/- 5.1 for the CT2DM group. The CT2DM subjects had an average A1c level of 6.7+/-0.5%.

2.2 Cardiovascular Measures

The Tecumseh Step Test is a cardiovascular fitness evaluation that challenges subjects at a submaximal intensity. This analysis necessitated a stopwatch, 30.3 cm step-stool, a blood pressure machine, and pulse oximeter to measure cardiovascular strength. Before starting, participants' resting heart rate (HR), oxygen saturation (SaO_2), and blood pressure (BP) were recorded. Participants were then instructed to step up and down on the step-stool to the pulse of a metronome set at 96 beats per minute for a total of 2 minutes. After test completion, HR and SaO_2 were measured again.

2.3 Balance Measures

Balance conditions: Maintaining a stable stance requires prompt interactions between the three sensory systems (visual, vestibular, proprioceptive), equating to a weak interaction among any of these systems, which ability to cause increased postural instability. Therefore, we analyzed the deviations present in postural distance and sway when participants were instructed to maintain static balance during eight different conditions that challenged their sensory systems. The initial four conditions were performed on a consistently firm surface, whereas the last four were completed on a foam mat. For both surfaces, the conditions involved the participants 1) keeping their eyes open, 2) keeping their eyes closed, 3) keeping their eyes open with head movement, and 4) keeping their eyes closed with head movement. Participants followed the pulsation of a metronome set to 60 beats per minute for tasks involving head movement. Closing the eyes omit visual input, which causes the reallocation of balance responsibilities to the vestibular and proprioceptive systems. We introduced the mat surface to alter proprioceptive information, while head movements were initiated to modify the vestibular information. In doing so, multiple sensory systems are collectively being challenged, which can disturb postural stability.

Balance Assessments: The Berg Balance Scale (BBS), Functional Reach Test (FRT), and 30 Second Sit to Stand Test (30CST) were administered to each participant to assess stability and fall risk, and standard protocols were followed for each test. The BBS involves 14 items, and each item is graded on a 0-4 point scale, with a maximum possible score of 56. The 30CST required participants to perform as many sit-to-stand as possible with proper form (arms crossed while using a chair that does not have arm support) for 30 seconds. The FRT necessitated participants to stand next to a wall, position the arm at a 90 ° angle of shoulder flexion with their hand closed, and reach forward as far as they can while their feet remain in a stationary position. The distance of movement was calculated in centimeters by measuring the start and end positions of the third metacarpal.

2.4 Data Analysis

The current study conducted multiple one-way analysis of variances (ANOVA) with Statistical Package for the Social Sciences (SPSS) version 25 to compare both groups based on the body composition, cardiovascular, and balance components.

3. Results

The demographic data of CG and CT2DM participants are detailed in Table 1. Although both groups showed similarities a slight increase was observed for weight, BMI, body fat percentage, and visceral fat components in the CT2DM compared to CG.

The cardiovascular profile of both groups is highlighted in Table 2. A step test was performed to gathered cardiovascular data and identify distinctions among groups. The CT2DM exhibited changes in the cardiovascular profile in systolic blood pressure (SBP) and heart rate compared to the CG group. Specifically, CT2DM had a higher SBP (147.4+/-15.8) compared to CG participants (128.9+/-20.0) (p=0.026), along with a slightly higher diastolic blood pressure (DBP). Additionally, increases in heart rates from the initial to final readings were more evident in CT2DM participants than in CG participants.

Table 3 depicts the balance characteristics of both the CG and CT2DM groups across the various balance conditions. Balance profile was assess to understand the impact of T2DM on motor control. Our study found that balance characteristics were congruent for both groups throughout the conditions, although some balance issues were identity and

perceptible with distance and sway increase as the difficulty of the tasks increased, especially among the CT2DM group.

Table 1 Demographic and clinical variables (mean ± standard deviation). Results of Student's *t*-test performed between the two sample groups: controlled diabetic group without peripheral neuropathy (CT2DM); healthy non-diabetic control group (CG). Significance threshold = $P \leq 0.05$; significant P= threshold value; non-significant P=calculated value; NA=not applicable.

Group	CG (N=18)	CT2DM (N=15)	P Value
Age (years)	56.0 +/-4.7	57.7+/-5.1	0.39
Gender	Females: 11 Males: 7	Females: 8 Males: 7	N/A
Height (inches)	64.5 +/- 3.9	65.8 +/- 4.3	0.59
Weight (pounds)	162.2 +/- 8.6	176.6 +/- 75	0.27
Body mass index (BMI) (kg/m^2)	26.1+/-3.1	29.0+/-3.8	0.13
Body Fat%	32.7+/-11.1	36.5+/-7.5	N/A
Visceral fat level	9.5+/-2.8	12.1+/-5.0	N/A
Skeletal muscle %	26.0+/-6.3	26.1+/-5.8	N/A
HbA1c (%)	N/A	6.7+/-0.5	N/A
Years following diagnosis of diabetes	N/A	8.0+/-5.8	N/A

Table 2 Cardiovascular Characteristics During Step Test

	Control (N=18)	CT2DM (N=15)	P value
Initial SaO_2	98.2+/-1.0	97.9+/-0.8	0.442
Initial HR (bpm)	73.8+/-13.1	77.1+/-13.9	0.552
Final SaO_2	96.6+/-3.5	97.7+/-1.2	0.373
Final HR (bpm)	96.7+/-19.6	105.2+/-15.6	0.275
Time to normalize (sec)	2.05+/-0.5	2.27+/-0.47	0.56
SBP (mmHg)	128.9+/-20.0	147.4+/-15.8	0.05
DBP (mmHg)	80.4+/-16.1	100.9+/-34.4	0.052
Saturation O_2	98.1+/-1.0	97.9+/-0.8	0.535
Pulse (bpm)	73.9+/-13.0	77.4+/-14.5	0.534
SaO_2: oxygen saturation; HR: heart rate; SBP: systolic blood pressure, DBP: diastolic blood pressure			

Table 3 Balance Characteristics of CG and CT2DM Groups Under Different Balance Tasks

Balance Characteristics (cm)	Control (N=14)	CT2DM (N=9)	P value
EO Distance	26.2+/-15.2	26.4+/-4.4	0.970
EO Sway	0.12+/-0.3	0.03+/-0.0	0.405
EC Distance	29.7+/-12.2	31.0+/-6.9	0.789
EC Sway	0.09+/-0.2	0.03+/-0.0	0.452
EO HUD Distance	34.2+/-13.7	37.5+/-12.5	0.563
EO HUD Sway	0.13+/-0.34	0.04+/-0.01	0.458
EC HUD Distance	36.9+/-15.1	51+/-26	0.113
EC HUD Sway	0.12+/-0.3	0.06+/-0.03	0.521
MEO Distance	77.9+/-35.2	64.0+/-19.4	0.293
MEO Sway	0.08+/-0.04	0.07+/-0.02	0.409
MEC Distance	110.3+/-47.4	102.2+/-44.0	0.686
MEC Sway	0.12+/-0.1	0.12+/-0.1	0.850
MEO HUD Distance	101.0+/-34.6	124.6+/-44.2	0.167
MEO HUD Sway	0.11+/-0.04	0.14+/-0.04	0.109
MEC HUD Distance	153.1+/-55.0	183.7+/-109.3	0.382
MEC HUD Sway	0.16+/-0.06	0.22+/-0.15	0.167
Sit to Stand (30sec)	14.6+/-2.4	14.1+/-2.9	0.635
Berg Balance Scale (BBS) Score	55.2+/-1.7	52.7+/-2.9	0.01
Functional Reach Score (inch)	33.8+/-2.5	28.7+/-2.3	0.064
EO: eyes open; EC: eyes closed; HUD: with head movement; MEO: eyes on open on mat; MEC: eyes closed on mat.			

The BBS scores between the two groups also showed some tendencies for balance problems, with an average score of 55.2+/-1.7 for CG participants and 52.7+-2.9 for CT2DM participants (p=0.013). Finally, the 30CST and FRT scores were virtually consistent between the groups.

4. Discussion

This study proposes a comparison of body composition factors, cardiovascular measures, and balance performance across multiple outcome measures in middle-aged Latinx-Hispanic adults who present both with and without T2DM. No substantial variations in the variables mentioned above were identified in the CT2DM group, aside from higher SBP values and decreased BBS scores compared to the CG group. The comparable findings in both groups can be attributed to CT2DM participants managing their T2DM effectively and the simplicity of some tasks and conditions. These similar results may also be due to the ceiling effect, as the balance measures were

designed to be administered to older adults rather than those who were middle-aged, such as our participants, causing scores among both groups to be higher than intended by the test's design.

Body Composition factors: The first finding of this study was that while the demographic patterns between the two groups were considerably analogous, the CT2DM group presented with indications of marginally higher values for certain health variables, such as weight, BMI, body fat percentage, and visceral fat levels. This outcome aligns with previous literature in which the above-mentioned elevated variables were definitively found to be attributed to the clinical presentation of T2DM [20, 21]. With this, early reports have ascertained that obesity in diabetic patients is often a result of poor management of HbA1c levels, cholesterol, and hypertension, which was also prevalent in our participants, as depicted in Table 2 [20].

Cardiovascular characteristics: The second finding of this research showed higher SBP values in the CT2DM group than in the CG. Our results demonstrate that even during controlled stages of the disease, cardiovascular alterations can be identified in diabetics, which is comprehensible due to the progressive nature of diabetes. Previous reports have highlighted diabetes as a disease that can provoke cardiovascular complications by damaging arteries via the building of formating hardened fatty deposits inside the arteries, known as atherosclerosis [22, 23]. With this artery change, increased plaque buildup can elevate blood pressure, leading to even greater risks for heart attacks and strokes in T2DM patients if diabetes is inappropriately managed. According to the American Diabetes Association, 2 out of 3 people with diabetes experience high blood pressure, with stage 2 hypertension categorized as an SBP greater than 140 mmHg and a DBP of greater than 90 mmHg [24]. Considering the cardiovascular tendency in diabetics, we speculate that our CT2DM participants' hypertensive statuses are potentially improperly managed due to the lack of appropriate medications, inaccurate medication dosages or physical inactivity.

In a qualitative study, participants reported believing that controlling their blood sugar was more crucial than managing their blood pressure and lacked knowledge regarding the risks associated with hypertension, such as an increased risk of kidney disease when factoring in T2DM [25]. Other cardiovascular characteristics, such as initial and final HR values, were marginally higher among CT2DM participants, yet their ability to complete the step test continuously and in its entirety for two minutes indicates that they have sufficient cardiovascular endurance. Research regarding higher HR in diabetic patients compared to healthy individuals is limited. One study postulated that a higher resting heart rate increases the risk of T2DM, especially in combination with high BMI and blood pressure [26]. In another interesting research line, researchers concluded that a higher resting HR increases the risk of cardiovascular diseases and death [27]. Thus, based on our results and the evidence above from previous studies, we infer that the parallelity between our subjects' cardiovascular measures is because the CT2DM participants show efficacy in managing their diabetes and blood glucose levels. Alternatively, because the CT2DM participants had both slightly increased DBP and HR values, we recommend the monitoring of vital signs frequently in T2DM patients to avoid further cardiovascular complications and reduce the risk of mortality, even when the disease is in a controlled state.

Balance characteristics: Sway, BBS, and FRT were the three tools used to establish participants' balance profiles, therefore allowing us to identify different aspects related to balance in those with controlled diabetes. From this, we ascertain that the third main outcome of this study illustrates similarities in balance factors among participants in both the CG and CT2DM groups, indicating that when the disease is properly managed, controlled diabetics can preserve balance.

BBS: The average BBS score of those in the CT2DM group was 52.7, notably lower than that in the CG. Previous research examining BBS performance in the geriatric, stroke, and Parkinson's population, established a score less than 45 indicates fall risk in these conditions [28]. Our results are consistent with previous research conducted on community-dwelling participants who are functionally independent [29], in which the average BBS score was 55 for both female and male subjects between the ages of 60 and 69. After identifying an age-related decrease in test scores in the BBS, Steffen and colleagues underlined how physical therapists should utilize age-and gender-related data when utilizing assessment measures. Our results also favorably correlate with a previous study in which diabetic subjects yielded BBS scores that were not indicative of being fall risks, although the authors exhorted them to partake in physical therapy

interventions to maintain or advance their balance mechanisms [30].

FRT: With regard to normative scores for the FRT, prior investigations have neglected to establish cut-off scores for middle-aged adults who are sedentary; however, one study was able to derive a cut-off score indicative of fall risk in those with Parkinson's disease as 30.1 cm with 56% sensitivity [31]. Our CT2DM subjects' average FRT score of 28.7 cm is not within normative ranges and is fairly borderline regarding the possibility of being fall risks. Our participants must have also evinced the ceiling effect to manifest for the clinical assessments, considering that the majority of the literature derived cut-off scores for older adults rather than the middle-aged population. Jernigan and colleagues emphasized that solely utilizing traditional cutoff scores to identify fall risk in diabetic patients with neuropathy can fail to identify fall risk in nine out of ten recurrent fallers [32]. In their study, cut-off scores for BBS and FRT were modified to ≤52 and ≤31.7 cm, respectively, yielding higher diagnostic accuracy and sensitivity levels compared to the cutoff scores that are traditionally adhered to [32]. Therefore, we presume that our participants' performance scores from the balance assessments we administered will decline as their age increases, as well as if their lifestyle behaviors, such as lack of exercise and blood pressure management, are overlooked. Individuals with diabetes can benefit from engaging in physical activities that can curtail many associated health issues; benefits seen by those with T2DM who have incorporated physical activities include improved A1c levels, blood pressure, mental health, exercise capacity, and a decreased risk of heart disease and stroke [33, 34].

Sway: An increase in distance and sway was perceptible as the complexity of the balance conditions increased, which is a plausible outcome considering the challenges our protocol imposed on the sensory systems that are responsible for maintaining balance. However, increased deviations in distance and sway seen in the CT2DM participants is concerning, as this could potentially foreshadow both the sustaining of alterations to sensory systems and becoming fall risks in the future. Several researchers now contend that, even prior to the presence of peripheral neuropathy, diabetic patients can exhibit balance and gait impairments [18, 35] with increased joint movements, decreased gait speed, decreased cadence, reduce single limb support during gait, increased sway as well as heightened abnormalities in those who present with neuropathy [8, 14, 36]. We believe that balance variations were insignificant in our study due to the static balance conditions in the protocol not being strenuous enough to prescribe balance difficulties in our participants. As previously proposed, the corresponding balance profiles among the two groups may be a result of the CT2DM participants' managing their blood glucose values.

Our main limitation in this investigation was not incorporating activities challenging enough to elicit expected deviations in the balance measures. As a result, we suggest that future inquiries focus on examining balance characteristics in CT2DM participants during gait and single-leg activities. Furthermore, due to the complex nature and specificity of the inclusion and exclusion criteria for this study, we were able to recruit enough participants to identify trends, but not enough to draw any definitive conclusions.

5. Conclusion

Our investigation has led us to determine that the cardiovascular and balance characteristics in middle-aged Latinx-Hispanic participants with CT2DM are comparable to CG subjects as a result of efficacy in managing diabetes, the leniency of the balance tasks, and the elicitation of the ceiling effect in the balance outcome measures. Although statistical significance was only apparent across the two measures, we contend that our results present some clinical relevance. Our findings suggest that there is a need for the development of balance outcome measures aimed at assessing middle-aged adults with comorbidities, as the majority of established balance outcome measures and their respective cut-off scores exhibit a propensity toward assessing older adults. The minor decrease in balance performance in the middle-aged CT2DM participants, the inactive lifestyle, as well as the close proximity to cut-off scores in some of the outcome measures indicate vulnerability to impending health risks, such as falls and cardiovascular complications.

Therefore, qualified clinicians should aim to identify early clinical presentations of T2DM-related complications to determine the health status and fall risk of patients with the disease rather than relying solely on certain cut-off scores; the inevitably higher scores of younger diabetics' partaking in senescence-based outcome measures and assessments may very well be the result of the ceiling effect and do not

determine the absence of early balance or cardiovascular alterations.

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