

# Immediate Effects Of Hemodialysis On Hand Grip Strength And Functional Capacity

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## Abstract

**Background** Pediatric chronic kidney disease (CKD) is accompanied by serious health problems and is linked to a number of co-morbid disorders including decreased muscle strength, lung capacity, functional ability, growth, and bio-psychosocial alterations that affect quality of life (QoL). **Aim** To investigate the immediate effect of hemodialysis (HD) on hand grip strength (HGS) and functional capacity in children with ESRD. **Methods** Sixty-three children with end stage renal disease (ESRD); stage V; of both sexes, aged 4 to 14 years, who were receiving HD in the Pediatric Nephrology Unit, Abo El-Reesh hospital participated in this study. Anthropometric measures and demographic data were recorded before HD session. The HGS and 6MWT measurements were taken immediately before and after HD session. **Results** The mean HGS values evaluated immediately after HD compared to pre-HD session showed a statistically significant reduction. As opposed to that, the 6MWT mean values was significantly increased ( $p < 0.05$ ). **Conclusion** Dialysis is an imperative treatment for patients with ESRD, but it has negative effects on functional performance. Children with ESRD need monitoring of not only medical issues but also functional capacity and physical aspects.

**Keywords:** Children; Chronic kidney disease; Functional capacity; Hand grip strength; Hemodialysis.

## INTRODUCTION

It is well known that chronic renal disease is a significant health issue that is threatening to become an epidemic due to its rising prevalence and frequency. Its actual prevalence and incidence may be underestimated by epidemiologic data as it is usually asymptomatic, especially in early stages (1). In children, CKD is linked to severe cardiovascular morbidity and mortality, hospitalizations, and common specific issues such reduced muscle force, lung function, functional capacity (FC), growth, and bio-psychosocial alterations that affect quality of life (QoL) (2).

Moreover, Children with CKD have reduced muscle strength, regardless of growth retardation or body mass index (BMI) status. Having CKD for a long period of time and being exposed to it at a young age is linked to reduced muscular strength. Acidosis, stunted growth, poor nutrition, low body mass index, and low physical activity are potential mediators of the effect of CKD on muscle strength (3).

Handgrip strength (HGS) is a useful indicator of the strength and endurance of muscles. It might potentially function as a predictor of health consequences (4). A reliable method for assessing isometric muscular strength in children is grip strength, which is strongly related to overall muscle strength. As a result, one may utilize grip strength as a general predictor of muscular strength (5). A dynamometer is used to measure HGS according to tradition. The procedure is easy, quick, cheap, and standardized for use with older people (6).

The functional capacity of chronic renal patients can be assessed using the 6MWT, a mean evaluation technique that is simple to use, affordable, and effective. When compared to the healthy peers, stage V CKD patients exhibited quite lower functional capabilities as determined by the 6MWT (7). Regardless of gender, it can be shown that patients with CKD stage 5, perform less than expected for the distance on the 6MWT, showing a reduced functional capability of this population (8).

Although it has been (9) reported that, HD long run effect has on general health as quality of life & functional capacity, few data are available about the immediate effect of HD on muscle strength and functional capacity and the impact of the assessment's timing, i.e. after or before the HD session, on the outcomes (10, 11). Also, most of these studies were done on adolescents and the elders. Therefore, this study was conducted to assess the immediate effect of HD on HGS

and functional capacity in children with stage 5 ESRD. It may also be useful for demonstrating how the timing of the 6MWT and HGS, i.e., after or before a HD session, affects the outcomes.

## **METHODOLOGY**

### **Subjects**

This study was conducted on sixty-three children undergoing HD for CKD from both sexes, aged from 4 to 14 years old, between December 2020 and September 2021. The patients' files, Parents interviews or the hospital's computerized records system were used to gather information about the patients' gender, age, nationality, body mass index (BMI), and the main cause of renal failure.

### **Study design**

An Observational prospective cohort study was conducted from December 2020 to September 2021.

### **Ethical considerations**

Before the beginning of data collection about the children, their parents or legal guardian were asked to sign a consent form in order to request their participation.

### **Participants**

Sixty-three volunteer children with CKD recruited from Pediatric Nephrology at Abo El-Reesh hospital, Cairo, Egypt participated in the current study. Inclusion criteria were: 1) aged 4 to 14 years, 2) both sexes, 3) ESRD (stage 5) was determined based on glomerular filtration rate (15 mL/min/1.73 m<sup>2</sup>) and 4) receiving HD. If a child had any of the following conditions, they were excluded; 1) neurological, cardiopulmonary, cognitive disorders; 2) uncontrolled hypertension/diabetes, or 3) diabetes significant cerebral or peripheral vascular disease.

### **Procedures for evaluation**

The demographic data and anthropometric measurements for each child including name, age, sex, weight, height and GFR was recorded in a designed data collection sheet. The HGS and 6MWT were assessed immediately before the child was connecting to the HD machine and immediately after HD.

#### ***Assessment of hand grip strength***

Children were taught to adjust the dynamometer to their hand size on their own in order to get the highest performance. Subjects were instructed to hold the dynamometer maximally tightly in response to a verbal command while maintaining elbow flexed at 90°, and neutral forearm position with adducted shoulder. Analysis was performed using the highest HGS value obtained from three trials (12). Using a Camry digital hand held dynamometer with a precision of 0.5 kg; the child's non-fistula side was tested for the assessment of HGS.

#### ***Assessment of functional capacity***

The 6MWT was used to assess functional capacity. It was demonstrated to be a suitable, reliable, and affordable technique for monitoring patients' functional exercise capacity with renal illness (7). Children were permitted to walk on a 20 meters long walkway, which was rectangular and uninterrupted, using the 6-MWT in accordance with the standards of the American Thoracic Society. In order to assure safety and to estimate the precise distance that the child walk in six minutes, the therapist carefully followed the child while using a stopwatch. They were told to complete as many loops of the course as they could without running in the allotted six minutes. Every five meters, a chair was put in case the child was unable to walk while the stopwatch was running. If the child was unable to precede the test, the test will be stopped (13,14). Following the American Thoracic Society's recommendations, 6MWT conducted the examination of functional capacity (15). Children were encouraged to walk as quickly as they could for the period of six minutes on a level 20-meter track, and the distance they covered was measured in meters. During the test, children could stop and take a break, but they were told to start walking again as soon as they were ready to do so. The greater distance was then recorded.

## **Statistical analysis**

A paired t test was used to compare HGS and 6MWT before and after HD. Shapiro-Wilk test was used to confirm the normal distribution of data. A level of significance of  $p < 0.05$  was used for all statistical analyses. For all statistical measures, the statistical package for social sciences (SPSS) version 24 for Windows was used.

## **RESULTS**

Table (1) showed the subject characteristics of the study sample. Data obtained pre and immediately post HD among CKD children regarding HGS and 6MWT were analyzed and compared statistically.

**Table (1)** The study population clinical characteristics.

Variable	Value
Age (years)	8.8 ± 2.9
Sex	
Boys	36 (57.1%)
Girls	27 (42.9%)
Weight (Kg.)	20.3 ± 6.7
Height (cm.)	111.5 ± 12.4
Body mass index (Kg/m <sup>2</sup> )	15.9 ± 2.7

From a total sample of 63 children, seven children were unwilling to conduct the HGS test. So, only 56 children were analyzed. There was a significant decrease in the HGS findings post dialysis when compared to pre dialysis ( $p = 0.004$ ). There was a significant increase in the 6MWT post dialysis when compared to pre dialysis ( $p = 0.0001$ ) as shown in table 2.

**Table(2)** Comparison of the mean values of HGS and functional capacity pre and post hemodialysis:

	Pre-HD	Post-HD	MD	Df	t- value	p-value
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
HGS	7.19 ± 3.46	6.64 ± 3.22	0.55±1.37	55	2.974	0.004*
6MWT	331.81 ± 66.70	347.85 ± 68.08	-16.04	54	-3.904	0.0001

$\bar{x}$ : Mean; SD: Standard deviation; MD: Mean difference; t value: Paired t value                      p value: Probability value; \*: Significant; Df: Degree of freedom                      HGS: Hand grip strength; 6MWT

## DISCUSSION

It has been demonstrated that after starting HD, individuals with CKD experience deterioration in their capacity to carry out activities of daily living, which is independently related with mortality (16). Associated side effects with an HD session have been recorded in patients with CKD (17). Additionally, HD can cause b2 microglobulin to accumulate in skeletal muscle, which can lead to amyloidosis, which might have an impact on functional status over time (18). There is paucity and contradiction of information about the acute changes of functional status such muscle strength and functional capacity in relation to the hemodialysis session especially those regarding children.

So, the aim of this research was to examine at the acute effects of HD on HGS and functional capacity in children with ESRD. Additionally, it might be useful for demonstrating how the timing of the 6MWT and HGS (i.e., prior to or following the hemodialysis session) affects the outcomes.

The main findings in the current study showed that there was a statistically significant decline in the values of HGS after the dialysis session compared with those before connection to HD machine. The study also showed a significant improvement regarding 6MWT post dialysis.

The significant decreased HGS values after the HS session comes in consistent with **Pinto et al., (11)** who noted that following the dialysis session, HGS significantly decreased. The elbow was bent at a 90-degree angle during the test as the HGS was measured on the arm without a fistula before connection to the machine, and after HD sessions. The study was conducted on a large sample size ( $n = 156$ ) but it was on adults whose median age was 56 years old.

Also, it agrees with **Delanaye et al., (19)** who verified that both males and females' HGS considerably decreased following the dialysis session. In both clinical settings and subsequent epidemiological and clinical research, the time of the HGS measurement should be considered. It is necessary to test HGS at the same time in relation to the hemodialysis session in order to reduce the HGS measurement variation between patients receiving dialysis. They recommended that the ideal time to monitor HGS would be before to the dialysis session.

On the other hand, **Leal et al. (10)** demonstrated that, prior to and following dialysis, HGS did not alter. However, HGS was measured on an unfistulated arm that was extended. The sample size was limited ( $n = 43$ ); the mean age and BMI were respectively 54.5 12.2 years and 24.0 4.1 (kg/m<sup>2</sup>). Additionally, it was unclear from this paper when the HGS measurements were made ((either prior to or after the machine connection).

**Warner et al., (20)** also contradicted our findings and reported that ESRD patients' upper extremity or cognitive performance did not change consistently in the period immediately following HD. While following dialysis, patients frequently mention feeling tired or fatigued. Though the sample size was small ( $n = 21$ ), the mean age and BMI were respectively 56±17 years and 29.8± 6.8 (Kg/m<sup>2</sup>)

The improvement in 6MWT in the current study immediately after HD session is consistent with **Yilmaz et al., (21)** who claimed that HD improves pulmonary function testing, maybe because it reduces volume overload. **Agrawal and Awad**

(22) stated that the 6MWT and spirometry measurements (FEV1, FVC, MVV, and FEV1/FVC) showed a significant correlation.

While on the other hand, **Alvi and Shukla (23)** reported that there was a considerable reduction in the distance walked in post-dialysis, in contrast to pre dialysis session.

There are some limitations in our study. First, the size of the cohort was small. Second, we only evaluated children in one department (the Nephrology unit at Abo El Reesh hospital), which restricts the generalizability of any results to the total population of ESRD community. Even while conducting this study in other nephrology institutions would be more difficult, it might result in a more thorough analysis of the data. Third, even while we assume the assessment tools used reflect a variety of functional evaluations, they might not be able to accurately measure the "fatigue" that HD patients frequently experience. Finally, there was no true control group for the cohort in our study because each child's baseline evaluation acted as their own.

## CONCLUSION

It was possible to conclude from the obtained results and the related literature that HGS significantly decreases while the functional capacity significantly improves immediately after the dialysis session. In clinic practice and clinical studies, the timing of the HGS and the functional capacity tests must be taken into account. So, we suggest that before a dialysis session is the ideal time for HGS testing (before connection to the machine). While following a dialysis session is the ideal time to measure functional capacity with 6MWT.

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