

Impact of chronic kidney disease on anthropometric profile, health-related quality of life and cognitive function in children

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Background

Chronic kidney disease (CKD) is commonly labelled as a silent killer associated with multiple comorbid conditions.

Purpose

To explore the impact of CKD on anthropometric profile, health-related quality of life (QoL) and cognitive function in children.

Patients and methods

A total of 150 children with CKD, age ranged from 8 to 12 years were assigned according to glomerular filtration rate into three groups of equal numbers; group I (stage 2 and 3), group II (stage 4) and group III (stage 5). Anthropometric measurements, QoL and cognitive function were measured and compared to 100 healthy age-matched groups.

Results

Compared with normal children, children with CKD showed a statistically significant short stature, low body weight, anaemia and poor QoL and cognitive impairments. Moreover, those at stage 5 yielded the worse scores.

Conclusion

CKD is associated with comorbid conditions as growth failure, anaemia, poor QoL performance and cognitive impairments.

Keywords:

chronic kidney disease, cognition, end-stage chronic kidney disease, quality of life, renal dialysis

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Introduction

Chronic kidney disease (CKD) is a generic term that denotes functional or constructional damage of the kidney or reduction in glomerular filtration rate (GFR) lower than 60 ml/min/1.73 m² according to Schwartz formula for more than 3 months [1,2].

Children with CKD are at risk of comorbid events, including anaemia, cardiac diseases, growth, bone density disorder, neurocognitive impairments and psychological changes that have an influence on quality of life (QoL) [2,3].

Insufficient growth is a significant problem in paediatric patients with CKD caused by various factors, including malnutrition, anaemia, metabolic acidosis and persistent microinflammations. Additionally, CKD is clinically presented by cerebrovascular diseases, brain atrophy, slow conduction velocity on electrophysiology studies and particular cognitive deficits have been illustrated in patients with CKD [4,5].

When compared to healthy controls, patients with CKD are less physically active, have difficulties in carrying out activities of daily living and

occupational tasks and reduced health-related quality of life (HRQoL). Predialytic and dialysis CKD individuals report significantly reduced physical capacity. Furthermore, the mortality rate is higher among patients who receive dialysis (62%), in contrast to the nonsedentary patients [6].

The main goal of this study was to investigate the impact of CKD on anthropometric profile, HRQoL and cognitive function in children.

Patients and methods

Ethical aspects

The study procedures were carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for trails including humans. Informed consent: Parents or a legal guardian for the children signed a written informed agreement for partnership and publication of the results before conducting the study procedures.

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Study design

A cross-sectional observational study that evaluated anthropometric and biochemical measurements, cognitive function and QoL variables of children with CKD was conducted from November 2016 to April 2018.

Sample size estimation

A preliminary pilot study was conducted to identify potential clinically significant differences between the study groups using the G*Power version 3.1.9.2. The minimum size of each group was estimated based on a statistical significance level of 0.05 and a power of 0.80. For children with CKD groups, at least 47 children should be included. Therefore, 50 children with CKD were included in each group. A hundred typically developing volunteer children, matched for age and sex, were recruited from general schools and the surrounding communities.

Patients

A convenient sample of 150 volunteer children with CKD between 8 and 12 years of age have been screened and recruited from the Nephrology Clinic at Abo El-Reesh Hospital, Cairo University, Egypt. The GFR, using the updated Schwartz equation, was used to grade children with CKD into Kidney Disease Outcomes Quality Initiative-CKD stages. They were assigned to three groups of equal numbers, stages 2 and 3 (mild to moderate), stage 4 (predialysis) and stage 5 (dialysis) [1].

Study protocol

The study protocol consisted of an assessment of anthropometric and biochemical measurements, QoL and cognitive function. The procedures were proceeded by an interdisciplinary team, including paediatric nephrologists, physical therapists, paediatricians and nurses.

Outcome measures

Anthropometric measurements

Children's age, weight and height were registered from medical interview, physical screening and accurate analysis of patients' hospital file.

Biochemical measurements

The haemoglobin level and GFR (ml/min/1.73 m²) were recorded from the children latest medical reports.

Quality of life assessment

The Paediatric Quality of Life Inventory (PedsQL, Mapi Research Trust company, France, distributes the PedsQL™ internationally) was developed to quantify

HRQoL of children and adolescents aged 2–18 years. It is composed of equivalent child self-report and parent proxy-report forms obtainable in numerous international languages including Arabic. The PedsQL 4.0 generic core scales – Arabic Egypt, age 8–12 years, consist of 23 questions and evaluate how frequently of a trouble the child has had over the past month. Interpretation of the scale reveals the mean performance as total scale score (TSS), physical functioning score (eight questions), emotional functioning score (EFS, five questions), social functioning score (SFS, five questions) and school function scores (SchFS, five items). Child performance was scored on 0–4 scale. The responses for each item are reverse recorded and linearly converted into a 0–100 scale as follows: 0=100, 1=75, 2=50, 3=25, 4=0. The scale score for each dimension and TSS were calculated with higher results reflecting better HRQoL [7].

Cognitive function

The PedsQL cognitive function standard version – Arabic child self-report and parent proxy-report for children from 8 to 12 years was used to evaluate cognitive function. It is formed of six items covering one dimension. The respondents indicated how often of a trouble the child had over the past month. The higher scores indicate lower problems [7].

Statistical analysis

Statistical tests were fulfilled using IBM SPSS (SPSS Inc., Chicago, IL) statistics 22 software. The analysis of data for this study was done using descriptive statistics and the differences between the different groups were analysed using analysis of variance (ANOVA) test followed by LSD post-hoc test. The differences in demographic characteristics of both the groups were assessed using ANOVA tests and χ^2 -test. Data were first analysed using the Kolmogorov–Smirnov test to test the normality of the data and Levene's test to test the homogeneity of variances. The level of significance for all tests was set at 0.05.

Results

Anthropometric profile

The weight and height mean±SD of the four groups are represented in Table 1. There was a significant difference among the four groups in weight as *P* value was 0.0001 as revealed by ANOVA test. The normal group showed a higher weight in comparison to the stage 2 and 3 CKD, stage 4 CKD and stage 5 CKD groups (*P*<0.05) using LSD post-hoc test. In addition, stage 2 and 3 CKD groups showed a higher weight

Table 1 Participants' demographic data and biochemical assessment

	Normal (N=100)	Stage 2 and 3 (N=50)	Stage 4 (N=50)	Stage 5 (N=50)	P value
Age (years)	9.61±0.91	9.81±1.02	9.82±0.99	9.77±1.05	0.48
Sex [N (%)]					
Boys	52 (52)	27 (54)	26 (52)	31 (62)	0.67
Girls	48 (48)	23 (46)	24 (48)	19 (38)	
Weight (mean±SD) (kg)	43.36±6.89	32.07±1.82	29.48±1.94	26.65±2.49	0.0001*
Height (mean±SD) (cm)	134.47±5.75	128.09±2.94	123.28±3.38	120.36±2.99	0.0001*
Haemoglobin level (mean±SD) (g/dl)	12.01±1.95	9.87±1.77	8.24±1.43	7.21±1.2	0.0001*
Glomerular filtration rate (mean±SD) (ml/min/ 1.73 m ²)	92.36±2.3	45.58±7.49	17.01±5.91	8.53±1.56	0.0001*

* $P < 0.05$, significant.

Table 2 Comparison between chronic kidney disease groups in quality of life

	Stage 2 and 3	Stage 4	Stage 5	P value
Parents form (mean±SD)				
PFS	75.34±7.23	52.9±7.67	43.18±6.52	0.0001*
EFS	73.7±6.76	53.6±7.76	41.0±7.88	0.0001*
SFS	71.6±6.65	53.9±7.57	39.2±8.22	0.0001*
SchFS	71.1±6.41	51.9±6.99	37.9±7.69	0.0001*
TSS	72.93±5.28	53.07±6.21	40.32±3.73	0.0001*
Child form (mean±SD)				
PSS	75.1±7.18	52.72±6.92	43.53±6.43	0.0001*
EFS	74.7±6.57	55.0±7.75	39.8±7.82	0.0001*
SFS	72.4±6.08	54.0±6.22	38.9±8.03	0.0001*
SchFS	71.3±5.87	52.6±7.08	37.7±7.7	0.0001*
TSS	73.37±4.91	53.58±5.54	39.98±3.69	0.0001*

EFS, emotional functioning score; PFS, physical functioning score; SchFS, school functioning score; SFS, social functioning score; TSS, total scale score. * $P < 0.05$, significant.

than stage 4 and 5 CKD groups as P values were 0.006 and 0.0001, respectively. Finally, stage 4 CKD group showed a higher weight than stage 5 CKD groups as the P value was 0.003.

Regarding the height, there were significant differences among the four groups in height as P value was 0.0001, as revealed by ANOVA test. The normal group showed higher height in comparison to the stage 2 and 3 CKD, stage 4 CKD and stage 5 CKD groups ($P < 0.05$). Furthermore, stage 2 and 3 CKD groups showed higher height than stage 4 and 5 CKD groups as the P value was 0.0001. Finally, stage 4 CKD group showed higher height than stage 5 CKD groups as the P value was 0.001.

Biochemical measurements

The haemoglobin level and GFR means and SD of the four groups are represented in Table 1. For the haemoglobin level, there were significant differences among the four groups in haemoglobin level as P value was 0.0001, as revealed by ANOVA test. The normal group showed a higher haemoglobin level in comparison to the stage 2 and 3 CKD, stage 4 CKD and stage 5 CKD

groups ($P < 0.05$). In addition, stage 2 and 3 CKD groups showed a higher haemoglobin level than stage 4 CKD and stage 5 CKD groups, as P values were 0.0001 and 0.0001, respectively. Finally, stage 4 CKD group showed a higher haemoglobin level than stage 5 CKD groups as P value was 0.003.

Regarding GFR, there were significant differences among the four groups in GFR as P value was 0.0001, as revealed by ANOVA test. The normal group showed a higher GFR in comparison to the stage 2 and 3 CKD, stage 4 CKD and stage 5 CKD groups ($P < 0.05$). In addition, stage 2 and 3 CKD groups showed a higher GFR than stage 4 and 5 CKD groups as P values were 0.0001 and 0.0001, respectively. Finally, stage 4 CKD group showed a higher GFR than stage 5 CKD groups as P value was 0.0001.

Quality of life

Table 2 shows the comparison between CKD groups in QoL. There was a significant difference between the three CKD groups in parent's form TSS and subtest scores, including PSS, EFS, SFS and SCHFS as P value was 0.0001. Moreover, stage 2 and 3 CKD groups showed higher scores than stage 4 and 5 CKD groups ($P < 0.05$). Furthermore, stage 4 CKD group showed higher scores than stage 5 CKD groups as P value was 0.0001.

There was a significant difference between the three CKD groups in child's form TSS and subtest scores, including PSS, EFS, SFS and SCHFS as P value less than 0.05. Stage 2 and 3 CKD group showed higher scores than stage 4 and 5 CKD groups ($P < 0.05$). Furthermore, stage 4 CKD group showed higher scores than stage 5 CKD groups as P value was 0.0001 as shown in Table 2.

Cognitive function

PedsQL cognitive function scores of parent/child form comparison between CKD groups are represented in

Table 3 Comparison between chronic kidney disease groups in cognitive function

	Stage 2 and 3	Stage 4	Stage 5	<i>P</i> value
Parents form (mean±SD)	73.55 ±6.25	55.45 ±10.83	41.97 ±7.17	0.0001*
Child form (mean ±SD)	73.8±6.07	57.22 ±7.28	42.86 ±6.78	0.0001*

**P*<0.05, significant.

Table 3. There was a significant difference between the three CKD groups in parent's form scores as *P* value was 0.0001. Stage 2 and 3 CKD groups showed higher scores than stage 4 and 5 CKD groups (*P*<0.05). Furthermore, stage 4 CKD group showed higher scores than stage 5 CKD groups as *P* value was 0.0001.

Concerning the child's form cognitive function, there was a significant difference between the three CKD groups in the child's form cognitive function scores as *P* value was 0.0001. Stage 2 and 3 CKD groups showed higher scores than stage 4 and 5 CKD groups (*P*<0.05). Furthermore, stage 4 CKD group showed higher scores than stage 5 CKD groups as *P* value was 0.0001.

Discussion

The current study attempted to investigate the impact of chronic kidney disease on anthropometric profile, HRQoL and cognitive function in children.

The main findings of this study suggest that children at CKD stage 2 through 5 have lower anthropometric and biochemical measurements, cognitive impairments and poor QoL when compared with healthy age-matching children. Furthermore, those at stage 2 and 3 exhibited better scores with respect to all measured variables, while lower scores were recorded in children at stage 5.

Regarding the anthropometric and biochemical measurements, the results showed that, children with severe CKD undergoing dialysis have the shortest stature, lower body weight and severe anaemia. Anaemia is a condition in which blood haemoglobin level less than 11.0 g/dl in children aged 0.5–5 years, less than 11.5 g/dl in children aged 5–12 years and less than 12.0 g/dl in children aged 12–15 years [2].

Several causes of poor linear growth have been reported, including age at onset of CKD, the cause of renal disease, protein-calorie malnourishment, increased protein catabolism, metabolic disorders, osteodystrophic kidney changes, anaemia, urinary sodium losses and other electrolyte anomalies, anaemia and medications such as steroids [8,9].

It was reported that patients at CKD stage 3 over stage 5, have poor longitudinal growth due to growth hormone impedance rather than deficiency. The North American Paediatric Renal Trials and Collaborative Studies reported that children with predialysis CKD, dialysis and transplantation, respectively, have severe short stature [10,11].

The results of the current study showed that children with CKD are at risk for growth delay, this could be attributed to malnutrition during the early years of their development. This explanation is supported by previous studies, concluding that malnutrition during the first 3 years of life in which growth and neurodevelopment progress is rapid, may result in serious growth restriction and developmental delays [12,13].

Regarding QoL, the study showed impaired performance in physical, social, emotional and school functioning performance among children with CKD and the worse performance was recorded in those at stage 4 and 5. As previously reported, anaemia and malnutrition may have an adverse effect on the general health, well-being and QoL. Improper nutrition in chronic diseases increases the morbidity and mortality and worsens QoL when compared with normal diseases [11].

The clinical condition and treatment significantly affect the QoL and physical activities in children with CKD as they are submitted to several factors, including complex drug treatments, dietetic and hydric restrictions, invasive treatments and even hospitalisations. They present poor physical, social and psychosocial performance than their healthy peers [14–16].

Children and adolescents with CKD represent impairments with respect to QoL, muscle force, lung function, functional capability, growth and biopsychosocial changes that have influences on QoL [3].

Poor functional capability and physical performance in patients with CKD can be influenced by deconditioning, muscle weakness and disuse atrophy, general fatigue and lower-extremity oedema [17].

Musculoskeletal disorders result from decreased protein-calorie absorption and protein imbalance. Uraemic myopathy is the primary cause of decreased strength and endurance properties of the respiratory muscles. The previously mentioned factors result in changes in type II muscle fibres and blood vessels resulting in intravascular calcification, and decrease in local blood flow, resulting in muscle changes [18,19].

Regarding cognitive function, the current study showed lower PedQL cognitive-scale scores in children with CKD at 2 through 5 stages which was significantly reduced in children at stage 5. These observations may be attributed to the vascular changes and malnutrition. Significant cognitive impairments are common at all stages of CKD, in particular patients with advanced-stage disease and potentially affect the patient well-being and QoL. The aetiology of cognitive impairments is mainly cerebrovascular disease [20–22].

Inflammation, endothelial dysfunction, atherosclerosis, oxidative stress, anaemia, hyperhomocysteinaemia, symptomatic and asymptomatic brain ischaemia and uraemic toxins are common in patients with CKD. The evidence indicates that the previous factors correlate with cognitive impairments [23–25]. The results of the current study showed significant impairment in children at 2 through 5 stages, particularly those undergoing dialysis. This comes in agreement with previous studies which reported that, cognitive impairments are related to low mental function in individuals with CKD and it is more considerable in those on dialysis [26,27].

Dialysis treatment may cause oedema and reduced cerebral perfusion that contribute to cognitive involvement by agitating brain ischaemia due to diminished intravascular volumes and fluid exchanges [5,28].

Though evidence indicates that haemodialysis enhances cognitive function in patients with CKD, a significant, yet ignored, portion of the individuals on haemodialysis suffer from moderate to severe cognitive impairment [28,29].

Despite the importance of this study, a spotlight on some limitations is recommended, such as the underlying reasons of CKD, the duration of the disease and the type of dialysis. Cognition covers aspects of brain functions such as awareness, language, memory, learning, reasoning, decision-making and problem-solving. The assessment of cognition was conducted by a brief scale giving a score on the general cognitive function. Further studies to better elucidate the finding are warranted.

Conclusion

Irrespective of the primary cause of renal damage and stage, the onset of CKD triggers a chain of events with a common final pathway where kidney damage progresses to kidney failure. Monitoring of medical,

nutrition, behavioural, mental and psychological aspects is highly recommended.

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Conflicts of interest

There are no conflicts of interest.

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