

# Effect of a diet program and aerobic exercise in class II and class III obese children with chronic kidney disease

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## Abstract

**Introduction.** Obesity is a significant factor in the development of numerous chronic kidney diseases. Chronic kidney disease reduces exercise capacity and muscle strength, which is suggested to improve through exercise. The study investigated the effect of a diet program and aerobic exercises in obese children with chronic kidney disease.

**Methods.** Thirty children of both sexes aged 12–16 years with class II or class III obesity in accordance with body mass index (BMI) and first 2 stages of chronic kidney disease were selected from Paediatric Nephrology Unit, Cairo University. They were randomly assigned into 2 equal groups. The control group received routine medical treatment (blood pressure control, treatment of hyperlipidaemia, non-steroidal anti-inflammatory drugs). The experimental group received routine medical treatment in addition to a diet program and aerobic exercises 3 times per week for 3 months. Blood urea nitrogen, serum creatinine, C-reactive protein, urine albumin, sodium, potassium, cholesterol, high-density lipoprotein, low-density lipoprotein, and triglycerides were evaluated before and after treatment in both groups.

**Results.** There were significant differences between the mean pre- and post-treatment parameters of kidney function, lipid profile, and BMI within each group ( $p < 0.05$ ). Significant differences were observed in the mean parameters of kidney function, lipid profile, and BMI between the 2 groups after treatment in favour of the experimental group ( $p < 0.05$ ).

**Conclusions.** As the experimental group showed more positive results, the diet control program and aerobic exercise had a positive effect in class II and class III obese children with chronic kidney disease.

**Key words:** diet program, aerobic exercise, obesity, chronic kidney disease

## Introduction

Chronic kidney disease (CKD) affects approximately 7–12.5% of the population in the United States of America. It is considered a predisposing risk factor for cardiovascular disease, one of the primary causes of morbidity and mortality in children with CKD. Cardiovascular hazard occurs early in CKD patients [1, 2]. Dyslipidaemia in CKD, typically manifested by increased triglyceride level and reduced high-density lipoprotein (HDL), is associated with a high risk for atherosclerosis [3].

Low exercise capacity in children with CKD is due to various factors, such as anaemia, sedentary lifestyle, chronic inflammation, and cardiovascular dysfunction, to enumerate the main reasons [4, 5]. Many evidence-based reports suggest that children with renal diseases are at a high risk of low exercise capacity and decreased muscle strength, which can have an unfavourable impact on their lives [4, 6].

Childhood obesity can pathologically affect many body organs and lead to serious problems, which include hypertension, dyslipidaemia, insulin resistance, dysglycaemia, fatty liver disease, and psychosocial complications. In general, comorbidities of children obesity may be categorized under physical and psychosocial issues [7–9].

Renal disease treatments include nutritional restriction to lower protein consumption and to adjust electrolyte imbalance. It is important to pay attention to lipid intake, so fat utilization should be regulated in quantity and quality in a diet program [10]. Exercise training is essential and has many benefits for all children with renal diseases. Exercise is divided into controlled outpatient programs in a rehabilitation centre and home exercise programs [5, 7, 11].

Although there is strong evidence in adults that exercise is beneficial, it would be wrong to assume that this is also the case in children, who have additional complications, e.g., impaired growth and development. Thus, this study was carried out to analyse the effect of a diet control program and aerobic exercise in class II and class III obese children with CKD after successive 3 months of treatment.

## Subjects and methods

### Study design

The study followed a pretest-posttest experimental design. The independent variable was obese children with CKD. The measured variables were kidney function (blood urea nitrogen, serum creatinine, C-reactive protein, urine albumin,

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sodium, and potassium), lipid profile (cholesterol, HDL, low-density lipoprotein [LDL], triglycerides), and body mass index (BMI), evaluated before and after 3 months of treatment.

### Sample size determination

The G\*Power 3.1 software (Heinrich Heine University, Düsseldorf, Germany) was used to calculate the sample size with 90% power, 0.05 type I error (2-tailed), and effect size of 0.99. As a result, 15 subjects were recruited in each group and the total number of participants was 30.

The inclusion criteria were as follows: children of both sexes, age 12–16 years, class II or class III obesity in accordance with BMI classification (35–40 kg/m<sup>2</sup>), and first 2 stages of CKD. Patients were excluded if they had genetic obesity syndromes, had undergone a surgical procedure within the previous 3 months, had congenital or acquired skeletal deformities or any neurological deficits, such as convulsions or involuntary movements, or were receiving muscle relaxants. Also, children with renal, bone marrow, or stem cell transplantation, or leukaemia or HIV in the previous 5 months, as well as those with a history of a structural heart disease were excluded [12].

### Randomization method

The patients were randomly divided into 2 groups: in the first group (control group, 15 children), the odd numbers were selected, while in the second group (experimental group, 15 children), the even numbers were selected.

### Instrumentation

A valid and reliable height and weight measuring scale system was used for detecting the weight and height of the children and calculating BMI.

A fully automated machine processed the blood samples for laboratory investigations of blood urea nitrogen, serum creatinine, C-reactive protein, urine albumin, sodium, potassium, and lipid profile.

### Assessment procedures

Each child underwent the same evaluation, which was performed by the same therapist at the beginning and after 3 months of the treatment. The evaluation procedures included the measurement of blood urea nitrogen, serum creatinine, C-reactive protein, urine albumin, sodium, potassium, cholesterol, HDL, LDL, triglycerides, and BMI before and after 3 months of treatment.

### Treatment procedures

The control group received routine medical treatment as prescribed by the physician, including aggressive blood pressure control, treatment of hyperlipidaemia, radiocontrast media to avoid nephrotoxins, and non-steroidal anti-inflammatory drugs. The experimental group received routine medical treatment in addition to a diet program (low-calorie diet) and aerobic exercise. A 10-minute warm-up and stretching were performed, then aerobic exercise was carried out on a cycle ergometer for 20 minutes at 15 W, followed by walking on a treadmill for 10 minutes and 10-minute cool-down/relaxation exercises, 3 times per week for 3 months.

### Data analysis and statistical design

The Statistical Package for the Social Sciences (version 20 for Windows; SPSS Inc., Chicago, USA) was used for data analysis. Data were expressed as mean ± standard deviation. A comparison between the mean values of age, height, and BMI in the 2 groups measured before treatment was performed with unpaired *t*-test. MANOVA served to compare within- and between-group effects. Values of *p* ≤ 0.05 were considered significant.

### Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Ethical Scientific Committee of the Faculty of Physical Therapy, Cairo University (approval No.: P.T.REC/012/001861). The Pan African Clinical Trials Registry number is PACTR201804003311164.

### Informed consent

Informed consent has been obtained from the parents of all individuals included in this study.

### Results

None of the patients in either treatment group dropped out throughout the study period. The mean age of the children in the control and the experimental groups was 14.20 ± 1.196 and 14.10 ± 1.25 years, respectively. The mean height of the control and experimental groups participants was 153.6 ± 6.7 and 152.7 ± 6.8 cm, respectively. The mean BMI of the children in the control and the experimental groups equalled 34.9 ± 7.8 and 36.6 ± 2.8 kg/m<sup>2</sup>, respectively. There was no significant difference in the mean values of age, height, or BMI between the groups (*p* > 0.05), as shown in Table 1.

Table 1. General characteristics (mean ± SD) of subjects in both groups

Item	Age (years)	Height (cm)	BMI (kg/m <sup>2</sup> )
Control group	14.20 ± 1.196	153.6 ± 6.7	34.9 ± 7.8
Experimental group	14.10 ± 1.25	152.7 ± 6.8	36.6 ± 2.8
<i>t</i>	0.258	0.419	-0.915
<i>p</i>	0.798	0.677	0.366
Significance	NS	NS	NS

BMI – body mass index, NS – not significant

### The effect of treatment on kidney function

Table 2 presents the differences between the control and the experimental groups in the pre- and post-treatment mean values of blood urea nitrogen, serum creatinine, C-reactive protein, urine albumin, sodium, and potassium. Statistically non-significant differences (*p* > 0.05) were observed between the groups before treatment. There were highly statistically significant differences (*p* < 0.05) after treatment in favour of the experimental group. Also, significant differences between pre- and post-treatment values were indicated within each group (*p* < 0.05).

Table 2. Mean values of blood urea nitrogen, serum creatinine, C-reactive protein, urine albumin, sodium, and potassium

Item	Before treatment (mean ± SD)	After treatment (mean ± SD)	p	Significance
Blood urea nitrogen				
Control group	20.45 ± 5.33	16.45 ± 4	0.002	S
Experimental group	19.25 ± 6	10 ± 2.2	0.001	S
Significance	p = 0.536 NS	p = 0.001 S		
Serum creatinine				
Control group	1.64 ± 0.24	1.3 ± 0.22	0.004	S
Experimental group	1.7 ± 0.25	0.79 ± 0.14	0.001	S
Significance	p = 0.169 NS	p = 0.001 S		
C-reactive protein				
Control group	14.1 ± 5.44	11.3 ± 3.8	0.003	S
Experimental group	14.5 ± 3.7	5.5 ± 2.3	0.001	S
Significance	p = 0.825 NS	p = 0.001 S		
Urine albumin				
Control group	74.9 ± 23	52.1 ± 22	0.002	S
Experimental group	69.65 ± 20	24.2 ± 9.2	0.001	S
Significance	p = 0.753 NS	p = 0.001 S		
Sodium				
Control group	174.6 ± 27.3	152.7 ± 16.1	0.003	S
Experimental group	180.35 ± 29	131.4 ± 8.2	0.001	S
Significance	p = 0.471 NS	p = 0.002 S		
Potassium				
Control group	9.55 ± 2.7	6.82 ± 1.5	0.002	S
Experimental group	10.88 ± 3	4.08 ± 0.68	0.001	S
Significance	p = 0.076 NS	p = 0.001 S		

NS – not significant, S – significant

Table 3. Mean values of lipid profile parameters and BMI

Item	Before treatment (mean ± SD)	After treatment (mean ± SD)	p	Significance
Cholesterol				
Control group	209.46 ± 24.8	191.86 ± 19.8	0.005	S
Experimental group	199.86 ± 25.7	149.53 ± 14.9	0.001	S
Significance	p = 0.815 NS	p = 0.001 S		
LDL				
Control group	134 ± 16	120.8 ± 12.9	0.003	S
Experimental group	139.65 ± 17.4	91.73 ± 9.3	0.001	S
Significance	p = 0.094 NS	p = 0.001 S		
HDL				
Control group	37.6 ± 5.4	43.2 ± 4.3	0.002	S
Experimental group	37.2 ± 5.2	50.2 ± 3.2	0.001	S
Significance	p = 0.777 NS	p = 0.001 S		
Triglycerides				
Control group	202.2 ± 24.7	181.2 ± 18	0.003	S
Experimental group	192.5 ± 21.2	129.7 ± 10.3	0.001	S
Significance	p = 0.074 NS	p = 0.001 S		
BMI				
Control group	36.8 ± 2.78	30.9 ± 3	0.004	S
Experimental group	37.28 ± 3.7	23.9 ± 2.6	0.001	S
Significance	p = 0.510 NS	p = 0.006 S		

LDL – low-density lipoprotein, HDL – high-density lipoprotein, BMI – body mass index, NS – not significant, S – significant

## The effect of treatment on lipid profile and BMI

Table 3 depicts the differences between the control and the experimental groups in the pre- and post-treatment mean values of lipid profile parameters (cholesterol, LDL, HDL, and triglycerides) and BMI. Statistically non-significant differences ( $p > 0.05$ ) were observed between the groups before treatment. There were highly statistically significant differences ( $p < 0.01$ ) after treatment in favour of the experimental group. Also, significant differences between pre- and post-treatment values were indicated within each group ( $p < 0.05$ ).

## Discussion

Children with CKD obtain decreased results on exercise tolerance tests, such as the peak oxygen uptake test, or on functional capacity tests and the gradually progressive aerobic cardiovascular endurance run test [4]. So, this study was conducted to investigate the effect of a diet program and aerobic exercises on kidney function, lipid profile, and BMI in class II and III obese children with CKD.

The results of the current study revealed significant differences between pre- and post-treatment mean values of blood urea nitrogen, serum creatinine, C-reactive protein, urine albumin, sodium, potassium, lipid profile parameters, and BMI within each group. Also, there were significant differences between the groups after treatment in favour of the experimental group.

The improvement at the end of the treatment program in the control group can be due to the use of medical treatment, which had an enhancing effect on all the measured variables. These results agree with those achieved in a study that investigated the effect of 12-month treatment with atorvastatin on proteinuria and renal disease progress among 56 CKD children. After 12 months, protein voiding in urine and the progress of renal disease were improved in patients treated with atorvastatin [13].

The improvement in the experimental group observed at the end of the treatment program can be attributed to the low-fat, low-carbohydrate Mediterranean diet, which exerts a favourable effect on CKD children with or without diabetes mellitus, with regard to urinary albumin voiding and glomerular filtration rate [14].

Also, the more effective results in the experimental group may be due to reducing weight as a result of diet and exercises. Wilson et al. [15] reported that physical exercises interference was an additional tool in children and adolescent obesity management. Diet-only and diet with exercise treatment reduces weight and improves metabolic profile and cardiovascular indices. Also, the mentioned study revealed that adding exercise to dietary interference resulted in a considerable adjustment of HDL cholesterol, fasting glucose, and fasting insulin levels.

The results of this study are in line with those obtained by Rahmy et al. [16], who performed research among 50 patients with stages 3 and 4 of CKD, divided into 2 groups. The study group received moderate aerobic exercises and the control group received their medications only. Urine and blood samples were collected for determining glomerular filtration rate, serum urea, serum creatinine, and serum lipid profile before the initiation of the training program and after the completion of the study. The researchers concluded that moderate aerobic exercises improved kidney function and lipid profile and could delay progression of CKD stages 3 and 4.

One of the mechanisms that clarify the effective consequences of exercise is fat usage via lipid oxidation through

exercise. Training and caloric reduction constitute an effective method for treatment of obesity which helps reduce weight, decrease infection, and achieve a long-term goal of improving life quality [17, 18]. The results of this study also agree with the outcomes obtained by Aucella et al. [19], who indicate that systematic exercises can support psychological and functional enhancement and ultimately increase the quality of life in CKD patients.

Most of the previous studies on CKD in adults found a positive effect of exercises on kidney function, quality of life, and BMI. Regular exercise (regardless of type, intensity, length of intervention, or supervision) showed a statistically significant decrease in blood HDL level. An improvement in serum creatinine, albumin, and general protein was observed at the end of treatment. Research among adults and children revealed a strong correlation between good results of serum creatinine and albumin levels. In turn, no study defined adverse effects of exercises in CKD adults [20].

This may be attributed to the end result of energy control for renal function and CKD progress. In one trial, 24-hour proteinuria was decreased by incorporation of a diet and exercise regimen. Two additional trials with a dietary intervention showed a remarkable reduction of proteinuria [21].

Aerobic exercises, as well as a dietary program markedly decrease BMI. Interestingly, resistance exercise may lower trunk fat mass without reducing BMI, which suggests magnification in lean body mass. Data on the result of energy management on the nature of life imply a useful effect [22].

## Limitations

There was a difficulty in persuading parents to engage their children in the exercise group (experimental group).

## Conclusions

A diet control program and aerobic exercise in addition to medical intervention have a favourable effect on kidney function, lipid profile, and BMI in class II and III obese children with CKD.

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## Disclosure statement

No author has any financial interest or received any financial benefit from this research.

## Conflict of interest

The authors state no conflict of interest.

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