American Journal of Preventive Cardiology 17 (2024) 100629

Contents lists available at ScienceDirect

American Journal of Preventive Cardiology

journal homepage: www.journals.elsevier.com/american-journal-of-preventive-cardiology

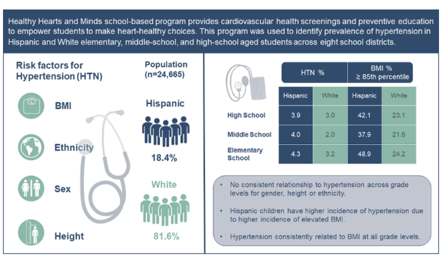
Original Research

School screening programs to identify hypertension in Hispanic youth

Austin M. Pollack [a], Landon D. Hamilton [a], NaNet A. Jenkins [a], Paige C. Lueders [a], Gary J. Luckasen [a,*]

[a] *UCHealth Research Northern Colorado, Loveland CO, USA*

GRAPHICAL ABSTRACT



ARTICLE INFO

Keywords:
Hypertension
Adolescents
Racial disparities

ABSTRACT

Elevated blood pressure during childhood can lead to hypertension in adulthood and is associated with an increased risk of future cardiovascular disease with early identification as the best option for prevention. This study examines the prevalence of hypertension in Hispanic and White youths and reports the ability of a school-based program to identify hypertension in school-aged children. Approximately 3.5 % of students had hypertension while 7.5 % of students had elevated blood pressure. Elevated body mass index (BMI) was the most common predictor of hypertension in all three grade levels (elementary: 5th grade, middle: 7th grade, and high school: 10th grade). In the elementary school age group, the significant predictors of hypertension were an elevated BMI, sex, and height. In the middle school age group, the factors that were significant predictors of hypertension included ethnicity, an elevated BMI, and height. In high school age students, the only significant predictor of hypertension was elevated BMI; ethnicity alone was not a significant predictor. The only group that ethnicity was a significant predictor of hypertension was the middle school age. Given that at all three grade levels, the Hispanic students had a higher percentage with elevated BMIs compared to White students, they should be considered at higher risk of hypertension.

1. Introduction

1.1. Cardiovascular disease

Cardiovascular disease (CVD) is the leading cause of death in the United States. Risk factors associated with CVD include hyperlipidemia, hypertension, diet, weight, diabetes, smoking, and physical activity[4, 21],. Hypertension is the leading risk factor for CVD in the world and originates from a variety of genetic, environmental, and social factors including obesity[5]. According to the center for disease control and

* Corresponding author: 2500 Rocky Mountain Avenue Suite 1800, Medical Center of the Rockies, Loveland, Colorado 80538, USA.
E-mail address: gary.luckasen@uchealth.org (G.J. Luckasen).

https://doi.org/10.1016/j.ajpc.2023.100629
Received 7 June 2023; Received in revised form 8 December 2023; Accepted 18 December 2023
Available online 5 January 2024

prevention (CDC), 1 in 25 youth (ages 12–19) have hypertension and 1 in 10 have elevated blood pressure[1]. Elevated blood pressure during childhood can lead to hypertension in adulthood and is associated with an increased risk of future cardiovascular disease[2]. Prevalence of hypertension in Hispanic adults is 5 % higher than non-Hispanic white adults[3] with early identification the best option to prevent future CVD. Suboptimal blood pressure control is the most common cause of cardiovascular and cerebrovascular disease, including stroke, ischemic heart disease, other forms of heart failure, and peripheral arterial disease[6]. Development of atherosclerotic cardiovascular disease (ASCVD) can occur in younger individuals as noted in multiple trials [7–9]; elevated childhood blood pressure (for children aged 1–12 ≥ 90th percentile to <95th percentile or 120/80 mmHg to <95th percentile (whichever is lower); for children 13–17, 120/<80 to 129/<80 mmHg) [10] is associated with hypertension in adulthood and increased risk of future cardiovascular disease [2,22], These diseases result in an economic toll of over $320 billion in health care costs and lost productivity annually[11] with disparities occurring across ethnic cohorts[3,12,13],.

1.2. Hispanic health disparities

The Hispanic population is the largest ethnic minority group in the United States, comprising 17 % of the population and totaling over 53 million individuals[14]. CVD is the leading cause of death in this cohort with the population exhibiting a 5 % higher incidence of hypertension than non-Hispanic White adults[12]. Hispanic adults develop hypertension four years earlier than non-Hispanic White individuals leading to higher incidence of CVD, mortality, morbidity, and disability at an earlier age[3,13]. Twenty percent of CVD-related deaths are preventable through improvements in factors such as obesity, physical inactivity, smoking, hypertension, hyperglycemia, and total cholesterol[15]. Despite risk factor reduction being one of the most successful and cost-effective manners to combat CVD, the Hispanic community is the least likely ethnic group to seek preventative medical care[15].

1.3. Youth health concerns

Early identification of hypertension, or prehypertension, in pediatric populations has been a goal for many years. Shifting the implementation of hypertension prevention, treatment, and screenings to children and adolescents has the potential to minimize the risk of CVD in adulthood [3]. Recent work indicates that CVD risk in adults can be identified in childhood[2,16]. Previous studies suggest obesity and other anthropometric findings such as height, weight, skinfold thickness, and arm circumference are significant predictors of hypertension in children[17,23]. There is limited information available on blood pressure and ethnic disparities in children and adolescents.

The purpose of this study is to examine the prevalence and predictors of hypertension in Hispanic and White youths, and report the ability of a school-based program to identify hypertension in school-aged children. This study will directly assess significant predictors of hypertension in school-aged students, determine if health disparities exist earlier in Hispanic versus White children, and verify if a school screening program is the most effective way to identify the at-risk population.

2. Materials and methods

2.1. Sample

This study was exempt from IRB review due to utilization of de-identified data. partial support for this study was funded through UCHealth northern Colorado foundation and UCHealth research administration.

The data used in this study was collected by the UCHealth healthy hearts and minds (HHM) program in northern Colorado (see Appendix A for details of program) across eight school districts from the years 2017–2022 and a continuation of previously published data[18]. All students within the eight school districts were included in this study if parental consent was provided to participate in the HHM screening program and they self-described their ethnicity as Hispanic or White; a student was excluded from this analysis if they chose multiple ethnicities. Other ethnicities were excluded due to small representation in the northern Colorado sample. A total of 24,665 screening time points in children ranging from ages 7 through 20 years (52.8 % female) met inclusion criteria and all data was collected onsite at each respective school during one visit. Barriers to Hispanic youth participation were addressed by providing translated school materials and permission forms in Spanish and language interpreters available to children and parents.

2.2. Analysis

Significant predictors of hypertension in school age students were identified using saturated multivariate logistic regression models including measures for ethnicity, sex, body mass index (BMI) status, and height. BMI status (Healthy ≥5th-<85th, Overweight ≥85th-<95th, Obese ≥95th) is categorized by age and sex specific BMI percentiles as defined by the CDC guidelines[19]. Backward elimination was used for variable selection to indicate best model fit based on the chi-square score from the null and residual deviance. Individual models were built to determine prevalence of hypertension for each grade level (elementary: 5th grade, middle: 7th grade, and high school: 10th grade) analyzing systolic and diastolic pressure separately. Prevalence of hypertension was reported by means, standard deviations, and percentages. Significant logistic regression variables were then included in ANCOVA and *t*-test models to determine differences between significant predictors and ethnicities. Data was analyzed using R-Studio version 4.2.1 with significance set a $\alpha < 0.05$.

3. Results

Overall, the study population contained 18.4 % Hispanic students and 81.6 % White students. In the high school age group, there were 7701 time points with 21.9 % Hispanic students and 78.1 % White students. In the middle school age group, there were 6878 time points with 13.9 % Hispanic students and 86.1 % White students. In the elementary school age group, there were 10,086 time points with 18.9 % Hispanic students and 81.1 % White students.

For the high school age group, 3.9 % of Hispanic students (61.0 % female) had hypertension compared to 3.0 % of White students (53.5 % female). For the middle school age group, 4.0 % of Hispanic students (53.6 % female) had hypertension compared to 2.0 % of White students (51.9 % female). For the elementary school age group, 4.3 % of Hispanic students (56.4 % female) had hypertension compared to 3.2 % of White students (50.4 % female).

Table 1 shows the means, standard deviations, and percentages of different biometric values between Hispanic and White students. Figs. 1 and 2 display the average systolic and diastolic blood pressure differences between Hispanic and White students. A *t*-test or chi-square test was used to determine significant differences between the two groups and α=0.05 was used to determine significance. No covariates were included in the *t*-tests; this is only to determine if any differences exist without controlling for any variables. There were significant differences between BMI in all age groups and significant differences in blood pressure between middle and elementary school students. There was no significant difference in blood pressure in Hispanic and White high school students.

Table 1
Biometric values for all school aged students (mean ± standard deviation or percentage).

High School: Biometric Value	Hispanic (n = 1681)	White (n = 6020)	Significance
Age (years)	15.5 ± 0.99	15.5 ± 0.97	0.144
Sex (% female)	61.0	53.5	<0.001
Body Mass Index (kg/m^2)	24.3 ± 5.7	22.1 ± 4.3	<0.001
Systolic Blood Pressure (mmHg)	107.8 ± 11.0	107.5 ± 10.8	0.376
Diastolic Blood Pressure (mmHg)	66.8 ± 8.3	66.6 ± 8.4	0.298
Hypertension (%)	3.9	3.0	0.070
Middle School: Biometric Value	**Hispanic (n = 949)**	**White (n = 5929)**	**Significance**
Age (years)	13.0 ± 0.63	13.0 ± 0.48	0.769
Sex (% female)	53.6	51.9	0.332
Body Mass Index (kg/m^2)	21.8 ± 5.1	20.0 ± 4.0	<0.001
Systolic Blood Pressure (mmHg)	104.9 ± 10.8	103.5 ± 10.3	<0.001
Diastolic Blood Pressure (mmHg)	65.7 ± 8.0	64.5 ± 8.0	<0.001
Hypertension (%)	4.0	2.0	<0.001
Elementary School: Biometric Value	**Hispanic (n = 1905)**	**White (n = 8181)**	**Significance**
Age (years)	10.7 ± 0.59	10.7 ± 0.62	0.052
Sex (% female)	56.4	50.4	<0.001
Body Mass Index (kg/m^2)	20.5 ± 4.9	18.2 ± 3.4	<0.001
Systolic Blood Pressure (mmHg)	101.7 ± 10.4	99.7 ± 10.4	<0.001
Diastolic Blood Pressure (mmHg)	65.7 ± 8.0	64.2 ± 7.9	<0.001
Hypertension (%)	4.3	3.2	0.019

4. High school age students

4.1. High school regression model analysis

Ethnicity (*p-value* =0.0745), sex, and height, were not significant predictors of hypertension for high school students. The only significant predictor of hypertension was BMI status (*p-value* <0.001). This model predicts a healthy weight student a 2.2 % chance of having hypertension, an overweight student a 3.6 % chance of hypertension, and an obese student a 9.6 % chance of having hypertension. 42.1 % of Hispanic high school students had elevated BMIs compared to 23.1 % of White high school students (*p-value* <0.001; Fig. 3) suggesting there is a significant difference in BMIs between Hispanic and White students.

4.2. High school ancova model analysis

The ANCOVA model examines the differences in systolic blood pressure in Hispanic and White high school aged students when controlling for BMI. The model suggests no difference between Hispanic and White students (*p-value* =0.461; Table 2) but there is a significant difference in the systolic blood pressure in students with elevated BMIs (*p-value* <0.001; Table 2).

The ANCOVA model examines the differences in diastolic blood pressure in Hispanic and White high school aged students when controlling for BMI. The model suggests there is no difference between Hispanic and White students (*p-value* =0.225; Table 3) but there is a significant difference in the diastolic blood pressure in students with elevated BMIs (*p-value* <0.001; Table 3).

Table 4 shows the means and standard deviations of different biometric values between Hispanic and White high school students. A *t*-test was used to determine significant differences between the two groups and α=0.05 was used to determine significance. No covariates were included in these *t*-tests; this is only to determine if any differences exist without controlling for any variables. There were no significant differences in blood pressure or age, but there were significant differences in height, weight, and BMI.

5. Middle school age students

5.1. Middle school regression model analysis

Ethnicity alone was a significant predictor of hypertension (*p-value*

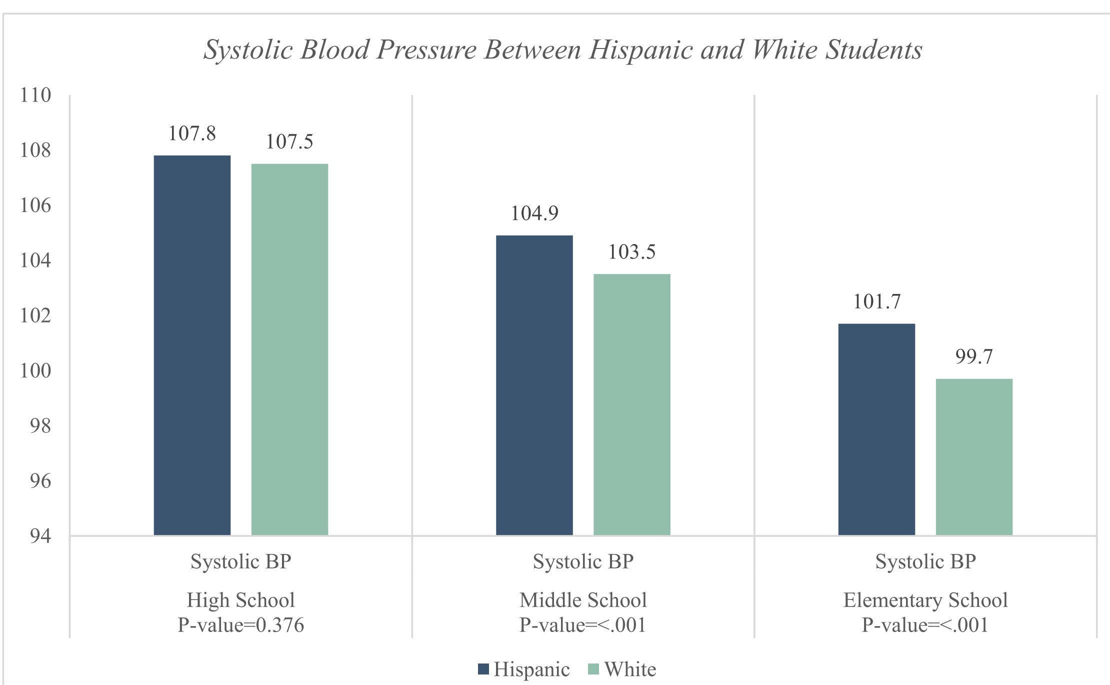


Fig. 1. displays the systolic blood pressures differences between Hispanic and White students. There was no significant difference in the high school age group, but significant differences existed in the middle and elementary school age groups.

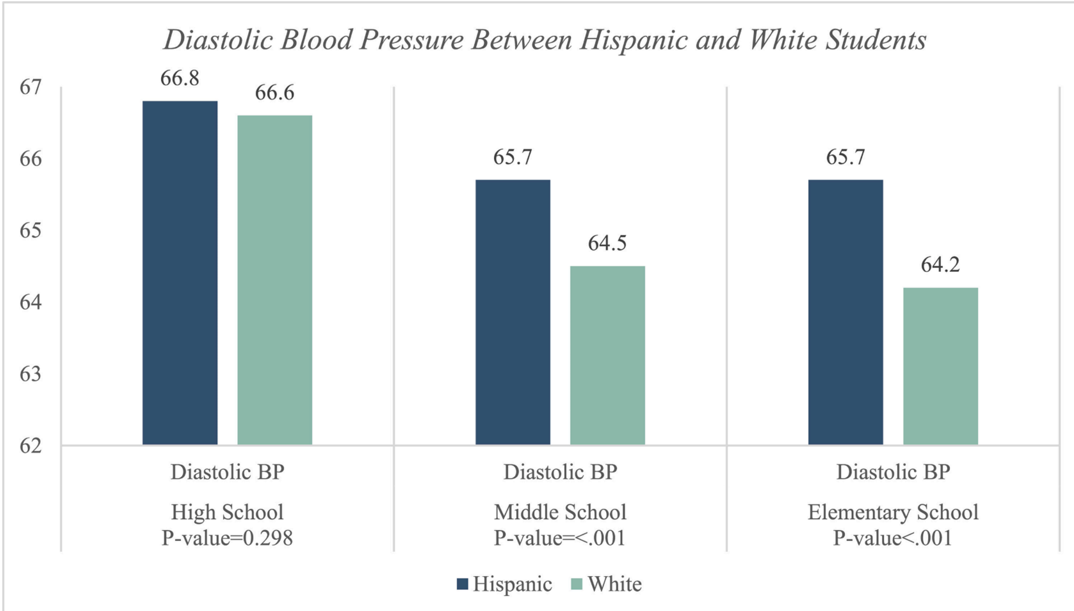


Fig. 2. displays the diastolic blood pressures differences between Hispanic and White students. There was no significant difference in the high school age group, but significant differences existed in the middle and elementary school age groups.

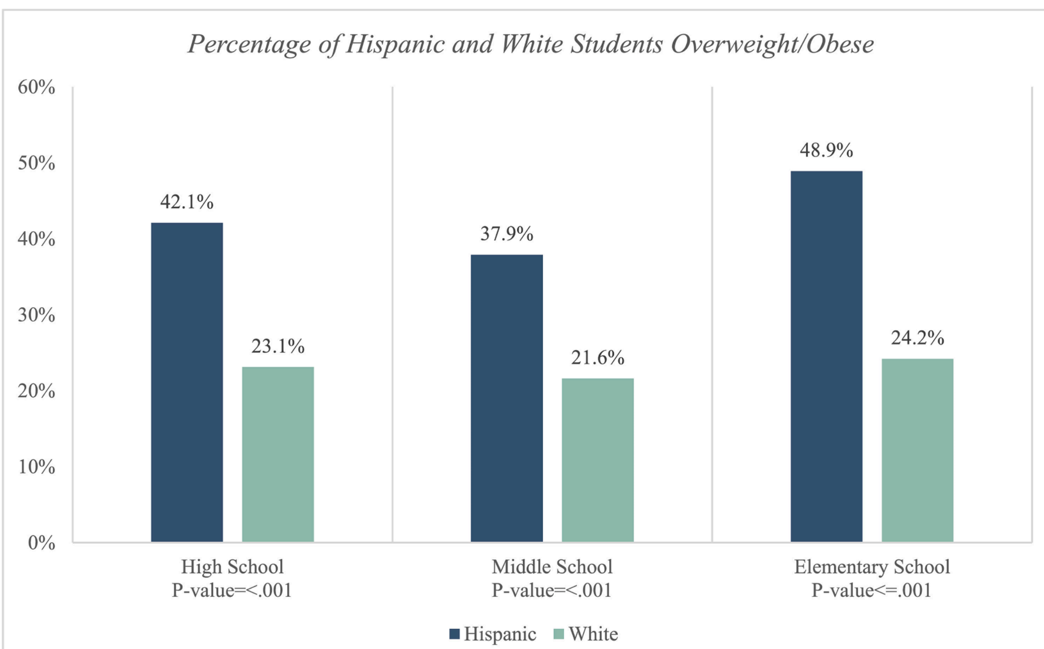


Fig. 3. displays the percentage of Hispanic and White students with elevated BMIs (BMI percentile ≥85th). There were significant differences in all age groups between Hispanic and White students when comparing BMIs.

Table 2
Systolic blood pressure ANCOVA model for high school aged students.

Factor	Df	Sum Sq	Mean Sq	*F value*	*P-value*
Ethnicity	1	60	60	0.544	0.461
ElevatedBMI	1	51,795	51,794	469.600	<0.001
Residuals	7674	846,407	110		

Table 3
Diastolic Blood pressure ANCOVA model for high school aged students.

Factor	Df	Sum Sq	Mean Sq	*F value*	*P-value*
Ethnicity	1	101	101	1.471	0.225
ElevatedBMI	1	121	12,182	177.394	<0.001
Residuals	7674	527,008	69		

<0.001) for middle school students. Using backward selection, the best model to predict hypertension included ethnicity (*p-value* =0.018), BMI status (*p-value* <0.001), and height (*p-value* =0.043). Sex was not a significant predictor in this age group. To simplify model interpretation, height was excluded in the final model predictions. This model predicts a Hispanic middle school student with an obese BMI an 8.0 % chance of

Table 4
Biometric values for high school aged students (mean ± standard deviation).

Biometric Value	Hispanic	White	Significance
Age (years)	15.5 ± 0.99	15.5 ± 0.97	0.144
Systolic Blood Pressure (mmHg)	107.8 ± 11.0	107.5 ± 10.8	0.376
Diastolic Blood Pressure (mmHg)	66.8 ± 8.3	66.6 ± 8.4	0.298
Weight (lbs)	143.1 ± 38.4	139.1 ± 31.7	<0.001
Height (inches)	64.2 ± 3.4	66.4 ± 3.4	<0.001
Body Mass Index (kg/m^2)	24.3 ± 5.7	22.1 ± 4.3	<0.001

having hypertension compared to a 5.2 % chance for a White middle school student with an obese BMI. This model predicts a Hispanic middle school student with a healthy BMI a 2.6 % chance of having hypertension compared to a 1.7 % chance for a White middle school student with a healthy BMI. 37.9 % of Hispanic students had elevated BMIs compared to 21.6 % of White students (*p-value* <0.001; Fig. 3) suggesting there is a significant difference in BMIs between Hispanic and White students.

5.2. Middle school ancova model analysis

The ANCOVA model examines the differences in systolic blood pressure in Hispanic and White middle school aged students when controlling for BMI. The model suggests there is a difference between Hispanic and White students (*p-value* <0.001; Table 5) and a significant difference in the systolic blood pressure in students with elevated BMIs (*p-value* <0.001; Table 5).

The ANCOVA model examines the differences in diastolic blood pressure in Hispanic and White middle school aged students when controlling for BMI. The model suggests there is a difference between Hispanic and White students (*p-value* <0.001; Table 6) and a significant difference in the diastolic blood pressure in students with elevated BMIs (*p-value* <0.001; Table 6).

Table 7 shows the means and standard deviations of different biometric values between Hispanic and White middle school students. A *t*-test was used to determine significant differences between the two groups and α=0.05 was used to determine significance. No covariates were included in these *t*-tests; this is only to determine if any differences exist without controlling for any variables. There were no significant differences in age, but there were significant differences in systolic and diastolic blood pressure, height, weight, and BMI.

6. Elementary school age students

6.1. Elementary school regression model analysis

Ethnicity alone was not a significant predictor of hypertension (*p-value* =0.277) for elementary students. Using a saturated model that includes ethnicity, sex, elevated BMI, and height, we found a few significant predictors of hypertension. The best model to predict hypertension include sex (*p-value* =0.0493) and BMI status (*p-value* <0.001). This model predicts a male elementary school student with an obese BMI a 7.9 % chance of having hypertension compared to a 12.5 % chance for a female middle school student with an elevated BMI. This model predicts a male elementary school student without an elevated BMI a 1.6 % chance of having hypertension compared to a 2.7 % chance for a female middle school student without an elevated BMI. 48.9 % of Hispanic students had elevated BMIs compared to 24.2 % of White students (*p-value* <0.001; Fig. 3) suggesting there is a significant difference in BMIs between White and Hispanic students.

Table 5
Systolic blood pressure ancova model for middle school aged students.

Factor	Df	Sum Sq	Mean Sq	*F value*	*P-value*
Ethnicity	1	1440	1440	14.0	<0.001
ElevatedBMI	1	31,213	31,213	303.5	<0.001
Residuals	6825	701,921	103		

Table 6
Diastolic blood pressure ANCOVA model for middle school aged students.

Factor	Df	Sum Sq	Mean Sq	*F value*	*P-value*
Ethnicity	1	1158	1158	18.33	<0.001
ElevatedBMI	1	9702	9702	153.60	<0.001
Residuals	6825	431,110	63		

Table 7
Biometric values for middle school aged students (mean ± standard deviation).

Biometric Value	Hispanic	White	Significance
Age (years)	13.0 ± 0.63	13.0 ± 0.48	0.769
Systolic Blood Pressure (mmHg)	104.9 ± 10.8	103.5 ± 10.3	<0.001
Diastolic Blood Pressure (mmHg)	65.7 ± 8.5	64.5 ± 8.0	<0.001
Weight (lbs)	119.0 ± 32.6	112.7 ± 27.8	<0.001
Height (inches)	61.7 ± 3.1	62.6 ± 3.1	<0.001
Body Mass Index (kg/m^2)	21.8 ± 5.1	20.0 ± 4.0	<0.001

6.2. Elementary school ANCOVA model analysis

The ANCOVA model examines the differences in systolic blood pressure in male and female elementary school aged students when controlling for BMI. The model suggests there is a difference between male and female students (*p-value* =0.033; Table 8) and a significant difference in the systolic blood pressure in students with elevated BMIs (*p-value* <0.001, Table 8).

The ANCOVA model that examines the differences in diastolic blood pressure in male and female elementary school aged students when controlling for BMI. The model suggests there is a difference between male and female students (*p-value* =0.0095; Table 9) and a significant difference in the systolic blood pressure in students with elevated BMIs (*p-value* <0.001; Table 9).

Table 10 shows the means and standard deviations of different biometric values between Hispanic and White elementary school students. A *t*-test was used to determine significant differences between the two groups and α=0.05 was used to determine significance. No covariates were included in these *t*-tests; this is only to determine if any differences exist without controlling for any variables. There were no significant differences in age, but there were significant differences in systolic and diastolic blood pressure, height, weight, and BMI.

To answer the final research question asking if these predictor variables differ based on grade level, we compared the results of the models above. In the high school age group, the only significant predictor of hypertension was elevated BMI, ethnicity alone was not a significant predictor. In the middle school age group, the factors that were significant predictors of hypertension included ethnicity, an elevated BMI, and height. In the elementary school age group, the significant predictors of hypertension were an elevated BMI, sex, and height. It appears there are different significant predictors of hypertension across the grade levels with the exception of having an elevated BMI being a consistent predictor.

6.3. Discussion

In all three grade levels, the one consistent significant predictor of

Table 8
Systolic blood pressure ANCOVA model for elementary school aged students.

Factor	Df	Sum Sq	Mean Sq	*F value*	*P-value*
Sex	1	385	385	4.553	0.033
ElevatedBMI	1	14,168	14,168	167.667	<0.001
Residuals	1419	119,909	85		

Table 9
Diastolic blood pressure ANCOVA model for elementary school aged students.

Factor	Df	Sum Sq	Mean Sq	*F value*	*P-value*
Sex	1	378	378	6.473	0.0095
ElevatedBMI	1	5787	5787	103.185	<0.001
Residuals	1419	79,584	56		

Table 10
Biometric values for elementary school aged students (mean ± standard deviation).

Biometric Value	Hispanic	White	Significance
Age (years)	10.7 ± 0.59	10.7 ± 0.62	0.052
Systolic Blood Pressure (mmHg)	101.7 ± 10.4	99.7 ± 10.4	<0.001
Diastolic Blood Pressure (mmHg)	65.7 ± 8.0	64.2 ± 7.9	<0.001
Weight (lbs)	94.9 ± 29.3	84.5 ± 21.4	<0.001
Height (inches)	56.7 ± 3.1	56.9 ± 3.0	0.005
Body Mass Index (kg/m^2)	20.5 ± 4.9	18.2 ± 3.4	<0.001

hypertension was elevated BMI. Given that at all three grade levels Hispanic students had significantly higher BMIs than White students, they should be considered at higher risk of hypertension. Earlier hypertension onset may lead to racial and ethnic disparities of CVD[3]. This study suggests that Hispanic students are at a higher risk of developing hypertension at an earlier age than White students, highlighting the importance of early hypertension prevention and screenings.

In the high school age group, the only significant predictor of hypertension was elevated BMI; ethnicity alone was not a significant predictor. There were no significant differences in systolic or diastolic blood pressure between Hispanic and White students in this age group. In the middle school age group, the factors that were significant predictors of hypertension included ethnicity, elevated BMI, and height. There were significant differences in systolic and diastolic blood pressure between Hispanic and White students when controlling for BMI in this age group. In the elementary school age group, the significant predictors of hypertension were an elevated BMI, sex, and height. There were no significant differences between Hispanic and White students but there was a significant difference between males and females in this age group.

6.4. Treatment/Future direction

Standard treatment measures for hypertension have not improved long term outcomes in the Hispanic population. This is partially from lack of medical follow up and adherence to medical programs but primarily due to poor access to medical care, resulting in delayed diagnosis or no diagnosis at all[10]. One treatment approach is to identify hypertension earlier through school-based education and screening programs similar to UCHealth Healthy Hearts and Minds Program. Through early identification in a school based-screening, treatment can begin with lifestyle modifications such as weight control and education. The increased knowledge in CV risk and treatment modalities are beneficial, especially when the entire family is involved in lifestyle change, for example with the HHM family program (see Appendix B). A child can be the agent of change for an entire family unit to improve lifestyle and possibly decrease cardiac events in the child and/or parent(s). The HHM family program has shown that if the whole family is involved in the education process that all members show improvement in cardiovascular risk with 6-month data showing improvements in systolic blood pressure and weight in adult family members[20].

Provided that BMI status is a consistent predictor across age cohorts, the earlier intervention can be introduced, the more effective it be. Therefore, initiating programs, particularly through the family in elementary students, is likely to be more effective on a long term basis. However, intervention at any age is appropriate and needed particularly with obesity and hypertension due to the proven long-term cardiovascular risk associated with both. Hypertension is under diagnosed, thus using an obesity reduction program could be an efficient way to treat both[10].

Control of blood pressure and prevention of CVD should be goals of therapy in all groups but especially in those with early onset of blood pressure elevation. Identifying risk factors for CVD earlier and instructing children in effective lifestyle measures is paramount in helping to decrease levels of CVD, especially in at risk populations.

6.5. Strengths/Limitations

The strength of the data is demonstrated by 30 years of HHM's well-established partnerships and integration amongst the school districts. The data is representative of the northern Colorado region due high level of student participation. Data is collected on site by trained medical professionals utilizing best practices according to national guidelines [10,19].

One potential limitation with this study is the blood pressure data is from one-time screening time points and not from a diagnosis from a physician. A physician would diagnose hypertension based on multiple blood pressure readings and this data set only includes a single blood pressure reading for each participant. It is not feasible to record additional time points on individual students per year due to budgetary and staffing constraints. However, follow up screening data on students who participated in HHM at multiple time points (5th, 7th, and 10th grade) indicate 72–90 % of students maintain their BMI Status from 5th grade to 10th grade[20]. The impact of socioeconomic status on obesity and hypertension is well recognized and should be included in future trials but was not available in this study.

6.6. Screening program recommendation

For children, future CVD risk can be modified by combining blood pressure measurements with a school-based education and screening program that emphasizes adoption of healthy lifestyle habits. These types of school-based programs reach the maximum number of children and are the most effective in mitigating risk since they can be repeated in an age specific manner through grades 4–12.

CRediT authorship contribution statement

Austin M. Pollack: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Landon D. Hamilton:** Methodology, Formal analysis, Writing – review & editing. **NaNet A. Jenkins:** Conceptualization, Methodology, Resources, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Paige C. Lueders:** Data curation, Writing – review & editing. **Gary J. Luckasen:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Gary J. Luckasen reports was provided by University of Colorado Health. Gary J. Luckasen reports a relationship with UCHealth that includes: employment.

Acknowledgements

We would like to acknowledge the Healthy Hearts and Minds staff for organizing the data collection as well as the participating schools and school districts. There was no funding provided for this study; however, the Healthy Hearts and Minds education and screening program is supported and funded through UCHealth's community benefit dollars.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ajpc.2023.100629.

References

[1] Flynn JT, Kaelber DC, Baker-Smith CM, Blowey D, Carroll AE, Daniels SR, de Ferranti SD, Dionne JM, Falkner B, Flinn SK, Gidding SS, Goodwin C, Leu MG, Powers ME, Rea C, Samuels J, Simasek M, Thaker VV, Urbina EM. Clinical practice guidelines for screening and management of high blood pressure in children and adolescents. September 1. American Academy of Pediatrics; 2017. https://publications.aap.org/pediatrics/article/140/3/e20171904/38358/Clinical-Practice-Guideline-for-Screening-and?autologincheck=redirected%3FnfToken.

[2] Azegami Tatsuhko, Uchida Keiko, Tokumura Mitsuaki, Mori Masaaki. Blood pressure tracking from childhood to adulthood. Pediatrics 2021 Nov 15;9:785356.

[3] Huang X, Lee K, Wang MC, Shah NS, Khan SS. Age at diagnosis of hypertension by race and ethnicity in the US from 2011 to 2020. JAMA Cardiol 2022;7(9):986. https://doi.org/10.1001/jamacardio.2022.2345.

[4] Tsao CW, Aday AW, Almarzooq ZI, Anderson CA, Arora P, Avery CL, American heart association council on epidemiology and prevention statistics committee and stroke statistics subcommittee. Heart disease and stroke statistics—2023 update: a report from the American heart association. Circulation 2023;147(8):e93–621.

[5] Caprio S, Daniels SR, Drewnowski A, Kaufman FR, Palinkas LA, Rosenbloom AL, Schwimmer JB. Influence of race, ethnicity, and culture on childhood obesity: implications for prevention and treatment: a consensus statement of shaping America's health and the obesity society. Diabetes Care 2008;31(11):2211.

[6] Carey RM, Muntner P, Bosworth HB, Whelton PK. Prevention and control of hypertension. JACC 2018;72(11):1278–93. https://doi.org/10.1016/j.jacc.2018.07.008.

[7] McGilll HC Jr, McMahan CA. Determinants of atherosclerosis in the young. Patholocgical determinants of atherosclerosis in youth risk scores are associated with early and advanced atherosclerosis. Pediatrics 2006;118:1447.

[8] Webber BJ, Seguin PG, Burnnett Dg, et al. Prevelance of risk factors for autopsy-determined atherosclerosis among US service members. 2001-2011. JAMA 2012;308:2577.

[9] Berenson GS, Srinivasan SR, Bao W, et al. Association between multiple risk factors and atherosclerosis in children and young adults. The Bogalusa heart study. N Engl J Med 1998;338:1650.

[10] Weaver D. Pediatric hypertension review of updated guidelines. Pediatr Rev 2019;40(7):354–7.

[11] CDC Foundation Bulletin: April 2015.

[12] Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. Pediatrics 2007;120(suppl 4):S164–92.

[13] Huang, X., Lee, Kristen, Wang, Michael, Shah, Nilay, Khan, Sadiya. Age of diagnosis of hypertension by race and ethnicity in the US 2011 to 2020. E1–E2. JAMA Cardiol. 2022.

[14] Rodriguez CJ, Allison M, Daviglus ML, et al. Status of cardiovascular disease and stroke in Hispanics/Latinos in the United States: a science advisory from the American heart association. Circulation 2014;130(7):593–625.

[15] Velasco-Mondragon E, Jimenez A, Palladino-Davis AG, Davis D, Escamilla-Cejudo JA. Hispanic health in the USA: a scoping review of the literature. Public Health Rev 2016;37:31.

[16] Jacobs DR, Woo JG, Sinaiko AR, et al. Childhood cardiovascular risk factors and adult cardiovascular events. N Engl J Med 2022;386:1877–88. 20; May 19.

[17] Menard Shirley w, Park Myung K, Schofield John. The San Antonio biethnic children's blood pressure study: anthropometric findings. Clini9cal Excell Nurse Practit 1999;3(1):19–27.

[18] Nelson TL, Puccetti N, Luckasen GJ. Healthy hearts: a cross-sectional study of clinical cardiovascular disease risk factors in Northern Colorado school children (1992–2013). BMC Obes 2015;2:1–8.

[19] Kuczmarski RJ, Kuczmarski MF, Roche AF. 2000 CDC growth charts: background for clinical application. Top Clin Nutr 2002;17(2):15–26.

[20] Luckasen, Gary, Austin Pollack, NaNet Jenkins, Landon Hamilton. Healthy hearts and minds family program data, publication pending, 2023.

[21] Elfassy, Tali, Hazzouri, Adina Zeki Al, et al.; Incidence of hypertension among US Hispanics/Latinos: the hispanic community health study/study of latinos, 2008 to 2017. Journal of the American Heart Association. 2020.

[22] Aggarwal Rahul, Yeh Robert W, Maddox Karen EJoynt, Wadhera Rishi K. Cardiovascular risk factor prevelance, treatment, and control in US adults aged 20-44 years, 2009 to march 2020. JAMA 2023. https://doi.org/10.1001/jama.2023.3207. March 5.

[23] Levy Rebecca, Brathwaite Kaye, et al. Analysis of active and passive tobacco exposure and blood pressure in US children and adolescents. JAMA Netw Open 2021;4(2):e2037936.