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Original Research Article

Healthy lifestyle program for hypertensive adolescents with a Vitamin D deficiency

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ABSTRACT

Background and Purpose of the Study: The purpose of this study is to gauge the efficacy of a healthy lifestyle program on adolescents who are hypertensive as well as deficient in Vitamin D. It has been a known fact that Vitamin D deficiency from birth to early childhood is linked to a higher risk of elevated systolic blood pressure during childhood and adolescence.

Materials and Methods: This study employed a quasi-experimental research design which took a purposive sample of 300 hypertensive adolescents who were formally diagnosed as Vitamin D deficient and attended follow-up consultations in an out-patient paediatric clinic in Banha University Hospital in Benha City, Egypt.

Several factors such as the respondents' socio-economic data and family history of chronic disease were taken into consideration when the study was done. The subjects' healthy lifestyle practices were also assessed both before and after they had been through the healthy lifestyle program. It also monitored the subjects' blood pressure and their intake of vitamin D before, during and after the course of the program. The study's subjects were asked to fill out a questionnaire before and after the program to evaluate their knowledge regarding hypertension and vitamin D deficiency. An observation checklist was used before and after the program to evaluate the subjects' practices when taking blood pressure measurements.

Results: The study showed that 72 percent of adolescents had a family history of hypertension. It also showed that female subjects exhibited a remarkable improvement in terms of their healthy lifestyle knowledge and practices after going through the healthy lifestyle program when compared to their male counterparts. The study showed a statistically significant relationship between the adolescents' healthy lifestyle and their socio-demographic characteristics such as their gender being female aged between 14-18 years old with secondary education and having appropriate economic status and healthy house conditions. The study also showed that among the male adolescent subjects, 94 percent were physically active, 60 percent were aged between 11-14 years and 55.7 percent had non-appropriate economic status.

Conclusion: The study concluded that the healthy lifestyle program was effective in changing the healthy lifestyle knowledge and practices of the adolescent subjects which in turn enabled them to manage their hypertensive condition and overcome their vitamin D deficiency.

1. Introduction

Previous studies have shown that there was a direct correlation between blood serum level of vitamin D and blood pressure taking into account the sensitivity of the vitamin D receptor.[1–3] This pointed to a most likely role of vitamin D deficiency in the development of hypertension among adolescents. Other studies[4,5] also reported that vitamin D deficiency from childbirth to early and late childhood was linked to a higher risk of an elevated systolic blood pressure during childhood.

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The established global blood pressure reference values for children aged between six and 19 years are as follows: Prehypertension, systolic blood pressure range between 130 and 139 mmHg and diastolic blood pressure between 85 and 89 mmHg. Stage one hypertension, systolic blood pressure range between 140 and 159 mmHg and diastolic blood pressure between 90 and 99 mmHg. Stage two hypertension, systolic blood pressure range between 160 and 179 mm/Hg and diastolic blood pressure between 100 and 109 mm/Hg.[6]

Sometimes, diagnosing hypertension can be very difficult and early detection has been deemed very important especially in preventing the associated risk of heart disease.[7] In more recent years, the medical field has noticed a rising incidence of paediatric hypertension with studies noting that more than 75 percent of teenagers remain undiagnosed. Studies also showed that the actual incidence of hypertension among teenagers was higher than the established rate of those as being diagnosed.[8]

Hypertension is a complex and multi-layered disease compounded by several risk factors such as diet and nutrition, stress and activity levels among others.[9] Although about 90-95 percent of causes linked to high blood pressure remain unknown, certain groups of people have been identified as having an increased risk of developing hypertension.[10] Other factors linked to hypertension include vitamin D deficiency which is an offshoot of being overweight and obese, academic stress, metabolic and hereditary factors, racial and ethnic predispositions, socio-economic status, cultural influences, growth rate and pubertal stage all of which made diagnosis a more daunting and demanding task.[11]

One of the more established factors associated with hypertension is a sedentary lifestyle defined as lacking or limited physical activity by a person. One example of a sedentary lifestyle consists of watching television or playing video games for long periods of time. Hypertension has been linked to a lack of exercise as well as lack of vitamin D in the umbilical cord blood during birth specifically lower than 11 ng/ml and lower than 25 ng/ml during the paediatric period of early childhood.[12]

Medical guidelines have established a pediatric as having a definite vitamin D deficiency when the amount of vitamin D in the blood is 25- D < 20 ng/ml, insufficiency as 21-29 ng/ml and sufficiency between 30-100 ng/ml.[13] The same guidelines instructed that in order to avoid being vitamin D deficient, intakes of vitamin D for paediatric less than one year of age should be between 400–1,000 IU/d and 600–1,000 IU/d for paediatric from one to 18 years of age.[14]

Vitamin D consumption is very important during the paediatric period as it is needed in accretion and bone development as well as for calcium absorption during the adolescent period. Certain diseases such as type 1 diabetes mellitus, hypertension, multiple sclerosis and cancer can be prevented by maintaining sufficient levels of vitamin D.[15] Apart from its effects on skeletal development such as promoting a normal bone growth and mineralisation during childhood, Vitamin D supplementation has also been known to prevent paediatric rickets. Adolescents who have sufficient exposure to sunlight and have a diet rich in foods like eggs, salmon and fortified milk products are considered to have achieved vitamin D supplementation from natural sources,[16,17]

Adolescents should be introduced to a healthy lifestyle control program early in life in order to improve their knowledge and lifestyle practices with the end goal of disease prevention. A collaborative effort between parents, school and health authorities should be made to promote awareness regarding hypertension in young people and discuss its prevention and control.[18] Our healthy lifestyle program prescribed lifestyle modification as well as weight control, exercise and a healthy diet in the improvement of blood pressure and overall health among adolescents.[19] Nurses who were involved in the project detected hypertension through screening although they also helped in educating parents and children about the debilitating effects of hypertension in their lives. They also helped promote the practice of a healthy lifestyle by discussing the importance of vitamin D, good nutrition and exercise among others in an effort to avoid high blood pressure among adolescents.[20]

2. Significant of Research

Hypertension has been identified as one of the major causes of high mortality and morbidity worldwide as well as a prime factor leading to stroke and coronary heart disease. Recent studies conducted in several western countries have shown an increasing rate of hypertension among children from seven to 19 percent.[21] A similar trend appeared among adolescents in Alexandria, Egypt where the prevalence rate of hypertension increased with age progression namely from a rate of 4.8 percent among adolescents aged 13-14 years to 15.7 percent among 17-year-olds.[22] There is a global problem of vitamin D deficiency with sub-optimal levels of 25(OH)D being a common occurrence. A severe deficiency was also identified mostly in the Middle East. Low serum 25-OHD (< 20 ng/ml) was found in 11.5 percent of the total sample taken from 200 boys and girls aged nine to eleven years who were recruited from two primary schools in Egypt's Giza governorate.[23]

Children who had low vitamin D from birth exhibited approximately 60 percent higher risk of systolic blood pressure at ages six-18 years while children who had continuous low levels of vitamin D through early childhood had a double risk of elevated systolic blood pressure at ages three-18 years.[24,25]

The healthy lifestyle program proved to be quite effective in reducing blood pressure by focusing on lifestyle and dietary changes like reducing sodium consumption and

increasing potassium intake as well as weight loss, stress reduction and regular exercise. All types of physical activity are considered advantageous towards maintaining a healthy blood pressure and should consist of a minimum of 150 minutes of moderate activity per week.[16] One critical aspect in the effective prevention, treatment and control of hypertension is early detection and diagnosis[26,27] The main purpose of the healthy lifestyle program was to improve the subjects' management of their condition by giving them training on how to properly measure blood pressure as well as impressed on them the importance of daily home-based monitoring in addition to improving their knowledge on various sources of vitamin D.

2.1. Research aims

Assess the healthy lifestyle of hypertensive adolescents who were deficient in vitamin D before and after the program.
Monitor the blood pressure and vitamin D of adolescents before and after the healthy lifestyle program.
Evaluate the adolescents' knowledge pertaining to hypertension and vitamin D before and after the healthy lifestyle program.
Compare the adolescents' practices regarding techniques of measuring blood pressure before and after program.
Discover the link between adolescents' healthy lifestyle practices and their demographic characteristics.

2.2. Hypothesis

The program will modify the lifestyle of hypertensive adolescents who have vitamin D deficiency.

The program will help adolescents control their blood pressure as well as improve their vitamin D supplementation.

Statistically significant differences will be found between an adolescent's knowledge and practices before and after the program.

A significant association will be discovered between the adolescents' healthy lifestyle practices vis-à-vis their selected demographic variables.

3. Materials and Methods

3.1. Technical design

Research design

Quasi-experimental design

3.2. Setting and sampling

Purposive sample from 300 hypertensive adolescents with vitamin D deficiency was diagnosed and follow up at pediatric out-patient clinic of Benha university hospital, Benha city, Egypt during 6 months.

3.3. Tools

Interview Questionnaire. The designed questionnaire touched on certain factors such as the following:

3.4. Tool 1

1. Socio-demographic characteristics such as the adolescents' age, gender, education, economic status and house conditions.
2. Family history of chronic disease such as hypertension, vitamin D deficiency, obesity and diabetes mellitus. The degree of familial relation was distinguished whether it was near or far. A near relative comprised the father, mother, brother and sister while a far relative consisted of the aunt, uncle, grandfather and grandmother.
3. Healthy lifestyle which included the following:
   (a) Nutrition guideline as dietary habits: whether the respondents' intake of salty and fatty diet was occasional or constant.
   (b) Physical activity: physically active or non-active. Physically active adolescents were those who reported doing exercise for more than one hour for at least three times per week.
   (c) Different sources of vitamin D: whether the respondents had a proper diet rich in vitamin D, had sun exposure and supplementation and these were differentiated as either enough or not enough.

3.5. Scoring

The sub-item of adolescent lifestyle was checked before and after the healthy lifestyle program. If the respondent answered "always" to a question, the respondent was given two points and if the respondent answered "sometimes" to a question, the respondent was given one point. If the respondents scored more than 50 percent based on their total response to the various categories in the questionnaire, then they were considered to have a healthy lifestyle and those who scored less than 50 percent were considered to have an unhealthy lifestyle.

3.6. Tool 2

The researcher measured the adolescents' blood pressure and their intake of vitamin D and these were noted down in the adolescents' health record both before and after the healthy lifestyle program.

3.7. Scoring

The researcher measured the respondents' blood pressure before they went through the healthy lifestyle program in order to determine whether they have managed to

control their blood pressure after the program. Their blood pressures were monitored during the two-month period and measurements were also taken after the implementation of the healthy lifestyle program.

The researcher also recorded the respondents' vitamin D levels before they started on the healthy lifestyle program in order to determine those who have either a deficient or insufficient intake of vitamin D. They were monitored during the two-month period of the program and their vitamin D levels were again recorded at the end of the healthy lifestyle program. The adolescents' serum 25(OH)D (vitamin D) values were taken from their health records after their doctors' decision.

3.8. Tool 3

The researcher had given the respondents two sets of questionnaires that correspond to before and after the implementation of the healthy lifestyle program. The questionnaires were designed to gauge the adolescents' knowledge with regards to hypertension specifically on meaning, signs and symptoms, predisposing factors, management and follow-up and the avoidance of complication. A similar set of questionnaires were also designed to determine the adolescents' knowledge on Vitamin D specifically on aspects of meaning, signs and symptoms, predisposing factors, screening test, management, prevention and complication.

3.9. Scoring

Knowledge scores were given to respondents based on their answers to various individual questions relating to hypertension and vitamin D. If they scored a total of less than 50 percent, they were considered to have poor knowledge. If they garnered a score of 50-75 percent, they were considered to have an average knowledge. If they got a score of more than 75 percent, they were considered to have good knowledge. If the adolescents gained an overall score of more than 70 percent, they were considered to have satisfactory knowledge and those with less than 70 percent to have unsatisfactory knowledge.

3.10. Tool 4

An observation checklist in relation to techniques of measuring the blood pressure was given to the respondents both before and after the implementation of the healthy lifestyle program.

3.11. Scoring

The observation checklist listed steps which the adolescents had to follow when taking blood pressure measurements. If they were able to follow the right technique, they were given two points. If they had done the step incorrectly, they were given one point but if they had not done the steps at all, they were given zero point. If their overall score following the different steps was more than 60 percent, then they were deemed as having an adequate practice and inadequate if they scored less than 60 percent.

3.12. Validity and reliability

Three experts from the pediatric nursing staff reviewed and revised the content of the questionnaires used in this study. Based on Cronbach's alpha, the internal consistency reliability of the questionnaire was 0.89.

3.13. Field work and administrative design

The researcher sought consent from the hospital director prior to embarking on the study and was given two days per week on Sundays and Tuesdays from 8 am to 12 pm during which the researcher was allowed to inter-act with the respondents. The researcher used the allotted time to educate and train the adolescents who were diagnosed with hypertension and vitamin D deficiency. The researcher also asked permission from all the participants and got oral consent to get involved in the study. The study was conducted from May to October 2020. All participants agreed to have their vitamin D analysis done both before and after the healthy lifestyle education program.

3.14. Pilot study

A pilot study was carried out on 15 adolescents in hospitals in Benha City. The purpose of the pilot study was to test the validity and clarity of the structured questionnaire, probe the study tools so as to reveal any potential modifications needed, estimate the average time required to obtain the necessary information, identify any potential difficulties in data collection as well as examine the overall survey technique to be used.

4. Ethical Consideration

All the measurements were conducted in private rooms in the hospital's out-patient clinics. All data collected through the self-reported questionnaires were kept confidential. Respondents were given the option not to participate in the study or to withdraw from the measurements prior to the completion of the program.

4.1. Program construction

1. *Preparation phase:* Prior to launching the actual study, the researcher conducted a review of the most recent and significant literature on the topic concerned. The review covered both national and international publications on the matter. The researcher also took the time to prepare the blood pressure devices to be used in the training of the participants.

2. *Planning and Implementation phase:* The study participants were divided into small groups of ten adolescents. At the start of the study, the researcher explained the objective as well as the potential benefits of the study to the participants.

The researcher collated the vitamin D investigation results from the follow-up records of each participant prior to starting the healthy lifestyle education program. The researcher then agreed with the participants to conduct a vitamin D analysis after two months of participation in the program. An interview date for each group was then set to discuss the results of the vitamin D analysis from the treating physician and to evaluate which participants showed improvement after undergoing training through the healthy lifestyle education program. The date was to fall on the same time as the follow-up clinics.

The participants also agreed with the researcher to have their blood pressure measurements taken before the start of the education program, during the follow-ups and after the two-month program in order to evaluate the results and determine which participants showed an improvement.

The researcher designed the healthy lifestyle education program into four sessions comprising three theoretical and one practical. Each program session lasted from 30 to 45 minutes. At the start of the program, the participants filled out questionnaires with their data and answered questions pertaining to family history of chronic disease. They also examined their knowledge about high blood pressure, vitamin D deficiency, healthy lifestyle as well as their skills on how to take blood pressure measurements and how to do exercise. This was necessary in order to determine the level of the participants' knowledge and skills before the implementation of the program.

The two theoretical sessions were given in sets of 15 minutes each and included a lecture on blood pressure with regards to meaning, signs and symptoms, predisposing factors, management, follow-up and avoidance of complications. The second session was set aside for a discussion on vitamin D with regards to meaning, signs and symptoms, predisposing factors, screening tests, management, prevention and potential complications. The third session was dedicated to examining the concept of a healthy lifestyle by discussing nutrition guidelines and various sources of vitamin D. As for the one practical session, it was done in sets of 15 minutes and included a demonstration of how to take a blood pressure measurement properly as well as do simple daily exercises.

The researcher employed a variety of educational materials such as videos and brochures in the implementation of the healthy lifestyle program. A training doll was used to demonstrate certain simple exercises to the participants. The researcher also taught the participants how to measure blood pressure and find the brachial pulse. The participants then tried to apply the learned knowledge by measuring the blood pressure as well as the brachial pulse on each other. The researcher then performed the same on the participants to make sure that the readings were correct and that they have conducted the measurements properly in the right way. The researcher also gave the participants booklets containing all the information that was given in the program for easy reference when they need it. The researcher also utilised various forms of communication between him and the participants to facilitate correspondence and a quick response to follow-up questions and inquiries by study participants.

4.2. Evaluation phase

Right after the implementation of the program, the study participants were assessed for their knowledge using the same knowledge questionnaire about hypertension and vitamin D. They were also evaluated as to the extent of their acquired skills by asking them to demonstrate several times the practices taught to them by the researcher based on the observation checklist.

4.3. Statistical design

The study used statistical analysis by means of the SPSS (statistical package for the social sciences) computer program. Descriptive measures such as number and percent were used to describe quantitative data. Paired T-Test was employed to account for the difference between two variables from the same population (e.g., a pre- and post-test score). Chi-Square Test was used to determine the strength of association between the different variables. Statistical significance was set at $P<0.05$.

5. Results

Figure 1: This illustrates that 72 percent of adolescents had a family history of hypertension at a near relative degree and 34 percent had a family history of obesity at a far relative degree while 38 percent of adolescents had no family history of diabetes mellitus.

5.1. Program

This table illustrates the efficiency of the healthy lifestyle program as shown by the statistically significant difference and a clear improvement of the healthy lifestyle of adolescents after the program. The highest proportion after the program was in the appropriate diet as it limited the consumption of foods rich in sugar and sodium. The best healthy lifestyle in the vitamin D source category was natural sun exposure or ultraviolet B irradiation with a value of 96.3 percent. After the education program, some 89.3 percent of adolescents were on the opinion that physical activity should take place every 2-3 days per week for a duration of 30 minutes to one hour.

Table 1: Healthy lifestyle distribution as proper diet, source of vitamin D and physical activity for hypertensive adolescents with vitamin D deficiency before and after the healthy lifestyle

Healthy life-style	**Before program**		**After program**		**t**	**P**
Proper diet	Always F (%)	Sometimes F (%)	Always F (%)	Sometimes F (%)		
Low-fat dairy products and skimps on saturated fat and cholesterol can lower the blood pressure by up to 11 mm Hg	53(17.7)	247(82.3)	260(86.7)	40(13.3)		
Eat three meals every day and intake of whole grains, protein and fruits	35(11.7)	265(88.3)	278(92.7)	22(7.3)	3.21	<.001
Healthy snacks such as vegetables instead of fried.	23(7.7)	277(92.3)	287(95.7)	13(4.3)	4.05	<.05
Drink water instead of soft drinks, sugary juices, or sports drinks.	16(5.3)	284(94.6)	292(97.3)	8(2.7)	5.23	<.05
Limit foods high in sugar, sodium , increase potassium	11(3.7)	289(96.3)	295(98.3)	5(1.7)	6.56	<.05
Less fast food, stop eat when full	31(10.3)	269(89.7)	275(91.7)	25(8.3)	4.12	<.05
Source of vitamin D					8.34	>.02
Natural sun exposure/ultraviolet B irradiation	76(25.3)	224(74.7)	287(95.7)	13(4.3)		
Dietary sources including oily fish, eggs, and from vitamin D-fortified foods such as dairy products and breakfast cereals.	88(29.3)	212(70.7)	283(94.3)	17(5.7)	3.21	<.01
Provide vitamin D supplementation at least 1,000 IU daily for adolescents who are at risk for vitamin D deficiency or insufficiency at least 3 months	90(30)	210(70)	281(93.7)	19(6.3)	2.23	<.001
Physical activity					7.01	<.05
Frequency: 2-3 d/w	66(22)	234(78)	289(96.3)	11(3.7)		
Time: from 30 minutes to one hour	92(30.7)	208(69.3)	268(89.3)	32(10.7)	5.12	<.01

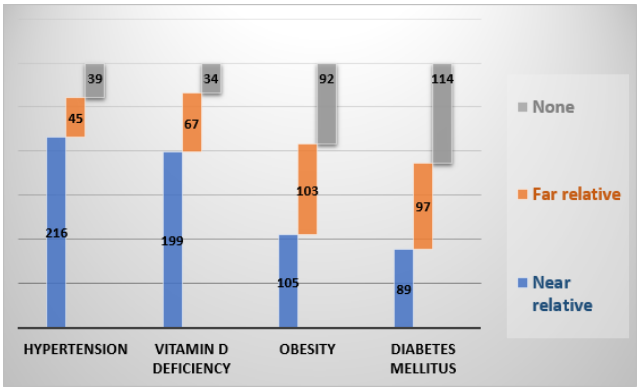

Fig. 1: Distribution of hypertensive adolescents with vitamin D deficiency related to family history of chronic disease

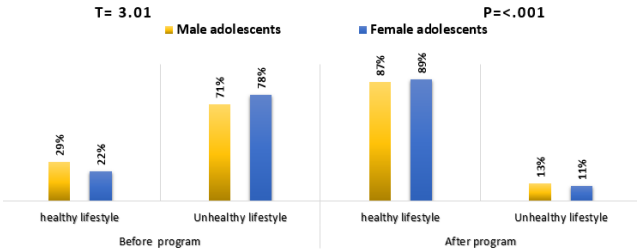

Fig. 2: Comparison of total lifestyles between male and female hypertensive adolescents with vitamin D deficiency before and after the healthy lifestyle program

Figure 2: This illustrates that female adolescents had a higher improvement of 89 percent in their healthy lifestyles after undergoing the healthy lifestyle program compared to male adolescents who showed a slightly less score of 87 percent.

Table 3: The study showed that there was a statistically significant relationship between the adolescents' healthy lifestyle and their socio-demographic characteristics such as their gender as females aged between 14-18 years old with secondary education and having appropriate economic status and healthy house conditions. After undergoing the healthy lifestyle program, the study also showed that among the male adolescent subjects, 94 percent were physically active, 60 percent were aged between 11-14 years and 55.7 percent had non-appropriate economic status.

Table 3 The study showed that after having been through the two-month healthy lifestyle program, a high number

Table 2: Relationship between socio-demographic characteristics of hypertensive adolescent with vitamin D deficiency and their healthy lifestyle before and after the healthy lifestyle program

Variables	Healthy life style Before program											After program												χ^2	P
	Source of vit D			Proper diet				Physical activity				Source of vit D				Proper diet			Physical activity						
	Enough		Not enough	Constantly		Occasionally		Active		Non active		Enough		Not enough		Constantly			Occasionally		Active		Non active			
	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%		
Gender																										
Male (n=150)	30	20	120	80	35	23,3	115	76,7	65	43,3	85	56,7	125	83,3	5	1,7	123	82	27	18	141	94	9	6	7.03	0.02
Female (N=150)	20	13,3	130	86,7	55	36,7	95	63,3	23	15,3	127	84,7	135	90	15	10	144	96	6	4	122	81,3	28	18,7	8.05	<0.05
11-14	22	7,3	50	16,7	60	20	150	50	60	20	111	37	66	22	6	2	187	82	23	7,7	180	60	30	10	7.23	0.04
14-18	28	9,3	200	66,7	30	10	60	20	40	13,3	89	29,7	225	75	3	1	86	96	4	1,3	119	39,7	10	3,3	4.12	<0.01
Education																										
Primary	10	3,3	50	16,7	22	7,3	80	26,7	33	11	55	18,3	42	14	18	6	92	96	10	3,3	83	27,7	2	0,7	9.45	0.03
Preparatory	20	6,7	40	13,3	21	7	100	33,3	12	4	87	29	55	18,3	5	1,7	111	82	20	6,7	88	29,3	11	3,7	8.13	0.02
Secondary	20	6,7	60	20	25	8,3	52	17,3	55	18,3	58	19,3	76	25,3	4	1,3	72	96	5	1,7	109	36,3	4	1,3	3.56	<0.05
Economic status																										
Appropriate	17	5,7	180	60	10	3,3	236	78,7	33	11	96	32	186	62	11	3,7	240	96	6	2	102	34	27	9	9.23	<0.05
Non appropriate	33	11	70	23,3	21	7	33	11	44	14,7	127	42,3	100	33,3	3	1	44	82	7	2,3	167	55,7	4	1,4	3.76	0.23
House condition																										
Healthy	17	5,7	190	63,3	12	4	186	62	18	6	154	51,3	200	66,7	7	2,3	190	82	8	2,7	165	55	7	2,3	7.13	0.14
Unhealthy	33	11	60	20	33	11	70	23,3	52	17,3	76	25,3	88	29,3	5	1,7	90	96	3	1	108	36	20	6,7	3.12	<0.01

Table 3: Distribution of blood pressure and 25-hydroxy vitamin D measurements ofadolescents (N= 300) before and after the healthy lifestyle program

Variable	Before-program												After two months from healthy lifestyle program												t	P
	Blood pressure								25-hydroxy vitamin D				Blood pressure								25-hydroxy vitamin D					
	Systolic				Diastolic				Deficient		Insufficient		Systolic				Diastolic				Optimal		Insufficien			
	Controlled		high		Controlled		high		F	%	F	%	Controlled		High		Controlled		High		F	%	F	%		
	F	%	F	%	F	%	F	%					F	%	F	%	F	%	F	%						
Male adolescents	70	46.7	80	53.3	60	40	90	60	77	51.3	73	48.7	140	93.3	10	6.7	135	90	15	10	145	96.7	5	3.3	3.12	<.05
Female adolescents	100	66.7	50	33.3	120	80	30	20	80	53.3	70	46.7	120	80	30	20	144	96	6	4	138	92	12	8	2.34	<.05

of both female and male adolescents were able tostabilise their blood pressures as shown by their blood pressure readings. Similarly, most of the adolescents with 25-hydroxy vitamin D deficiency were able to achieve optimal vitamin D sufficiency from a previous state of being vitamin D deficient and insufficient after going through the healthy lifestyle program.

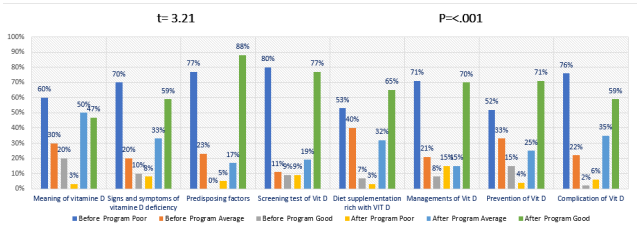

Fig. 3: The difference of knowledge levels of hypertensive adolescents in relation to vitamin D before and after the healthy lifestyle program

Figure 3**:** The study revealed a statistically significant difference on the knowledge levels of adolescents after undergoing the healthy lifestyle program. The adolescents showed a good knowledge level of 88 percent for predisposing factors and 77 percent for screening tests of vitamin D.

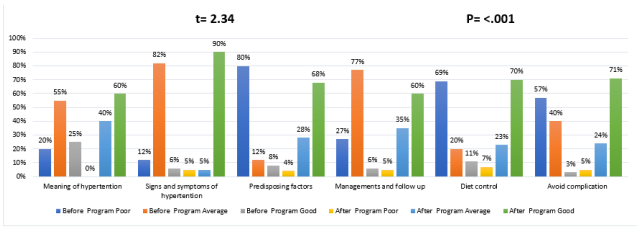

Fig. 4: Difference of knowledge levels of adolescents in relation to hypertension before and after the healthy lifestyle program

Figure 4: The study showed a statistically significant difference in the knowledge levels of adolescents pertaining to blood pressure after undergoing the healthy lifestyle program. The adolescents obtained a good knowledge level of 90 percent for signs and symptoms and 71 percent for avoidance of complications.

Figure 5: The study showed that female adolescents achieved a more satisfactory knowledge level of 95 percent after undergoing the healthy lifestyle program compared to male adolescents who scored a lower knowledge level of 90 percent.

Table 4: Distribution of adolescents' practice in relation to blood pressure measurement before and after the healthy lifestyle program (N=300).

Table 4The study revealed a statistically significant difference in the adolescents' practice of taking blood pressure measurements after undergoing the healthy

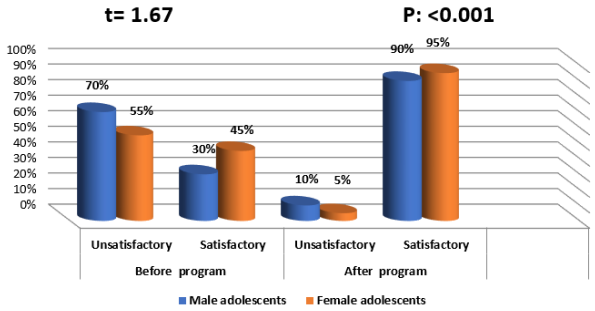

Fig. 5: Difference of total knowledge levels between genders before and after the healthy lifestyle program

lifestyle program. Adolescents garnered a score of 100 percent for the best practice of using a stethoscope when taking blood pressure measurements and forstaying silent while taking blood pressure readings.

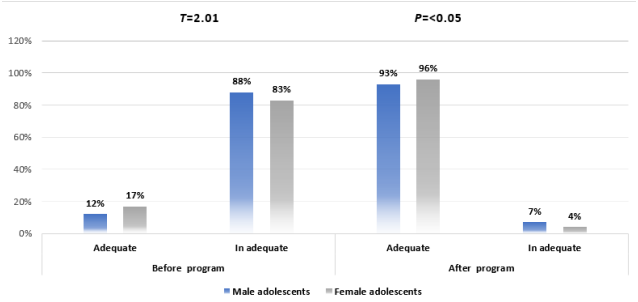

Fig. 6: Difference of adolescents' total levels of practice before and after the healthy lifestyle program according to their gender

Figure 6**:** The study showed a marked improvement of 96 percent among female adolescents' total level of practice compared to their male counterparts' lower score of 93 percent after undergoing the healthy lifestyle program.

6. Discussion

This research seeks to test the hypothesis that participation in a healthy lifestyle programme instigates behavioral change in hypertensive adolescents with vitamin D deficiency endeavouring to manage their blood pressure levels and enhance their vitamin D intake. Findings from this study revealed a statistically significant difference in adolescents' knowledge and practices pre- and post-participation in the program. In addition, a significant correlation was evident between healthy lifestyle behavior at baseline and following completion of the programme in this adolescent sample, based on a number of specific demographic characteristics.

Table 4: Distribution of adolescents' practice in relation to blood pressure measurement before and after the healthy lifestyle program (N=300).

Practice steps	Before program			After program			t	
	Done well N (%)	In correct N (%)	Not done N (%)	Done well N (%)	In correct N (%)	Not done N (%)		
- Prepare stethoscope	59(19.7)	65(21.7)	176(58.7)	300(100)	0	0	9.03	0.02
-An appropriately sized blood pressure cuff	40(13.3)	169(56.3)	91(30.3)	279(93)	21(7)	0	5.54	<0.05
-A blood pressure measurement instrument such as an aneroid or mercury column sphygmomanometer or an automated device with a manual inflate mode.	45(15)	87(29)	168(56)	300(100)	0	0	6.04	<0.05
- Five minutes to relax before the first reading.	2(0.6)	5(1.7)	293(97.7)	262(87.3)	23(7.7)	15(5)	7.03	<0.05
- Sit upright with their upper arm positioned so it is level with their heart	0	9(3)	291(97)	234(78)	66(22)	0	5.98	<0.05
-Remove excess clothing that might interfere with the BP cuff or constrict blood flow in the arm.	79(26.3)	88(29.3)	133(44.3)	198(66)	77(25.7)	25(8.3)	6.98	<0.05
-No talking during the reading.	78(26)	99(33)	123(41)	300(100)	0	0	5.45	<0.05
- Wrap the BP cuff snugly around the arm.	38(12.7)	96(32)	166(55.3)	293(97.7)	6(	1(	4.21	<0.05
-Palpate/locate the brachial artery and position the BP cuff so that the ARTERY marker points to the brachial artery.	0	1(0.3)	299(99.7)	245(81.7)	50(16.7)	5(1.7)	5.72	<0.05
- Place the bell of the stethoscope over the brachial artery at strongest pulse sounds.	4(1.3)	95(31.7)	201(67)	265(88.3)	22(7.3)	13(4.3)	5.34	<0.05
-Begin pumping the cuff bulb and inflated to 160 - 180 mmHg until no hear sounds through the stethoscope.	59(19.7)	37(12.3)	257(85.7)	255(85)	42(14)	3(1)	4.32	<0.05
- Slowly Deflate the BP cuff should fall at 2 - 3 mmHg per second, because faster may likely result in an inaccurate measurement.	40(13.3)	3(1)	296(98.7)	295(98.3)	1(0.3)	4(1.3)	5.21	<0.05
- Listen for the systolic reading through heard the first occurrence of rhythmic sounds	45(15)	8(2.7)	287(95.6)	289(96.3)	9(3)	2(0.6)	5.61	<0.05
-Listen and note for the Diastolic Reading as the BP cuff pressure drops and the sounds fade.	2(0.6)	2(0.6)	289(96.3)	288(96)	6(2)	6(2)	6.12	<0.05
- Slowly Deflate the BP cuff: should fall at 2 - 3 mmHg per second, anything faster may likely result in an inaccurate measurement.	0	19(6.3)	278(92.7)	286(95.3)	7(2.3)	7(2.3)	5.16	<0.05
- Double check for accuracy by taking a reading with both arms and averaging the readings and wait five minutes between readings.	79(26.3)	44(14.7)	249(83)	259(86.3)	33(11)	8(2.7)	4.98	<0.05

The current research identified that 34% of hypertensive adolescents had a first-degree relative with a history of obesity. Analysis of the prevalence of hypertension in children attending public schools in a Brazilian cohort reported a significant relationship between nutritional status and increased systolic and diastolic blood pressure, with this pattern being more pronounced in children who were overweight.[28] In addition, children classified as obese were most likely to display elevated blood pressure readings. Similarly, an investigation of blood pressure management in a United States-based sample of children reported that obesity, smoking and lifestyle factors, such as lack of physical activity and a sedentary lifestyle, were associated with increased blood pressure, even among young children in the preschool years.[29] The majority of participants in this study also reported a family history of high blood pressure, thus highlighting the requirement to monitor blood pressure levels from three years of age onwards.

The current research demonstrates positive health-enhancing behaviours among hypertensive adolescents who had completed a lifestyle programme. The majority of respondents 96.3% and 89.3% committed to undertaking physical exercises for between 30–60 minutes two to three days per week.[30] identified a number of health benefits associated with engaging in physical activity programmes within school settings for young people aged between 6–18 years. The latter authors advocate for the ongoing promotion of physical exercise in light of the strong evidence base to support positive lifestyle habits and physical health status. Conversely, sedentary behaviour can lead to high blood lipid levels and hypertension among children. Based on a sample comprising 496 Greek adolescent students in the 12–17 years age group,[31] recommended the integration of moderate intensity activities into young people's daily lives. Subsequent research undertaken by[32] on a United States-based child and adolescent cohort presenting with hypertension and vitamin D deficiency advised that they embrace a number of lifestyle changes in order to reduce their high blood pressure levels. This included referral to an intensive behavioural intervention programme adopting a broad-based and family-focused approach, which incorporated participating in sporting activities and regular physical exercise, as well as promoting the maintenance of a healthy diet. The findings from research conducted by[33] concur with the current study, where the former examined the lifestyle patterns, diet and exposure of New York dwellers to sunshine as a source of vitamin D. They reported that intake of the recommended daily allowance of vitamin D was associated with the adoption of multiple strategies, including good nutrition, sunlight and consuming fortified foods and supplements. However, greatest impact in terms of hypertension was achieved by maintaining a healthy diet which is low in sugar and sodium, an outcome consistent with the current research findings. Exposure to natural sunlight or ultraviolent B irradiation was identified as the most effective lifestyle-related means of sourcing vitamin D.[34] contend that the programme they devised successfully instigated positive lifestyle behavioural change among their sample characterised by high blood pressure and vitamin D deficiency, thus helping them to maintain normal blood pressure levels.

The current research found that a statistically significant relationship occurred between this adolescent cohort's capacity to maintain a healthy lifestyle and a number of sociodemographic factors. These include: being female; within the 14–18 years age group; attending secondary school; of average socioeconomic status; and exposed to healthy environmental conditions. The proportion of male adolescents engaging in a healthy lifestyle following completion of a behaviour management programme was influenced by the following factors: aged between 11–14 years (90%); being physically active (60%); and of low socioeconomic status (55.7%). This concurs with outcomes from research undertaken by[35] in the central Iranian city of Isfahan, which investigated the relationship between hypertension and socioeconomic factors. The latter authors reported a correlation between average socioeconomic status and the maintenance of a normal body weight, while also remaining physically active. In the case of female adolescents that urban dwellers classified as being of average or low health status tended not to be underweight. Furthermore, earlier work has shown that a strong correlation exists between the capability to sustain a healthy lifestyle and social class, which was based on two variables, namely education and income. Current research findings are also in line with those emanating from another Iranian study conducted by[36], which sought to establish hypertension prevalence rates, as well as the relationship between this condition and various demographic determinants, biochemical markers and anthropometric measurements. Education was identified as a key predictor in the adoption of a healthy lifestyle, while being an urban dweller was also a strong influencing factor. The authors have argued that as adolescents grow and mature, in combination with being exposed to a positive healthy environment with sufficient income levels, both their awareness and capacity to maintain a healthy lifestyle increases. These determinants impact favourably upon their blood pressure management strategies, along with also addressing their vitamin D deficiencies.

The current study found that a statistically significant difference occurred between adolescents' knowledge levels pre- and post-participation in a healthy lifestyle programme. This was evidenced by 90% reporting having acquired good knowledge levels, while 71% were aware of the signs and symptoms associated with hypertension, as well as strategies to implement to prevent complications arising from this condition. These findings concur

with an earlier study undertaken in the White Nile Sudanese state by[37], who investigated the impact of participation in a health education programme on attendees' knowledge of hypertension, along with recommended management techniques. Significant increases in accurate knowledge regarding various hypertension-related elements were noted among those who had completed the programme ($p < 0.001$). This included knowledge regarding dietary management, clinical symptomatology, hypertension-related complications and the recommended levels of physical activity. Similar findings emerged in Brazilian-based research conducted by[38] exploring the impact of educational programmes on blood pressure management among a hypertensive cohort. The outcomes were found to be positive, with participants demonstrating: increased knowledge levels, including in relation to deterioration characteristics and complications sequence; favourable attitudes towards hypertension management; and greater willingness to comply with therapeutic interventions. These findings are indicative of improved awareness of hypertension and vitamin D deficiency, thus increasing capacity to manage blood pressure readings, along with ensuring adherence to intake of recommended daily vitamin D allowances.

Findings two months post-completion of the current study's healthy lifestyle programme revealed that both male and female adolescents who were implementing its recommendations had brought their blood pressure readings under control. Similar results were reported by[19], where White Nile Sudanese state residents attending health education programmes improved both their knowledge and management of their hypertension condition. Post-participation monitoring revealed that 92% of attendees had acquired sufficient knowledge levels to instigate positive lifestyle modifications in relation to diet and exercise, resulting in effective blood pressure management and considerable weight loss. These outcomes also concur with earlier research undertaken by[39]exploring the correlation between blood pressure readings and fruit, fruit juice and vegetable intake in a random sample comprising 794 adolescents drawn from 12 different private schools based in the northeast region of Brazil. Twice daily consumption of fruit was associated with reduced systolic and diastolic blood pressure readings. However, vegetable intake instigated a more significant decrease in systolic blood pressure. The current study results are in accordance with those of[40], where their research demonstrated the positive benefits associated with education programmes in terms of blood pressure management and the maintenance of healthy lifestyle behavioural change in a Turkish-based sample. The current research showed that the majority of adolescents initially presenting with vitamin D deficiencies, measured using a 25-hydroxy vitamin D blood test, progressed from insufficient to optimal levels, as documented in their medical notes two months post-completion of the healthy lifestyle programme. A quasi-experimental research design adopted by[41] produced similar findings involving 175 girls within the 12–14 years age group, who were attending primary care services in Gonabad in Iran. They noted that, in contrast to the control group, participants assigned to the intervention condition implemented a range of behavioural changes conducive to improving their vitamin D intake, thus resulting in significantly positive effects ($p < 0.001$).

[42] reported positive outcomes having conducted a randomised clinical trial involving the self-measurement of blood pressure among an urban New York-based adolescent cohort. The aneroid manometer was deemed to be a suitable device to use at home for those aged between 4–18 years. This sample demonstrated high-level skills following appropriate training in this monitoring method. These findings are in line with the current research, whereby self-measurement of blood pressure levels post-completion of the healthy lifestyle program resulted in statistically significant positive practices among adolescents, when compared with baseline measures. Best practice was adhered to in all cases in terms of blood pressure measurement post-participation in the education program, including teaching the adolescents stethoscope and blood pressure instrument usage, along with ensuring no talking took place during the readings. Imparting key skills including pulse measurement in the upper arm was found to be effective in the monitoring and management of their blood pressure levels. It is the researcher's contention that the increased prevalence of hypertension among children can be attributed to a rise in obesity levels, sedentary lifestyles and nutritional deficiency. This research clearly underlines the vital importance of promoting physical activities and vitamin D supplement intake, along with maintaining a healthy lifestyle.

7. Conclusion and Recommendations

The study has reached the conclusion that the healthy lifestyle program was able to successfully modify the adolescents' healthy lifestyle knowledge and practices which in turn enabled them to manage and control their hypertension and vitamin D deficiency. The study also helped the researcher gain a better understanding on how demographic factors affect the adolescents' capability to manage and control their hypertension and vitamin D deficiency.

The study recommends further research and continuous promotion of a healthy lifestyle program for hypertensive adolescents who are deficient in vitamin D.

It also strongly recommends the development and establishment of programs and policies that promote physical activity and reduce sedentary behaviours. The study also endorses the promotion of healthy nutrition

among children of different age groups.

The study recommends regular screening for hypertension among children and that school health programs should include a regular practice of taking blood pressure measurements.

One other recommendation that the study suggests is for nurses to have the added responsibility of promoting an awareness campaign on the dangers of vitamin D deficiency among mothers.

8. Ethics Approval and Consent to Participate

The study received ethical approval from adolescent, nursing students, and Nurses voluntarily participated in the study and completed a consent form prior to answering the questionnaire. In case of minors, informed consent was obtained from the legal guardians. All methods were conducted in accordance with relevant guidelines and regulation.

9. Availability of Data and Materials

All data generated or Analyzed during this study are included in this published article.

10. Authors' Contributions

Designed the research study, Analyze the data, and wrote the paper

11. Source of Funding

There no funding grant

12. Conflict of Interest

The author declare no competing interest

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