

CURRENT PERSPECTIVES AND PREVENTION STRATEGIES OF HYPERTENSION AMONG ADOLESCENTS AND ADULTS

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Abstract

Purpose: In this review, we compared hypertension between adolescents and adults and evaluated distinctive prevention programs.

Research Methodology: Systematic Review

Results: At present, the definition of hypertension used in adolescents, especially those aged ≥ 13 years, is the same as that in adults so that blood pressure monitoring can be easily performed. Despite the aforementioned programs for preventing hypertension, unsatisfactory results are observed in adults; adults find it difficult to follow the program because it is difficult to change unhealthy lifestyle habits, such as low physical activities, bad food habit, poor sleeping pattern, stress, and smoking habits, which have developed in adolescence. Thus, it is important to start preventing hypertension during adolescence to prevent hypertension in adulthood.

Limitations: This paper is not a meta-analysis. Prevention strategies of hypertension may vary among countries from different cultural and characteristic conditions.

Contribution: This review could contribute positively in decreasing the incidence of hypertension worldwide.

Keywords: Hypertension; Blood Pressure; Adolescence; Adulthood; Prevention

Introduction

Hypertension, that is, a high blood pressure level, is commonly found in adults but is also present in adolescents and even in children. Some studies have revealed that hypertension in adults may start during adolescence (Giles et al,2009; Flynn,2017; Tirosh et al,2010; Chen and Wang,2008; Sun et al,2007; Lai et al,2014). The worldwide prevalence of hypertension in adolescents may vary, and its incidence rate has been increasing every year (Savitha et al,2007; Saing,2005; Kurnianto et al,2020). A higher prevalence of hypertension in adolescents leads to declining quality of life and increasing morbidity and mortality, particularly in adults (Flynn,2017; Tirosh et al,2010; Chen and Wang,2008; Sun et al,2007; Lai et al,2014; Saing,2005; Kurnianto et al,2020).The costs of hypertension treatments may increase every year; thus, it is more effective to employ promotive and preventive programs rather than curative and rehabilitative treatments. Hypertension and its complications subsequently lead to higher cost of medication, prolong medication consumption, and decrease quality of life (Weintraub and Rudolph,2011; Lim et al,2012).

In this review, we aimed to compare the incidence of hypertension between adolescents and adults and evaluate distinctive prevention programs. This review could contribute positively in decreasing the incidence of hypertension worldwide.

Hypertension

Definition

Hypertension is defined as increased arterial systemic blood pressure above the normal level (Giles et al,2009). In adults, it is defined as a disorder of systemic blood circulation with an increase in systolic blood pressure (≥ 140 mmHg) and/or diastolic blood pressure (≥ 90 mmHg) detected in two blood pressure measurements with a 5-min interval and at rest (Giles et al,2009). The recent guideline published by the American Heart Association (AHA) and American College of Cardiology (ACC) in 2017 reveals changes in hypertension definition. Hypertension is now defined as increased systolic blood pressure ≥ 130 mmHg and/or diastolic blood pressure ≥ 80 mmHg (Whelton et al,2018).

Similar to adults, hypertension can also occur in adolescents. The Fourth Report on High Blood Pressure in Children and Adolescents defined hypertension as an average systolic and diastolic blood pressure $\geq 95^{\text{th}}$ percentile based on sex, age, and height in three measurements or more (Flynn,2017). Moreover, in 2017, the American Academy of Pediatrics (AAP) defined hypertension based on age and described hypertension as follows: hypertension in children aged 1 to <13 years is defined as an average systolic and diastolic blood pressure $\geq 95^{\text{th}}$ percentile, and hypertension in children aged ≥ 13 years is defined as increased systolic blood pressure ≥ 130 mmHg and/or diastolic blood pressure ≥ 80 mmHg. This definition is suitable and in accordance with the guidelines released by the AHA and ACC in the same year (Flynn,2017).

Epidemiology

According to the World Health Organization, in 1975, approximately 594 million people had hypertension, and the numbers have doubled to approximately 1.13 billion people in 2015 (Dzau and Balatbat,2019). A previous study included samples taken from 90 countries in 2016 and revealed that 31.1% of the adults have hypertension (Mills et al,2016).

Hypertension incidences in adolescents may vary worldwide, and approximately 1.3% to 21.6% of adolescents develop hypertension due to aging (Savitha et al,2007; Ejike et al,2010; Bell et al,2019). In Indonesia, approximately 3.1% to 4.6% of adolescents have hypertension, but the incidences have been increasing every year (Saing,2005; Kurnianto et al,2020). Given the increasing rate of hypertension and risks, adolescents may experience decreased quality of life, and if hypertension persistently occurs in adulthood, it may lead to higher morbidity and mortality risks (Flynn,2017; Tiros et al,2010; Chen and Wang,2008; Sun et al,2007; Lai et al,2014; Saing,2005; Kurnianto et al,2020).

Classification

In 2003, the Seventh Report of The Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure VII (JNC VII) classified blood pressure into normal, prehypertension, hypertension stage I, and hypertension stage II. Accordingly, the AHA and 2017 ACC Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in adults classified blood pressure into normal, elevated, hypertension stage I, and hypertension stage II (Whelton et al,2018). The descriptions are depicted in Tables 1 and 2.

In 2004, The Fourth Report On The Diagnosis, Evaluation, and Treatment Of High Blood Pressure In Children And Adolescents classified blood pressure into normal, prehypertension, hypertension, hypertension stage I, and hypertension stage II. Furthermore, in 2017, the AAP released a new classification of hypertension: normal, elevated, hypertension stage I, and hypertension stage II, as presented in Tables 3 and 4 (Flynn,2017).

Etiologies/Risk Factors

Adolescents and adults usually have primary or essential hypertension (85%–95% of cases). Two main factors cause hypertension: genetics and lifestyle. Genetics contributes approximately 30% of hypertension risk. Higher hypertension risk is caused by unhealthy lifestyles. Lifestyles include physical activities, eating pattern, sleeping pattern, stress, and smoking habit (Luma and Spiotta,2006; Ranasinghe et al,2015; Liu et al,2014; Kurnianto et al,2020; Yoo and Park,2017; Andrade et al,2017; Huang et al,2014; Byrne et al,2016).

In this modern era, there may be lifestyle changes in adolescents and adults, such as eating junk food, canned food, bottled sausages, canned beverages, preserved fruits and

vegetables, and food with high levels of sugar, salt, fat and cholesterol; sedentary behaviors because many activities can be carried out using modern technology; and driving a vehicle over short distances instead of walking. These unhealthy lifestyles are harmful to the human body and health and can influence physical decline caused by less physical activities and improper eating pattern leading to hypertension (Kurnianto et al,2020; Singhal et al,2010; Wilson and Ampey,2001).

Adolescents whose family or parents have a hypertension history show a higher risk to cardiometabolic diseases such as overweight, obesity, and hypertension. Parents or adults can affect the health of their offspring or adolescent children through genetic and environmental factors. Adolescents usually imitate the habits or lifestyles of their parents, particularly unhealthy eating patterns such as inappropriate nutrition intake including excessive salt and calorie consumptions leading to obesity, sedentary behavior, smoking habit, stress, and sleep deprivation. Adolescents also imitate teachers, family, friends, adults, and public figures(Ranasinghe et al,2015; Liu et al,2014; Yoo and Park,2017; Andrade et al,2017; Huang et al,2014; Byrne et al,2016).

Adolescents whose parents have a history of hypertension may have higher hypertension risk in the future than adolescents whose parents do not have hypertension. If the parents have hypertension, the risk of congenital hypertension is 4–15 times higher than in those whose parents are normotensive. If both parents have hypertension, their children have a 44.8% risk of hypertension. In addition, if one parent has hypertension, adolescents have a 12.8% risk of hypertension (Saing,2005). People whose families have a history of hypertension may experience significant increased blood pressure during childhood, adolescence, and into adulthood (Singh et al,2010). Blood pressure variation in humans is caused by genetic factors, but the genes that cause the variation remain unknown (Zheng et al,2016).

Diagnosis

The recommended blood pressure measurement method utilizes sphygmomanometer and auscultation: that is, the stethoscope is placed on the brachial artery in the proximal and medial cubital fossa of the right hand. The length of the cuff covers 80% of the upper limb, while its width covers 40% of the upper limb (area between the acromion and olecranon). Bigger cuffs can generate lower blood pressure, while smaller cuffs can generate higher blood pressure. Blood pressure is appropriately measured after a 3- to 5-min break, and the environment is supposed to be noiseless. During blood pressure measurement, children are seated and the right arm is positioned as high as the heart. If the blood pressure is higher than the 90th percentile, the measurement should be repeated twice immediately to obtain valid results, and the average blood pressure is used for classification. Therefore, when using the new AAP clinical practice guidelines, blood pressure measurement results are recorded based on sex, age, and height if the adolescents aged <13 years, and the cut-off is used as in adults if the adolescents are ≥13 years old (Flynn,2017; Kurnianto et al,2020; Luma and Spiotta,2006).

Several items should be considered to understand the table of blood pressure based on sex, age, and height: (1) using the Center for Disease Control and Prevention (CDC) growth chart given the percentile of height based on age, (2) conducting systolic and diastolic blood pressure measurements and recording the results in children, (3) using the table of the National Health and Nutrition Examination Survey which is based on sex and age of children; and (4) determining the percentile of blood pressure and classifying the results in children. In children and adolescents, blood pressure is rarely measured, and higher blood pressure is usually diagnosed in adults. Previous studies stated that nearly 75% of hypertension and 90% of pre-hypertension incidences in children and adolescents are not diagnosed comprehensively (Flynn,2017; Luma and Spiotta,2006). Moreover, it is much simple to classify blood pressure in adults and adolescents aged ≥13 years.

Hypertension Prevention in Adults

Eleven programs have been initiated and employed worldwide to prevent hypertension in adults (categorized as secondary prevention), including Dietary Approaches to Stop Hypertension (DASH), Diet Exercise and Weight Loss Intervention Trial (DEW-IT), PREMIER trial, Hypertension Improvement Project (HIP) trial, The Logan Healthy Living Program, and programs to change unhealthy lifestyles in many countries (Appel et al,1997; Miller et al,2002; Maruthur et al, 2009; Dolor et al,2009; Eakin et al,2008; Cakir and Pinar,2006; Chao et al,2012; Garcia et al,2001; Hacıhasanoglu and Gozum,2011; Jafar et al,2009).

DASH is a program focusing on effective eating pattern to lower blood pressure in hypertension patients in the United States. The intervention is given for 8 weeks by medical doctors to each participant without involvement of the family by maintaining nutrition intake per day based on the Recommended Dietary Allowances for Americans (Appel et al,1997).

DEW-IT is an intervention program related to lifestyles such as dietary allowance, increased physical activities, and weight loss through direct consultation with the medical doctors by adult hypertension patients in the United States. The individualized program is conducted for 9 weeks with investigation of blood pressure measurements every 2 weeks by the medical doctors without involvement of the family (Miller et al,2002).

The PREMIER trial program includes provision of education via leaflets dealing with lifestyles, lifestyle modifications (improving physical activities ≥ 180 min per week; decreasing weight; decreasing fat, salt, and calories intake; decreasing alcohol consumption; and eating sufficient fruits and vegetables). In this 6-week program, the activities are recommended to each adult hypertension patient in the United States without involving their family and other party, and blood pressure is monitored until the end of the program (Maruthur et al, 2009).

The HIP trial is a strategy to change behavior in adult hypertension patients in the United States through active interventions between medical doctors and patients for 18 months. Monitoring is required to discover changes in lifestyles and blood pressures every 3 months. Intervention performed by the medical doctors employs three major elements. The first element is the use of module exercise for 45 min per day according to the guidelines of JNC-7 and module of lifestyle modifications to control blood pressure. The module can be received through audio streaming, slide presentation, and printed media based on the recommendation of the medical doctors. The second element is medication algorithm program and evaluation for the medical doctors. The third element is adherence evaluation of medical doctors toward the JNC-7 guideline. The intervention strategy of the medical doctors consists of system support, feedback, knowledge, motivation, self-efficacy, and skills which can influence adherence toward the guideline of the treatment. Intervention is carried out by dividing the patients into groups of 10–15 members, while each group is monitored by a health professional. Therefore, every patient is given dietary and physical activity guideline books. The intervention strategy include knowledge, motivation, self-efficacy, and skills which can influence adherence toward treatment and lifestyle changes (Dolor et al,2009).

The Logan Healthy Living Program encourages lifestyle improvement (physical activity and eating pattern) via telephone-based consultations as the primary service for low-income adult hypertension patients living in the remote areas of Logan, Queensland, Australia. The intervention is carried out for 12 months. The intervention strategies include self-efficacy/self-esteem, motivation toward results and belief; encouragements from family, friends, and neighbors, and the society; feedback; motivation; and utilization of workbook media that contain goal setting, problem solving, self-reward, support social, positive self-talk, relapse, and action plan which can influence patient lifestyles (Eakin et al,2008).

Moreover, in Istanbul, Turkey, lifestyle modification programs use an initial intervention strategy: nurses give patients a 30-min education related to behaviors related to hypertension prevention such as eating pattern, nutrition allowance based on DASH, alcohol consumptions, smoking habit, and physical activities. The intervention is given for 6 months; therefore, there will be a meeting every 3 months to maintain and strengthen the behaviors (Cakir and Pinar,2006).

The Chinese government regulates an intervention strategy that includes a health management program including individual nutrition allowance and physical activity, education concerning with self-health management, telephone-based consultation, meetings for discussing health, and health promotion materials. The intervention is carried out once per month by trained health professionals, for a total of 18 months (Chao et al,2012).

The Mexican government uses the following intervention strategy: participants are visited by nurses 1–2 times per month for 6 months. In every visit, blood pressure is measured, and the results are then observed. Meanwhile, lifestyle changes are discussed, and participants are advised regarding healthy lifestyles along with the blood pressure target (Garcia et al,2001).

The government of Erzincan, Turkey, uses an intervention strategy in which nurses provide education related to healthy lifestyles (dietary allowance, eating pattern, low salt food, stress management, weight control, physical activity, risks of alcohol, and smoking habit) every month for 6 months (Hacihasanoglu and Gozum,2011). Meanwhile, the Pakistan government applies an intervention strategy in which health professionals provide education (dietary allowance

based on DASH, physical activity, weight control, and no smoking habit) to the patients. The program can be carried out at home attended by all family members. The first visit is performed for 90 min, and the next visits are done once every 3 months for 24 months (Jafar et al,2009).

However, based on all regulated programs, unsatisfactory results were obtained because adults are resistant to change unhealthy lifestyle habits which have started in adolescence (Fang et al,2016; Tang et al,2013; Steptoe and McMunn,2009; Mellen et al,2008; Fang et al,2010).

Hypertension Prevention in Adolescents

To prevent hypertension in children and adolescents (categorized as primary or pre-primary prevention), seven programs have been regulated in many countries: the School-EduSalt trial to reduce salt consumption, efforts to stop smoking habit in the form of An informal school-based peer-led intervention for smoking prevention in adolescence (ASSIST) and Repeated implementation intention formation on adolescent smoking initiation (RIIF), efforts to maintain eating pattern, and efforts to improve physical activities (Singhal et al,2010; Wilson and Ampey,2001; He et al,2013; Ma et al,2019; Campbell et al,2008; Conner et al,2019; Thompson et al,2013; Fardy et al,1996).

School-EduSalt is a program regulated in many schools in China to reduce salt intake by using an intervention strategy: education related to low salt consumption is given to children in schools in the forms of presentations, assignments, home works, role plays, and quizzes which can stimulate the students to join the program. The program is carried out every 2 weeks for one semester (4.5 months) and involves parents, friends, and teachers to provide and maintain the program. Adolescents can gain awareness regarding not consuming food with high salt levels, which is a common family behavior (He et al,2013; Ma et al,2019).

ASSIST is a school-based program applied in the United Kingdom and Wales that uses an intervention strategy to prevent smoking habit. The program involves recruiting students (motivators) who have the same age as the participants (controllers) to prevent smoking habit and giving the students treatment in a 2-day training outside the schools. The treatment aims to deliver detailed information related to harmful effects of smoking and programs to stop the smoking habit. The motivators as well as the students are given the intervention for 10 weeks through daily activities and the results are recorded in monitoring books. The trainers of the motivators visit once every few weeks to monitor. Rewards and charters are used as stimulants for the motivators to join the program (Campbell et al,2008).

Furthermore, Leeds and Staffordshire, in the United Kingdom, employ the following intervention program: in the RIIF program, teachers give 50 min educational presentations in class every 6 months. The students are given materials, motivations, and intentional implementation such as anti-smoking messages, ways to avoid offers to smoking, anti-smoking captions in the forms of words and pictures, and homework assignments (Conner et al,2019).

Singhal et al. (2010) introduced a program to maintain eating patterns in schools in India using an intervention strategy. In the first 6 weeks, the program is introduced to the students. Then, over the next 18 weeks, 30-min educational sessions concerning dietary allowance are given once a week, with education related to food distribution, sources, and benefits for health (carbohydrate, calories, fibers in vegetables and fruits, fats, proteins, and nuts); effects of fried food and junk food; and information regarding healthy cooking and diseases in accordance with lifestyles. The students can actively participate in physical school activities for 30 min 5 days per week, and education related to physical activity at home is given, including limiting time for watching television, doing house chores (e.g. sweeping), walking short distances, keeping food journals, and conducting question-answer sessions related to physical fitness. Individual consultations regarding lifestyle, eating patterns, and physical activity are carried out for 1 hour per week. School policy is changed to provide healthy food in the canteens, such as not selling carbonated beverages and unhealthy food with high calories. The teachers and parents are involved in the program. Consultations about dietary allowance and communication with the parents are conducted for 5–7 min per month to confirm lifestyle, dietary allowance, and physical activity in adolescents. The program also aims to train adolescents as volunteers to give information to their friends related to health to sustain the program.

Thompson et al. (2013) presented a church-based program to improve physical activity in North Carolina, United States, employing an intervention program that uses a spiritual/religious approach. A 60-min interactive educational session, divided into 30-min two sessions, includes theology studies concerning healthy lifestyle and attitude toward healthy behaviors. Within the

session, healthy appetizers and pure water are served. Every week during the 12-week program, aerobic exercises with music are performed based on the sociocultural aspects of the society.

The Physical Activity and Teenage Health (PATH) is a program that employs an intervention strategy to improve physical fitness in adolescents in New York. Health promotion activities are given for 30 min 5 times every week for 11 weeks. In each session, the adolescents perform resistance and aerobic exercises for 20–25 min, and teachers provide 5-min discussions related to healthy lifestyle habits, physical activity, dietary allowance, non-smoking habits, stress management, heart attack, cancer, and motivations. Every adolescent is given an assignment and description related to physical activities and physical fitness for adolescence (Fardy et al,1996).

Limitations: This paper is not a meta-analysis. Prevention strategies of hypertension may vary among countries from different cultural and characteristic conditions.

Conclusion

At present, the definition of hypertension used in adolescents, especially those aged ≥ 13 years, is the same as that in adults so that blood pressure monitoring can be easily performed. Despite the aforementioned programs for preventing hypertension, unsatisfactory results are observed in adults; adults find it difficult to follow the program because it is difficult to change unhealthy lifestyle habits, such as low physical activities, bad food habit, poor sleeping pattern, stress, and smoking habits, which have developed in adolescence. Thus, it is important to start preventing hypertension during adolescence to prevent hypertension in adulthood.

Abbreviations

AAP	American Academy of Pediatrics
ACC	American College of Cardiology
AHA	American Heart Association
ASSIST	An informal school-based peer-led intervention for smoking prevention in adolescence
CDC	Center for Disease Control and Prevention
DASH	Dietary Approaches to Stop Hypertension
DEW-IT	Diet Exercise and Weight Loss Intervention Trial
HIP	Hypertension Improvement Project
JNC VII	Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure VII
PATH	Physical Activity and Teenage Health
RIIF	Repeated implementation intention formation on adolescent smoking initiation

Declarations

Conflicts of interest: The authors have no conflicts of interest to declare.

Funding: The authors would like to thank the Indonesia Endowment Fund for Education (*Lembaga Pengelola Dana Pendidikan*) for supporting this study.

Ethics approval and consent to participate: Not applicable

Studies involving animals must include a statement on ethics approval: Not applicable

Consent for publication: Not applicable.

Availability of data and materials: Not applicable.

Acknowledgements: Not applicable.

Authors' Contributions

All authors participated in the drafting of the manuscript.

All authors read and approved the final manuscript.

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Table 1. Blood Pressure Classification According to the JNC VII

Blood Pressure Classification	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Normal	<120	<80
Prehypertension	120–139	80–89
Hypertension stage I	140–159	90–99
Hypertension stage II	≥160	≥100

Source: Whelton et al,2018

Table 2. Blood Pressure Classification According to ACC 2017

Blood Pressure Classification	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Normal	<120	<80
Elevated	120–129	<80
Hypertension stage I	130–139	80–89
Hypertension stage II	≥140	≥90

Source: Whelton et al,2018

Table 3. Blood Pressure Classification According to the Fourth Report

Blood Pressure Classification	
Normal	Systolic and diastolic blood pressures are lower than the 90 th percentile
Prehypertension	Systolic and diastolic blood pressures are higher or equivalent to the 90 th percentile but lower than the 95 th percentile
Hypertension	Systolic and diastolic blood pressures are higher or equivalent to the 95 th percentile
Hypertension stage I	Systolic and diastolic blood pressures are between the 95 th and 99 th percentiles plus 5 mmHg
Hypertension stage II	Systolic and diastolic blood pressures are higher than the 99 th percentile plus 5 mmHg

Source: Flynn et al,2017

Table 4. Blood Pressure Classification According to the AAP 2017

Classification	Age 1 to <13 Years	Age ≥13 years
Normal	<90 th P	<120/80 mmHg
Elevated	90 th –<95 th P or <120/80 mmHg	120/80–129/80 mmHg
Hypertension stage I	≥95 th to <95 th P + 12 mmHg, or 130/80–139/89 mmHg	130/80–139/89 mmHg
Hypertension stage II	≥95 th P+ 12 mmHg, or ≥140/90 mmHg	≥140/90 mmHg

Source: Flynn et al,2017. P, percentile