

# Factors Contribute to Elevated Blood Pressure Values in Children with Type 1 Diabetes Mellitus: A Review

Nabeeha Najatee Akram, Wasnaa Hadi Abdullah, Basma Adel Ibrahim

Paediatric Department, College of Medicine, Al-Mustansiriyah University, Baghdad, Iraq

## Abstract

Hypertension is common in children with type 1 diabetes mellitus. Although the exact prevalence of hypertension in pediatric patients with diabetes mellitus is unknown, many studies show rates ranging from 6% to 16%. Several studies looked at the variables that impact blood pressure levels in type 1 diabetes. However, articles in pediatric age group are limited. Upon reviewing the recently published articles, the factors which found to have a significant relationship with blood pressure readings in children with type 1 diabetes mellitus are as follows: patient age, gender, body composition, total fat percentage, body mass index, diabetes duration, glycated hemoglobin levels, and diabetic nephropathy.

**Keywords:** Children, diabetes, hypertension

## INTRODUCTION

Hypertension is one of the most common chronic health problems around the globe, and it's a well-known and controllable cause of cardiovascular disease and death.<sup>[1]</sup> Patients with diabetes mellitus (DM) are more likely to have hypertension.<sup>[2]</sup> Hypertension is common in children with type 1 diabetes (T1DM). Although the exact prevalence of hypertension in pediatric patients with DM is unknown, many studies show rates ranging from 6% to 16%. The prevalence was affected by age and rose among Asian Pacific Islander and American Indian children, but gender was not significantly different.<sup>[3-5]</sup> In a study done in the US, children with even a single raised blood pressure measurement were found to have a higher chance of acquiring hypertension than adults.<sup>[6]</sup> For many important reasons, it is critical to identify and manage hypertension in children with type 1 diabetes. Furthermore micro- and macrovascular complications can be prevented in diabetic children by controlling hypertension.<sup>[7]</sup> Lower blood pressure objectives, preferably 130/80 mm Hg, have been advocated by consensus recommendation committees.<sup>[8]</sup> Despite the recommendations, hypertension in children with T1DM is still not properly recognized and treated as much as required.<sup>[9,10]</sup> This can be attributed to poor

screening,<sup>[4]</sup> the need for repeated measurements, which can lead to delayed diagnosis,<sup>[11]</sup> and inconvenience with prescribing anti-hypertensive medications in pediatrics.<sup>[12]</sup>

## FACTORS CONTRIBUTE TO ELEVATED BLOOD PRESSURE VALUE IN CHILDREN WITH T1DM

The effects of body mass index (BMI) on blood pressure in diabetic children have been extensively studied. Daymen *et al.*<sup>[12]</sup> and Pietrzak *et al.*<sup>[13]</sup> show a positive correlation between BMI and hypertension in children with T1DM. Overweight and obesity are defined by an excess of total body mass combined with an excess of fat mass. Body fat is now recognized as not just a source of energy but also a very active secreting organ. Adipokines are hormones produced by fat tissue that have a role in insulin sensitivity modulation.<sup>[14]</sup> Insulin resistance causes arteriosclerosis, which leads to cardiovascular disease, when combined with hyperglycemia, dyslipidemia, and hypertension.<sup>[15]</sup>

**Address for correspondence:** Dr. Wasnaa Hadi Abdullah,  
Paediatric Department, College of Medicine, Al-Mustansiriyah University,  
Baghdad, Iraq.  
E-mail: [wasnaa.hadi@uomustansiriya.edu.iq](mailto:wasnaa.hadi@uomustansiriya.edu.iq)

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Body composition as a factor linked to increased blood pressure in diabetic patients was investigated by Daymen *et al.* The body composition which expressed as percentage of each of the followings (Total fat mass, lean body mass, soft tissue fat mass, fat / lean ratio, and abdomen fat and trunk fat) measured by Dual energy X-ray absorptiometry (DEXA) found to have significant effect on development of hypertension in T1DM. Daymen *et al.* found that abdominal fat percent was the only parameter strongly and significantly related to mean arterial blood pressure and systolic blood pressure (SBP) in the diabetic patients, while diastolic blood pressure (DBP) was affected by abdominal fat %, duration of diabetes and fat/lean ratio in addition to abdominal fat percent.<sup>[12]</sup> Both Drożdż *et al.*<sup>[16]</sup> and Eisenmann *et al.*<sup>[17]</sup> found that an increase in body fat mass in healthy children resulted in increased values of both systolic and diastolic blood pressure.

High levels of glycated hemoglobin (HbA1c) may be associated with increased blood pressure in pediatric patients with T1DM. De Oliveira *et al.* in a descriptive study involved 60 children and adolescents with an established diagnosis of T1DM demonstrated a positive relation of elevated HbA1c levels and development of prehypertension, in their study each 1% increase in HbA1c is associated with an increase of 1.73 mmHg in diastolic blood pressure (DBP).<sup>[18]</sup> However, Pietrzak *et al.* found no association between metabolic control as estimated by HbA1c and blood pressure values.<sup>[13]</sup> An elevated HbA1c levels which reflect poor glycemic control and hyperglycemia had adverse effect on vascular wall function and structure. The consequences of hyperglycemia on the vascular wall have been well documented in the literatures. Hyperglycemia can contribute to the onset of hypertension. Vasoconstriction (through changes in endothelin and nitric oxide) and extracellular matrix deposition can occur as a result of elevated levels of advanced glycation end products, reactive oxygen species, and sorbitol. Protein kinase C activation might be crucial in these processes.<sup>[19,20]</sup>

In addition, elevated HbA1c levels are strongly linked to microvascular problems, such as diabetic nephropathy, which carries a high risk of cardiovascular disease.<sup>[21,22]</sup> Microalbuminuria has been linked to greater diastolic blood pressures, whereas better glycemic management (HbA1c less than 7.5%) has been linked to a lower risk of microalbuminuria.<sup>[23]</sup>

Furthermore, a positive correlation between DBP and diabetes duration was found by Pietrzak *et al.* with no significant association with systolic blood pressure.<sup>[13]</sup> With regards to gender, lower systolic blood pressure values were observed among girls than boys, diastolic blood pressure values were comparable in both sexes.<sup>[13]</sup>

Regarding diabetic nephropathy, prehypertension and hypertension are more prevalent in diabetic patients with microalbuminuria, this is in agreement with studies

conducted by Amritanshu *et al.*,<sup>[24]</sup> who found that development and progression of microalbuminuria is closely linked to hypertension. However; Omar *et al.*'s<sup>[25]</sup> study found no significant difference in the prevalence of hypertension between diabetic patients with or without microalbuminuria. On the contrary, in their study, Rönnback *et al.*<sup>[26]</sup> found that type 1 diabetic patients had a greater pulse pressure that increases earlier and more rapidly than the nondiabetic background group, even in the absence of diabetic kidney damage.

## CONCLUSIONS

Hypertension in children with T1DM is likely to be more common than previously thought. Blood pressure changes in type 1 diabetes raise the risk of microvascular and macrovascular problems. Several studies looked into the factors that influence blood pressure levels in type 1 diabetes children and adolescents. The age, gender, body composition, total fat percentage, BMI, diabetes duration, glycated hemoglobin (HbA1c) levels, and diabetic nephropathy in type 1 diabetic patients were all found to have a significant relationship with high blood pressure.

## Ethical consideration

Not applicable.

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## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Lenfant C, Chobanian AV, Jones DW, Roccella EJ; Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Seventh report of the joint national committee on the prevention, detection, evaluation, and treatment of high blood pressure (JNC 7): Resetting the hypertension sails. *Hypertension* 2003;41:1178-9.
2. Sowers JR, Epstein M. Diabetes mellitus and associated hypertension, vascular disease, and nephropathy. An update. *Hypertension* 1995;26:869-79.
3. Margeisdottir HD, Larsen JR, Brunborg C, Overby NC, Dahl-Jørgensen K; Norwegian Study Group for Childhood Diabetes. High prevalence of cardiovascular risk factors in children and adolescents with type 1 diabetes: A population-based study. *Diabetologia* 2008;51:554-61.
4. Rodriguez BL, Dabelea D, Liese AD, Fujimoto W, Waitzfelder B, Liu L, *et al.*; SEARCH Study Group. Prevalence and correlates of elevated blood pressure in youth with diabetes mellitus: The SEARCH for diabetes in youth study. *J Pediatr* 2010;157:245-51.e1.
5. Schwab KO, Doerfer J, Hecker W, Grulich-Henn J, Wiemann D, Kordonouri O, *et al.*; DPV Initiative of the German Working Group for Pediatric Diabetology. Spectrum and prevalence of atherogenic risk factors in 27,358 children, adolescents, and young adults with

- type 1 diabetes: Cross-sectional data from the German diabetes documentation and quality management system (DPV). *Diabetes Care* 2006;29:218-25.
6. Sun SS, Grave GD, Siervogel RM, Pickoff AA, Arslanian SS, Daniels SR. Systolic blood pressure in childhood predicts hypertension and metabolic syndrome later in life. *Pediatrics* 2007;119:237-46.
7. Berenson GS. Childhood risk factors predict adult risk associated with subclinical cardiovascular disease. The Bogalusa heart study. *Am J Cardiol* 2002;90:3L-7L.
8. American Diabetes Association. Standards of medical care in diabetes-2006. *Diabetes Care* 2006;29:S4.
9. Wherrett D, Huot C, Mitchell B, Pcaud D. Type 1 diabetes in children and adolescents. *Can J Diabet* 2013;37:S153-62.
10. Nambam B, DuBose SN, Nathan BM, Beck RW, Maahs DM, Wadwa RP, *et al.*; T1D Exchange Clinic Network. Therapeutic inertia: Underdiagnosed and undertreated hypertension in children participating in the T1D exchange clinic registry. *Pediatr Diabetes* 2016;17:15-20.
11. Steigleder-Schweiger C, Rami-Merhar B, Waldhör T, Fröhlich-Reiterer E, Schwarz I, Fritsch M, *et al.* Prevalence of cardiovascular risk factors in children and adolescents with type 1 diabetes in Austria. *Eur J Pediatr* 2012;171:1193-202.
12. Downie ML, Ulrich EH, Noone DG. An update on hypertension in children with type 1 diabetes. *Can J Diabetes* 2018;42:199-204.
13. Pietrzak I, Mianowska B, Gadzicka A, Młynarski W, Szadkowska A. Blood pressure in children and adolescents with type 1 diabetes mellitus—the influence of body mass index and fat mass. *Pediatr Endocrinol Diabetes Metab* 2009;15:240-5.
14. Rasouli N, Kern PA. Adipocytokines and the metabolic complications of obesity. *J Clin Endocrinol Metab* 2008;93:S64-73.
15. Abd El Dayem SM, Battah AA. Hypertension in type 1 diabetic patients—the influence of body composition and body mass index: An observational study. *Anadolu Kardiyol Derg* 2012;12:60-4.
16. Drozd D, Kwinta P, Korohoda P, Pietrzyk JA, Drozd M, Sancewicz-Pach K. Correlation between fat mass and blood pressure in healthy children. *Pediatr Nephrol* 2009;24:1735-40.
17. Eisenmann JC, Sarzynski MA, Glenn K, Rothschild M, Heelan KA. ACE I/D genotype, adiposity, and blood pressure in children. *Cardiovas Diabetol* 2009;8:1-8.
18. de Oliveira S, da Cunha Nascimento D, Tibana RA, de Oliveira SL, de Sousa Neto IV, Falleiros RK, *et al.* Elevated glycated hemoglobin levels impair blood pressure in children and adolescents with type 1 diabetes mellitus. *Diabetol Metab Syndr* 2016;8:4.
19. Brownlee M. The pathobiology of diabetic complications: A unifying mechanism. *Diabetes* 2005;54:1615-25.
20. Ceriello A. Controlling oxidative stress as a novel molecular approach to protecting the vascular wall in diabetes. *Curr Opin Lipidol* 2006;17:510-8.
21. Orchard TJ, Forrest KY, Kuller LH, Becker DJ; Pittsburgh Epidemiology of Diabetes Complications Study. Lipid and blood pressure treatment goals for type 1 diabetes: 10-year incidence data from the Pittsburgh epidemiology of diabetes complications study. *Diabetes Care* 2001;24:1053-9.
22. Fullerton B, Jeitler K, Seitz M, Horvath K, Berghold A, Siebenhofer A. Intensive glucose control versus conventional glucose control for type 1 diabetes mellitus. *Cochrane Database Syst Rev* 2014;2:3-24.
23. Laffel LM, McGill JB, Gans DJ. The beneficial effect of angiotensin-converting enzyme inhibition with captopril on diabetic nephropathy in normotensive IDDM patients with microalbuminuria. North american microalbuminuria study group. *Am J Med* 1995;99:497-504.
24. Amritanshu K, Kumar A, Anand K. Clinical profile and factors associated with microalbuminuria in type 1 diabetes mellitus in children and adolescents. *Int J Res Med Sci* 2015;3:1247-51.
25. Omar MA, Rezk MM, El-Kafoury AA, Kandil MS. Microalbuminuria and glycated hemoglobin in children with type 1 diabetes mellitus. *Alexandr J Med* 2015;51:83-8.
26. Rönneback M, Fagerudd J, Forsblom C, Pettersson-Fernholm K, Reunanen A, Groop PH; Finnish Diabetic Nephropathy (FinnDiane) Study Group. Altered age-related blood pressure pattern in type 1 diabetes. *Circulation* 2004;110:1076-82.