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(Research Article)

Nutritional status as a risk factor of elevated blood pressure in preschool children

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Abstract

Background: High blood pressure is a risk factor for cardiovascular disease and neurological disease among children and adults. The American Heart Association recommended blood pressure evaluation among children aged more than 3 years for early detection of complications. Nutritional status was considered to have association with elevated blood pressure in children.

Objective: To assess the association between nutritional status and the blood pressure of preschool children in Denpasar, Bali.

Methods: This was a descriptive analytic cross-sectional study. Four hundred and fifty-six children aged 3-6 years who attended Kindergarten 2019 in Denpasar were enrolled by the cluster random sampling design.

Results: From 456 samples obtained ratio between boys and girls was 1,1: 1. Median age of the sample was 5 years (3-5 years old). The majority of nutritional status was well nourished (52.2%) and obesity was found 11.8%. majority children had normotension (64%), and followed by pre-hypertension (25.4%), hypertension stage 1 (8.6%) and hypertension stage 2 (2%). Bivariate analysis showed that obesity and sex were risk factor for toddler having higher level of blood pressure with. Multivariate analysis showed children with obesity and boys are 2.8- and 1.8-times more likely to have hypertension (CI 95% 1.72-4.81; CI 95% 1.24-2.76, respectively). Low birth weight and prematurity were not found to be significantly related to level of blood pressure.

Conclusion: Children with obesity were found to be significantly related to elevated blood pressure (hypertension).

Keywords: Nutritional status; Risk factor; Preschool; Elevated blood pressure

1. Introduction

High blood pressure contributes for developing diseases and causes 7 million deaths every year in the world [1,2]. High blood pressure in children/younger age is thought to be one of major risk factor for heart disease and stroke in adults. Some evidence suggested that essential hypertension in adults is a continuation from childhood period. The American Heart Association recommends that children > 3 years old must have routine blood pressure evaluation [1]. Hypertension is defined as systolic or diastolic blood pressure more than 95th percentile based on age, sex and height and the measurement should be carried out at least 3 times at different evaluation. The etiology of hypertension can be divided into primary (essential) and secondary to other diseases, such as kidney disease [2]. The causes of hypertension in early life are commonly related to several factors, familial hypertension, birth weight, dietary factors, and physical activity [3].

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The prevalence of high blood pressure in children has increased in recent years. Reddy et al. reported prevalence of hypertension was 4.4% in children aged 6-15 years. Several studies have found a higher prevalence [1]. The study by Sorof et al. reported that the prevalence of increased blood pressure at the first visit was 19.4%, decreasing to 9.5% at the second visit and 4.5% on the third visit [3]. While studies in Europe reported the prevalence of increased blood pressure at the first visit was 8.8% and decreased at the second visit to 4.2% [4]. The prevalence of hypertension based on AAP was 12.92%, specifically Grade 1 hypertension was 10.88% and Grade 2 hypertension was 2.04% [5]. Chadha et al. reported about 11.7% of school children in Delhi was hypertension, while Anand and Tandon, et al. found hypertension in 0.4% of the children aged 5-17 years old [6].

The prevalence of being overweight in children has sharply increased over the last five decades and, as in adults, being overweight is associated with risk of several cardiovascular disease [7,8]. The prevalence of overweight children aged 2 - 5 years old in US was 13.0%, obesity children was 8.4% and super obesity was 2.1% [9]. This prevalence is similar to Indonesian Ministry of Health Report, that revealed prevalence of obese children in 2018 was 8% [10]. Preschool children (6 – 7 years old) in Iran were found to be overweight and obesity as high as 15.5% and 9.9%, respectively [11]. Marron et al reported children with overweight and obesity at age 4 years old and followed up to 6 years old, the prevalence of overweight increased from 5.7%-16.5% to 8.9%-17.0% and obesity increased from 3.0%-5.4% to 6.1%-10.1%. Prevalence overweight children became obese was 20.6%-29.3% [12].

Children with prehypertension 14% developed hypertension in 2 years later and among adolescents with prehypertension and obesity combined, 68% of boys and 43% of girls had hypertension 2 years later. Compared with normotensive patients, those with prehypertension are more likely experience higher cholesterol levels, obesity or overweight as measured by Body Mass Index (BMI) and diabetes [13].

The risk of children and adolescent who have hypertension and obesity, should get more attention and awareness, since these problems will lead to the development of worse complications, medication problems, school and learning problems. Because of the importance of the study, unconvincing evidence, and lack of the data of mental disorder in this susceptible population in Indonesia, especially in Bali, this study was conducted in order to characterize the nutritional status and blood pressure of preschool children and the relationship between nutritional status and blood pressure of preschool children.

The results of this study will give valuable contributions to the field of children with obesity, hypertension and its related area. The more comprehension in this specific area will improve the service quality, construct comprehensive and holistic treatment, and develop suitable intervention technique to overcome and prevent the cardiovascular disorder in the future.

2. Methods

This study was an analytic cross sectional observational design. The study was conducted during period August 2019-December 2019. Data were collected at kindergarten in the Denpasar City, Bali by interviewing parents using questionnaire and direct examination of blood pressure checks and anthropometric examination. Selection of early childhood education was done by cluster random sampling, namely random sampling of all PAUDs in the city of Denpasar which were made strata. The number of kindergartens in this study is 21, 6 Denpasar Utara, 5 Denpasar Barat, 5 Denpasar Timur and 5 Denpasar Selatan. All children who attend school and enroll in selected kindergarten will be the research sample. The target population was preschool children aged 3-5 years. The accessible population was preschool children aged 3-5 years who attended kindergarten in Denpasar during the study period. The sample population is a population that meets the inclusion and exclusion criteria. The inclusion criteria are children age 3-5 years old and attending PAUD in Denpasar in 2019. Subjects will be excluded if the questionnaire data is incomplete and parents refused to participate and refused to sign the informed consent.

The definition of operational variables was as follows; age is the chronological age at the time of the sample. Age is calculated based on the date, month, and year of birth, and is expressed in full in units of years. Gender is determined based on phenotypic appearance. Birth weight is determined based on the weight measured at birth. Gestational age is determined the first day of the last menstruation or measured by ultrasonography (USG) data. Nutritional status is determined based on Body Weight (BW) according to body height (BH) (BW / BH). Determination of nutritional status using Water low classification with the determination of obesity used measurements with Body Mass Index (BMI) according to age (BMI for Age), in this study categorized as obese and non-obese. Measurement of blood pressure using an aneroid sphygmomanometer with a child cuff. The cuff was placed 2 fingers above the cubital fossa. Subsequently, blood pressure was be plotted into the blood pressure percentile. Blood pressure percentiles were defined based on a blood pressure table according to the height percentile by age using criteria based on the American Academy of

Pediatrics (AAP), which is divided into normotension (<90th percentile), increased blood pressure / pre-hypertension (90-95 percentile), hypertension grade 1 (95th percentile to <95th percentile + 12mmHg), and hypertension grade 2 (> 95th percentile + 12mmHg), which in this study were divided into 2 groups, namely normotension and hypertension [5].

The sample size was determined by the sample size formula for unpaired categorical analytical research, with a value of alpha value 5% and power was 80%. Therefore, the required sample size was 336 samples. The collected data were analyzed using SPSS 22.0 software to describe the characteristics of the subject and the variables studied. Categorical variables are presented in terms of numbers and percentages. Numeric variables are presented in the form of mean and standard deviation if the data are normally distributed, or as medians and ranges if the data are not normally distributed. Processed data are presented in table and narrative form. Bivariate data analysis to determine the association between obesity and hypertension of preschool children using the Chi-square test. Multivariate analysis with logistic regression was performed to assess association between nutritional status and hypertension after considering other confounding variables. An assessment and statement of the ethical suitability of this study was provided by the Research Ethics Commission of the Faculty of Medicine, Udayana University, Sanglah Hospital Denpasar (1220 / UN14.2.2VII.14 / LT / 2020).

3. Results

During the August to December 2019, 456 children met the exclusion and inclusion criteria. The ratio between men and women is almost the same, namely 1.1: 1. The median age was 5 years (3-6 years), the child's weight was 18 kg (12.4 - 47 kg), the child's height was 109 cm (80 - 133 cm) and the upper arm circumference was 16.5 cm (10.5 - 32 cm). Most of the nutritional status of children in this study had good nutrition was 52.2%, but the proportion of obesity in this study was also high 11.8%. The median Body Mass Index (BMI) was found to be 15.3 kg / m2 (10.6 - 32.1 kg / m2).

Table 1 Demography characteristic of subject

Variable	n = 456	%
Gender		
Boys	217	47.6
Girls	239	52.4
Anthropometric Status		
Well nourished	238	52.2
Undernourished	99	21.7
Overweight	65	14.3
Obesity	54	11.8
Blood pressure level		
Normotensive	292	64
Pre-hypertension	116	25.4
Hypertension stage I	39	8.6
Hypertension stage II	9	2
Birth body weight		
BBW ≥ 2500gram	429	94.1
BBW < 2500gram	27	5.9
Gestational age		
GA ≥ 37 weeks	357	78.3
GA ≤ 37 weeks	99	21.7

Other characteristics such as the proportion of hypertension in this study were quite high, namely, prehypertension was 25.4%, first-degree hypertension was 8.6% and grade II hypertension was 2%. Data on child characteristics are presented in Tables 1 and 2. In this study, 261 subjects (68.5%) were found to be non-obese subjects (68.5%) and 120 subjects (31.5%) with hypertension, while 31.5% of obese subjects with normotension were found. subjects (41.3%) and hypertension 44 subjects (58.7%). Several risk factors that can cause hypertension in children aged 3-6 years are gender, body mass index, birth weight and gestational age. These factors were tested for bivariate analysis and showed the results that sex and body mass index were significantly related to the incidence of hypertension with PR values of 0.5 (0.342-0.743) and 3.075 (1.85-5.11) which are presented in the Table 3. These two factors were then tested for multivariate analysis, after adjusting for other significant variables. The PR value was obtained for gender 1.85 (1.249-2.760) and on the body mass index 2.877 (1.720-4.811) can be seen in Table 4.

Table 2 Demography characteristics

Variable	**n = 456**
Age (year), median (IQR)	5 (1)
Birth body weight (gr), median (IQR)	3160 (700)
Blood pressure	
Systolic (mmHg), median (IQR)	90 (10)
Diastolic (mmHg), median (IQR)	60 (10)
Anthropometric status	
Body Height (cm), median (IQR)	109 (8)
Body weight (kg), median (IQR)	18 (4,8)
Mid arm circumference (cm), median (IQR)	16.5 (3)
Water low (%), median (IQR)	98.5 (20)
BMI (kg/m2), median (IQR)	15.3 (3.22)

Table 3 Bivariate analysis risk factors with blood pressure

Variable	**PR (CI95%)**	**P value**
Gender	0.5 (0.342-0.743)	0.001*
Body mass index	3.075 (1.85-5.11)	0.001*
Birth body weight	1.047 (0.408-2.342)	0.912
Gestational age	0.962 (0.604-1.532)	0.871

* Significant p value < 0,05 Chi-squared

Table 4 shows the results of the multivariate test which shows that there is a relationship between obesity and hypertension. There is a positive and statistically significant relationship. Obese children have 2.8 times the chance and male sex have 1.8 times the likelihood of developing hypertension. Birth weight and gestational age were not found to be significantly associated with the incidence of hypertension.

Table 4 Multivariate analysis risk factors with blood pressure

Variable	**aPR (CI95%)**	**P value**
Gender	1.85 (1.249-2.760)	0.002*
Body mass index	2.877 (1.720-4.811)	0.001*

* Significant p value < 0,05 Chi-squared

4. Discussion

Hypertension is a major risk factor for heart and blood vessel disease. Although the prevalence of hypertension in children is lower than in adults, there is insufficient evidence to suggest a root of essential hypertension was from asymptomatic hypertension in children. Various studies have reported wide range of prevalence of hypertension in children. The highest prevalence rate was 22% and the lowest was 0.6% [6]. The prevalence of hypertension based on AAP was 12.92%, with details of grade 1 hypertension was 10.88% and grade 2 hypertension was 2.04% [5]. Chadha et al. reported about 11.7% of school children in Delhi was hypertension, while Anand and Tandon, et al. found hypertension in 0.4% of the children aged 5-17 [14]. This study found the proportion of hypertension was 25.4% pre-hypertension, 8.6% children was grade 1 hypertension and 2% children was grade 2 hypertension.

Risk factors associated with the incidence of hypertension such as gender, birth weight, gestational age, obesity, family history of hypertension, physical activity, and diet. One of the risk factors is obesity, which is still the most common nutritional problem among children in developed countries. The management of obesity and its complications have become a concern [15]. The proportion of obesity in this study was 11.8%. this finding was almost the same as the prevalence of obesity reported by Mohan which was 11% [12]. However, it is lower than the prevalence of obesity in Indonesia according to the 2018 RISKESDAS, which was 8% [10].

Early detection of the negative effects that may occur in children with obesity is especially important [15]. In obese children there is an abnormality in the arterial pressure control mechanism which can increase blood pressure, as well as the excretion of sodium and water through pressure natriuresis and diuresis. As long as the excretion of sodium and water still exceeds the intake, there is an increase in renal tubular reabsorption resulting in a decrease in extracellular fluid volume and cardiac output until the blood pressure returns to normal. Conversely, when blood pressure decreases, the kidneys will retain salt and water until the arterial pressure returns to normal. Natriuresis pressure is the key to a feedback system that stabilizes blood pressure and body fluid volume. In addition, several other mechanisms explain the incidence of hypertension in obesity, namely the activation mechanism of the Sympathetic Nervous System (SNS), the Renin-Angiotensin System (RAS), glucocorticoids, fatty tissue, changes in kidney structure, insulin resistance, hyperleptinemia and vascular endothelial dysfunction [8,17].

This study reports several risk factors associated with the incidence of hypertension, such as gender, body mass index, birth weight and gestational age. Gender (PR 0.5 (0.342-0.743); aPR 1.85 (1.249-2.760)) and body mass index (PR 3.075 (1.85-5.11); aPR 2.877 (1.720-4,811)) were associated significantly with elevated blood pressure (hypertension). Obese children experienced hypertension by 58.7%, while obese children with normotension were 41.3%. Obese children with hypertension had a 2.8-fold risk, with a 95% confidence interval between 1.72 and 4.81. A similar case was also reported by a cohort study in Canada on grade 7, 9 and 11 school children from 1999-2005 with the result that the risk of the incidence of hypertension increased 2 times in children with excess nutrition (OR 2.63; 95% CI 1.75-3. , 92) [14,15,16]. Likewise studies conducted by the United States National Health Survey Data, namely the risk of hypertension incidence doubled in obese patients [19]. However, this is contrary to the study conducted by Bogalusa, this study reports systolic and diastolic blood pressures did not increase, although there was an increase in obesity prevalence from 6% to 17% during the study period from 1974-1993 [14].

The prevalence of hypertension in men is more frequent than in women. The United States reported a difference in prevalence rates of 4%, Canada was 8% and Western Europe was 11%. This is said to be related to steroid hormones which have an important role in blood pressure levels. In boys the hormone testosterone is said to have a permissive effect, whereas estrogen in women has a protective effect [20,21]. A Canadian study reported increased blood pressure in boys at grade 7 (OR 1.29; 95% CI 0) , 77-2.16), level 9 (OR 1.98; 95% CI 1.35-2.93), and level 11 (OR 2.74; 95% CI 1.52-4.94) .13 This is in accordance with the study, namely the male gender experiencing hypertension increased 1.8 times.

The weakness of this study is that it does not include other risk factors that can cause hypertension, such as family history of hypertension, physical activity and children's diet. In addition, the measurement of blood pressure in the subject was carried out only once. Therefore, it is possible that these factors also have a relationship with the incidence of hypertension, it is necessary to carry out further research.

5. Conclusion

This study can prove that obese children have a risk of developing hypertension 2.8 times compared to children who are not obese. From the results of this study, it can be concluded that anthropometric status can be used as a predictor of the risk of hypertension.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interests. The author reports no conflicts of interest in this work. By this statement, all authors who consist of Ni Putu Indah Kusumadewi Riandra, Gusti Ayu Putu Nilawati, and Ketut Suarta have no conflict of interest regarding this manuscript publication.

Statement of informed consent

Informed consent was obtained from the patient whose data mentioned in the study.

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