ejpmr, 2024, 11(2), 64-70

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

HAND GRIP STRENGTH AND ITS CORRELATES IN THE ASSESSMENT OF PROTEIN ENERGY MALNUTRITION IN MAINTENANCE HEMODIALYSIS PATIENTS

Nandu Krishnan J.[1], Sebastian Abraham[3]*, Mohandas M. K.[2] and Ragi Krishnan[4]

[1]Senior Resident, Department of Nephrology, Government Medical College, Kottayam, Kerala, India.
[2]Professor, Department of Nephrology, Government Medical College, Kottayam, Kerala, India.
[3]Additional Professor, Department of Nephrology, Government Medical College, Kottayam, Kerala, India.
[4]Assistant Professor, Department of Nephrology, Government Medical College, Kottayam, Kerala, India.

***Corresponding Author: Dr. Sebastian Abraham**

Additional Professor, Department of Nephrology, Government Medical College, Kottayam, Kerala, India.

Article Received on 22/11/2023 **Article Revised on 12/12/2023** **Article Accepted on 03/01/2024**

ABSTRACT
Hand grip strength (HGS) is a simple, reliable and easily reproducible tool to diagnose and monitor protein energy wasting (PEW) in chronic kidney disease (CKD) patients. It is also a powerful predictor of mortality in them. HGS of CKD patients were recorded and correlated with established clinical and anthropometric parameters of PEW and Malnutrition Inflammation Score (MIS). An observational cohort study based on a sample population of one hundred CKD patients on maintenance hemodialysis (MHD) was performed. The demographic details were obtained using proforma, anthropometric measurements taken using tapes and calipers and HGS calculated with handheld mechanical dynamometer. Results were analyzed using SPSS software using multivariate regression analysis and Pearson correlation coefficient to correlate the parameters of PEW. Results: HGS correlated well with gender, MIS, anthropometric measures, body mass index, and biochemical parameters like hemoglobin, albumin, transferrin saturation and did not with age, dialysis vintage, residual renal output, serum urea or creatinine. HGS is a simple and effective tool to identify and monitor protein energy malnutrition in maintenance hemodialysis patients and enable early interventions to address the issues.

KEYWORDS: Hand grip strength (HGS); Chronic kidney disease (CKD); Protein energy wasting (PEW); Maintenance Hemodialysis(MHD); Malnutrition Inflammation Score(MIS).

INTRODUCTION
Malnutrition, a prevalent issue among dialysis patients, significantly contributes to both mortality and morbidity.[1,2] Detecting and monitoring malnutrition in these patients relies on various biochemical parameters. The reasons behind malnutrition in maintenance hemodialysis patients are multifaceted.[3,11,12] Within the hemodialysis population, two types of malnutrition have been identified: inadequate nutrition caused by insufficient dietary intake (true malnutrition), and an altered body composition characterized by depleted somatic and visceral protein pools due to a catabolic state associated with inflammation.[3,14]

Various measures including biochemical parameters, anthropometry, malnutrition scores-Subjective Global Assessment(SGA), Malnutrition Inflammation Score(MIS), bioimpedance, has been extensively used a tool for detecting malnutrition.[6,8,9] Commonly used biochemical parameters like albumin, haemoglobin, transferrin, prealbumin are useful in identifying high risk patients but are confounded by various other factors like inflammation, chronic liver disease, iron deficiency anemia etc.[4,10]

MATERIALS AND METHODS
An observational cohort study was done in chronic kidney disease patients on maintenance hemodialysis enrolled in dialysis unit of Medical College, Kottayam, Kerala, India.

The sample size calculation was done with reference to the study of Birajdar N et al.[7] with alpha 0.05, beta 0.20, the expected correlation coefficient r=0.29, the standard normal deviate for $\alpha = Z_\alpha = 1.9600$,the standard normal deviate for $\beta = Z_\beta = 0.8416$, $C = 0.5 \times \ln[(1+r)/(1-r)] = 0.2986$.
Total sample size = $N = [(Z_\alpha+Z_\beta)/C]^2 + 3= 91$ rounded off to 100.

Inclusion Criteria: All maintenance hemodialysis (MHD) patients aged more than 18 years and who had been doing dialysis for more than 3 months either through arterio-venous fistula(AVF) or internal jugular vein (IJV) catheter.

Exclusion Criteria

1. Maintenance hemodialysis patients who have neuromuscular problems or any general condition which can interfere with the assessment.
2. Patients with known malignancies, or any upper limb malformations.

Non-probability consecutive sampling was applied as sampling technique. Prior to the start of study, the approval from the institutional ethical committee was taken. Only those patients were enrolled for study who met the inclusion criteria and prior to inclusion written consent was taken. We collected our data trough an interview followed by physical examination and then checking the laboratory tests. All the interview and physical examination was performed by principal investigator and all the information was recorded in a manual proforma/ excel sheet by same investigator.

The general demographic details (age, gender, comorbidities), dialysis details (duration, frequency, vintage), anthropometric evaluation, (height, weight, body mass index, triceps skin fold thickness (TSF), mid arm muscle circumference (MAMC) and hand grip strength (HGS), and laboratory investigations of serum parameters (hemoglobin, creatinine, urea, albumin, serum transferrin saturation (TSAT), total cholesterol) were obtained. In all patients the MIS score was calculated based on history and physical examination.

All anthropometric measurements were done in the non-fistula arm pre-dialysis as there were concerns of bleeding if the patient overexerts. Body weight assessment and anthropometric measurements were performed before patients are in for hemodialysis treatment or within 5 to 20 minutes after termination of the treatment. Triceps skinfold (TSF) thickness was measured with a conventional skinfold calliper using standard techniques.

The hand grip strength (HGS) was measured with the patient seated with the elbow flexed at 90 degrees and the forearm in the neutral position.[8] Three measurements were taken and the best reading was noted for the study. A Smedley type hand dynamometer was used. The patients had to self-adjust the dynamometer depending on their hand size. Anthropometric measurements were done in all patients. The mid arm circumference was measured with a stretchable tape.

The mid arm muscle circumference was calculated using the following formula.

MAMC = MAC (cm)-π TSF (mm)/10.

The Malnutrition-Inflammation Score

The MIS has four sections (nutritional history, physical examination, Body Mass Index, and laboratory values) and 10 components.[8] Each component has four levels of severity, from 0 (normal) to 3 (severely abnormal). The sum of all 10 MIS components can range from 0 (normal) to 30 (severely malnourished); a higher score reflects a more severe degree of malnutrition and inflammation.

Data Management and Statistical Analysis

The demographic, laboratory and anthropometric variables were reported as mean (±sd). Analysis with multiple linear regression analysis and Pearsons correlation coefficient was done to look for significant association between HGS and various laboratory and anthropometric variables. The relations between hand grip strength, dialysis vintage, laboratory variables (hemoglobin, creatinine, albumin, transferrin saturation, total iron binding capacity, total cholesterol etc) and anthropometric variables (Body Mass Index, triceps skin fold thickness, mid arm muscle circumference) were studied. All statistical analyses was done with SPSS Version 21. A P value of <0.05 was considered significant.

RESULTS AND DISCUSSION

Results

Table 1 -Study population characteristics.

	Male (n=73)		Female (n=27)		Total (n=100)	
	mean	**sd**	**mean**	**sd**	**mean**	**sd**
Age (years)	49.2	11.9	43.7	12.8	47.7	12.3
HD vintage (years)	3.6	2.7	3.4	2.3	3.6	2.6
Urine o/p (ml)	319.2	394.2	268.5	309.7	305.5	372.5
BMI (kg/m2)	23.3	4.3	21.9	4.1	22.9	4.3
TSF (cm)	0.7	0.7	0.6	0.3	0.7	0.6
MAC (cm)	24.0	3.9	22.8	4.3	23.7	4.0
MAMC (cm)	21.8	4.4	20.8	4.3	21.5	4.4
Hb (gm/dl)	10.2	1.4	10.2	1.1	10.2	1.4
S.Albumin (gm/dl)	3.9	0.3	3.7	0.3	3.8	0.3
S.Total cholesterol (mg/dl)	142.8	35.1	156.6	33.4	146.5	35.0
TSAT (%)	29.4	5.3	29.1	5.4	29.3	5.3
TIBC (ug/dl)	219.4	19.8	218.9	15.1	219.3	18.6
MIS	5.0	2.4	5.0	2.8	5.0	2.5
S.Urea (mg/dl)	124.1	28.1	114.0	22.9	121.3	27.1
S.Creatinine (mg/dl)	12.5	20.3	9.9	2.9	11.8	17.4
HGS (kg)	26.7	10.3	19.6	10.7	24.8	10.8

Table 2: Characteristics of study population among males and females.

	Male		Female		Total	
	N	**%**	**n**	**%**	**n**	**%**
Age in years						
<60	61	83.6	24	88.9	85	85
≥60	12	16.4	3	11.1	15	15
NKD						
CGN	34	46.6	13	48.1	47	47
CTID	4	5.5	1	3.7	5	5
DKID	21	28.8	8	29.6	29	29
IRF	14	19.2	5	18.5	19	19
Access						
AVF	70	95.9	27	100	97	97
Catheter	3	4.1	0	0	3	3
HD frequency						
Twice/week	25	34.2	10	37	35	35
Thrice/week	48	65.8	17	63	65	65
MIS						
No MIS < 8	69	94.5	24	88.9	93	93
Yes MIS >8	4	5.5	3	11.1	7	7
HD vintage						
<4 years	52	71.2	19	70.4	71	71
>4 years	21	28.8	8	29.6	29	29
Urine out put						
<100 ml	35	47.9	14	51.9	49	49
100-500 ml	24	32.9	10	37	34	34
>500 ml	14	19.2	3	11.1	17	17

The mean ± sd of the parameters studied among males and females respectively are tabulated as above.

The mean HGS of the entire population studied was 24.8±10.8 kg and MIS 5±2.5. 93% of patients had normal MIS while 7% was diagnosed to have malnutrition with MIS being more than 8.

Table 3: Correlation of HGS with Other Parameters.

Correlation of HGS with other parameters	Pearson Correlation coefficient R	p
Age	0.04	0.714
HD vintage	-0.07	0.491
Urine o/p	-0.02	0.846
BMI	.328	0.001
TSF	-.272	0.006
MAC	.263	0.008
MAMC	.364	<0.001
Hb	.197	0.049
S.Albumin	.200	0.046
S.Total cholesterol	-0.06	0.550
TSAT	.227	0.023
TIBC	0.10	0.348
MIS	-.412	<0.001
S.Urea	0.08	0.436
S.Creatinine	0.03	0.807

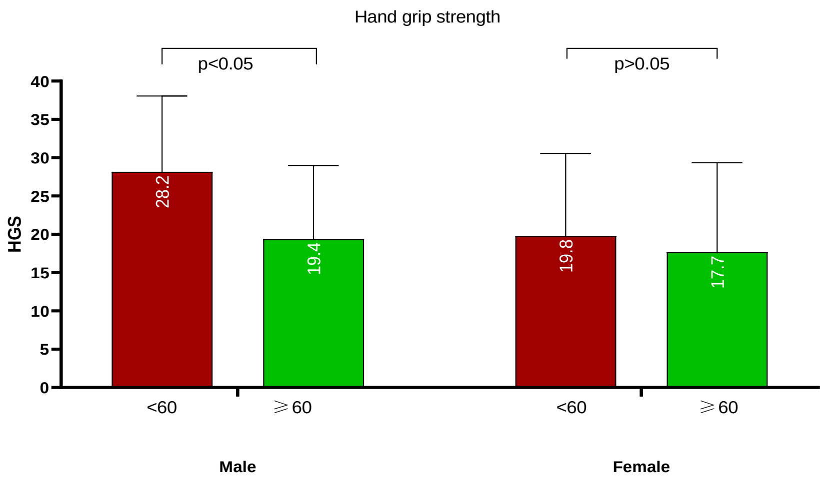

Figure 1: Age wise HGS distribution among males and females.

The mean HGS was statistically significant between males and females with males having higher HGS than females. HGS was higher in younger males (age < 60) than in elderly males but it was not significantly different among females although younger females had higher HGS.

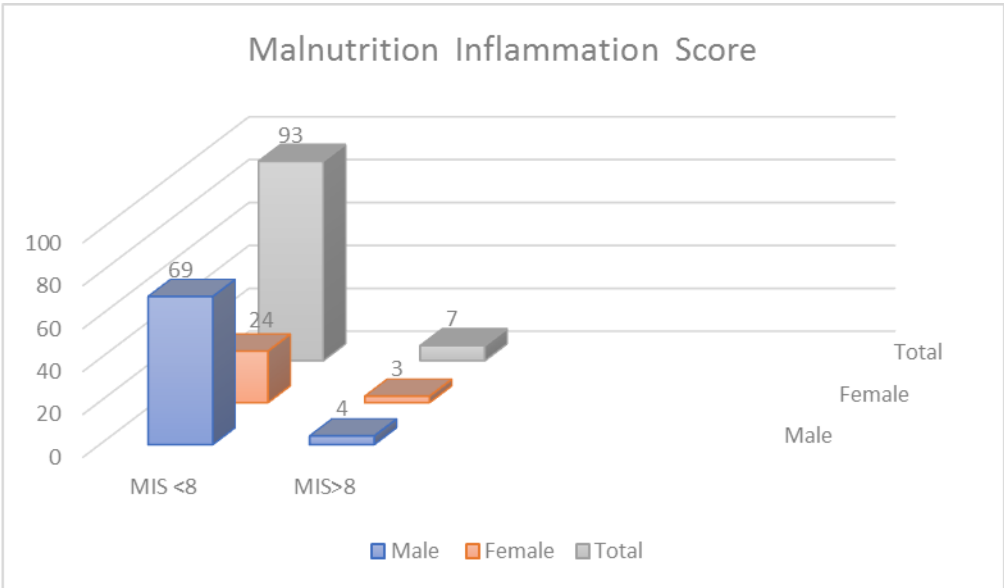

Figure 2: MIS among patients.

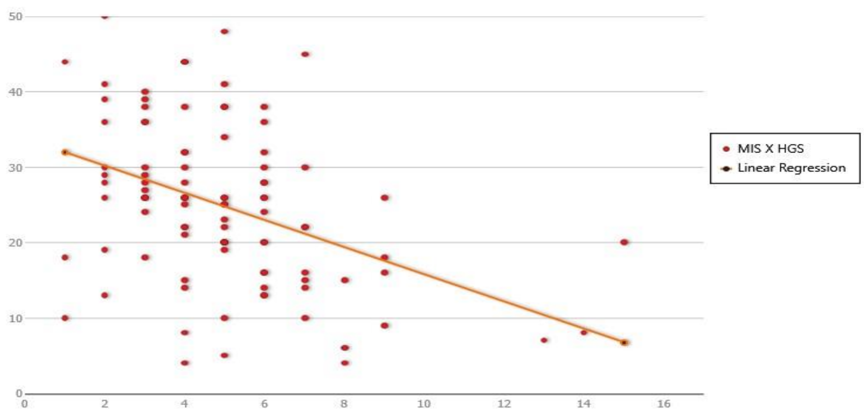

Figure 3: Scatter plot of MIS (x axis) vs HGS (y axis).

MIS correlated with HGS with a pearson correlation coefficient r-0.412 and p value of <0.001.MIS significantly correlated with HGS among MHD patients and HGS decreased with increasing MIS scores.

DISCUSSION

The study focused on the correlation of anthropometry, biochemical parameters and malnutrition inflammation score(MIS) with handgrip strength(HGS) to find out if it could be used as tool for identifying hemodialysis patients at risk for protein energy wasting. HGS could be done on every dialysis session with the handheld mechanical dynamometer hence making it an ideal tool to assess the progress of the patients frequently.

The mean hand grip strength (HGS) of the entire population studied was 24.8±10.8 kg and MIS 5±2.5. The mean ± sd of HGS of males were 26.7±10.3 kg and females were 19.6±10.7 kg and total mean of the population being 24.8±10.8 kg. The mean HGS was statistically significant between males and females with males having higher HGS than females. This is in accordance with the studies of ***Bansal and Viviane O Leal et al***.[40,45] HGS was higher in younger males (age < 60) than in elderly males but it was not significantly different among females although younger females had higher HGS.

In our study it was found that HGS was significantly correlating with Malnutrition Inflammation score(MIS) with HGS decreasing for increasing MIS. This is in accordance with the study of *Caroline et al and Luciana et al.*[45,47] In our study 93% of the patients had no malnutrition with MIS < 8 and 7% of patients had malnutrition with MIS > 8. MIS correlated with HGS with a pearson correlation coefficient r-0.412 and p value of <0.001 and HGS decreased with increasing MIS scores.

The native kidney disease **(**NKD**)** of patients were as follows: 47% of chronic glomerulonephritis (CGN); 29% -diabetic kidney disease(DKD); 19% ischemic renal failure(IRF) and 5% chronic tubule-interstitial disease(CTID). The mean ± sd of HGS of patients with native kidney disease (NKD) being ischemic renal failure(IRF) was 22.3±8.2 kg; diabetic kidney disease(DKD)- 24±10.7 kg; chronic tubulointerstitial disease(CTID)-28.2±11 kg and chronic glomerulonephritis (CGN)-25.9±11.9 kg respectively. The correlation of HGS with NKD was not statistically significant at p value of 0.536.

In our study 97 % of the patients had AVF as their access for maintenance hemodialysis and 3% on permanent tunnelled catheter in IJV. The mean ± sd of HGS was 25±10.8 kg in patients on MHD via AVF and 19.3±13.3 kg in patients with access as IJV catheter. The difference in HGS of patients with regard to access was not statistically significant at p value of 0.378.

The dialysis frequency in study population was - 65 % of MHD patients were undergoing thrice weekly dialysis while 35 % were on twice weekly dialysis. The mean ± sd of HGS of patients undergoing twice weekly HD was 23±10 kg and thrice weekly was HD 25.8±11.2 kg. The difference in HGS among patients on twice or thrice weekly MHD was not statistically significant at p value of 0.220.

In our study, out of the males (n= 73); 52 patients had a hemodialysis vintage of < 4 years while 21 patients had > 4 years. Out of the females (n=27) 19 patients had HD vintage of < 4 years and 8 patients had >4 years**.** In the original MIS, dialysis vintage contributes to the comorbid condition scoring: 0 if vintage <1 year, 1 if vintage 1 to 4 years, and at least 2 if vintage >4 years. But this is not taken into account in revised MIS.

The dialysis vintage was more than four years in 71 % of patients and less than four in 29 % patients. The HGS did not correlate statistically with the dialysis vintage of the patients with pearson correlation coefficient of r-0.07 and p value of 0.491.

This was in sharp contrast to the studies by ***Markaki Anastasia*** and ***Birajdar N*** where hand grip strength correlated with dialysis vintage and it reduced with increasing dialysis vintage.[7,19]

Our study population had 49 % of patients with a residual urine output of less than 100 ml and 17 % had urine output of more than 500 ml and 34 % of the MHD patients had urine output between 100-500 ml. The HGS did not correlate with the residual urine output of the patients on MHD in my study with a pearson correlation coefficient of -0.02 and p value of 0.846 which was insignificant. The studies by ***Markaki*** had revealed a positive correlation for HGS with residual renal function.

The mean ± sd of serum albumin in my study population was 3.9±0.3 mg % for males and 3.7±0.3 mg % & for females and 3.8±0.3 mg % for the whole study population. Serum albumin correlated with HGS with a pearson correlation coefficient r-0.200 with significant p value of < 0.05 meaning HGS was higher in patients with more serum albumin and vice versa. The studies from ***Birajdar N*** showed a trend for correlation but those of ***Markaki*** highlighted significant correlation between HGS and serum albumin. The studies from ***O Heimbürger et al*** could not establish correlation of HGS with serum albumin.[15]

The mean ± sd of body mass index in my study population was 23.3±4.3 kg/m^2 for males and 21.9±4.1 kg/m^2 for females. BMI correlated with HGS with a pearson correlation coefficient r - 0.328 with significant p value of 0.001.HGS was more in patients with higher BMI and lower in low BMI patients which was evidenced by statistically significant correlation.

The mean ± sd of mid arm muscle circumference in males was 21.8±4.4 cm and 20.8±4.3 cm in females respetively and that of study population was 21.5±4.4 cm.Mid arm muscle circumference (MAMC)correlated with HGS with a pearson correlation coefficient r-0.364 and a significant p value of <0.001.Patients with a lower mid arm muscle circumference had a lower hand grip strength compared to those with a higher MAMC. This is in accordance with studies from ***Birajdar N, Caroline et al and Anastasia Markaki et al.***[13]

The mean ± sd of triceps skin fold thickness in males was 0.7±0.7 cm and 0.6±0.3 cm in females respetively and that of study population was 0.7±0.6 cm. TSF thickness correlated with HGS with a pearson correlation coefficient r-0.272 and a significant p value of 0.006. Patients with a lower TSF thickness had a lower hand grip strength compared to those with a higher TSF thickness.

The mean ± sd of transferrin saturation (TSAT) in males was 29.4±5.3 % and 29.1±5.4 % in females respetively and that of study population was 29.3±5.3 %. TSAT correlated with HGS with a pearson correlation coefficient r-0.227 and a significant p value of 0.023.Patients with a lower TSAT had a lower hand grip strength compared to those with a higher TSAT.

The mean ± sd of serum hemoglobin in males was 10.2±1.4 mg % and 10.2±1.1 % mg in females respetively and that of study population was 10.2±1.4 mg %. Hemoglobin correlated with HGS with a pearson correlation coefficient r-0.197 and a significant p value of 0.049. Patients with a lower hemoglobin had a lower hand grip strength compared to those with a higher hemoglobin. The results contrast with studies from those of ***Birajdar N*** where no correlation was seen with HGS and serum hemoglobin.

The mean±sd of **serum TIBC** in males was 219±19.8 ug/dl and 218.9±15.1 ug/dl in females respetively and that of study population was 219.3±18.6 ug/dl. Serum TIBC did not correlate with HGS with a pearson correlation coefficient r-0.10 and a p value of 0.348.

The current study could not demonstrate a significant correlation of HGS with serum urea and creatinine. This result contrasts with studies from ***Birajdar N*** where HGS positively correlated with serum creatinine.The total serum cholesterol also did not correlate with HGS.

CONCLUSION

Our study on hand grip strength (HGS) in the assessment of protein energy malnutrition (PEM) in maintenance hemodialysis (MHD) patients was an attempt to correlate it with laboratory parameters, anthropometric measures and malnutrition inflammation score(MIS). The mean hand grip strength was statistically significant between males and females with males having higher HGS than females. 93% of the study population had no malnutrition with Malnutrition Inflammation Score (MIS) < 8 and 7 % of patients had malnutrition with MIS > 8. MIS significantly correlated inversely with HGS. Hand grip strength was reduced in patients with increasing MIS scores. The correlation of HGS with native kidney disease, dialysis access, dialysis vintage and residual renal function was not statistically significant. There was significant correlation between HGS and laboratory parameters like serum haemoglobin, serum albumin, serum TSAT and anthropometric measures like Mid arm muscle circumference, TSF thickness, body mass index. Serum urea/creatinine levels did not correlate with HGS which is in contrast to other studies available. To conclude hand grip strength could be effectively used as a tool for assessing and monitoring protein energy wasting in chronic kidney patients on dialysis as it has established correlation with most of the anthropometric measures, laboratory parameters and malnutrition inflammation score.

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