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Gestão & Cuidado em Saúde

Correlation between type of diabetes and arterial stiffness in adult patients

Correlação entre o tipo de diabetes e rigidez arterial em pacientes adultos

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ABSTRACT

Diabetes mellitus (DM) can induce changes in different arterial territories and is associated with the development of cardiovascular consequences. The pathophysiological mechanism underlying these associations has not yet been fully elucidated in the literature. However, arterial stiffness may be an important pathway linking DM to increased cardiovascular morbidity and mortality. This works aims to verify the correlation between DM type and arterial stiffness in patients diagnosed in adulthood. Ninety diabetic patients aged 54.1 ± 9.3 years were allocated into 2 groups: patients with type 1 DM (T1DM; n=30) and type 2 (T2DM; n=60). Anthropometric parameters as well as arterial stiffness were evaluated using the pulse wave velocity (PWV) method. There was a longer duration of diabetes (p=0.007), lower body mass (p=0.034), BMI (p=0.007) and waist circumference (p<0.001) in patients with T1DM compared to T2DM. A higher PWV rate (p<0.001) was observed in T1DM patients when compared to T2DM. Analyzing together or separately regarding the etiology of DM, it was observed that the higher the HbA1c concentration (>8%) the higher the PWV values (p<0.05). A positive correlation was observed between PWV and patients' age (r=0.89; p<0.001), duration of diabetes (r=0.71; p<0.001) and HbA1c (r=0.70; p <0.001). Individuals with T1DM had greater arterial stiffness when compared to T2DM, and these changes were associated with greater metabolic dysfunction in this population.

Keywords: Arterial stiffness. Diabetes mellitus. Pulse wave velocity.

RESUMO

O diabetes mellitus (DM) pode induzir alterações em diferentes territórios arteriais e está associado ao desenvolvimento de consequências cardiovasculares. O mecanismo fisiopatológico subjacente a essas associações ainda não se encontra totalmente elucidado na literatura. No entanto, a rigidez arterial pode ser um

caminho importante que liga o DM ao aumento da morbimortalidade cardiovascular. Este estudo objetiva verificar uma correlação entre o tipo de DM e rigidez arterial em pacientes diagnosticados na fase adulta. Noventa pacientes diabéticos com idade de 54,1 ± 9,3 anos foram alocados em 2 grupos: paciente com DM do tipo 1 (DM1; n=30) e tipo 2 (DM2; n=60). Foram avaliados os parâmetros antropométricos bem como a rigidez arterial através do método da velocidade de onda de pulso (VOP). Evidenciou-se um maior tempo de diabetes (p=0,007), menor massa corporal (p=0,034), IMC (p=0,007) e circunferência da cintura (p<0,001) nos pacientes com DM1 em comparação com os DM2. Observou-se maior índice de VOP (p<0,001) nos pacientes DM1 quando confrontados com os DM2. Analisando conjuntamente ou separado quanto à etiologia do DM, observou-se que quanto maior a concentração de HbA1c (>8%) maior foram os valores da VOP (p<0,05). Foi observada uma correlação positiva entre a VOP e a idade dos pacientes (r=0,89; p<0,001), duração do diabetes (r=0,71; p<0,001) e a HbA1c (r=0,70; p<0,001). Pessoas com DM1 apresentaram maior rigidez arterial quando comparados aos DM2, sendo que essas alterações foram associadas com uma maior disfunção metabólica nessa população.

Introduction

Diabetes mellitus (DM) is a chronic endocrine-metabolic disease characterized by persistent hyperglycemia resulting from an ineffective interaction in the production and/or action of insulin, causing short- and long-term complications (Banday *et al*., 2020). DM affects countless people around the world, not only directly impacting the individual, but also generating a constant state of alert for those who are close to them and follow their daily routine. Furthermore, DM is a disease that is in full expansion, being classified as an ongoing epidemic, causing a high number of complications for patients and high mortality rates, in addition to generating excessive direct and indirect costs in the annual health budget. health (Standl *et al*., 2019).

According to Padovani *et al*. (2020), around 16 million Brazilians were diagnosed with DM, with its incidence rate growing by 61.8% in the last ten years. The Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL) survey by the Ministry of Health revealed in 2019 that, in Brazil, the prevalence of DM ranges from 7.4% in individuals aged between 45 and 54 years to 17.3% in individuals aged between 55 and 64 years and 23% in individuals aged over 65 years (Sá Da Silva *et al*., 2021).

Adult individuals with type 1 DM (DM1) or type 2 DM (DM2) are at higher risk of developing cardiovascular diseases (CVD) compared to the general population (Rajbhandari *et al*., 2021). These complications can be classified as microvascular, the most common being nephropathy, retinopathy, and neuropathy, and macrovascular, which include coronary artery disease (CAD), stroke and peripheral arterial disease (PAD). DM is closely linked to the

precocity of CVD, bringing forward its manifestation by up to 15 years in diabetic individuals without adequate control of the disease. When DM is accompanied by arterial stiffness, the risk of CVD and all-cause mortality increases substantially (Aday and Matsushita, 2021).

High fasting blood glucose concentration has been identified as one of the potential risk factors for arterial stiffness. Furthermore, glycated hemoglobin A1c (HbA1c) emerges as a more stable indicator of glucose levels over the past three months, and an increase in HbA1c has been reported to be related to the development of arterial stiffness (Pérez *et al*., 2022).

Arterial stiffness can be assessed non-invasively using the pulse wave velocity (PWV) method. PWV is recommended as a representative marker of cardiovascular risk (Soukup *et al*., 2022). Some studies have shown that the increase in fasting glycemic levels or HbA1c is related to arterial stiffness estimated by PWV not only in patients with DM (Turgutkaya and Aşçi, 2021), but also in individuals with normal and borderline glucose levels (Firmino *et al*., 2023). These results suggest that a gradual increase in blood glucose levels causes worsening of arterial stiffness and the presence of additional chronic conditions, such as dyslipidemia, hypertension, and obesity, which can have a significant impact on PWV, and consequently, on arterial stiffness (Baba *et al*., 2023; Jin *et al*., 2023; Piko *et al*., 2023).

In this context, the present study is justified by the possibility of the PWV method establishing itself as a crucial technology for the early detection of arterial stiffness and, in this way, minimizing the risks of cardiovascular complications associated with DM. Furthermore, although some studies demonstrate an association between DM and arterial stiffness, there are few reports in the scientific literature on the impact of the type of DM on arterial stiffness in individuals diagnosed in more advanced stages of the disease. Therefore, the objective of this study was to verify the correlation between types of DM and arterial stiffness assessed through PWV in patients diagnosed in the adult stage of the disease.

1 Methodology

A cross-sectional and exploratory study was conducted, with an institutional basis, composed of patients with DM of both sexes, aged over 18 years and who were being routinely treated at the Diabetes Outpatient Clinic of the Endocrinology Discipline of the Hospital de Clínicas (HC) of the Federal University of Triângulo Mineiro (UFTM) between 2010 and 2018.

The sample for the present investigation was selected using a non-probabilistic sampling method, which is a common approach in clinical studies. A total of 90 patients with DM participated in the study and were divided into two groups: patients with DM1 (n=30) and patients with DM2 (n=60). The study included patients of both sexes diagnosed with either type 1 or type 2 diabetes, aged over 18 years, with a basic literacy level and who were participating in routine care at the Diabetes Outpatient Clinic of the Discipline of Endocrinology at HC-UFTM. Individuals with a history of ketoacidosis, clinical or biochemical evidence of renal failure, presence of connective tissue diseases known to affect arterial vascularization, history of non-diabetic or obstructive renal disease, microscopic or macroscopic hematuria, history of glomerulonephritis or nephrolitholithiasis, gestational diabetes, history of alcoholism, smoking, ischemic heart disease, cerebrovascular disease, and peripheral vascular disease were excluded from the study.

Initially, contact was established via email with the HC-UFTM Processes and Projects Office—Ebserh/SGPTI Branch. This department is responsible for the management of approvals for medical record consultations for access to the Management Application for University Hospitals (AGHU in Portuguese). The objective of this communication was to obtain information on the total number of diabetic patients treated at the specialty outpatient clinic. Subsequently, the researchers contacted us by telephone to confirm the data and invited the patients to appear on the days scheduled for their respective appointments. Subsequently, patients were contacted on the days and times of their routine appointments at the outpatient clinic. During the meeting, the researchers provided detailed information about the research and invited patients to participate in the study on a voluntary basis. The informed consent form (ICF) was presented verbally and in writing, allowing the subjects to read, comprehend, complete, and sign the authorization document. This study was approved by the UFTM Ethics and Research Committee (opinion nº 1.731.086/2016 and Certificate of Presentation for Ethical Assessment nº 57348316.1.0000.5154).

Following the initial stages of presenting the study and selecting volunteers, the researchers had access to the patients' records, where they obtained information regarding personal data, family history, history of the current illness, health-related lifestyle, behavioral habits, and laboratory tests collected within 90 days prior to the PWV test. The study employed an experimental design with visits. During these visits, a series of assessments were

conducted to obtain an anthropometric profile, hemodynamic parameters, and arterial stiffness at rest.

The anthropometric assessment was conducted using a digital scale (Design Clean HD313 – Tanira®) to define body mass and a stadiometer (E120p – Tonelli®) to determine height. The data were then used to calculate the body mass index (BMI), which is defined as the ratio of body weight (in kilograms) to height squared (in meters).

In order to obtain resting hemodynamic values, volunteers were placed on a stretcher in the supine position in a room with a quiet environment and a temperature between 21 and 25 degrees Celsius. The volunteers were instructed to remain lying down and awake for a period of 15 minutes to identify the lowest resting heart rate (HR). This was achieved using electrocardiographic records obtained using an electrocardiogram (ECG ECAFIX FUNBEC®). Blood pressure levels were quantified using an automated digital sphygmomanometer (Omron M3 Intellisense®), which enabled the identification of systolic (SBP), diastolic (DBP), and mean (MAP) blood pressure (BP) values. The relative cardiac work index was evaluated using the double product (DP), which is calculated by multiplying the systolic blood pressure (SBP) by the heart rate (HR).

Subsequently, all participants underwent an examination to determine arterial stiffness. To ensure the reliability of the results, participants were instructed to abstain from stimulant drugs, caffeine, tobacco, alcoholic beverages, high-fat foods, medications, and physical activity for at least 24 hours prior to the test. The experimental sessions were conducted in a clinical laboratory setting at a controlled temperature (21-25°C) in the morning, approximately two hours after the first regular breakfast.

Non-invasive pulse wave velocity (PWV) analysis was conducted using the Mobil-O-Graph® version 4.6 IEM GmbH device and the Hypertension Management Software Client-Server® software from version 4.6 (HMS CS). Brachial artery PWV shapes were recorded for a period of 15 minutes. This method employs an oscillometric approach to capture the pulse waveform of the brachial artery with an arm cuff. Recordings were conducted at the peripheral arterial disease (PAD) level for approximately 10 seconds using a conventional blood pressure (BP) cuff and a high-fidelity pressure sensor (MPX5050, Freescale Inc., Tempe, AZ). The sensor was connected to a 12-bit analog-to-digital converter via an active analog low-pass filter with a cutoff frequency of 0 to 25 Hz. Following digitization, signal processing was conducted using a three-level algorithm. In the initial stage of the process, the individual

pressure waves were evaluated to ascertain their plausibility. This was achieved by testing the position of the minima and the corresponding wavelengths. In the second stage, all individual pressure waves were compared with one another to identify any artifacts. Subsequently, a generalized transfer function was employed to generate an aortic pulse wave. The fundamental concept underlying a transfer function is the modification of a specific frequency range within the acquired pulse signal to obtain the aortic pressure wave. The first positive zero crossing of the fourth-order time derivative of the generated aortic pulse wave represents the desired inflection point. Finally, the coherence of the measured parameters was evaluated. Consequently, the inflection point of each pulse wave was compared with the midpoint of inflection. The oscillometric signal was recorded at the diastolic level for a sufficient duration to permit the derivation of central hemodynamic parameters (SHARMAN *et al*., 2023).

For statistical analysis, the SigmaStat program (Jandel Scientific Software, SPSS, Chicago, IL, USA) was employed. Continuous parametric variables were presented as the mean ± standard deviation of the mean, non-parametric data were presented as the median and percentiles (25% and 75%), and categorical variables were presented as percentages. The normality of the data was tested using the Shapiro-Wilk test, and the homogeneity of the data was tested using Levene's test. Comparisons between groups were made using either the unpaired Student's t test or the Mann-Whitney U test, depending on the presence or absence of normality of distribution and/or homogeneity of variance. The chi-square test was employed to analyze categorical variables. Pearson's correlation coefficient was employed for correlation analysis. Statistical significance was determined by a p-value of less than 0.05.

2 Results

Table 1 presents data regarding general and anthropometric characteristics, duration of diabetes, and etiology of previous comorbidities. There were no significant differences in relation to age, sex, height, comorbidities such as hypertension and dyslipidemia, as well as the use of antihypertensive medications and treatment with statins. However, patients with DM1 exhibited a longer duration of diabetes (p=0.007), lower body weight (p=0.034), BMI (p=0.007), and waist circumference (p<0.001) compared to patients with DM2.

Table 1. General and clinical characteristics of patients participating in the study according to diabetes status.

	DM1 (n = 30)	DM2 (n = 60)	p-values
Age (years)	55.5 ± 6.7	53.5 ± 10.2	0.255*
Diabetes duration (years)	18.0 [14.0-23.0]	12.5 [8.0-20.0]	0.007†
Male gender n (%)	17 (56.7)	31 (51.7)	0.714#
Female gender n (%)	13 (43.3)	29 (48.3)	0.795#
Body mass (kg)	66.5 [62.5-83.0]	76.9 [67.5-87.5]	0.034†
Height (cm)	165.6 ± 8.1	165.9 ± 10.1	0.870*
BMI (kg/m2)	25.0 [23.1-28.4]	27.2 [25.0-30.1]	0.007†
Waist circumference (cm)	76.0 [71.0-81.0]	96.8 [92.8-99.3]	<0.001†
Hypertension n (%)	30 (100)	60 (100)	0.999#
Medications			
iACE n (%)	12 (40.0)	28 (46.7)	0.233#
ARBs n (%)	9 (30.0)	11 (18.3)	0.209#
β-blockers n (%)	23 (76.7)	41 (68.3)	0.410#
BCCs n (%)	15 (50.0)	22 (36.7)	0.095#
Diuretics n (%)	9 (30.0)	14 (23.3)	0.494#
Dyslipidemia n (%)	6 (29.0)	15 (25.0)	0.597#
Treatment with statins n (%)	5 (16.7)	12 (20.0)	0.136#

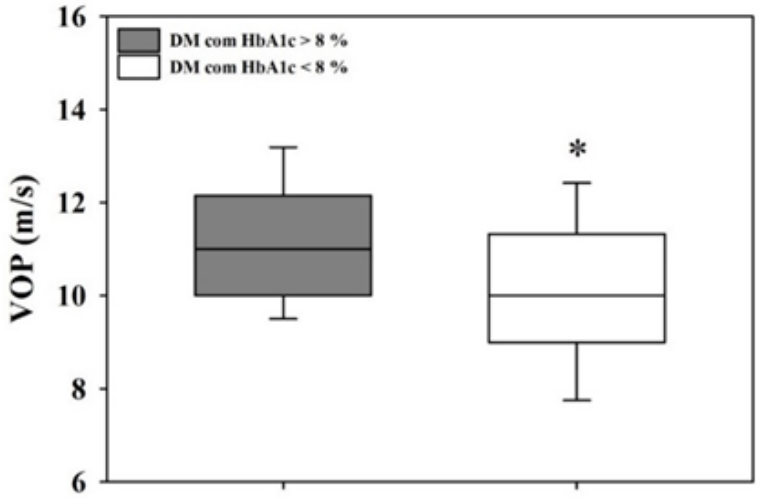
Values presented as n (%), means ± SD (standard deviation), medians (10%, 25%, 75% and 90% percentiles). BMI: body mass index; iACE: inhibitors of the angiotensin-converting enzyme; ARBs: angiotensin II receptor antagonists; BCCs: blockers of calcium channels.
*values for comparisons between groups using independent samples and Student's t test.
†values for comparisons between groups using the Mann-Whitney test.
#values for comparisons between groups using the Chi-square test.
Source: prepared by the authors.

Regarding hemodynamic parameters, no significant differences were observed in HR, SBP, DBP, MAP, and DP between individuals with DM1 (78.1 ± 12.1 bpm) and the DM2 group (75.6 ± 10.7 bpm; p = 0.342). Similarly, no significant differences were found in SBP (133.4 ± 8.6 mmHg in DM1 vs. 135.8 ± 5.4 mmHg in DM2; p = 0.473) or DBP (85.6 ± 2.3 mmHg in DM1 vs. 86.2 ± 12.3 mmHg in DM2; p = AM (101.4 ± 7.1 mmHg in DM1 vs. 102.5 ± 8.5 in DM2;

p=0.790) and DP (10426.7 ± 1884.5 mmHg/bpm in DM1 vs. 10684.7 ± 2152.8 mmHg/bpm in DM2; p=0.696).

Figure 1 illustrates the relationship between glycemic control and the PWV of patients with DM. Individuals with DM1 and DM2 with HbA1c values above the cutoff point of 8% exhibited a higher PWV value (11.0 [10.0-12.1 m/s]) compared to those with DM and lower HbA1c values. The mean PWV was 10.5 [9.3-11.5 m/s] (p=0.039).

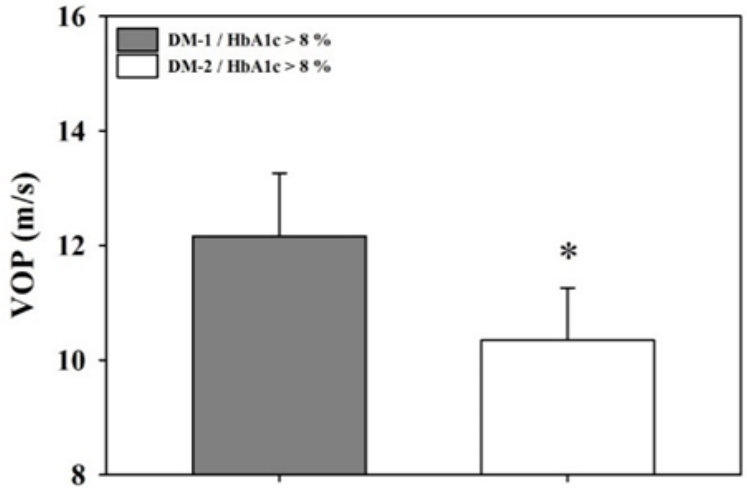
Figure 1. Median values (10%, 25%, 75% and 90% percentiles) of pulse wave velocity (PWV) according to glycated hemoglobin (HbA1c) using the cutoff point of 8.0% in patients with diabetes mellitus. *p=0.034.



*p=0.034.
Source: prepared by the authors.

When the groups were separated according to the DM classification and the HbA1c cut-off point greater than 8% (Fig. 2), it was observed that the PWV of patients with DM1 was higher (12.1 ± 1.0 m/ s) when compared to patients with DM2 (10.3 ± 0.9 m/s; (p < 0.001).

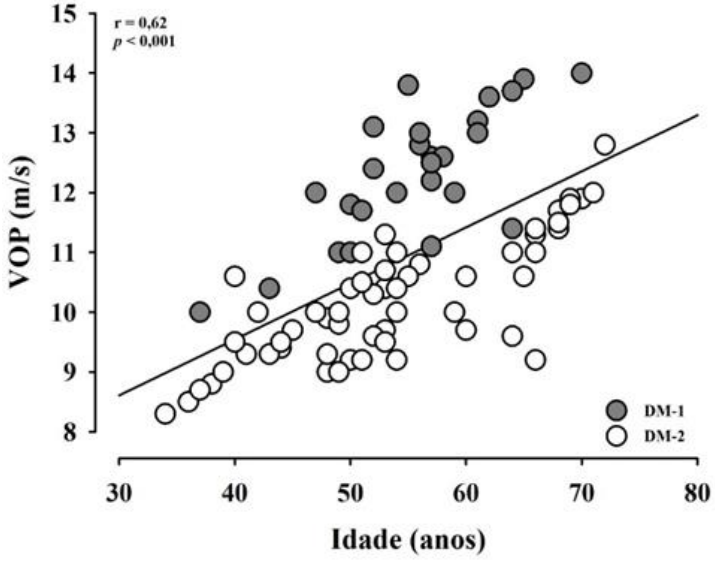
Figure 2. Mean values (± MPD) of pulse wave velocity (PWV) according to glycated hemoglobin (HbA1c) with a cut-off point greater than 8.0% in patients with type 1 (DM1) and type 2 diabetes mellitus (DM2).



*p<0.001.
Source: prepared by the authors.

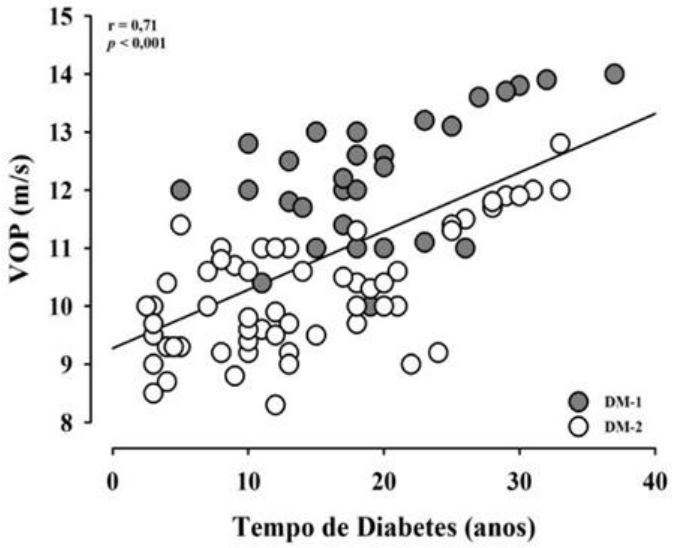
A positive and significant correlation was found between PWV and the age of DM patients (r=0.62; p<0.001; Fig. 3). Additionally, a correlation was observed between PWV and diabetes duration (r=0.71; p<0.001; Fig. 4). Furthermore, a positive correlation was observed between PWV and HbA1c (r=0.70; p<0.001; Fig. 5).

Figure 3. Pearson correlation coefficient between age and pulse wave velocity (PWV) in patients with type 1 (DM1) and type 2 (DM2) diabetes mellitus.



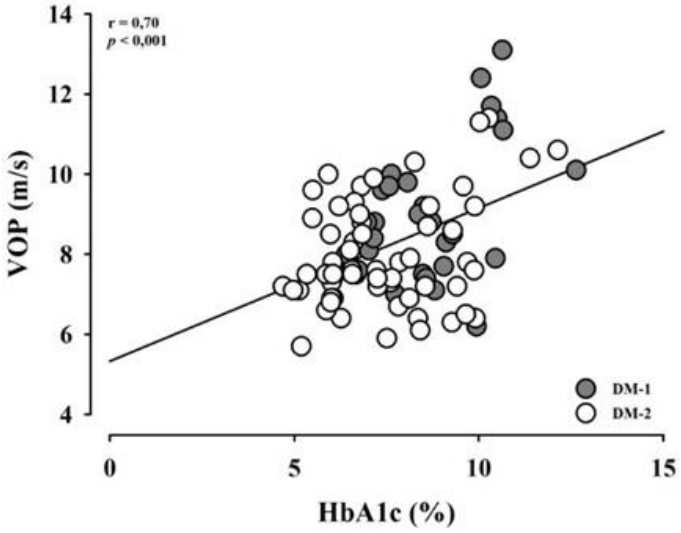
Source: prepared by the authors.

Figure 4. Pearson correlation coefficient between diabetes mellitus (DM) time and pulse wave velocity (PWV) in patients with type 1 (DM1) and type 2 (DM2) diabetes mellitus.



Source: prepared by the authors.

Figure 5. Pearson correlation coefficient between blood concentration of glycated hemoglobin (HbA1c) and pulse wave velocity (PWV) in patients with type 1 (DM1) and type 2 (DM2) diabetes mellitus.



Source: prepared by the authors.

3 Discussion

The initial objective of this study was to assess the impact of the specific types of DM diagnosed in the adult stage of the disease on vascular health. The primary finding of this investigation was that in a group of patients with DM1, the arterial stiffness index was higher

than in patients with DM2. This increase was correlated with a longer time since diagnosis of the disease and a higher level of HbA1c.

Some studies have demonstrated functional and structural changes in large arteries due to arterial stiffness and clinical parameters in different populations with chronic non-communicable diseases (Azahar *et al*., 2023; Paapstel and Kals, 2022). Among these, diabetes mellitus (DM) (Giraldo-Grueso and Echeverri, 2020; Tian *et al*., 2022) has been identified as a significant contributor to arterial stiffness. Moreover, previous studies have indicated that patients with DM1 (González-Clemente *et al*., 2021) exhibit greater arterial stiffness than individuals with DM2 (Staef *et al*., 2023) and non-diabetics (Liang *et al*., 2023). These findings are consistent with the shape observed in our results. The study presented here is significant, not only in investigating potential correlations between different types of DM and cardiovascular health parameters, but also in evaluating methodologies and possible biases in different populations.

Regarding the correlation between PWV and HbA1c, our findings are consistent with those of previous studies explaining that long-term high levels of circulating glucose led to the formation of advanced glycation end products, resulting from the glycation of non-enzymatic proteins, and creating irreversible cross-links in stable tissue proteins (Yu *et al*., 2019). This may also explain the influence of HbA1c on arterial stiffness, as demonstrated in our correlation. Furthermore, some studies indicate that the relationship between diabetes and elastic arteries emerges early, even during a pre-diabetic state of insulin resistance (Fu *et al*., 2021).

Adults with DM1 or DM2 are at a higher risk of developing CVD than the general population. However, it is known that the process of endothelial dysfunction (arterial stiffness) begins early (Candelino *et al*., 2022). Although most diabetes studies focus on youth with DM1, emerging data indicate that the burden of diabetes-related complications among adolescents with DM2 is at least as significant as that of those with DM1 (Tomic *et al*., 2022).

The risk of CVD in patients with DM1 is particularly high. It has been observed that patients with DM1 have stiffer arteries than non-diabetic individuals in the same age group, and this process of arterial stiffening begins before any sign of microvascular complications or macrovascular diseases can be detected (Monteiro *et al*., 2021).

Similarly, previous studies have shown changes in arterial structure and function in individuals with DM2, primarily increased aortic stiffness (Lim *et al*., 2020; Loutradis *et al*.,

2020), suggesting that arterial stiffness may contribute to accelerated endothelial dysfunction in these patients. Changes in arterial stiffness in DM2 occur early, even in the absence of other risk factors or clinical manifestations of cardiovascular disease. An *et al*. (2021) demonstrated higher rates of both aortic PWV (predominantly elastic artery) and brachial PWV (predominantly muscular) in patients with DM2 without clinical manifestations of cardiovascular disease or associated risk factors. In the same study, aortic PWV was related to blood glucose levels and HbA1c, highlighting the role of the hyperglycemic state in changes in the vascular function of these patients.

Many of the pathophysiological mechanisms responsible for vascular dysfunction in diabetes are determined by hyperglycemia, which is associated with the activation of pro-inflammatory transcription factors and increased oxidative stress, leading to vasculopathy (Liu *et al*., 2023). Increased levels of the advanced glycation product of hemoglobin can alter the matrix of molecules in the vessel wall, resulting in loss of elasticity and cross-linking of intermolecular collagen (Fuhr *et al*., 2022). Furthermore, some studies show dysfunction of endothelial and vascular smooth muscle cells in diabetic individuals compared to controls, indicating that DM can reduce the bioavailability of endothelial nitric oxide and attenuate the sensitivity of smooth muscle cells to nitric oxide (Velagic *et al*., 2020; Wang *et al*., 2022). All these pathways appear to be involved in mediating arterial stiffness associated with hyperglycemia.

One of the techniques for studying arterial stiffness, the greatest determinant of the relationship between the reflex wave phenomenon and pulse pressure, is the measurement of arterial PWV, which is positioned as a rigorous method for determining arterial distensibility (Tomiyama *et al*., 2020), based on a solid experimental basis and counting on important contributions from scientific research (Sequí-Domínguez *et al*., 2020).

PWV, by definition, is the distance covered by the blood flow subtracted by the time it takes to cover the distance (Park *et al*., 2022). It is a method that has non-invasive applicability and is considered the "gold standard" for measuring aortic stiffness. Better diagnoses are associated with lower PWV values, which means that the arteries are distensible and elastic. The analysis of arterial stiffness parameters can help prevent CVD and mortality since PWV is an important predictor of such disorders (Sequí-Domínguez *et al*., 2020). In this sense, concerning the analysis of PWV values in monitoring diabetes status, it can be expected that the higher value of this variable found in individuals with DM1 in this study will have significant

clinical consequences. In fact, a current study reports that an increase of a single unit (m/s) leads to a 15% higher risk of mortality from cardiovascular events (Sara *et al*., 2022), and the risk of cardiovascular events is greater when the value of PWV is equal to or greater than 10 m/s (Patoulias *et al*., 2020).

4 Study limitations

Some limitations need to be considered in the present study. First, the brachial PWV methodology was used as a measure of arterial stiffness instead of carotid-femoral PWV. Although both are considered "gold standard", and the validity and accuracy of brachial PWV compared to carotid-femoral PWV have been previously demonstrated (ZHANG *et al*., 2023), and the American Heart Association also recommends brachial PWV as a common indicator for arterial stiffness (REY-GARCÍA and TOWNSEND, 2021), brachial PWV is limited, in relation to carotid-femoral PWV, by the inclusion of a long muscular arterial segment. This may introduce differentiated classification in the assessment of arterial stiffness (CHIRINOS *et al*., 2019).

Secondly, the sample size was relatively small, suggesting studies with a larger number of individuals for a more robust conclusion regarding the vascular profile in individuals with different types of DM. Third, evidence proves that arterial stiffness has a strong correlation with target organ damage and is a risk factor for cardiovascular events in the hypertensive population, independent of other better-known risk factors (SEQUÍ DOMÍNGUEZ *et al*., 2020). It is also known that DM can cause hypertension, as insulin resistance makes it difficult for cells to access circulating glucose, triggering high blood glucose levels, which contributes to the stiffening of arteries and increased blood pressure. In the present study, all participating volunteers (DM1 and DM2) are diagnosed with hypertension. However, Oliveira *et al*. (2013) demonstrated that there was no significant interaction between DM and hypertension on arterial stiffness, thus reducing the hypertensive influence on the results of vascular parameters obtained by PWV.

Finally, the cross-sectional study design provided only exploratory data on causal relationships that reaffirm the relationship between DM types and increased arterial stiffness.

Conclusion

Adult individuals with DM1 showed greater changes in their metabolic profile and arterial stiffness compared to patients with DM2. The greater metabolic decompensation observed in patients with DM1 due to higher HbA1c levels positively correlated with arterial stiffness, represented by a higher PWV. This reinforces the idea that PWV is a powerful predictor of mortality across the spectrum of glucose tolerance, showing a significant association with HbA1c.

The possibility of early detection of these changes through non-invasive methods makes it possible to identify patients at the highest risk who will benefit from treatment. Additionally, it opens a new perspective on the therapeutic approach to diabetic patients, with the adoption of measures that interfere with these vascular changes and consequently help to reduce the cardiovascular mortality of these patients.

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