Child Blood Pressure Profile in Bali, Indonesia

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Abstract

BACKGROUND: Mortality and morbidity in an adult will be reduced by controlling hypertension from an early age. Uncontrolled blood pressure since children can contribute to diseases such as heart disease, organ damage, and decreased quality of life. As changes in lifestyle, it is estimated that hypertension in children will continue to increase. Until now, data regarding the profile of blood pressure in children in Indonesia is still lacking.

AIM: The purpose of this study was to determine the prevalence of increased blood pressure and hypertension in children in Bali.

METHODS: This study was a cross-sectional study. The sampling technique in this study was multistage random sampling, that is, from 9 regencies in Bali, the selection of 3 regencies to be sampled according to socio-economic stratification based on regional economic growth and regional per capita income in Bali Province.

RESULTS: From 1257 samples examined the prevalence of increased blood pressure, and hypertension was 689 children (54.8%). From the age group, the prevalence of an increase in blood pressure and hypertension in the age group ≤12 years was 47.3%, and in the age group >12 years was 62.2%. Increased blood pressure in nutritional status including Obesity 51.4%, Nutrition More 52.9%, Good Nutrition 42.2%, Nutrition Less 43.9%, Malnutrition 50.0%. In families with a history of hypertension, the prevalence of increased blood pressure and hypertension in subjects was 60.3% and in families without a history of hypertension was 43.4%.

CONCLUSION: It can be concluded that there is still a prevalence of hypertension in children in Bali. Health efforts are needed so that they can minimise the further health impact that might occur. It should also be noted that various factors can influence the prevalence of increased blood pressure and hypertension in children.

Introduction

Hypertension still becomes the world’s concern as this disease could occur at such a young age with its continuous risks until adult and contribute to heart disease, organs damage, and decreased quality of life [1, 2]. Early management of hypertension could decrease mortality and morbidity related to this disease. Its percentage in children varies one another. A study by Meng L et al. showed the increased blood pressure percentage in children aged 3 – 18 years as 3.1% [3]. Also reported that between 2011 to 2014, the prevalence of children hypertension aged 8 – 17 years old was 2.2% [2]. A study by Gupta et al. found the aetiology of hypertension itself, of which 423 children aged >5 years who had hypertension were 275 children (65%) with essential hypertension of 43% and secondary by 57%. It was also found that the most age experienced hypertension ranged from 13 to 19 years old [4].

Blood pressure measurement in children is more complicated than the adults, because of children, blood pressure values need to be seen according to each normal percentile based on their age, sex, and height. Also, children are harder to cooperate in the measurements, often because they were scared to the examiner; therefore, it could bias the results [5, 6].

Heretofore, there is still a little of profile data of children blood pressure in Indonesia. Moreover, there were only some studies related to children blood pressure as the lack of concern since the difficulty of the measurement and probably also due to small prevalence that could be such a lack in its urgency.
Therefore, the primary objective of this study was to find out the hypertension prevalence of children in Bali. Secondary, it aims to prove the relation of some factors such as age, nutrition status and family history to children blood pressure in Bali. The obtained profile data is expected, contributing to the improvement of screening and prevention management, which can earlier be done in hypertension of children.

Material and Methods

It was a descriptive, cross-sectional study using a questionnaire and direct examination of the samples. All of the children from elementary and junior high school in Bali Province were included in this study. The inclusion criteria included children aged 6 to 18 years when examination conducted, willing to participate in this study, students, of elementary or junior high school in Bali Province, and live with both biological parents. The exclusion criteria included children with corticosteroid history of > 2 weeks or other drugs impacted blood pressure, children were absent when examination conducted, and research questionnaires were not filled.

The sampling technique is using multistage random sampling, which is from 9 regencies/municipalities in Bali, it was chosen 3 regencies/municipalities to become sampling sites according to socio-economic stratification based on regional economic growth and regional per capita income. In each stratification area in Bali Province, 1 regency/municipality was taken using the stratified random sampling method, 9 districts/municipalities were designated as sampling locations using cluster sampling method, distribution of 9 sub-districts was carried out proportionally based on proportions the number of elementary and junior high school students in each selected district/municipality. Then, from 9 selected sub-districts, 18 elementary or junior high schools are designated as sampling locations using the cluster sampling method. Determination of students/children selected as samples in each primary school is done by simple random sampling method.

Blood pressure was determined using a sphygmomanometer to get designated samples' blood pressure. The measurement was conducted according to Flynn TJ et al., algorithm both in procedure and hypertension determination [6], i.e.: (1) percentile < 90: normotension; (2) percentile ≥ 90 to < 95 or 120/80 mmHg to percentile < 95: prehypertension; (3) percentile ≥ 95: hypertension, as a nominal measurement scale. Age was defined as chronological age at the time the sample examined. Samples were chosen at the age group of 28 days to 18 years, as a numeric measurement scale. The familial factor was a factor of father or mother who has prior hypertension history. The familial factor was determined by interview and direct examination to the parents; then the results would be categorised into the group “yes” or “no”, as a nominal measurement scale. Exclusive breastfeeding was defined as giving only breast milk to the babies without infant formula, or other food and drink for 6 months, the results were obtained from the interview to parent and would be categorised into the group “yes” or “no”, as a nominal measurement scale.

Nutrition status was determined according anthropometry status, i.e. body weight (BW) to length or height (L/H). Samples aged ≤ 5 years used Z-Score BW/H based on WHO Anthro Chart with interpretation: (1) Z-score BW/H > 3 SD: obese; (2) Z-score BW/H > 2 SD: overweight; (3) Z-score BW/H > 1 SD: potential risk of overweight; (4) Z-score BW/H < -2 SD: wasted; (5) Z-score BW/H < -3 SD: severely wasted. While patients aged > 5 years, it used BW/H based on The Centers for Disease Control and Prevention (CDC) 2000 and then classified to Waterlow criteria (BW/ideal body weight) as following: (1) Obesity: > 120%; (2) More nutrition: > 110 – 120%; (3) Good nutrition: 90 – 110%; (4) Less nutrition: 70% to 90%; (5) Malnutrition: < 70%, as a nominal measurement scale.

The diagnosis was established through anamnesis, physical examination, work up, and a decision made by the physician. The diagnosis of essential hypertension was established if: (1) increased blood pressure ≥ 95 in 3 times measurements; (2) no other causes leading to secondary hypertension; and (3) no influence of drugs that potentially increase blood pressure. While secondary hypertension evaluated by a physician.

Calculation of the estimated sample size required, using the sample size formula [7] by setting the significance level at 1.96, mean of standard deviation in the previous references was 25.3% [8], as well as the degree of precision was set at 2.5%, the number of samples from each group needed was 1161 children.

The obtained then collected and processed into software, to be analysed using the program. Descriptive analysis to determine the prevalence of hypertension in children, childhood obesity, and parental history of hypertension. Bivariate test (chi-square test) and calculation of prevalence ratio (PR) used to assess the relationship between hypertension and related factors. All parents/guardians who will be included in this study have obtained and approved oral and written explanation regarding the purpose and procedure of the study. This research has received approval from the Ethics Committee of Medicine Faculty of Udayana University-Sanglah Denpasar Hospital.
Results

This study has been running for 6 months, and the sample was 1257 children from 1161 planned samples. Stratified random sampling used had resulted in three selected districts, namely: Denpasar, Karangasem and Singaraja. In those cities, the selection of elementary and junior high schools was obtained based on cluster sampling 1 and 2 with the distribution of the number of students whose number of students was quite balanced from the entire study sample. This study included an exclusive breastfeeding history and a parental history of hypertension. All canteens studied in the school were categorised as "Red" category (not in the table), which meant that almost all food sold in the canteen in this school is unhealthy or has given no effect on the health of the subject. Certain foods became the risk factors for the incidence of hypertension in children.

Table 1 showed the distribution of sample characteristics. The sex proportion in this research was not much different. In the age category, the age of children included this study was at balanced composition for ages ≤ 12 years and ages > 12 years. The highest proportion of students used as research subjects was 7th-grade students, in the amount of 22.9% while the lowest was 3rd-grade students, which 4.7%. While students from Bali are 96.8% of all students studied.

| No | Characteristic | Frequency | Percentage |
|----|----------------|-----------|------------|
| 1  | Sex            |           |            |
|    | Male           | 633       | 50.4%      |
|    | Female         | 624       | 49.6%      |
| 2  | Age            |           |            |
|    | Median (IQR), years     | 12.03 (3.40) |   |
|    | Minimum-Maximum | 5.80 – 17.37 |   |
|    | Age category    |           |            |
|    | ≤ 12 years old  | 620       | 49.3%      |
|    | > 12 years old  | 637       | 50.7%      |
| 3  | Grade of school |           |            |
|    | 1              | 71        | 5.6%       |
|    | 2              | 79        | 6.2%       |
|    | 3              | 59        | 4.7%       |
|    | 4              | 138       | 11.0%      |
|    | 5              | 123       | 9.8%       |
|    | 6              | 131       | 10.4%      |
|    | 7              | 288       | 22.9%      |
|    | 8              | 133       | 10.6%      |
|    | 9              | 236       | 18.8%      |
| 4  | Level          |           |            |
|    | Elementary     | 600       | 47.7%      |
|    | Junior High School | 657      | 52.3%      |
| 5  | District of School |         |            |
|    | Denpasar       | 418       | 33.3%      |
|    | Singaraja      | 440       | 35.0%      |
|    | Karangasem     | 399       | 31.7%      |
| 6  | Origin         |           |            |
|    | 1217           | 96.8%      |
|    | Outside Bali   | 40        | 3.2%       |
|    | Total          | 1257      | 100%       |

Table 2 is a distribution of subject based on their clinical conditions. The median of waist circumference obtained was 65 cm. Nutritional status of good nutrition was 38.8%, more nutrition was 12.6%, and obesity was 30.2%. Samples who experienced hypertension grade 1 were 22.2%, and grade 2 was 14.1% while samples who began to experience increased blood pressure were elevated in the amount of 18.5%.

| No | Clinical condition (n = 1257) | Median (IQR) | Min-Max |
|----|-------------------------------|--------------|---------|
| 1  | Weight (kg)                   | 40.0 (21.0)  | 15.0 – 105.0 |
| 2  | Height (cm)                   | 140.0 (21.5) | 104.0 – 245.0 |
| 3  | Waist circumference (cm)      | 65.0 (17.0)  | 40.0 – 118.0 |
| 4  | Body mass index (kg/m2)       | 18.6 (6.3)   | 10.5 – 36.8 |
| 5  | Systole (mmHg)                | 120.0 (15.0) | 70.0 – 180.0 |
| 6  | Diastole (mmHg)               | 70.0 (10.0)  | 40.0 – 130.0 |
| 7  | Nutritional status            | Frequency    | Percentage |
|    | Obesity                      | 379          | 30.2%      |
|    | More nutrition               | 159          | 12.6%      |
|    | Good nutrition               | 488          | 38.8%      |
|    | Less nutrition               | 221          | 17.6%      |
|    | Malnutrition                 | 10           | 0.8%       |
| 8  | Blood pressure                | Normal       | 568        | 45.2% |
|    | Elevated                     | 233          | 18.5%      |
|    | Hypertension grade 1         | 279          | 22.2%      |
|    | Hypertension grade 2         | 177          | 14.1%      |
| 9  | Exclusive breastfeeding (n = 528) | Yes        | 379        | 71.8% |
|    | No                           | 149          | 28.2%      |
| 10 | Parental history of hypertension (n = 528) | Yes     | 46         | 8.7%  |
|    | No                           | 482          | 91.3%      |
| 11 | Hospitalization history (n = 528) | Yes    | 60         | 11.4% |
|    | No                           | 468          | 88.6%      |

Historical data of exclusive breastfeeding, parental history of hypertension and hospitalisation history were not obtained 100% of the data because most parents did not remember.

| No | Characteristic | Normal | Elevated | Hypertension 1 | Hypertension 2 | Total |
|----|----------------|--------|----------|----------------|---------------|-------|
| 1  | Sex            | Male   | 290 (44.2%) | 111 (17.5%) | 140 (22.1%) | 402 (16.1%) | 633 (100%) |
|    | Female         | 288 (46.0%) | 119 (19.9%) | 139 (22.3%) | 75 (12.2%) | 442 (100%) |
| 2  | Age            | Female | 568 (45.2%) | 233 (18.5%) | 279 (22.2%) | 177 (14.1%) | 1257 (100%) |
|    | Male           | 528 (47.8%) | 233 (20.5%) | 239 (20.0%) | 131 (11.4%) | 832 (100%) |
|    | Median (IQR)   | 11.41 (3.43) | 13.61 (3.37) | 12.17 (2.58) | 11.37 (2.95) | 12.03 (3.40) |
|    | Mean Rank      | 560.45 | 847.01  | 661.19   | 527.03       |     |
| 3  | Level          | Female | 327 (52.7%) | 57 (9.2%) | 127 (20.5%) | 109 (17.6%) | 620 (100%) |
|    | Male           | 241 (37.8%) | 76 (12.3%) | 152 (23.9%) | 68 (10.7%) | 637 (100%) |
| 4  | School         | Female | 322 (53.7%) | 56 (9.2%) | 119 (19.9%) | 104 (16.7%) | 600 (100%) |
|    | Male           | 246 (37.4%) | 78 (12.7%) | 160 (24.6%) | 73 (11.1%) | 657 (100%) |
| 5  | Origin         | Female | 275 (65.6%) | 74 (17.7%) | 60 (14.4%) | 9 (2.3%) | 418 (100%) |
|    | Male           | 106 (24.5%) | 49 (11.1%) | 145 (33.5%) | 108 (25.1%) | 440 (100%) |
| 6  | Nutritional status | Female | 185 (46.4%) | 110 (27.6%) | 74 (18.5%) | 30 (7.5%) | 399 (100%) |
|    | Male           | 149 (30.9%) | 79 (16.1%) | 105 (21.7%) | 19 (3.9%) | 358 (100%) |
| 7  | Exclusive breastfeeding | Female | 177 (34.4%) | 76 (14.5%) | 121 (24.3%) | 71 (14.0%) | 346 (100%) |
|    | Male           | 59 (12.1%) | 27 (5.8%) | 48 (9.9%) | 5 (1.0%) | 120 (100%) |
| 8  | Parental history of hypertension | Female | 149 (28.3%) | 60 (11.5%) | 88 (17.2%) | 23 (4.5%) | 328 (100%) |
|    | Male           | 115 (23.9%) | 33 (6.6%) | 87 (17.6%) | 19 (3.9%) | 254 (100%) |

Table 2: Distribution of blood pressure based on sample characteristic

Table 3: Distribution of blood pressure based on sample characteristic
The distribution of blood pressure based on sample characteristics can be seen in Table 4. Differences in the composition of subjects experiencing hypertension were found in the subject's composition in blood pressure with hypertension grade 2, which was 16.1% in male compared to 12% in female.

Table 4: Data Distribution of Sistole and Diastole based on age and sex

| Percentile | Sistole (Mean ± SD) | Diastole (Mean ± SD) |
|------------|---------------------|----------------------|
|            | Male                | Female               |
| <6         | 116.6 ± 12.9        | 117.6 ± 14.0        |
| 6-8        | 118.7 ± 15.1        | 119.4 ± 16.7        |
| 8-10       | 115.2 ± 11.5        | 117.3 ± 11.8        |
| 10-12      | 117.7 ± 15.2        | 119.7 ± 14.4        |
| 12-14      | 113.6 ± 17.8        | 114.9 ± 13.2        |
| 14-16      | 113.9 ± 12.0        | 120.4 ± 12.0        |

The subject's distribution with hypertension grade 1 was the largest distribution (28.4%) of children who experienced increased blood pressure. Whereas the highest region experiencing increased blood pressure was Singaraja (75.5%). In obese children, 57% of children experienced increased blood pressure and 17.4% with grade 2 hypertension. While in children with more nutrition, 68.6% experienced increased blood pressure, with 10.1% with grade 2 hypertension.

Discussion

In this study, the prevalence of hypertension was 36.3%, in which hypertension grade 1 was 22.2%, and grade 2 was 14.1%. This prevalence resembled results obtained by Fuiano et al., [9] in 2006 in Foggia-Italy, which found 35.1% of boys and 40.2% in girls aged 3 to 16 years. This result was higher than the prevalence of 24.2% in children aged 7 to 11 years obtained by Mohkam et al., [10] in 2011 in Tehran-Iran, and also the prevalence of 20.6% in children aged 8 to 13 years obtained by Urrutia-Rojas, et al., [11] in Fort Worth Texas-USA in 2006. This prevalence was also higher than study in Khartoum- Sudan in 2010 by Salman, et al., [12] which found of 4.9% in children aged 6 to 12 years, prevalence in Sabinas Hidalgo-Mexico in 2009 by Aregullin-Eligio and Alcorta-Garza [13] of 4.9% in children aged 6 to 12 years, and prevalence of 13.8% in children aged 5 to 17 years by Moore, et al., [14] in Oklahoma-USA in 2009.

The differences in the prevalence of hypertension from various studies could be caused by several factors including the differences in the
definition of hypertension in each country, the difference of race or ethnicity, culture, lifestyle, type of food, the prevalence of obesity, and genetic factors of each. Other factors that affect the prevalence of hypertension were the differences in study design, methods of examination of blood pressure, age range, and the number of samples [15].

The prevalence of hypertension in this study was high, reaching 36.3%, this result was similar to the prevalence of hypertension in the adult population in Indonesia in 2007 by 31.7% [16] and much higher than expected by Falkner, et al., [17] of 3 to 5% in children. The high prevalence of hypertension in this study was probably caused by the high prevalence of obesity in the population. This study found obesity was 30.2% and including the rural and urban area. This condition probably caused by all the school of the subject have red canteen category, there for the pattern of food habit at school is not healthy and the student stays at school 6-8 hours-per-day. Quality and quantity persuasive education are needed in the future to make correction of food habits on children at school.

Obesity in children continues to be on the rise, with a predicted increase of 40% in the next decade [18]. The National Health and Nutrition Examination Survey data showed that since 1976–1980, obesity has doubled among preschool children 2-5 years of age and tripled among children and adolescents 6-19 years of age [19], [20]. The most recent National Health and Nutrition Examination Survey data from 2007 to 2008 showed 10% of infants and toddlers < 2 years of age had a weight-for-height ≥ 95th percentile, and 17% of children aged 2 – 19 years had a weight-for-height ≥ 95th percentile [21], [22], [23]. In the USA, the prevalence of obesity was 17% from 2011 to 2014 in the pediatric population [24]. In Europe, an estimated prevalence of 20% of children and adolescents are overweight, with one-third of these being considered as obese [25]. Obesity, or increased BMI, can now be considered as a risk factor not just for cardiovascular disease and diabetes, but also for CKD [18], [19], [20], [21], [22], [23], [24], [25], [26]. The increase in CKD in those who are obese is thought to be in part due to increased metabolic demands which, in turn, lead to a compensatory glomerular hyperfiltration injury in the kidney [18], [19], [20], [21], [22], [23], [24], [25], [26], [27]. This is now termed obesity-related glomerulopathy, and it has been speculated that a decrease in the number of functional nephrons might also be implicated in the pathogenesis [27], [28]. Obesity can also lead to RAAS activation along with many other metabolic pathways leading to HTN and the metabolic syndrome [29], [30].

Metabolic syndrome is defined by three metabolic abnormalities such as obesity, elevated BP, low high-density lipoprotein cholesterol, hypertriglyceridemia, and hyperglycemia. 68 The prevalence of metabolic syndrome in adolescents was 4.5% from 1994 to 2004, as reported in the US National Health and Nutrition Survey data. It is estimated from the CKD study that 13% of children with CKD had metabolic syndrome [30], [31]. The strong relationship between metabolic syndrome and CKD has become increasingly identified [32], [33], [34].

The high prevalence of hypertension in primary school children required the attention to prevent in the short- and long-term complications of this disease. This result proved that the government needed to do early detection and intervention for hypertension in children in Bali. Also, the school could work together with the government health centre to perform blood pressure checks routinely for the students and provide education to parents. These results could also be basic data for a general practitioner or paediatrician to perform blood pressure checks routinely in pediatric patients.

This study also found a high prevalence of obesity in primary and junior high school children in Bali; the prevalence was 30.2%. Based on this study result and the results of previous studies, blood pressure checks should be done periodically in children with obesity to detect hypertension. Also, the more important thing was how the government, in this case, the health department, the school, and parents play a role to control obesity in children. Early detection Program of obesity in children, education about obesity and lifestyle risk for a parent, and parent awareness of the dangers of obesity would play a role in efforts to control the disease.

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