Association Between Obesity, Hypertension and Target Organ Damage in Children

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ABSTRACT

Background: The author analysed the association between obesity and hypertension as well as the association between the degree of hypertension and target organ damage.

Methods: 61 children with suspected hypertension were evaluated. Ambulatory blood pressure monitoring was done in all of them. An echocardiogram and ophthalmologic examination were done in all children with confirmed hypertension and high-normal blood pressure and testing for microalbuminuria in most of them. The association between obesity and hypertension and between the degree of hypertension and target organ damage was tested using the chi-squared ($\chi^2$) and exact Fisher (if needed) statistical test.

Results: Nine children with confirmed hypertension (50%), 13 children with high normal blood pressure (61.9%), and 10 children with normal blood pressure (45.5%) were obese. There was no statistically significant association between obesity and hypertension ($p = 0.82$). 66.7% of patients with hypertension and 38.1% of those with high-normal blood pressure had left ventricular hypertrophy ($p = 0.14$). 38.9% of patients with hypertension and 9.5% of those with high-normal blood pressure had hypertensive retinopathy ($p = 0.34$). 43.8% of patients with hypertension but 57.9% of those with high-normal blood pressure had microalbuminuria ($p = 0.69$). There was no statistically significant association between the degree of hypertension and left ventricular hypertrophy, hypertensive retinopathy, or microalbuminuria.

Conclusion: The presented study did not prove a statistically significant association between obesity and hypertension or between the degree of hypertension and target organ damage.

Keywords: Ambulatory blood pressure monitoring, Body mass index, Hypertensive retinopathy, Left ventricular hypertrophy.

1. Introduction

We define hypertension as systolic and/or diastolic blood pressure at or above the 95th percentile, measured on at least three separate occasions. We define high-normal blood pressure (HNB) as average systolic and/or diastolic blood pressure between 90th and 95th percentile as well as blood pressure at least 120/80 mmHg even if below 90th percentile in adolescents. We speak of normal blood pressure in children when systolic and diastolic blood pressure is below the 90th percentile for age, sex, and height [1]. Body mass index (BMI) is commonly used in assessing obesity in children. It is more than 95th percentile in obesity, between 85th and 95th in overweight, and less than 85th percentile in children with normal weight. The objectives of the study were to determine whether there is an association between obesity and hypertension, as often reported, as well as between the degree of hypertension and target organ damage (TOD), presenting with left ventricular hypertrophy (LVH), hypertensive retinopathy and microalbuminuria [1]–[3]. The observations from clinical practice led the author to question these associations.

2. Material and Methods

61 consecutive children and adolescents, aged 7–18 years, referred to our institution due to suspected hypertension, were included in the retrospective study. There were 47 boys and 14 girls among them. Ambulatory blood pressure monitoring (ABPM) was done in all of them. Only patients with essential hypertension were included...
in the study. Cases of secondary hypertension (renovascular hypertension, for example) were therefore excluded by investigations done routinely in the evaluation process of children with hypertension (ultrasound of the abdomen with Doppler of renal arteries, tests for renal function (electrolytes, urea, creatinine in blood, urine analysis), catecholamines in serum and thyroid hormones and other studies, when appropriate). An echocardiogram and ophthalmologic examination, among other investigations, were done in all children with confirmed hypertension and HNBP while testing for microalbuminuria was done in most of them. The association between BMI and hypertension and also between the degree of hypertension and target organ damage was tested using the chi-squared ($\chi^2$) and exact Fisher (when appropriate) statistical test. The calculations were done using the computer program R (R version 3.0.1).

### 3. Results

Normal blood pressure was detected in 22 children (36.1%), HNBP in 21 (34.4%) of them, and hypertension in 18 children (29.5%). Nine children with confirmed hypertension (50%), 13 children with HNBP (61.9%), and 10 children with normal blood pressure (45.5%) had obesity. Table I presents these results in more detail. Since the proportion of cells in the table with less than five units was 33%, the assumption for $\chi^2$ was not fulfilled and the Fisher exact test was necessary. No statistically significant association between BMI and hypertension was confirmed ($p = 0.8233$). Table II presents results when overweight children and those with normal BMI were combined in one category and compared with obese children. In this case, the proportion of cells in the table with less than five units was 0%, therefore Fisher exact test was not necessary and the assumption for $\chi^2$ was fulfilled. Likewise, no statistically significant association between obesity and blood pressure level was confirmed ($p = 0.5413$).

12 among 18 children with confirmed hypertension (66.7%) and 8 among 21 children with HNBP (38.1%) had LVH. We detected no statistically significant association between the degree of hypertension and LVH ($p = 0.14$). Table III presents these results. Evidence of hypertensive retinopathy was detected in seven children with hypertension (38.9%) and in two of those with HNBP (9.5%). Microalbuminuria was detected in 7 out of 16 patients with hypertension (43.8%) and in 11 out of 19 patients with HNBP (57.9%). We did not find a statistically significant association between the degree of hypertension and hypertensive retinopathy ($p = 0.34$) or microalbuminuria ($p = 0.69$). Table II: Association between Obesity and Blood Pressure Level

<table>
<thead>
<tr>
<th>Blood Pressure Level</th>
<th>Overweight and normal weight</th>
<th>Obese children</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal blood pressure</td>
<td>12</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>High-normal blood pressure</td>
<td>8</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>Hypertension</td>
<td>9</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Sum</td>
<td>29</td>
<td>32</td>
<td>61</td>
</tr>
</tbody>
</table>

Legend: LVH—Left ventricular hypertrophy.

### 4. Discussion

Obesity and hypertension are both common conditions and their causal relation seems to be widely accepted [1]. A study among Canadian children confirmed the association between obesity and elevated blood pressure (both hypertension and HNBP). Overweight was associated with hypertension but not HNBP. In addition, overweight was not associated with hypertension among girls [2]. In that study hypertension and HNBP were defined according to the average of three blood pressure recordings on a single occasion. However, the European Society of Hypertension (ESH) recommendations suggest that hypertension should be confirmed by several office blood pressure recordings at different time points. In addition, blood pressure recordings in a home environment may improve the management of these patients [1]. In the present study, ABPM was done in all patients, thus excluding patients with white coat hypertension who constitute a significant proportion of children evaluated for suspected hypertension. A published study in children revealed an association between obesity and elevated blood pressure but blood pressure was measured only once, after five minutes of rest [3]. However, this is not in concordance with the above-mentioned ESH recommendations [1]. Another study in adults showed that higher visceral adipose tissue (especially retroperitoneal fat) is the only fat parameter independently associated with developing hypertension. Visceral adipose tissue is therefore considered more important in the relationship between obesity and hypertension than total adiposity [4]. BMI may therefore not be the most accurate measure of obesity, but it is simple to calculate, practical to use in everyday clinical practice, and therefore widely accepted at this moment.

The present analysis did not show a statistically significant correlation between BMI category/obesity and...
blood pressure level. Therefore, endothelial dysfunction and intrinsic properties of the vessel wall, which regulate peripheral vascular resistance which in turn influences blood pressure, may be more crucial in the etiology of hypertension. On the other hand, other factors may be involved indirectly in the association between obesity and blood pressure, such as salt consumption. Namely, it is well known that obesity is usually linked not only to an increased amount of ingested food but also to its worse quality, containing a lot of salt, especially in fast and processed food. A recently published article highlighted that overweight children are at increased risk of developing increased blood pressure due to a high salt intake because of their predisposition to be salt-sensitive [5]. A recent study revealed a greater increase in systolic blood pressure for each gram of increased sodium intake among overweight and obese children compared with normal-weight children [6]. These findings indirectly support the hypothesis that obesity per se is not responsible for elevated blood pressure. We should also not neglect that proper cuff size is important in measuring blood pressure because a cuff too small, which may be chosen especially in obese children, gives falsely high values.

In the present study, LVH was detected in 66.7% of children with hypertension and in 38.1% of those with HNBP. Despite this difference, the significant association between the degree of hypertension and LVH was not proven. One of the previous studies revealed an LVH prevalence of 47% in patients with systolic hypertension [7]. Another published study confirmed a significantly higher prevalence of LVH in children with HNBP than in those with normal blood pressure and an equal prevalence of LVH in children with HNBP and in those with hypertension [8]. This is in agreement with the result of this study.

Renal damage due to hypertension manifests as a kidney dysfunction or microalbuminuria, which is considered a sign of a deranged glomerular filtration barrier. It is defined as 2–30 mg albumin/mmol creatinine or 30–300 mg/day in urine and is correlated with worsening of kidney function and increased risk for cardiovascular disease [1]. However, LVH and microalbuminuria often coexist in children with essential hypertension [9].

Vascular atherosclerotic injuries, including the ones in the retina that can be visualized by fundoscopy, may be considered an early sign of hypertension [1]. This is in agreement with this study since not a statistically significant correlation between hypertension degree and hypertensive retinopathy was proven. On the other hand, a published study on children found hypertensive retinopathy in 51% of those with essential hypertension [10]. This is a little higher than in the present study in Slovenian children where 38.9% of patients with hypertension had retinal abnormalities.

According to available literature data, this is the first study analysing the correlation between BMI and blood pressure and the correlation between blood pressure level (hypertension vs. HNBP) and TOD using ABPM in all included patients. Possible limitations of this analysis are the small number of studied subjects and the fact that the sample of patients was a referral and not a general population sample. A larger study evaluating these associations would be beneficial.

5. Conclusion

The present study did not prove a correlation between obesity and hypertension as is commonly thought. Likewise, it did not prove a correlation between hypertension degree and TOD. The latter should be actively looked for in patients with HNBP, in addition to patients with hypertension. Nevertheless, obesity is a significant issue as it carries an increased risk for other diseases, such as diabetes, cardiovascular disease, osteoarthritis, chronic kidney disease, and others. In addition, it is associated with issues in social functioning [11].

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Conflict of Interest

Author declares no conflict of interest.

References