

The Correlation Between Obesity and Chronic Kidney Disease in Children and Adolescent Populations



Riti Kalra^{1,2}, Nikhil Nair², and Rupesh Raina^{2,3}

¹ Department of Nephrology, Akron Children's Hospital, Akron, OH

² Department of Medicine, Case Western Reserve University, Cleveland, OH

³Department of Nephrology, Akron Nephrology Associates/ Cleveland Clinic Akron General Medical Center, Akron, OH

Introduction

- As of 2018, nearly 20% (19.3 million) children and adolescents are either overweight or obese.
- According to The World Health Organization, the rate of those overweight and obese has risen significantly from 4% in 1975 to nearly 18% in 2016.
- Among children and adolescents, obesity is linked to higher rates of diabetes, high blood pressure, high blood cholesterol, coronary heart disease, and mortality.
- Recent estimates implicate obesity as being the cause of between 24 and 33% of all renal disease.
- Although obesity has been linked to the increasing incidence of chronic kidney disease (CKD) in children and adolescents, the correlation has not been fully elucidated.

Pathogenesis

Obesity

- The fundamental cause behind obesity includes long-term imbalance of calories consumed versus calories expended, appetite, and physical activity. Access to health-care systems, socioeconomic status, and underlying hereditary and environmental factors play critical roles in the pathogenesis of obesity as well.
- Obesity is distinguished by an excess adiposity. It is measured by the Body Mass Index (BMI). A high BMI is proportional to adiposity and excess weight.

Chronic Kidney Disease

- CKD is characterized by the decrease in kidney function over time.
- In adolescents, the primary causes of CKD include diabetes, high blood pressure, glomerulonephritis, interstitial nephritis, polycystic kidney disease, urinary track infections (UTI), structural complications of the kidney, and nephrotic syndrome.
- The functionality of the kidney is measured via glomerular filtration rate (GFR). Three tests may be used to determine the presence or absence of CKD: high blood pressure, urine albumin and serum creatine.

References

- Nehus, E. J., Khoury, J. C., Inge, T. H., Xiao, N., Jenkins, T. M., Moxey-Mims, M. M., & Mitsnefes, M. M. (2017). Kidney outcomes three years after bariatric surgery in severely obese adolescents. *Kidney international*, 91(2), 451–458. <https://doi.org/10.1016/j.kint.2016.09.031>
- Tsuboi, N., Okabayashi, Y., Shimizu, A., & Yokoo, T. (2017). The Renal Pathology of Obesity. *Kidney international reports*, 2(2), 251–260. <https://doi.org/10.1016/j.ekir.2017.01.007>
- Kovesdy, C. P., Furth, S. L., Zoccali, C., & World Kidney Day Steering Committee (2017). Obesity and Kidney Disease: Hidden Consequences of the Epidemic. *Canadian journal of kidney health and disease*, 4, 2054358117698669. <https://doi.org/10.1177/2054358117698669>
- Jadresic, L., Silverwood, R. J., Kinra, S., & Nitsch, D. (2019). Can childhood obesity influence later chronic kidney disease?. *Pediatric nephrology (Berlin, Germany)*, 34(12), 2457–2477. <https://doi.org/10.1007/s00467-018-4108-y>
- Ding, W., Cheung, W. W., & Mak, R. H. (2015). Impact of obesity on kidney function and blood pressure in children. *World journal of nephrology*, 4(2), 223–229. <https://doi.org/10.5527/wjn.v4.i2.223>
- Correia-Costa, L., Azevedo, A., & Caldas Afonso, A. (2019). Childhood Obesity and Impact on the Kidney. *Nephron*, 143(1), 8–11. <https://doi.org/10.1159/000492826>
- "Obesity and Overweight." World Health Organization. World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>.

Objectives

- Assess the effect of obesity on the development of renal disease, specifically CKD, among global child and adolescent populations.
- Assess risk factors associated with CKD, treatments, such as bariatric surgery.

Methodology

- Design:** This is a retrospective literature review on the incidence of both obesity and CKD in the pediatric and adolescent population.
- Study Population:** Pediatric and adolescent (<18 years old) patients with both obesity and CKD were evaluated.
- Study Variables:** Comorbidities (metabolic syndrome, diabetes, cholesterol, heart disease, etc.), blood pressure, CKD management/progression, co-interventions.

Results

- Microalbuminuria, hypertension low HDL, proteinuria, insulin resistance, WBC, uric acid, macroalbuminuria, the HOMA-R index, and the HbA1c prevalence rates were calculated based on 12 individual studies as well as an aggregated cohort.
- Aggregated prevalence:**
 - Microalbuminuria = 4.63% ± 4.68%
 - Hypertension = 3.11% ± 6.21%
 - Low HDL = 7.36% ± 9.78%
 - Proteinuria = 8.73% ± 13.48%
 - Insulin resistance = 9.98% ± 20.43%
 - Uric acid = 88.88% ± 14.85%
 - Macroalbuminuria = 0.17%
 - HOMA-R index = 75.87% ± 29.51%

Discussion

- Among children and adolescent populations, obesity is a potent risk factor for the development of renal disease.
- Obesity increases the risk of developing major risk factors of CKD, thus having a direct impact on the development of CKD.

BMI is Not The Most Accurate Tool To Quantify Obesity

- BMI cannot differentiate between body fat and muscle.
- Certain factors such as age, height, sex, ethnicity, muscle mass, and sexual maturation should be accounted for when analyzing the relationship between BMI and body fat among children and adolescents.

Effects of Bariatric Surgery on Renal Function in Pediatric Age Patients

- Obesity is a preventable risk factor (i.e., bariatric surgery and/or lifestyle changes) which could further decrease the likelihood of development of renal disease.
- While the first, and preferred treatment of obesity involves healthy lifestyle changes, in those with poor adherence and in need in urgent need of weight loss, bariatric surgery be an appropriate modality.
- Bariatric surgery offers changes to the structure to the digestive system to limit the amount of food and nutrition an individual can intake.
- Still, further research, clinical trial, and refinement is necessary to understanding the nuances of this technique.

Conclusion

- The progression of obesity in CKD can be gauged by levels of blood pressure, albumin, HDL, WBCs, iron acids, HbA1c levels, as well as insulin resistance.
- Although information is scarce surrounding the correlation between obesity and CKD in children and adolescent populations, it is evident that both are interconnected.

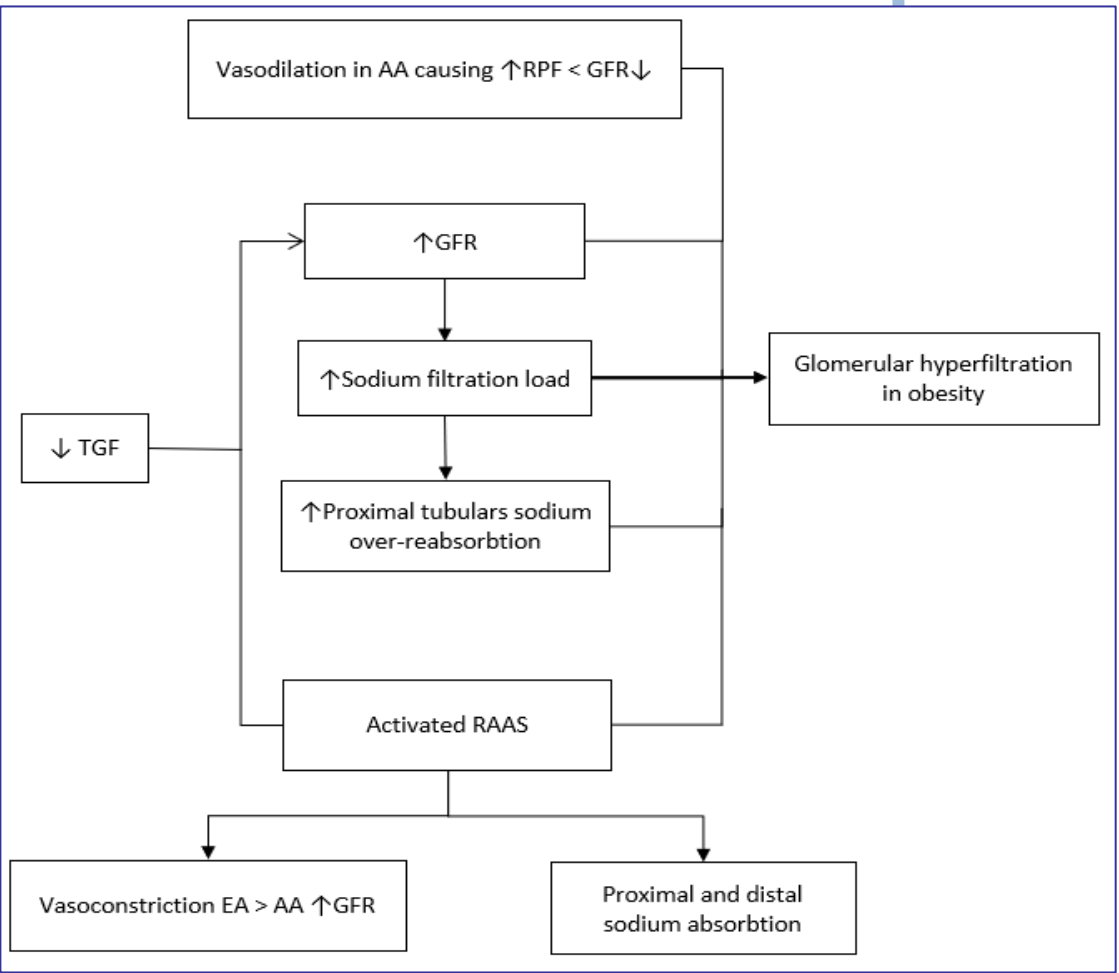


Figure 1 identifies multiple pathways leading to chronic kidney disease secondary to obesity.

- Kidney weight, glomerular hypertrophy, hemodynamic changes, increased salt sensitivity, and RAAS activation have shown strong correlations between obesity and renal involvement.