

Comparison of renal function between normal-weight and overweight children

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ABSTRACT

Obesity in children is associated with hypertension, dyslipidemia, cardiovascular disease, diabetes mellitus, colon cancer, and kidney disease. Most of the studies that evaluate the association between obesity and kidney disease have been done in adults. This study was planned to compare renal function between normal-weight and overweight children. In this case-control study, 92 children (45 boys, 47 girls) aged 7-12 years were included in the analysis. 46 children (23 boys, 23 girls) with BMI 85th percentile or greater (mean age, 9.09 years) were compared with 46 controls (22 boys, 24 girls) with BMI 5th-84th percentile (mean age, 8.63 years). Blood and urine sample were taken from case and control groups. Urine albumin/creatinine ratio and urine calcium/creatinine ratio and glomerular filtration rate (GFR) were determined. Children in the overweight and control groups were matched according to age and sex. Glomerular filtration rate, urine calcium/creatinine ratio, urine albumin/creatinine ratio, blood pressure, and serum creatinine were compared between normal-weight and overweight children. Our finding showed no significant difference regarding GFR, albuminuria, calciuria, blood pressure, and serum creatinine between normal-weight and overweight children.

Key words: Children, kidney, overweight

Introduction

Obesity in children is becoming a worldwide epidemic. The National Health and Nutrition Examination Survey (NHANES) IV, 1999-2002, documents that 16% of children are overweight and 31% are at risk for becoming overweight or are already overweight, representing a nearly 300% increase since the 1960s.^[1]

The etiology of childhood obesity is multi-factorial and includes genetic, neuroendocrine, metabolic, psychological, environmental, and socio-cultural factors.

In children, leptin and ghrelin are hormones which have

an influence on energy balance. Leptin is a regulator of long-term energy balance and ghrelin is an appetite stimulatory signal.^[2]

Obesity is associated with many complications such as hypertension, dyslipidemia, cardiovascular disease, diabetes mellitus (insulin resistance and resulting hyperglycemia), and colon cancer.^[3] Renal risks of overweight are being recognized recently.

Adipose tissue is an endocrine organ producing several protein (adipokines) and inflammatory mediators. The most important of these mediators are Interleukin (IL)-6, tumor necrosis factor-alpha (TNF), and adiponectin. C-reactive protein (CRP) and IL-10 are not the products of adipose tissue, but their circulating concentrations are under the control of adipokines. In obese patients, increase in IL-6, CRP, and TNF-alpha and decrease in adiponectin and IL-10 result in increased inflammation, tissue injury, and complications of obesity.^[2]

Several epidemiologic studies have demonstrated that obesity increases the risk of kidney disease.^[4] Overweight is a risk factor for the development of proteinuria and glomerulosclerosis,^[5] hypertension,^[6] and progression of underlying renal disease.^[7]

Sequelae of obesity are being increasingly recognized

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in children.^[8] Most of the studies that evaluate the association between obesity and kidney disease have been planned in adults.^[4] Accurate and comprehensive data on the extent of the problem on children are lacking. However, growing evidence suggests that long-term consequences of obesity on organs, including the kidney, has its origin in childhood.^[9]

This study is planned to compare renal function between normal-weight and overweight children.

Materials and Methods

This case-control study was planned to compare the renal function between normal-weight and overweight children.

Case and control groups were selected by simple randomization method from school children aged 7-12 years. The Body Mass Index (BMI) percentile was used for classification. Percentiles for BMI were calculated by using the 2000 Centers for Disease Control and Prevention (CDC) growth charts.^[10]

Case group (overweight children) were 46 otherwise-healthy children with BMI 85th percentile or greater. The control group consisted of 46 healthy children with BMI 5th-84th percentile. All children (case and control) had no history of previous diseases and results of their physical examinations were normal. Children with any present or previous sign or symptom of renal or non renal diseases were excluded from the study.

Control and case groups were matched for age and gender. The study was approved by the local ethics committee and informed consent was obtained from the parents.

Random morning spot urine samples were collected. Serum creatinine and urinary albumin, calcium, and creatinine excretion were measured. Urine albumin/creatinine ratio and urine calcium/creatinine ratio were determined. Glomerular filtration rate (GFR) was calculated using $K \times \text{Height} / P_{\text{creat}}$ ^[11] Where K is a constant, height represents the body height, and P_{creat} is the plasma creatinine concentration.

Information including age, sex, weight, height, blood pressure, GFR, albuminuria (albumin/creatinine ratio), calciuria (calcium/creatinine ratio) was recorded.

Statistical analysis was performed using SPSS. Chi-square test, independent *t* test and Mann–Whitney test were used. Statistical significance was defined as $P < 0.05$.

Results

In total, 92 children (45 boys, 47 girls) aged 7-12 years were included in the analysis. Cases were 46 children (23 boys, 23 girls) with BMI 85th percentile or greater (mean age, 9.09 years). Controls were 46 children (22 boys, 24 girls) with BMI 5th-84th percentile (mean age, 8.63 years). Cases and controls were similar, with no statistically significant differences in age and sex ($P < 0.05$). Mean and standard deviation (SD) of GFR, urine calcium/creatinine ratio, urine albumin/creatinine ratio, blood pressure (BP), and serum creatinine are shown in Table 1. No significant difference existed regarding GFR, albuminuria, calciuria, blood pressure, and serum creatinine between normal and obese children.

Discussion

The aim of this study was to compare renal function between normal-weight and overweight children. The study showed no significant difference regarding GFR, albuminuria, calciuria, blood pressure, and serum creatinine between normal and obese children.

In one study, the effect of obesity on renal function were evaluated in children aged 7-16.5 years; further, a significant positive correlation was found between GFR and BMI.^[12]

The wider age range in this study may be the cause of difference with our study, as a result of the relationship between height and GFR. However, in another research, no significant difference was found between GFR and BMI,^[13] which are in agreement with our study.

With regard to the comparison of albuminuria in normal-weight and overweight children, different results are found in literature. Some studies did not find any significant difference in protein and microalbumin excretion in the urine.^[12] On the other hand, in some studies, albuminuria was higher in obese versus normal-weight children.^[13-15] However, in one research, median albumin creatinine ratio and urinary albumin levels were higher in normal-weight children than in overweight children.^[16] Protein and albumin excretion in the urine of children

Table 1: Glomerular filtration rate, calcium/creatinine ratio, albumin/creatinine ratio, blood pressure, and serum creatinine in the study population

	Overweight children	Normal-weight children	P
GFR (ml/min)	98.90 ± 4.59	96.37 ± 3.73	0.49
Calcium/creatinine ratio	0.13 ± 0.15	0.12 ± 0.10	0.77
Albumin/creatinine ratio	0.049 ± 0.04	0.043 ± 0.03	0.74
BP (mm Hg)	103.74 ± 8.67	101.73 ± 8.32	0.4
Serum creatinine (mg/dl)	0.79 ± 0.20	0.74 ± 0.21	0.19

SD: Standard deviation, GFR: Glomerular filtration rate, BP: Blood pressure

are affected by several nonpathologic process (physical activity, body temperature, etc).^[11] Therefore, it appears that albumin excretion in children may not be a useful test for early detection of high-risk children.

Association between elevated blood pressure and childhood overweight has been documented in several studies,^[9,17] but some have been unable to demonstrate this association.^[13] Obesity is associated with the activation of renin-angiotensin system (RAS), increased sympathetic nervous system activity, and hyperinsulinemia, all of which may contribute to sodium reabsorption.^[18]

Limited data are available regarding association between calciuria and overweight. We thought that decreased activity in overweight children and, perhaps, some degree of tubular dysfunction resulting from obesity may affect calcium excretion. But we have not been able to find any association. In one study, overweight was not associated with earlier stone formation.^[19]

We have found different results with a number of studies. In addition to some reasons mentioned earlier, perhaps, the degree of renal damage is correlated with the duration of exposure and degree of obesity.

The major limitation of this study was that we did not evaluate all the glomerular and tubular functions. Since some functions may be impaired earlier in children, these changes may have been missed.

Conclusions

Our finding showed no significant difference regarding GFR, albuminuria, calciuria, blood pressure, and serum creatinine between normal-weight and overweight children. There is controversy regarding renal complication of obesity in children. We did not find in literature about how much time it takes for the renal effects of obesity to manifest. It appears that renal involvement is not an early clinically evident manifestation of obesity in childhood, a longer exposure to obesity is probably needed before renal function impairment appears. Accurate and comprehensive data on the extent of the problem on children are lacking. Therefore, additional research is needed to understand the same.

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