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LIAISON BETWEEN MEAN ARTERIAL PRESSURE AND GFR IN RENAL FAILURE PATIENTS

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ABSTRACT

Aim: A prospective observational study performed to find liaison between mean arterial pressure (MAP) and GFR in patients with kidney disease and to describe the gender – specific prevalence.

Objectives

- To find relationship between MAP and GFR in patients with HTN and CKD.
- Check the prevalence of MAP in males and females.
- Comparison between Hemodialysis and Non- dialysis patients correlating MAP and GFR.

Background: Low Mean arterial pressure can cause low renal blood flow and may cause damage to the kidneys. However, it is not clear in the general population whether or not low renal function is related to MAP. The present study examined the liaison between MAP and Glomerular filtration rate in patients undergoing hemodialysis treatment and in patients undergoing Non-dialysis treatment aged above 18 years. **Methodology:**A prospective observational study was performed on patients with chronic kidney disease (CKD) at Aster Prime hospital for duration of 6 months. 90 patients with chronic kidney disease were evaluated. The source of data collection was through case sheets and lab reports. **Results Before Dialysis:** Correlation between MAP1 and GFR in hemodialysis patients was performed and the results demonstrated that MAP1 and GFR are significantly negatively correlated (r = -0.624) and sig.(2 tailed) p value is less than 0.05 that is it is statistically significant. **After Dialysis:** Correlation between MAP2 and GFR in hemodialysis patients was performed and the results demonstrated that the MAP2 and GFR are significantly negatively correlated(r = -0.394) and sig.(2 tailed) p value is less than 0.05 that is it is statistically significant. **Non- Dialysis:** Correlation between MAP and GFR was performed and the results demonstrated that the MAP and GFR with correlation value (r = -0.074) and sig.(2 tailed) p value is more than 0.05 that is it is statistically not significant. **Conclusion:** Mean arterial pressure was associated with decreased GFR in patients undergoing hemodialysis, whereas the MAP was not associated with decrease in GFR in patients undergoing non- dialysis treatment.

KEYWORDS: Chronic Kidney disease (CKD), Mean arterial pressure (MAP), glomerular filtration rate (GFR), liaison, hemodialysis, non- dialysis.

INTRODUCTION

MAP is the measurement that shows the average arterial pressure during a single cardiac cycle. MAP is significant because it measures the pressure necessary or adequate pressure required for the perfusion to the organs of the body.[1]

The normal MAP range is from 60 to 100 mmHg. It is important to have a MAP of at least 60 mmHg to provide an adequate amount of blood to the arteries, kidneys, and brain. Mean arterial pressures that exceeds from the above range for longer periods of time if left untreated cause negative effects on the body.[2]

The MAP is often used as an expression of BP in hemodialysis patients, instead of using solely systolic or diastolic BP. Elevated BP is associated with decreased mortality in patients with end-stage renal disease undergoing maintenance hemodialysis (HD).[3] Acute circulatory failure is the main cause of renal failure in intensive care unit (ICU) patients, as low cardiac output and/or low mean arterial pressure (MAP) can cause low

renal blood flow (RBF) and harm the kidney.[4] Very low levels of MAP are known to increase the risk of acute renal insufficiency (AKI) occurrence . In counterpart, although a MAP of at least 65 mmHg is thought to be protective against organ failures, including renal, and is universally recommended, the true value of MAP that could really protect renal function against worsening is still unknown.

A research was carried out to examine the relationship between MAP and decreased GFR in participants aged ≥35 years from the Liaoning province of China. A total of 11345 representative individuals were selected and a cross-sectional survey was conducted to describe the gender-specific prevalence and factors associated with decreased GFR. They concluded that MAP was associated with decreased GFR in men, while in women MAP was not associated with decreased GFR. These findings provide some evidence that a different adaptive response to renal regulation may exist in males and females.[5]

The objective of this study is to find the relationship between MAP and GFR in patients with HTN and CKD, Check the prevalence of MAP in males and females and comparison between Hemodialysis and Non- dialysis patients correlating MAP and GFR.

In the general population, it is unknown how MAP influences the GFR. This study examined the relation between MAP and decreased GFR in participants aged ≥ 18 years from the ASTER PRIME hospital, India. Further, we studied the relationship to see if there was a difference between the genders.

MATERIALS AND METHODS

A prospective observational study was performed on patients with chronic kidney disease (CKD) at Aster Prime hospital for duration of 6 months. 90 patients with CKD out of which 45 patients were undergoing hemodialysis treatment and 45 patients were undergoing non-dialysis treatment, were evaluated. The parameters included were:

- Age, sex, BP and serum creatinine were recorded in the study participants.
- BP was measured before and after hemodialysis and, only once in non-dialysis patients. From this BP, MAP was calculated using the formula: MAP = DBP + 1/3(PP)
- Using serum creatinine in CKD Epidemiology Collaboration (CKD-EPI) equation the Glomerular filtration rate (GFR) was calculated.

Inclusion Criteria: Patients of either sex with CKD, patients with hypertension and CKD with MAP.

Exclusion Criteria: Pregnant women, patients below the age of 18 years and patients undergoing peritoneal dialysis.

The results were obtained using MS excel.

RESULTS

Hemodialysis Patients

MAP-The mean arterial pressure calculated from systolic and diastolic BP before the HD treatment is referred as MAP 1.

Table 1: Data on MAP1.

	MAP 1	Frequency	Percent
Valid	90.01 - 100.00	7	15.6
	100.01 - 110.00	24	53.3
	110.01 - 120.00	11	24.4
	120.01+	3	6.7
	Total	45	100.0

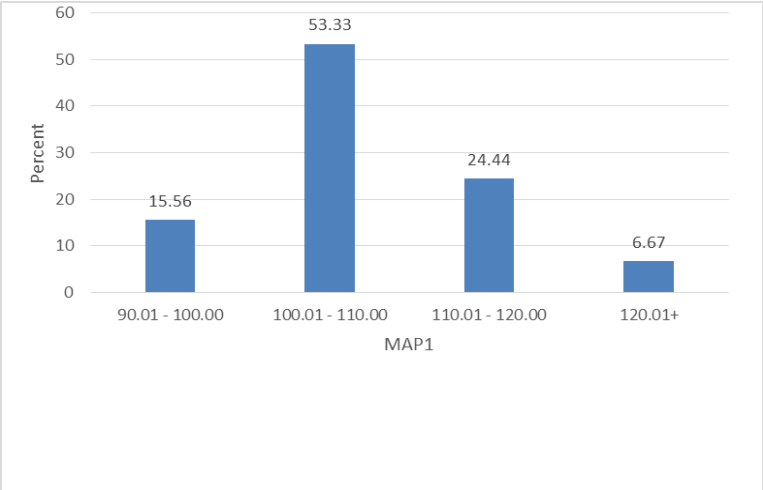

Figure 2: Shows elevated MAP1 before hemodialysis.

After dialysis

MAP 2: The MAP calculated from systolic and diastolic BP after the HD treatment is referred as MAP2.

Table 3: Data on MAP 2.

	MAP 2	Frequency	Percent	
Valid	60.01	- 70.00	2	4.4
	70.01	- 80.00	2	4.4
	80.01	- 90.00	8	17.8
	90.01 - 100.00	18	40.0	
	100.01	- 110.00	12	26.7
	110.01+	3	6.7	
	Total	45	100.0	

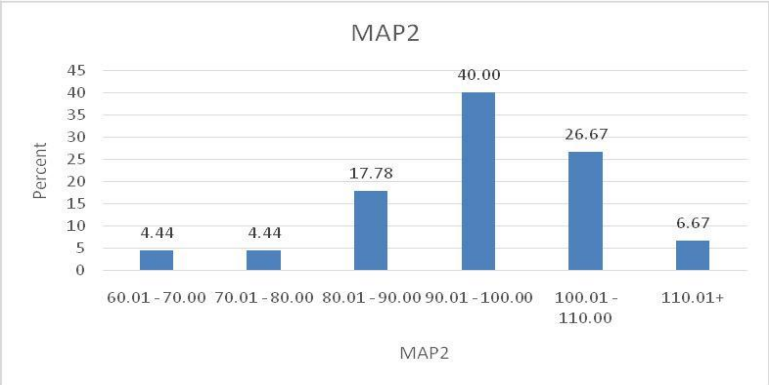

Figure 4: Shows MAP2 after HD treatment.

Glomerular Filtration Rate: GFR was calculated using CKD-EPI equation.

Table 5: Data on eGFR.

	GFR	Frequency	Percent
Valid	6.00	2	4.4
	7.00	4	8.9
	8.00	1	2.2
	9.00	6	13.3
	10.00	4	8.9
	11.00	5	11.1
	12.00	5	11.1
	13.00	6	13.3
	14.00	7	15.6
	15.00	2	4.4
	16.00	2	4.4
	17.00	1	2.2
	Total	45	100.0

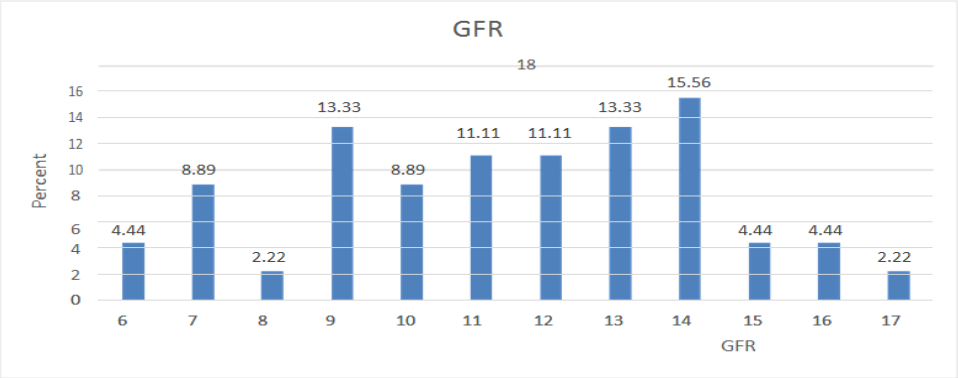

Figure 6: Shows GFR of patient undergoing HD treatment.

MAP1 versus MAP2

MAP1 and MAP2 were paired together and correlation between them was found using Paired T-Test and Pearson's coefficient respectively. Paired Samples Statistics gives univariate descriptive statistics (mean, sample size, standard deviation, and standard error) for each variable

Table 7: Paired Samples Statistics.

Paired Samples Statistics					
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**
Pair 1	MAP1	109.0370	45	7.44075	1.10920
	MAP2	96.1481	45	11.25812	1.67826

Paired Samples Correlations shows the bivariate Pearson correlation coefficient (with a two-tailed test of significance) for each pair of variables i.e. MAP 1 and MAP2 entered. The Paired Samples Correlation table give the information that MAP1 and MAP2 are significantly positively correlated (r = 0.555) as seen in the table below.

Table 8: Paired Samples Correlations.

Paired Samples Correlations					
			N	**Correlation**	**Sig.**
Pair 1	MAP1	&	45	0.555	0.0000770693
	MAP2				

Paired Samples Test gives the hypothesis test results. The mean between MAP1 and MAP2 calculated was 12.899 with std. deviation of 9.44 and std. error mean of 1.40 using CI as 95%. Sig. (2-tailed) is the *p*-value corresponding to the given test statistic t = 9.155 with degrees of freedom $df = 44$. As p value is less than 0.05 there is significant difference between MAP1 and MAP2.

Table 9: Paired Samples Test.

Paired Samples Test									
		Paired Differences					**t**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**				
					Lower	**Upper**			
Pair 1	MAP1 - MAP2	12.88889	9.44415	1.40785	10.05155	15.72622	9.155	44	0.000

MAP1 versus GFR

Correlation between MAP1 and GFR was performed using Pearson correlation coefficient (with a two-tailed test of significance) for each pair of variables i.e. MAP 1 and GFR.

Table 10: Descriptive Statistics for MAP1 and GFR.

Descriptive	**Statistics**		
	Mean	**Std. Deviation**	**N**
MAP1	109.0370	7.44075	45
GFR	11.3778	2.83876	45
Gender	1.7111	0.45837	45

The table given below shows that MAP1 and GFR are significantly negatively correlated (r = -0.624) and sig. (2 tailed) p value is less than 0.05 that is it is statistically significant.

Gender has no influence on this correlation.

Table 11: Correlation of MAP1 and GFR.

Correlations				
ControlVariables			**MAP1**	**GFR**
Gender	MAP1	Correlation	1.000	-0.624
		Significance(2-tailed)		0.000
		df	0	42
	GFR	Correlation	-0.624	1.000
		Significance(2-tailed)	0.000	
		df	42	0

MAP2 versus GFR

Correlation between MAP2 and GFR was performed using Pearson correlation coefficient (with a two-tailed test of significance) for each pair of variables i.e. MAP2 and GFR.

Table 12: Descriptive Statistics for MAP2 and GFR

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
MAP2	96.1481	11.25812	45
GFR	11.3778	2.83876	45
Sex	1.7111	0.45837	45

The table given below shows that MAP2 and GFR are significantly negatively correlated (r = -0.394) and sig. (2 tailed) p value is less than 0.05 that is it is statistically significant.

Gender has no influence on this correlation.

Table 13: Correlation of MAP2 and GFR.

Correlations					
Control Variables			MAP2	GFR	
Sex	MAP2	Correlation	1.000		-0.394
		Significance (2-tailed)			0.008
		df	0	42	
	GFR	Correlation	-0.394	1.000	
		Significance (2-tailed)	0.008		
		df	42		0

Non- Dialysis Patients

MAP- MAP calculated for patients undergoing non- dialysis treatment.

Table 14: Data on MAP in non-dialysis patients.

MAP			
		Frequency	**Percent**
Valid	60.01 - 70.00	2	4.4
	70.01 - 80.00	2	4.4
	80.01 - 90.00	9	20.0
	90.01 - 100.00	15	33.3
	100.01 - 110.00	11	24.4
	110.01 - 120.00	4	8.9
	130.01+	2	4.4
	Total	45	100.0

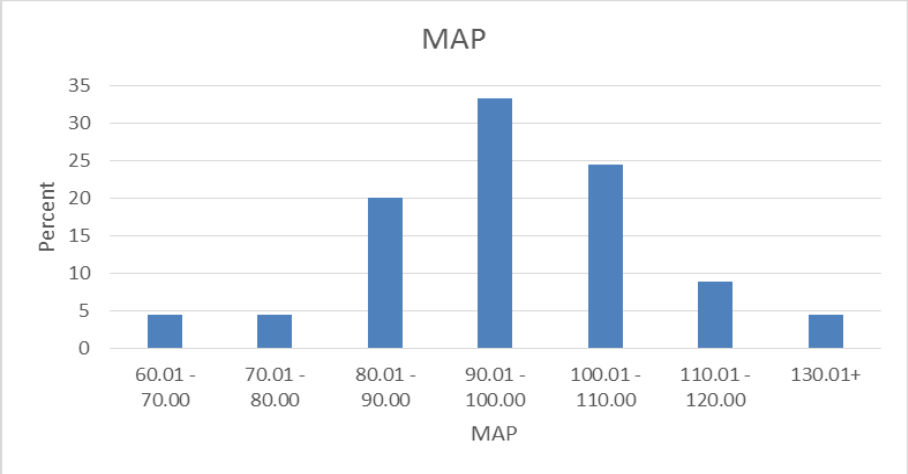

Figure 15: Shows MAP in non-dialysis

Glomerular Filtration Rate (GFR) - GFR was calculated using CKD-EPI equation

Table 16: Data on GFR in non-dialysis patients.

GFR			
		Frequency	**Percent**
Valid	<=30.00	1	2.2
	31.00 - 40.00	19	42.2
	41.00 - 50.00	10	22.2
	51.00 - 60.00	11	24.4
	61.00 - 70.00	2	4.4
	71.00+	2	4.4
	Total	45	100.0

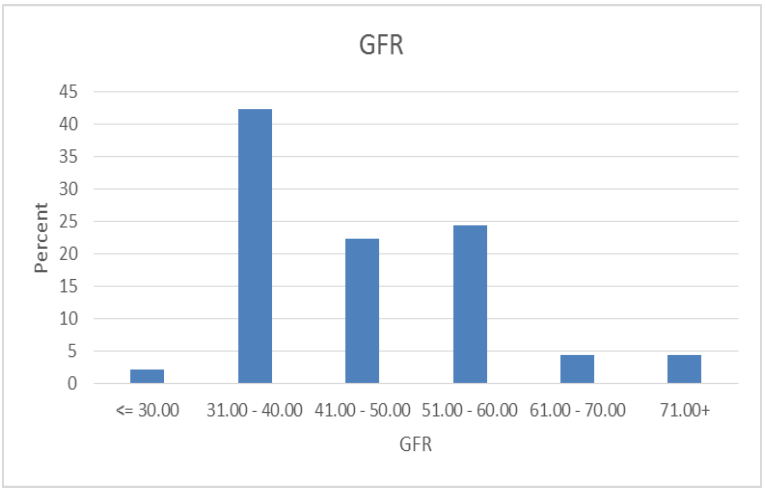

Figure 17: Shows GFR in non-dialysis.

MAP versus GFR

Correlation between MAP and GFR was performed using Pearson correlation coefficient for each pair of variables i.e. MAP and GFR.

Table 18: Descriptive Statistics for MAP and GFR in non-dialysis patients.

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
MAP	98.4370	13.84179	45
GFR	45.4667	12.24485	45
Gender	1.4444	0.50252	45

The table given below shows that MAP and GFR with correlation value (r = -0.074) and p value is more than 0.05 that is it is statistically not significant. Gender has no influence on this correlation.

Table 19: Correlation of MAP and GFR in non-dialysis patients.

Correlations				
Control Variables			**MAP**	**EGFR**
Gender	MAP	Correlation	1.000	-0.074
		Significance (2-tailed)		0.631
		df	0	42
	GFR	Correlation	-0.074	1.000
		Significance(2-tailed)	0.631	
		df	42	0

Dialysis versus non- dialysis

Comparison between unpaired means among 3 groups using ANOVA was performed.

Figure 20: Descriptive Statistics for ANOVA

Descriptive statistics of your k***=3 independent treatments.***

Treatment →	**A(MAP NON DIALYSIS)**	**B(MAP1 BEFORE DIAL)**	**C(MAP2 DIALYSIS)**	**Pooled Total**
observations N	45	45	45	135
sum ∑xi∑xi	4,429.67	4,906.66	4,326.63	13,662.96
mean ¯xx¯	98.4371	109.0369	96.1473	101.2071
sum of squares ∑x2i∑xi2	4,44,473.94	5,37,443.29	4,21,570.56	14,03,487.78
Sample variance s2s2	191.5913	55.3715	126.7413	154.4707
sample std. dev. ss	13.8417	7.4412	11.2579	12.4286
std. dev. of mean SE¯xSEx¯	2.0634	1.1093	1.6782	1.0697

Table 21: Conclusions from Anova.

One-way ANOVA of your k=3 independent treatments.

Source	**sum of squares SS**	**degrees of freedom νν**	**Mean square MS**	**F statistic**	**p-value**
Treatment	4,256.09	2	2,128.04	17.0834	0.00
Error	16,442.99	132	124.5681		
Total	20,699.07	134			

Conclusion from ANOVA

The p-value corresponding to the F-statistic of one-way ANOVA is lower than 0.05, suggesting that the one or more treatments are significantly different.

Tukey HSD Test

The Tukey HSD test was performed followed by ANOVA. This post-hoc test will identify which of the following pairs of treatments are significantly different from each other.

The p-value corresponding to the F-statistic of one-way ANOVA is lower than 0.01 which strongly suggests that one or more pairs of treatments are significantly different. There are 3 treatments K= 3, for which we shall apply Tukey's HSD test to each of the 3 pairs to pinpoint which of them exhibits statistically significant difference and the results are shown in table below.

Figure 22: Tukey HSD results

Tukey HSD results				
Treatments	**Tukey HSD**	**Tukey HSD**	**Tukey HSD**	
pair	Q statistic	p-value	inference	
A vs B	6.3709	0.0010053	** p<0.01	**DIFFEREENCE IS PRESENT**
A vs C	1.3762	0.5882855	insignificant	**DIFFERENCE ISNOT PRESENT**
B vs C	7.7471	0.0010053	** p<0.01	**DIFFERENCE IS PRESENT**

DISCUSSION

Chronic kidney disease is a worldwide public health issue. There is an increasing incidence and prevalence of ESRD, with poor prognosis. ESRD that requires treatment with dialysis or transplantation is the most widely used method of treatment in CKD patients.[6] Low mean arterial pressure can cause low renal blood flow and cause damage to the kidneys. However it is unclear whether or not decline in renal function is associated to MAP.[7] The main aim of this study is to find out the liaison between MAP and Glomerular filtration rate (GFR) in participants aged ≥18 in patients undergoing hemodialysis and Non-dialysis treatment.

We have collected the patient's demographics like age, gender, serum creatinine from patient case sheets and dialysis diary and further calculated glomerular filtration rate (GFR) and Mean arterial pressure (MAP). Our study has shown that the prevalence of male population is predominant over female in patients undergoing HD, and female population is predominant over male in Non-dialysis patients.

Before Dialysis

Correlation between MAP1 and GFR in hemodialysis patients was performed using Pearson correlation coefficient for each pair of variables i.e. MAP 1 and GFR. The results demonstrated that MAP1 and GFR are significantly negatively correlated (r = -0.624) and sig. (2 tailed) p value is less than 0.05 that is it is statistically significant.

After dialysis

Correlation between MAP2 and GFR in hemodialysis patients was performed using Pearson correlation coefficient for each pair of variables i.e. MAP2 and GFR. The results demonstrated that the MAP2 and GFR are significantly negatively correlated (r = -0.394) and sig.(2 tailed) p value is less than 0.05 that is it is statistically significant.

Non- Dialysis

Correlation between MAP and GFR was performed using Pearson correlation coefficient for each pair of variables i.e. MAP and GFR. The results demonstrated that the MAP and GFR with correlation value (r = -0.074) and sig.(2 tailed) p value is more than 0.05 that is it is statistically not significant.

When we compared unpaired means among 3 groups the p-value corresponding to the F-statistic of one-way ANOVA is lower than 0.05, suggesting that the one or more treatments are significantly different.

The Tukey HSD test was performed followed by ANOVA. It was observed that MAP of non-dialysis vs MAP1 before dialysis and MAP1 before dialysis vs MAP 2 after dialysis were significantly different whereas MAP of non- dialysis vs MAP2 after dialysis were found to be insignificant.

CONCLUSION

In this study the patients demographics like age, gender, serum creatinine from patient case sheets and dialysis diary were collected and we further calculated glomerular filtration rate (GFR) and Mean arterial pressure (MAP). Our study has shown that the prevalence of male population is predominant over female in patients undergoing hemodialysis and female population is predominant over male in Non- dialysis patients.

In patients undergoing hemodialysis we have compared the readings of MAP1 and MAP2 and correlation between them was found using Paired T-Test and Pearson's coefficient. As p value is less than 0.05 there is significant difference between MAP1 and MAP2.

When we compared MAP with gender in hemodialysis patients using the Paired sample statistics, as p value is less than 0.05 there is significant difference between MAP1 and MAP2 in both the genders.

In this study we also found that Mean arterial pressure (MAP) was associated with decreased GFR in patients undergoing hemodialysis, whereas the MAP was not associated with decrease in GFR in patients undergoing Non- dialysis treatment.

These findings provide some evidence that there might be an association between MAP and GFR in Non – dialysis patients as well, and paves the way for further studies aiming to identify liaison between MAP and GFR in Non- dialysis patients.

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