

# Type II Diabetes as the Main Risk Factor of Arterial Stiffness in Chronic Kidney Disease Patients

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# Type II Diabetes as the Main Risk Factor of Arterial Stiffness in Chronic Kidney Disease Patients

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## ABSTRACT

Chronic kidney disease (CKD) is frequently linked to an increased risk of cardiovascular disease. Diabetes, hypertension, dyslipidemia, and obesity are all traditional risk factors of cardiovascular disease in CKD. However, the contribution of each of the traditional risk factors to arterial stiffness is unknown. This was a correlational study with a cross-sectional design. This study included forty CKD patients from Universitas Airlangga Hospital Surabaya, between December 2019 until March 2020. Serum samples were used to measure laboratory parameters, and Doppler ultrasound was used to assess carotid-femoral Pulse Wave Velocity (cfPWV). Spearman's analysis was conducted to determine correlations between cf-PWV and e-GFR, HBA1C, serum creatinine, and cystatin-C. Mann-Whitney test was performed to determine the association between type II diabetes with cf-PWV. Significant results were continued with linear regression analysis model. There were significant correlations between cf-PWV and e-GFR, HBA1C, serum creatinine, and cystatin-C. HBA1C showed the most significant positive correlation with a moderate correlation coefficient ( $p = 0.000$ ;  $r = 0.581$ ). Patients with type II diabetes was associated with increased cf-PWV. Linear regression model also revealed that HBA1C and history of diabetes were significant predictors of increased cf-PWV in CKD patients ( $\beta = 0.400$ ;  $p = 0.011$  and  $\beta = 0.537$ ;  $p = 0.000$ , respectively). We found a positive correlation between HBA1C and cf-PWV and

association between type II diabetes and increased cf-PWV. This proved that type II diabetes, especially with high HBA1C, acted as a significant risk factor for predicting increased arterial stiffness in CKD patients.

## CCS CONCEPTS

• Applied computing; • Life and medical sciences; • Consumer health;

## KEYWORDS

Type II diabetes, cf-PWV, arterial stiffness, chronic kidney disease, cardiovascular disease

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## 1 INTRODUCTION

Chronic kidney disease (CKD) affects up to 15% of adults globally and may be linked to an increased risk of cardiovascular disease (CVD) [1]. Chronic kidney disease causes end-stage renal failure, reduces kidney function, and is linked to comorbidities including cardiovascular disease [2, 3]. Along with traditional risk factors, CVD can be caused by non-traditional risk factors in patients with CKD. Compared to the general population, traditional risk factors such as diabetes, hypertension, dyslipidemia, and obesity play a significant role. In patients with CKD, there is a bidirectional relationship between oxidative stress and inflammation [4, 5].

Diabetes prevalence has been growing globally in recent years [6]. Diabetes is a well-established risk factor for CVD, kidney failure, and death from any cause [7]. When diabetes is combined

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with arterial stiffness, the risk of CVD and all-cause death increases substantially [8]. Fasting blood glucose (FBG) levels have been implicated as a risk factor for arterial stiffness. Patients with prediabetes and diabetes have a faster pulse wave velocity (PWV) than normal FBG [9]. Blood glucose control and measuring arterial stiffness are critical for CKD patients, even at physiological HBA1C values [10].

In diabetics, arterial stiffness is linked to oxidative stress via NOS release and oxidative damage to endothelial cell proteins, lipids, and DNA. Inflammation can enhance arterial stiffness by lowering nitric oxide bioavailability and raising endothelin-1. Conversely, oxidative stress and inflammation can promote vascular stiffening by promoting vascular smooth muscle cell hyperplasia and collagen synthesis [11]. It has long been recognized that oxidative stress and inflammation can affect arterial stiffness, particularly in patients with CKD. However, the contribution of each of the traditional risk factors, especially type II diabetes, to arterial stiffness is unknown.

## 2 MATERIAL AND METHODS

### 2.1 Study design and participants

This was a cross-sectional study conducted on forty CKD subjects at Universitas Airlangga Hospital in Surabaya, Indonesia, between December 2019 and March 2020. Participants had to meet the following criteria: (1) male or female with CKD based on The Kidney Disease Improving Global Outcomes (KDIGO) criteria [12]; (2) be over the age of 21, and (3) be willing to participate in research and sign an informed consent form. Participants were excluded if they had any of the following: (1) acute coronary syndromes; (2) acute heart failure; (3) severe infections; (4) cancer; or (5) arrhythmia. The Ethical Committee of Universitas Airlangga Hospital approved this study with certificate number 189 / KEH / 2019.

### 2.2 Data collection

The following methods were used to collect data: history taking (history of hypertension, diabetes, dyslipidemia, and smoking), physical examination (blood pressure, body mass index, waist circumference), blood collection (lipid profile, renal function test, HBA1C), and Doppler Ultrasound of carotid and femoral artery.

### 2.3 Carotid-Femoral Pulse Wave Velocity (cf-PWV)

B-mode imaging was used to determine the position of the common carotid artery in the supine position up to the supraclavicular level (1-2 cm from bifurcation). Electrocardiography (GE Vivid 5, GE Healthcare, United States of America) was then performed concurrently with Doppler wave identification. The femoral artery was also examined. Using a digital caliper, time was measured from the R waves in the QRS complex to the Doppler wave foot. Using a measuring tape, the common carotid and femoral arteries were measured (d).

### 2.4 Statistical Analysis

Descriptive data were presented as the mean and standard deviation. Normality test was performed by Shapiro-Wilk test. Spearman correlations were used to determine the relationship between continuous variables. Mann-Whitney test was used to determine the

association between history of diabetes and cf-PWV. Variables that showed significant correlation/association with cf-PWV were analyzed further with linear regression test. When using a two-tailed analysis,  $P = 0.05$  was considered statistically significant. All analysis was conducted with SPSS version 23 (IBM SPSS, Inc.).

## 3 RESULTS

### 3.1 Characteristics of Study Subjects

Table 1 summarizes the characteristics of the study subjects. The age of the subjects ranged from 31 to 71 years old. Male patients (60%) were predominant than females (40%). The most prevalent cardiovascular risk factors identified in the study participants were hypertension (92.5%), diabetes (67.5%), and dyslipidemia (57.5%). Obesity was identified as a risk factor for cardiovascular disease in this study. The majority of study participants were overweight or obese, with a BMI of greater than 25 kg/m<sup>2</sup>.

Additionally, we discovered additional cardiovascular risk factors in the study subjects, including an increase in total cholesterol levels ( $204.72 \pm 50.47$  mg / dL), Low Density Lipoprotein (LDL) ( $122.87 \pm 41.72$  mg / dL), serum creatinine ( $7.24 \pm 6.93$  mg / dL), serum cystatin-C ( $3.91 \pm 2.69$  mg / L), and HBA1C ( $6.72 \pm 1.56$  %) and decrease in High Density Lipoprotein (HDL) ( $43.18 \pm 14.22$  mg / dL) and e-GFR ( $28.98 \pm 30.33$  mL / min / 1.73m<sup>2</sup>).

Continuous data were presented as mean  $\pm$  SD. All study subjects had varying stages of CKD. 42.5% of subjects had stage 5 CKD and had received dialysis, while only 7.5% had stage 1 CKD. The remainder of the patients had varying degrees of stage 2-5 CKD. All subjects were treated identically during the collection, sampling, and examination of primary data.

### 3.2 Results of the Carotid-Femoral Pulse Wave Velocity (cf-PWV) Measurement

The results of the cf-PWV test in the study subjects are summarized in Table 2. The Shapiro-Wilk test revealed that the data had an abnormal distribution ( $p < 0.05$ ); thus, the Spearman test was used to determine the correlation between the study subjects' characteristics and cf-PWV.

There were significant positive correlations between e-GFR and HBA1C and cf-PWV ( $r = 0.431$ ;  $p = 0.005$  and  $r = 0.581$ ;  $p = 0.000$ , respectively). Serum creatinine and cystatin-C also had significant negative correlations with cf-PWV ( $r = -0.490$ ;  $p = 0.001$  and  $r = 0.439$ ;  $p = 0.005$ , respectively) (Table 3).

\* = data with significant correlation ( $p < 0.05$ )

For categorical data, we performed analysis to determine the associations between hypertension, type II diabetes mellitus, dyslipidemia, and smoking. We found that type II diabetes was associated with increased cf-PWV ( $p = 0.000$ ) (Table 4). Linear regression confirmed that HBA1C and type II diabetes were predictive factors of increased cf-PWV ( $p = 0.011$  and  $0.000$ , respectively).

\* = data with significant association ( $p < 0.05$ )

\* = data with significant association ( $p < 0.05$ )

## 4 DISCUSSION

This study enrolled forty patients with chronic kidney disease, most of whom were male. Sex hormones contribute to CKD progression,

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Table 1: Characteristics of the participants

Variables	Value (n = 40)
Gender, male (%)	24 (60)
Age (years)	56.55 ± 8.1
Hypertension n (%)	37 (92.5)
Type II diabetes mellitus n (%)	27 (67.5)
Dyslipidemia n (%)	23 (57.5)
Smoking n (%)	6 (15)
Systolic Blood Pressure (mmHg)	139.43 ± 21.24
Diastolic Blood Pressure (mmHg)	78.63 ± 12.39
Body Mass Index (kg/m <sup>2</sup> )	26.02 ± 4.31
Waist circumference (cm)	95.22 ± 12.66
Total cholesterol (mg/dL)	204.72 ± 50.47
Low Density Lipoprotein (mg/dL)	122.87 ± 41.72
High Density Lipoprotein (mg/dL)	43.18 ± 14.22
Serum creatinine (mg/dL)	7.24 ± 6.93
e-GFR (mL/min/1.73m <sup>2</sup> )	28.98 ± 30.33
Serum cystatin-C (mg/L)	3.91 ± 2.69
HBA1C (%)	6.72 ± 1.56

Table 2: The study subjects' cf-PWV test results

	Min	Max	Mean	Standard deviation
cf-PWV (m/s)	5.41	29.21	12.42	5.46

Table 3: Correlation analysis between characteristics of study subjects and cf-PWV

Variables	r	p-value
Age	0.207	0.200
Systolic Blood Pressure	-0.291	0.069
Diastolic Blood Pressure	-0.133	0.412
Waist circumference	-0.071	0.665
Body Mass Index	-0.067	0.683
Total cholesterol	0.110	0.501
Low Density Lipoprotein	0.126	0.437
High Density Lipoprotein	0.168	0.299
Serum creatinine	-0.490	0.001*
e-GFR	0.431	0.005*
Serum cystatin-C	-0.439	0.005*
HBA1C	0.581	0.000*

Table 4: Associations between characteristics of study subjects and cf-PWV

Characteristics	p-value
Hypertension	0.401
Type II diabetes mellitus	0.000*
Dyslipidemia	0.871
Smoking	0.985

**Table 5: Linear regression between HbA1C and type II diabetes with cf-PWV**

Variables	Beta	p-value
HbA1C	0.400	0.011*
Type II diabetes mellitus	0.537	0.000*

with estrogen acting as a renoprotective factor by inhibiting oxidative stress. Male gender is associated with a more rapid progression of chronic kidney disease [13]. Other risk factors for CKD development include hypertension, hyperglycemia, albuminuria, dyslipidemia, BMI, lifestyle, and renal structure [13–15]. Most participants were over 50. Chronic kidney disease is considered to increase with age [16]. The high prevalence of CKD in older persons reflects the impact of risk factors such as diabetes and hypertension [17].

Muntner P et al. estimate that up to 86% of patients with chronic renal disease have hypertension. Hypertension is a modifiable risk factor for cardiovascular disease and is linked to CKD [18]. Uncontrolled hypertension has several adverse effects on kidney function, including glomerular sclerosis and arteriolar nephrosclerosis, which can damage the kidneys [19]. Diabetes mellitus is the second risk factor. Glycosylation end products and reactive oxygen species all contribute to diabetic kidney damage. The kidneys are damaged by many cytokines, growth factors, and hormones, leading to diabetic nephropathy [20]. Along with the two risk factors mentioned previously, the subjects of this study discovered that 57.5 % of subjects had dyslipidemia. Proteinuria is associated with high cholesterol and triglycerides levels. While lipoprotein lipase and LDL receptors are downregulated in CKD, an increase in triglycerides is caused by a slowdown in the catabolism of triglyceride-rich lipoproteins [21].

The average BMI of the subjects in this study was  $26.02 \pm 4.31$ , with a BMI of over 25 ( $\text{kg}/\text{m}^2$ ) is considered overweight and over 30 ( $\text{kg}/\text{m}^2$ ) is considered obese. Hypertension, diabetes, and low HDL all influence the link between obesity and CKD [22]. Biological processes that link obesity with CKD include hormonal variables, inflammation, oxidative stress, and endothelial dysfunction [23]. In this study's subjects, smoking was a minor risk factor. Only 15% of study participants have a history of smoking. Inflammatory responses, immune system regulation, vasopressin-mediated antidiuresis and insulin resistance are all affected by cigarette smoke exposure [24].

The results of the cf-PWV examination varied between 5.41 and 29.21 m/s for the subjects in this study. The standard noninvasive technique for assessing arterial stiffness is pulse wave velocity measurement in the carotid-femoral artery segment [25, 26]. The cf-PWV should be 10 m/s or higher to predict an increased risk of cardiovascular mortality. The link between higher cf-PWV and cardiovascular mortality and incidence [27]. Chronic kidney disease is a risk factor for increased arterial stiffness as measured by cf-PWV and progresses more rapidly than normal renal function subjects [28]. Additionally, cf-PWV is a marker of arterial disease progression in patients with CKD [29].

The presence of cf-PWV was weakly negatively correlated with the progression of kidney disease as measured by serum creatinine and cystatin-C, but positively correlated with glycemic status as

measured by HbA1c in this study. Temmar et al. also state that arterial stiffness and vascular calcification manifest earlier in patients with CKD [30]. However, as CKD progresses, only vascular calcification worsens [31]. Increased arterial stiffness is more closely associated with age, systolic blood pressure, diabetes, and vascular calcification in adult patients with chronic kidney disease than uremic toxicity [32].

There is a definite link between hyperglycemia, oxidative stress, inflammation, and type 2 diabetes mellitus development and progression [33]. Arterial stiffness and diabetes are two serious health problems that have been linked [34]. According to Tougaard et al., cfPWV was associated with an increased risk of renal complications, cardiovascular events, and mortality in diabetes individuals [35]. Oxidative stress has been linked to vascular stiffness in diabetics. Alterations in vascular function may be caused by increased oxidative stress and decreased anti-oxidant defense mechanisms [36, 37]. Arteriosclerosis is immediately associated with structural changes in the tunica media, including elastin fragmentation and calcification. Nonetheless, it is influenced by changes in the intima layer's cellular and molecular composition. By increasing the hemodynamic stresses in the vascular lining, particularly the low-impedance and high-flow vessel linings, arteriosclerosis can cause end-organ damage [28].

This study's limitations include subject diversity in terms of CKD development from early stages to end-stage renal disease. Another constraint is the control group's absence from the healthy population.

## 5 CONCLUSION

According to the results of this study, there was a positive correlation between HbA1C and cf-PWV in patients with CKD. While further studies are required to examine the clinical value of these results, type II diabetes could serve as a predictor of increased arterial stiffness. Thus, HbA1C testing should be regarded standard in CKD patients as a predictor of cardiovascular disease. Additional research with control is needed to determine the effect of type II diabetes and other parameters as the risk factor of arterial stiffness as measured by cfPWV that represent the risk of cardiovascular disease in CKD patients.

## REFERENCES

- [1] Matsushita K, van der Velde M, Astor BC, Woodward M, Levey AS, de Jong PE, et al. Association of estimated glomerular filtration rate and albuminuria with all-cause and cardiovascular mortality in general population cohorts: a collaborative meta-analysis. *Lancet* 2010;375:2073–81. [https://doi.org/10.1016/S0140-6736\(10\)60674-5](https://doi.org/10.1016/S0140-6736(10)60674-5).
- [2] Prodjosudjadi W, Suhardjono A. End-stage renal disease in Indonesia: Treatment development. *Ethn Dis* 2009;19.
- [3] Balitbang\_Kemendes\_RI. Basic Health Research Report of Indonesia Year 2018 (Laporan Nasional Riskesdas 2018). Riskesdas 2018 2018:182–3.
- [4] Cachofeiro V, Goicochea M, De Vinuesa SG, Oubia P, Lahera V, Llo J. Oxidative stress and inflammation, a link between chronic kidney disease and cardiovascular

- disease. *Kidney Int* 2008;74:S4–9. <https://doi.org/10.1038/ki.2008.516>.
- [5] Thaha M, Kadariswantiningsih IN, Empitu MA. Association of high blood pressure with elevated oxidative stress, inflammatory marker and albuminuria in chronic kidney disease patients. *J Med* 2019;20:12–8. <https://doi.org/10.3329/jom.v20i1.38815>.
- [6] Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, et al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res Clin Pract* 2018;138:271–81. <https://doi.org/10.1016/j.diabres.2018.02.023>.
- [7] Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, et al. Heart Disease and Stroke Statistics—2013 Update. *Circulation* 2013;127. <https://doi.org/10.1161/CIR.0b013e31828124ad>.
- [8] Quiles J, Morillas P, Bertomeu V, Mazon P, Cordero A, Soria F, et al. Combination of ankle brachial index and diabetes mellitus to predict cardiovascular events and mortality after an acute coronary syndrome. *Int J Cardiol* 2011;151:84–8. <https://doi.org/10.1016/j.ijcard.2010.04.097>.
- [9] Gomez-Sanchez L, Garcia-Ortiz L, Patino-Alonso MC, Recio-Rodriguez JI, Feuerbach N, Marti R, et al. Glycemic markers and relation with arterial stiffness in Caucasian subjects of the MARK study. *PLoS One* 2017;12:e0175982. <https://doi.org/10.1371/journal.pone.0175982>.
- [10] Turgutkaya A, Aşçı G. The association between Hba1c and arterial stiffness among non-diabetic patients with chronic kidney disease. *J Vasc Bras* 2021;20. <https://doi.org/10.1590/1677-5449.200245>.
- [11] Zanolì L, Rastelli S, Inserra G, Castellino P. Arterial structure and function in inflammatory bowel disease. *World J Gastroenterol* 2015. <https://doi.org/10.3748/wjg.v21.i40.11304>.
- [12] Levin A, Stevens PE, Bilous RW, Coresh J, De Francisco ALM, De Jong PE, et al. Kidney disease: Improving global outcomes (KDIGO) CKD work group. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. *Kidney Int Suppl* 2013;3:1–150. <https://doi.org/10.1038/kisup.2012.73>.
- [13] Valdivielso JM, Jacobs-Cachá C, Soler MJ. Sex hormones and their influence on chronic kidney disease. *Curr Opin Nephrol Hypertens* 2019. <https://doi.org/10.1097/MNH.0000000000000463>.
- [14] Duru OK, Li S, Jurkovic C, Bakris G, Brown W, Chen SC, et al. Race and Sex Differences in Hypertension Control in CKD: Results From the Kidney Early Evaluation Program (KEEP). *Am J Kidney Dis* 2008. <https://doi.org/10.1053/j.ajkd.2007.09.023>.
- [15] Gómez-Marcos MÁ, Recio-Rodríguez JI, Gómez-Sánchez L, Agudo-Conde C, Rodríguez-Sánchez E, Maderuelo-Fernandez JA, et al. Gender differences in the progression of target organ damage in patients with increased insulin resistance: The LOD-DIABETES study. *Cardiovasc Diabetol* 2015. <https://doi.org/10.1186/s12933-015-0293-1>.
- [16] Coresh J, Selvin E, Stevens LA, Manzi J, Kusek JW, Eggers P, et al. Prevalence of chronic kidney disease in the United States. *J Am Med Assoc* 2007. <https://doi.org/10.1001/jama.298.17.2038>.
- [17] Prakash S, O'Hare AM. Interaction of Aging and Chronic Kidney Disease. *Semin Nephrol* 2009. <https://doi.org/10.1016/j.semnephrol.2009.06.006>.
- [18] Muntner P, Anderson A, Charleston J, Chen Z, Ford V, Makos G, et al. Hypertension Awareness, Treatment, and Control in Adults With CKD: Results From the Chronic Renal Insufficiency Cohort (CRIC) Study. *Am J Kidney Dis* 2010. <https://doi.org/10.1053/j.ajkd.2009.09.014>.
- [19] Agarwal R, Andersen MJ. Prognostic importance of clinic and home blood pressure recordings in patients with chronic kidney disease. *Kidney Int* 2006. <https://doi.org/10.1038/sj.ki.5000081>.
- [20] Lea JP, Nicholas SB. Diabetes mellitus and hypertension: key risk factors for kidney disease. *J Natl Med Assoc* 2002.
- [21] Hager MR, Narla AD, Tammock LR. Dyslipidemia in patients with chronic kidney disease. *Rev Endocr Metab Disord* 2017. <https://doi.org/10.1007/s11154-016-9402-z>.
- [22] Foster MC, Hwang SJ, Larson MG, Lichtman JH, Parikh NI, Vasan RS, et al. Overweight, Obesity, and the Development of Stage 3 CKD: The Framingham Heart Study. *Am J Kidney Dis* 2008. <https://doi.org/10.1053/j.ajkd.2008.03.003>.
- [23] De Jong PE, Verhave JC, Pinto-Sietsma SJ, Hillege HL. Obesity and target organ damage: The kidney. *Int J Obes* 2002. <https://doi.org/10.1038/sj.ijo.0802213>.
- [24] Orth SR. Smoking and the kidney. *J Am Soc Nephrol* 2002. <https://doi.org/10.1097/01.ASN.0000018401.82863.FD>.
- [25] Ji H, Xiong J, Yu S, Chi C, Bai B, Teliewubai J, et al. Measuring the Carotid to Femoral Pulse Wave Velocity (CF-PWV) to Evaluate Arterial Stiffness. *J Vis Exp* 2018. <https://doi.org/10.3791/57083>.
- [26] Kim H-L, Kim S-H. Pulse Wave Velocity in Atherosclerosis. *Front Cardiovasc Med* 2019;6. <https://doi.org/10.3389/fcvm.2019.00044>.
- [27] Williams B, Mancia G, Spiering W, Rosei EA, Azizi M, Burnier M, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. *Eur Heart J* 2018. <https://doi.org/10.1093/eurheartj/ehy339>.
- [28] Lioufas N, Hawley CM, Cameron JD, Toussaint ND. Chronic kidney disease and pulse wave velocity: A narrative review. *Int J Hypertens* 2019. <https://doi.org/10.1155/2019/9189362>.
- [29] Townsend RR. Arterial stiffness and chronic kidney disease: Lessons from the Chronic Renal Insufficiency Cohort study. *Curr Opin Nephrol Hypertens* 2015. <https://doi.org/10.1097/MNH.0000000000000086>.
- [30] Temmar M, Liabeuf S, Renard C, Czernichow S, Esper N El, Shahapuni I, et al. Pulse wave velocity and vascular calcification at different stages of chronic kidney disease. *J Hypertens* 2010. <https://doi.org/10.1097/HJH.0b013e328331b81e>.
- [31] Nemesik J. Arterial stiffness, vascular calcification and bone metabolism in chronic kidney disease. *World J Nephrol* 2012;1:25. <https://doi.org/10.5527/wjn.v1.i1.25>.
- [32] Zanolì L, Lentini P, Briet M, Castellino P, House AA, London GM, et al. Arterial Stiffness in the Heart Disease of CKD. *J Am Soc Nephrol* 2019;30:918–28. <https://doi.org/10.1681/ASN.2019020117>.
- [33] Oguntibeju OO. Type 2 diabetes mellitus, oxidative stress and inflammation: examining the links. *Int J Physiol Pathophysiol Pharmacol* 2019;11:45–63.
- [34] Zheng M, Zhang X, Chen S, Song Y, Zhao Q, Gao X, et al. Arterial Stiffness Preceding Diabetes. *Circ Res* 2020;127:1491–8. <https://doi.org/10.1161/CIRCRESAHA.120.317950>.
- [35] Tougaard NH, Theilade S, Winther SA, Tofte N, Ahluwalia TS, Hansen TW, et al. Carotid-Femoral Pulse Wave Velocity as a Risk Marker for Development of Complications in Type 1 Diabetes Mellitus. *J Am Heart Assoc* 2020;9. <https://doi.org/10.1161/JAHA.120.017165>.
- [36] Alsagoff MY, Pikir BS, Thaha MT, Susilo H. Correlations between Total Antioxidant Capacity and 8-Hydroxydeoxyguanosine with Carotid-Femoral Pulse Wave Velocity in Chronic Kidney Disease. *Indones Biomed J* 2020;12:267–74. <https://doi.org/10.18585/inabj.v12i3.1241>.
- [37] Napoli C, de Nigris F, Williams-Ignarro S, Pignalosa O, Sica V, Ignarro LJ. Nitric oxide and atherosclerosis: An update. *Nitric Oxide - Biol Chem* 2006. <https://doi.org/10.1016/j.niox.2006.03.011>.

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Leticia Gomez-Sanchez, Luis Garcia-Ortiz, Maria C. Patino-Alonso, Jose I. Recio-Rodriguez, Natalia Feuerbach, Ruth Marti, Cristina Agudo-Conde, Emiliano Rodriguez-Sanchez, Jose A. Maderuelo-Fernandez, Rafel Ramos, Manuel A. Gomez-Marcos. "Glycemic markers and relation with arterial stiffness in Caucasian subjects of the MARK study", *PLOS ONE*, 2017

Publication

---

1 %

8

Sadishkumar Kamalanathan, Saibal Das, Akila Srinivasan, Nishanthi Anandabaskar, Jayaprakash Sahoo, Sandhiya Selvarajan. "Effect of vitamin D on arterial stiffness in type 2 diabetes patients with intermediate chronic kidney disease", *International Journal of Diabetes in Developing Countries*, 2021

Publication

---

1 %

9

Mi Ae Choi, Myoung Soo Kim, Cheol Kim. "Incidence and risk factors of medical device-related pressure injuries among patients

1 %



undergoing prone position spine surgery in the operating room", Journal of Tissue Viability, 2021

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[www.ogscience.org](http://www.ogscience.org)

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13

Hilmi Erdem Sumbul, Ayse Selcan Koc, Derya Demirtas. "Increased carotid-femoral pulse wave velocity and common carotid artery intima-media thickness obtained to assess target organ damage in hypertensive patients are closely related", Clinical and Experimental Hypertension, 2018

Publication

<1 %

14

Jill Neale. "Cardiovascular risk factors following renal transplant", World Journal of Transplantation, 2015

Publication

<1 %

15

Alaina M. Body, Zachary J. Plummer, Bryan M. Krueger, Justin Virojanapa, Rani Nasser, Joseph S. Cheng, Charles J. Prestigiacomo. "Retrograde ejaculation following anterior lumbar surgery: a systematic review and

<1 %

pooled analysis", Journal of Neurosurgery:  
Spine, 2021

Publication

16

Roderjan, Christian N., Claudia R.L. Cardoso, Marcel T. Ferreira, Elizabeth S. Muxfeldt, and Gil F. Salles. "Correlates of aortic stiffness progression in patients with resistant hypertension : importance of clinic and ambulatory blood pressure changes", Journal of Hypertension, 2015.

Publication

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[dspace.uc.ac.id](https://dspace.uc.ac.id)

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[trepo.tuni.fi](https://trepo.tuni.fi)

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20

Dearbhla M. Kelly, Peter M. Rothwell. "Does Chronic Kidney Disease Predict Stroke Risk Independent of Blood Pressure?", Stroke, 2019

Publication

<1 %

21

Sibo Wang, Tiankai Shan, Jun Zhu, Qiqi Jiang, Lingfeng Gu, Jiateng Sun, Yulin Bao, Bo Deng, Hao Wang, Liansheng Wang. "Mediation Effect of Body Mass Index on the Association of Urinary Nickel Exposure with Serum Lipid

<1 %

# Profiles", Biological Trace Element Research, 2022

Publication

22

[banglajol.info](http://banglajol.info)

Internet Source

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23

GV Ramesh Prasad. "Metabolic syndrome and chronic kidney disease: Current status and future directions", World Journal of Nephrology, 2014

Publication

<1 %

24

Kong, Xianglei, Xiaojing Ma, Lijun Tang, Zunsong Wang, Wenbin Li, Meiyu Cui, and Dongmei Xu. "Arterial stiffness evaluated by carotid-femoral pulse wave velocity increases the risk of chronic kidney disease in a Chinese population-based cohort : Arterial stiffness and chronic kidney disease", Nephrology, 2016.

Publication

<1 %

25

M. Shechter. "Vascular endothelial function predicts mortality risk in patients with advanced ischaemic chronic heart failure", European Journal of Heart Failure, 04/30/2009

Publication

<1 %

26

M.R. Oliveira, A. Gonçalves, M.A.C. Gabrielli, C.R. de Andrade, C.R. Scardueli, V.A. Pereira Filho. "The correlation of different methods for the assessment of bone quality in vivo: an

<1 %

observational study", International Journal of Oral and Maxillofacial Surgery, 2022

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27

[bmcmedicine.biomedcentral.com](https://www.bmcmedicine.biomedcentral.com)

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Arce Uribe Elsay. "Preferencia de conchas de gasterópodo en calcinus californiensis : plasticidad selectiva ante el riesgo de depredación", TESIUNAM, 2013

Publication

<1 %

32

Hiroshi Kumagai, Toru Yoshikawa, Kanae Myoenzono, Keisei Kosaki et al. "Sexual Function Is an Indicator of Central Arterial Stiffness and Arterial Stiffness Gradient in Japanese Adult Men", Journal of the American Heart Association, 2018

Publication

<1 %

33

Iglesias, P., and J. J. Diez. "Adipose tissue in renal disease: clinical significance and prognostic implications", Nephrology Dialysis Transplantation, 2010.

<1 %

34 Jung In Choi, Young Hye Cho, Sang Yeoup Lee, Dong Wook Jeong et al. "The Association between Obesity Phenotypes and Early Renal Function Decline in Adults without Hypertension, Dyslipidemia, and Diabetes", Korean Journal of Family Medicine, 2019

Publication

---

35 Khalid Siddiqui, Teena P. George, Salini S. Joy, Assim A. Alfadda. "Risk factors of chronic kidney disease among type 2 diabetic patients with longer duration of diabetes", Frontiers in Endocrinology, 2022

Publication

---

36 Ramírez Martínez Luis Alfonso. "Identificación de virus de influenza en perros", TESIUNAM, 2013

Publication

---

37 Sankar D. Navaneethan, Ciaran E. Fealy, Amanda C. Scelsi, Susana Arrigain, Steven K. Malin, John P. Kirwan. "A Trial of Lifestyle Modification on Cardiopulmonary, Inflammatory, and Metabolic Effects among Obese with Chronic Kidney Disease", American Journal of Nephrology, 2015

Publication

---

38 Simon Helleputte, Patrick Calders, Arthur Rodenbach, Joke Marlier, Charlotte Verroken,

<1 %

Tine De Backer, Bruno Lapauw. "Time-varying parameters of glycemic control and glycation in relation to arterial stiffness in patients with type 1 diabetes", Cardiovascular Diabetology, 2022

Publication

---

39

Soonil Kwon, So-Ryoung Lee, Eue-Keun Choi, Kyung-Do Han et al. "Fluctuating renal function and the risk of incident atrial fibrillation: a nationwide population-based study", Scientific Reports, 2019

Publication

---

40

Youssef M.K. Farag, Jameela A. Kari, Ajay K. Singh. "Chronic Kidney Disease in the Arab World: A Call for Action", Nephron, 2012

Publication

---

41

Yulan Lin, Zhiwen Huang, Xiaonan Xu, Wei Du, Haridah Alias, Zhijian Hu, Li Ping Wong. "Multi-dimensional psychosocial factors influencing the willingness to receive a COVID-19 vaccine booster: A survey among the public in Mainland China", Human Vaccines & Immunotherapeutics, 2022

Publication

---

42

"Oxidative stress and inflammation, a link between chronic kidney disease and cardiovascular disease", Kidney International, 12/2008

Publication

<1 %

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---

43

Ester S. Oh, Zhiying You, Kristen L. Nowak, Anna J. Jovanovich. "The Association of Monocyte Count and Monocyte-to-Lymphocyte Ratio with the Risk of Cardiovascular Outcomes in Patients with Chronic Kidney Disease", *Kidney360*, 2022

Publication

---

<1 %

44

Iván Caverro-Redondo, Vicente Martínez-Vizcaíno, Celia Álvarez-Bueno, José Ignacio Recio-Rodríguez et al. "Relationship between glycaemic levels and arterial stiffness in non-diabetic adults", *Medicina Clínica (English Edition)*, 2018

Publication

---

<1 %

45

Boggia, José, Ricardo Silvariño, Leonella Luzardo, and Oscar Noboa. "Significance of white-coat and masked hypertension in chronic kidney disease and end-stage renal disease", *Hypertension Research*, 2014.

Publication

---

<1 %

46

Giovanni F M Strippoli, Sankar D Navaneethan, David W Johnson, Vlado Perkovic et al. "Effects of statins in patients with chronic kidney disease: meta-analysis and meta-regression of randomised controlled trials", *BMJ*, 2008

Publication

---

<1 %

47

Mochamad Yusuf, Ivan Satria Pratama, Ruth Gunadi, Achmad Firdaus Sani. "Hemodynamic Stroke in Simultaneous Cardio Cerebral Infarction: A New Term for Cardiologist", Open Access Macedonian Journal of Medical Sciences, 2021

Publication

<1 %

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