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Original Article

Correlation between Interdialytic Weight Gain and Duration of Hemodialysis in Diabetic Patients

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ABSTRACT

Introduction: *Chronic kidney disease (CKD) is a global health challenge, particularly in developing countries, where it strains healthcare resources. Affecting over 10% of the worldwide population, CKD is linked to non-communicable diseases like obesity, diabetes, and hypertension. Hemodialysis, a renal replacement therapy, extends life but has high morbidity and mortality rates.* ***Aim of the study:*** *The study aims to investigate the correlation between interdialytic weight gain and the length of hemodialysis treatment in diabetic patients.* ***Methods & Materials:*** *This prospective observational study was conducted in the Nephrology Department at Dhaka Medical College Hospital, Bangladesh, over 1.5 years (December 2021 to May 2023). It involved 109 adult diabetic patients undergoing twice-weekly hemodialysis for over three months, selected through purposive sampling. By the study's end, 92 participants remained, categorized into three groups based on dialysis duration.* ***Result:*** *The study analyzed 92 participants' interdialytic weight gain (IDWG) in terms of dialysis duration. The mean age was 45.86±14.10 years, with a male majority of 65.2%. Most participants (66.3%) had an IDWG greater than 4%, averaging 2.88±1.04, with gains ranging from 0.60 to 4.67.* ***Conclusion:*** *The study found a significant negative correlation between interdialytic weight gain (IDWG) and hemodialysis duration in diabetic patients. Longer hemodialysis sessions were linked to lower IDWG, indicating*

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better fluid and diet compliance. With 66.3% experiencing significant IDWG, tailored interventions are needed to improve dietary habits and health outcomes, reducing mortality risk.

Keywords: *Interdialytic Weight Gain (IDWG), Chronic Kidney Disease (CKD), Hemodialysis, Diabetes, Hypertension*

INTRODUCTION

Chronic kidney disease (CKD) presents a significant challenge to health systems globally, consuming a substantial portion of healthcare resources. This issue is particularly critical for developing countries, which are grappling with both infectious diseases and the rising prevalence of non-communicable diseases such as obesity, diabetes, and hypertension. In these regions, the morbidity and mortality rates associated with CKD are exceedingly high due to limited access to treatment options[1]. Chronic kidney disease is a gradually worsening condition that impacts over 10% of people globally, affecting more than 800 million individuals[2]. Similar to many other countries, Bangladesh is also experiencing a rising prevalence of chronic kidney disease (CKD). Research indicates that CKD affects between 16% and 22% of the Bangladeshi population, with 11% of these cases being in stages III to V[3,4]. Annually, 200 to 250 individuals per million in Bangladesh progress to end-stage kidney failure (ESKF)[5]. Renal replacement therapy (RRT) is the cornerstone of care for patients with end-stage renal disease (ESRD). Dialysis, a form of RRT, extends survival, reduces morbidities, and enhances the quality of life. Nevertheless, despite numerous technological advancements, patients on dialysis still experience unacceptably high morbidity and mortality rates, and their quality of life often remains suboptimal[6]. Chronic hemodialysis (HD) patients frequently encounter volume overload and interdialytic weight gain (IDWG)[7]. IDWG results from salt and water intake between two hemodialysis sessions and serves as a parameter for fluid intake, considering daily urine output[8,9]. Higher IDWG is associated with increased predialysis blood pressure, greater intradialytic reductions in blood pressure due to higher ultrafiltration rates, and elevated mortality rates[9-13]. For patients with chronic volume overload before each dialysis session, the mortality risk is twice that of non-diabetic patients[7]. Additionally, severe IDWG is strongly linked to high-risk mortality. However, several studies have shown that even lower levels of IDWG are associated with increased mortality. Specifically, studies indicate that an IDWG greater than 5% of body weight[14], over 6% of body weight[15], and ≥4% of body weight[16] correlates with higher mortality rates. Achieving normal hydration status is a primary goal of hemodialysis (HD) therapy, and reaching the so-called 'dry weight' is a fundamental aspect of routine dialysis practice[17]. IDWG, reflecting ultrafiltration losses during dialysis, is largely influenced by oral fluid intake minus residual urine output

(when present) and insensible fluid losses. Oral fluid intake is primarily driven by thirst resulting from sodium intake in food, dialysate sodium (DNa) concentration, or intradialytic intravenous administration of saline. Other factors contributing to thirst may include high blood glucose levels in diabetic patients, potassium depletion, angiotensin II, and psychological factors[18]. Diabetes mellitus (DM), commonly known as diabetes, is the primary cause of chronic kidney disease (CKD). With the global prevalence of diabetes rising rapidly, the proportion of CKD cases linked to diabetes is expected to increase correspondingly[19]. ***Ifudu et al.*** (1994) found that diabetic patients experience interdialytic weight gain (IDWG) 20% more than non-diabetic patients[20]. The study aims to investigate the correlation between interdialytic weight gain and the length of hemodialysis treatment in diabetic patients. This research could enhance clinical understanding and enable healthcare professionals to improve patient care.

METHODS & MATERIALS

This prospective observational study occurred in the Nephrology Department at Dhaka Medical College Hospital (DMCH), Dhaka, Bangladesh. The study spanned 1.5 years, from December 2021 to May 2023. The study included 109 adult diabetic patients undergoing twice-weekly hemodialysis for over three months. Patients were chosen through purposive sampling based on specific inclusion and exclusion criteria. At the end of the three months, 17 patients were no longer part of the study: 3 patients had passed away, and 14 were lost to follow-up. Of the 92 patients, 22 had been on dialysis for less than six months, 33 had been on dialysis for between 6 and 9 months, and 37 had been on dialysis for more than nine months.

Inclusion criteria:
Patients with diabetes mellitus undergoing maintenance hemodialysis for chronic kidney disease.

Exclusion criteria:
Patients who had congestive heart failure, liver cirrhosis, hypothyroidism, hemoglobin disorders, severe anemia, acidosis, hypoxia, and patients who were under 18 years of age.

After outlining the study's aims, objectives, and procedures, written informed consent was secured from each participant. Subsequently, baseline demographic information of the patients was recorded, with all data kept strictly confidential. The institutional ethics committee granted ethical approval for the study. The study examined variables such as age, sex, duration of dialysis, and interdialytic weight gain (IDWG).
A total of 109 patients were included in the study and divided into three groups based on their dialysis duration:

Group A: On dialysis for less than six months
Group B: On dialysis for 6 to 9 months
Group C: On dialysis for more than nine months

Interdialytic weight gain was assessed for each patient using a mechanical

round dial weighing scale model M306800 from ADE Germany. This gain was calculated by subtracting the post-dialysis weight from the pre-dialysis weight from the previous session. Each patient's interdialytic weight gain was recorded weekly, and the average gain over the first three months was computed. Patients with an interdialytic weight gain exceeding 4% were classified as having significant weight gain.

Operational definitions:

Maintenance Hemodialysis (MHD): A patient with end-stage renal disease (ESRD) undergoing regular dialysis for 8 hours per week for a minimum of 3 months.

IDWG:

Interdialytic weight gain refers to the increase in body weight that occurs between two hemodialysis sessions. It is determined by subtracting the weight measured before the current session from the weight recorded after the previous session. Ideally, patients undergoing hemodialysis should not experience a fluid weight gain exceeding 2% of their body weight between sessions, equivalent to 1.4 kg for a 70 kg adult. A weight gains greater than 4% (2.8 kg for a 70 kg adult) is considered a significant interdialytic weight gain.

Duration of Dialysis:

The time frame begins with the start of dialysis and extends for a few months to years following it.

Data collection and analysis:

A semi-structured questionnaire has been created in Bengali, utilizing the chosen variables aligned with the specific objectives. After data collection, the information was entered and analyzed using the Statistical Package for Social Sciences (SPSS, Version 26.0). Various statistical analyses were conducted, including the Chi-Square test, Unpaired Student's t-test, ANOVA, and Bonferroni test. Spearman correlation was also performed. A p-value of less than 0.05 was considered statistically significant.

RESULT

According to eligibility criteria, finally, 92 subjects were analyzed. More than 45% of the participants were aged 21-40, while a smaller portion (18.5%) were over 60. The mean±SD of age is 45.86±14.10 years. Gender distribution was skewed towards males, who constituted 65.2% of the study population, compared to 34.8% of females (**Table I**).

Table – I: Distribution of the Study Subjects According to Age and Gender (*n*=92)

Age (years)	Frequency (*n*)	Percentage (%)
21-40	42	45.7
41-60	33	35.9
>60	17	18.5
Mean ± SD	45.86 ± 14.10	
Gender		
Male	60	65.2
Female	32	34.8

Regarding interdialytic weight gain (IDWG), most participants (66.3%) experienced an IDWG of more than 4%, while only 33.7% had an IDWG of 4% or less. The average IDWG across all subjects was 2.88, with a standard deviation of 1.04, and individual gains ranging from as low as 0.60 to as high as 4.67 (**Table II**).

Table – II: Interdialytic Weight Gain (IDWG) of the Study Subjects (*n*=92)

Interdialytic Weight Gain (IDWG)	Frequency (n)	Percentage (%)
≤4%	31	33.7
>4%	61	66.3
Mean±SD	2.88±1.04	
Min-max	0.60-4.67	

Table III represents the analysis of IDWG about the duration of dialysis, providing further insights. Participants undergoing dialysis for less than six months (*n*=22, 23.9%) exhibited the highest mean IDWG at 3.30±0.89. Those with a dialysis duration of 6-9 months (*n*=33, 35.9%) had a slightly lower mean IDWG of 3.08±1.03, while the group with more than nine months (*n*=37, 40.2%) of dialysis showed the lowest mean IDWG at 2.44±1.01. Statistical testing using the Bonferroni method revealed significant differences in IDWG between the shortest Group A (<6 months) and most extended Group C (>9 months) dialysis durations, with a p-value of 0.005. Additionally, there was a notable difference between Group B (6-9 months) and Group C (>9 months), with a *p*-value of 0.027. The overall comparison across all three duration groups confirmed a significant variation in IDWG, with a *p*-value of 0.003. This suggests that longer dialysis durations are associated with lower interdialytic weight gain among the study subjects. The scatter plot illustrates the relationship between interdialytic weight gain (IDWG) and the duration of dialysis among the study subjects. The data points, represented by green circles, show a negative correlation between these two variables. The line of best fit, shown in red, indicates a downward trend, suggesting that as the duration of dialysis increases, the IDWG tends to decrease.

Table – III: Association of Interdialytic Weight Gain (IDWG) with Duration of Dialysis (*n*=92)

Duration of Dialysis of Different Groups (months)	Interdialytic Weight Gain	
	***n* (%)**	**Mean±SD**
Group A (<6)	22 (23.9)	3.30 ± 0.89
Group B (6-9)	33 (35.9)	3.08 ± 1.03
Group C (>9)	37 (40.2)	2.44 ± 1.01
Bonferroni test		
Duration of dialysis	*p*-value	

Group A vs Group B	1
Group A vs Group C	0.005
Group B vs Group C	0.027
Group A vs Group B vs Group C	0.003

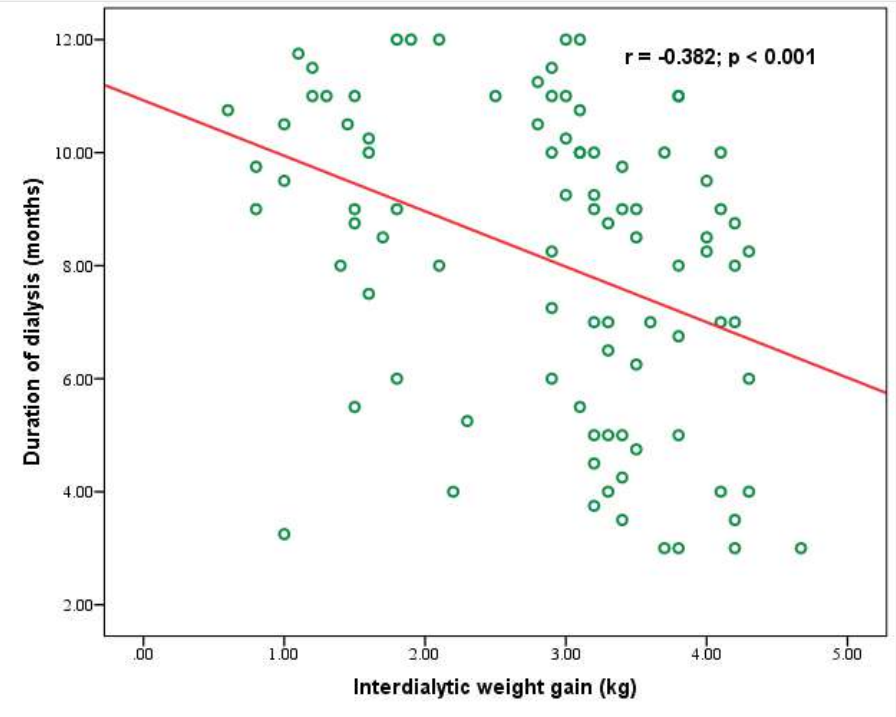

Figure – 1: Scattered Diagram Showing the Correlation of Interdialytic Weight Gain with the Duration of Dialysis

This is supported by the correlation coefficient (r) of -0.382, indicating a moderate negative correlation. The p-value of less than 0.001 signifies that this relationship is statistically significant. The scatter plot reinforces the finding that longer dialysis durations are associated with lower interdialytic weight gain, complementing the statistical analysis presented earlier. The negative correlation and significant *p*-value prove this inverse relationship (**Figure 1**).

DISCUSSION

This research examined the relationship between interdialytic weight gain and diabetic patients undergoing hemodialysis. This prospective analytical study included 109 diabetes mellitus patients undergoing maintenance hemodialysis, each attending twice-weekly sessions. The average age of participants in this study was 45.86±14.10 years, from 23 to 78 years. In contrast, comparable studies reported an average age of 63.23±10.85 years in their findings[21]. Males comprised 65.2% of the population, outnumbering females, who made up 34.8%, resulting in a male-to-female ratio of 1.88:1. According to Wahyuni et al. (2022), males were more prevalent than females[22]. Conversely, other

studies by ***Zahed et. al.*** (2017) indicated that females were more predominant, though their findings were not statistically significant (p<0.066)[23]. Sixty-one (66.3%) patients experienced an IDWG greater than 4%, while thirty-one (33.7%) patients had an IDWG of 4% or less. The average weight gain was 2.88±1.04 kg, ranging from 0.6 kg to 4.67 kg. This elevated IDWG was primarily attributed to uncontrolled diabetes mellitus, which increased both thirst and salt intake. Several studies support these findings[24-28]. They reported salt and water intake between dialysis sessions is the primary factor contributing to interdialytic weight gain (IDWG). Typically, sodium consumption through food is the main trigger for increased thirst. However, other factors also play a role in this process, such as the sodium concentration in the dialysis fluid, saline solution infusions during hemodialysis (particularly in the session's final minutes), residual kidney function, and hyperglycemia in diabetic patients[24-28]. ***Foley et. al.*** indicated that an IDWG greater than 4.8% was also linked to uncontrolled diabetes mellitus[14]. In another study, ***Saran et. al.*** found that an IDWG of over 5.7% was due to uncontrolled diabetes mellitus, skipped or shortened dialysis sessions, and hyperphosphatemia[15]. ***Kalantar-Zadeh et. al.*** reported that an IDWG of 4% or more was associated with younger age, male gender, diabetes, higher protein intake, and better nutritional status, leading to more excellent fluid retention[16]. They also found that activation of the sympathetic nervous system, the renin-angiotensin-aldosterone system, and the release of antidiuretic hormone could create a cycle that exacerbates IDWG. Furthermore, their study noted that using albumin or neurohormonal antagonists, such as vasopressin receptor antagonists, aldosterone antagonists, or nesiritide, helped reduce IDWG[16]. IDWG significantly decreased with longer durations of dialysis (p=0.003). In our study, 22(23.9%) patients received hemodialysis for less than six months (Group A), 33(35.9%) patients for around nine months (Group B), and 37(40.2%) patients for more than nine months (Group C). Comparing the durations, the difference between Groups A and B was not statistically significant (p=1.00), but there was an essential difference between Groups B and C (p=0.027) and between Groups A and C (p=0.005), as well as between Groups A and B and C (p=0.003). This trend was attributed to patients developing a more positive attitude towards fluid and diet compliance. Similar findings were reported by ***Wahyuni et. al.***, where they observed that 95.8% of patients on hemodialysis for less than 12 months had intolerable IDWG, while those on hemodialysis for 12-24 months had a 77.8% intolerance rate. All patients on hemodialysis for over 24 months had tolerable IDWG (100%)[22]. Their study also highlighted that more extended hemodialysis therapy increased patient knowledge and positive attitudes toward fluid and diet compliance. Consequently, as patients become more used to fluid and diet management, IDWG remains within tolerable limits[22]. Figure 1 demonstrates a significant negative correlation between IDWG and dialysis

duration (r = -0.382; p<0.001). Wahyuni et al. also found a strong negative correlation between hemodialysis duration and IDWG, reinforcing that more extended treatment periods enhance patient knowledge and attitudes toward compliance[22]. The findings indicate that IDWG is a common issue among dialysis patients, with a majority experiencing weight gain more significantly than the recommended levels. Moreover, the duration of dialysis appears to play a substantial role in IDWG, with longer durations correlating with reduced weight gain.

Limitations of the study:

The study's limitations include a small sample size and its focus on a single institution, which may limit the generalizability of the findings to other settings or populations. The study also considered diabetic patients undergoing twice-weekly hemodialysis, excluding other patient groups and dialysis regimens. Factors such as dietary habits, medication adherence, and fluid intake were not thoroughly controlled, which could influence interdialytic weight gain. Furthermore, the study's observational design restricts the ability to establish causal relationships between dialysis duration and interdialytic weight gain.

CONCLUSION & RECOMMENDATIONS

In conclusion, this study demonstrates a significant negative correlation between interdialytic weight gain (IDWG) and the duration of hemodialysis in diabetic patients. The results show that longer hemodialysis durations are associated with lower IDWG, suggesting that extended treatment may enhance patient fluid and diet compliance. With 66.3% of participants experiencing significant IDWG, these findings highlight the need for tailored interventions to manage fluid intake and improve dietary habits in dialysis patients. As hemodialysis duration increases, patients develop better strategies for controlling IDWG, improving health outcomes, and potentially reducing the associated mortality risk.

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Conflict of Interest

The authors declare no conflict of interest.

Ethical Approval

The study was approved by the Institutional Ethics Committee.

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