Impact of Interdialytic Weight Gain (IDWG) on Nutritional Parameters, Cardiovascular Risk Factors and Quality of Life in Hemodialysis Patients

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Abstract

Introduction. The amount of interdialytic weight gain (IDWG) considering body weight is of great importance in hemodialysis patients. In general practice, patients are asked to get standard weight between two hemodialysis sessions. However, it should be individualized considering patient’s weight. We aimed to determine the association between the IDWG and the nutritional parameters, cardiovascular risk factors, and quality of life.

Methods. Thirty-two patients receiving hemodialysis at least for one year were enrolled into the study. Patients were monitored for 12 consecutive hemodialysis sessions; and the arithmetic mean of IDWG was calculated. IDWG % was calculated in accordance with patients’ dry weight. Data of patients with IDWG<3% (Group I) and IDWG≥3 (Group II) were compared. Sociodemographic variables, laboratory, anthropometric measurements, blood pressure, left ventricular mass index, Subjective Global Assessment Scale and SF-36 Quality of Life Scale were applied to evaluate the patients.

Results. 59.4% (n=19) and 40.6% (n=13) of patients were included in Group I and Group II, respectively. In Group II, albumin (p=0.02), potassium (p=0.02), phosphorus (p=0.04), nPCR (p=0.03), physical function (p=0.04), role limitations caused by physical problems (p=0.03), general health (p=0.03), physical quality of life (p=0.04) scores were significantly higher. A significant correlation was detected between IDWG and physical and mental quality of life, total score SF-36, albumin, total protein and the potassium values.

Conclusions. Patients with an IDWG ≥ 3% have better nutritional parameters and quality of life scales. The limiting of IDWG to 1-2 kg, ingoring patient weight may give rise to malnutrition and a reduced quality of life.

Key words: hemodialysis, interdialytic weight gain, nutritional parameters, SF-36, triceps skinfold thickness

Introduction

The weight gain occurring in hemodialysis patients during the interval between the two hemodialysis sessions is called "interdialytic weight gain" (IDWG). Interdialytic weight gain is used as a measure to limit the weight gain between the two consequent dialysis sessions; however the values identified for this measure have been restricted to an absolute value of 1-2 kg [1,2]. Interdialytic weight gain usually tends to be relatively constant for each patient [1-3] and is affected by the dialytic factors (hypernatremia, the NaCl solution infusion during the hemodialysis), residual renal function, nutritional habits, hyperglycemia, environmental factors, the level of self-care and compliance with treatment [2-4]. Interdialytic weight gain may vary individually, while in the majority of the patients the IDGW is less than 5% of the body weight and is usually in the range of 2 and 3.5 kg [5].

In general, IDGW is thought to result from salt and water intake between the two dialysis sessions [2,3,6]. Liquid and salt are commonly consumed with carbohydrates, fats and proteins, suggesting that high IDWGs could be associated with a better nutritional state [2]. Despite the recent advances in hemodialysis, the mortality in dialysis patients is still very high, when compared to the normal population [1,7-9]. Malnutrition is one of the most significant risk factor for mortality in dialysis patients with no other concomitant systemic disease [1,7-11]. Malnutrition is defined as a state of nutrition, where inadequate, excessive or imbalanced intake of protein, energy and other nutrients cause measurable

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side effects on the tissues, whole body functions and the clinical outcomes [10]. Malnutrition may lead to suppression of the immune system, increased susceptibility to the infections, reduced wound healing, reduced functional capacity, anemia, erythropoietin resistance, and vascular access complications [1,7,11].

Malnutrition is multifactorial in chronic renal disease. Loss of protein, increased protein catabolism, endocrine causes and inadequate intake may be summarized as the etiologic factors [1,7-11]. In dialysis patients, strict diet, dysgeusia, nausea-vomiting, inadequate dialysis, psychological and socio-economical causes contribute to malnutrition [1,8-10].

The end-stage renal disease (ESRD) itself is also associated with many unfavorable factors such as hypertension, dyslipidemia and inflammation, which are also established as risk factors for cardiovascular diseases [12]. Using the percentage of the weight gain instead of a fixed number, is more correct to be in accordance between the body weight and weight gain. The weight gain per body weight takes into account patient’s measures. For example, a 3 kg weight gain is excessive for a patient weighing 50 kg (6%) but it is normal for a patient weighing 50 kg (3% increase) [1].

The amount of IDWG considering body weight is of great importance in hemodialysis patients. Thereof, the IDGW should be individualized as IDWG%: weight gain per body weight. In this descriptive and correlative and cross-sectional study, we aimed to analyze the possible correlation between IDGW% and sociodemographic variables, disease variables, nutritional state variables, cardiovascular risk factors and the quality of life in hemodialysis patients.

Material and methods

This study was conducted at the Adnan Menderes University Medical Faculty Hospital Hemodialysis Unit between February 2013 and April 2013.

Ethical Considerations

This study was performed in accordance with the principles of the Helsinki Declaration. The study was submitted to the local ethics committee of clinical research and was granted approval with decision number B.30.2. ADU.0.20.05.00/050.04-220, dated 31.08.2012. The objectives, methods, targets and the potential hazards of the study were explained to all individuals. The participants were informed and gave their informed consent before participating in the study.

The study population

Chronic hemodialysis patients for at least one year, aged 18-75 years, without overt hypervolemia, active infection or malignancy were considered to be eligible for the study. Forty patients were evaluated for eligibility and 32 patients fulfilled the criteria.

Study Group

The IDWG were recorded during 12 consecutive hemodialysis sessions. The IDWG (the current pre-dialysis weight minus the preceding post-dialytic weight) was measured in each hemodialysis session and the mean IDWG of 12 consecutive hemodialysis sessions was used for statistical analysis. The IDWG% was expressed as a proportion of the current dry weight [3,14]. Patients were grouped into 2 groups based on the percent IDWG considering the dry weight: Group I and Group II were composed of patients with IDWG less than 3% of dry weight and IDWG equal or greater than 3% of dry weight, respectively.

Data Collection Tools

Patients’ height, mid-arm circumference, and triceps skinfold thickness and pre-dialysis and post-dialysis weight were measured. A skin caliper was used for measuring triceps skinfold thickness. Mid-arm muscle circumference, arm muscle area were calculated by the Heymsfield formula [13]. Mid-arm fat area was calculated as 
\[
\frac{\text{[mid-arm circumference-triceps skinfold thickness]}^2}{2} \times \pi \times \text{triceps skinfold thickness}
\]

and body mass index (BMI) was calculated using the weight (kg)/height (m²) formula.

Blood pressure was measured throughout the 12 sessions, recorded and the arithmetic means were calculated. The "General data form" intended for the hemodialysis patients, and the "Session data form", "Subjective Global Assessment (SGA) Scale", "The Medical Outcomes Study Short Form 36-Item Health Survey (SF-36)" intended for the dialysis session, were used as data collection tools.

The SGA consisted of 5 components, including weight change, dietary intake, GI symptoms, functional capacity, subcutaneous fat and signs of muscle wasting. Each component was scored as A (normal), B (mild to moderate malnutrition) or C (severe malnutrition). Based on the data from all forms, the physician grouped the patients into 3 in accordance with the total SGA score as well-nourished (A), mildly-moderately malnourished (B) and severely malnourished (C) [15]. The SF-36 is designed as 2 main-topic scales that include 36 expressions and assess 8 health dimensions. The main topics are the quality of life and the global quality of life. The 8 dimensions are the Physical function (PF), Role limitations caused by physical problems, Pain, General health, Vitality/energy, Social function, Mental health/emotional well-being and Role limitations caused by emotional problems/mental health. Each dimension was scored as 0-100, with a higher score indicating better quality of life [16]. The SF-36 and the SGA forms completed...
by the investigator used the personal expressions and
the patient file records through face-to-face interviews.

**Biochemical Analysis**

During the initial session of the study, a 12-hour fasting
blood sampling was performed before the hemodialysis
for measuring urea, creatinine, sodium, potassium, cal-
cium, phosphorus, total protein, albumin, lipid panel and
hemoglobin. At the end of the hemodialysis session, post-
dialysis serum urea, serum creatinine and potassium
measurements were obtained. Urea reduction rate (URR)
was calculated as follows: [(pre dialysis urea-post dialy-
sis urea) x 100] / (pre dialysis urea). Single pool Kt/V was
calculated, using the Daugridas formula, and the nor-
malized protein catabolic rate (nPCR) calculated via
kinetic urea model [17].

**Echocardiographic Evaluation**

An experienced cardiologist conducted the echocardi-
ographic investigations at the Cardiology department of
our Faculty. Measuring the parameters by the Deve-
reux formula, the left ventricular mass was divided by
the body surface area to calculate the left ventricular
mass index (LVMI) [18]. A left ventricular mass index
>131 gr/m² and >100 gr/m² was accepted to indicate
the presence of left ventricular hypertrophy (LVH) for
males and females, respectively [19]. The patients were
divided into 2 groups as those with and without LVH.

### Table 1. Sociodemographic features of the groups

| Sociodemographic features | Group I (n=19) (IDWG < 3%) | Group II (n=13) (IDWG ≥ 3%) | P |
|---------------------------|---------------------------|---------------------------|---|
| **Age (mean±sd)**         | 64.1 ± 7.8                | 64.6 ± 9.3                | 0.954 |
| **Gender (n,%)**          |                           |                           |   |
| Male                      | 12(37.5%)                 | 7(21.9%)                  | 0.598 |
| Female                    | 7(21.9%)                  | 6(18.8%)                  |   |
| **Marital status (n,%)**  |                           |                           |   |
| Single                    | 1(3.1%)                   | 0(0%)                     |   |
| Married                   | 17(53.1%)                 | 13(40.6%)                 | 0.482 |
| Divorced/Widow            | 1(3.1%)                   | 0(0%)                     |   |
| **Education (n,%)**       |                           |                           |   |
| Literate                  | 1(3.1%)                   | 1(3.1%)                   | 0.162 |
| Primary school            | 13(40.6%)                 | 7(21.9%)                  |   |
| Middle school             | 3(9.4%)                   | 0(0%)                     |   |
| High school and higher    | 2(6.2%)                   | 5(15.6%)                  |   |
| **Profession (n,%)**      |                           |                           |   |
| Housewife                 | 6(18.8%)                  | 4(12.5%)                  |   |
| Retired                   | 10(31.2%)                 | 6(18.8%)                  |   |
| Self-employed             | 2(6.2%)                   | 2(6.2%)                   | 0.670 |
| Civil servants            | 0(0%)                     | 1(3.1%)                   |   |
| Laborer                   | 1(3.1%)                   | 0(0%)                     |   |
| **Live with (n,%)**       |                           |                           |   |
| Alone                     | 1(3.1%)                   | 0(0%)                     | 0.401 |
| With family               | 18(56.2%)                 | 13(40.6%)                 |   |
| **Income level (n,%)**    |                           |                           |   |
| Low-income                | 3(9.4%)                   | 1(3.1%)                   | 0.458 |
| Moderate                  | 16(50.0%)                 | 12(37.5%)                 |   |

**Statistical Data Analysis**

Statistical assessments were performed using the Sta-
tistical Package for Social Sciences for Windows, ver-
sion 17 [SPSS Inc; Chicago, IL, USA]. The descriptive
statistics was expressed in number (n, %) and the mean ±
standard deviation.

The quantitative variables were expressed as mean ±
standard deviation (SD), and the qualitative variables as
percentage (%) or proportion. The compliance of the
variables with the normal distribution was assessed by
the Kolmogorov-Smirnov test. For comparison of the
variables between the groups, the Student’s t-test and
the Mann-Whitney U test were used respectively in case
of normal and abnormal distribution. As for the qual-
titative variables, the chi-square test was used, or the
Fisher’s exact test if the expected values were below 5
in the cross tables. The correlations between the variables
were investigated using the Pearson’s correlation test.
A value of p<0.05 was considered significant.

**Results**

Thirty-two patients were included in the study. The mean
age was 64.3±8.3 years. 40.6% were males (13), 93.8%
were married, 62.5% were primary school graduates,
96.9% lived with the family, 50% were retired, 31.3%
were housewives and 87.5% had a moderate income.
With respect to the primary disease, 37.5% of them had hypertensive nephropathy and 25% had diabetic nephropathy. The mean dialysis duration was 24 months. In addition to ESRD, 34.4% of the patients had concomitant hypertension, 25% had diabetes and 12.5% had cardiac diseases.

The hemodialysis patients were grouped into 2 based on their IDWG: 19 patients (54.9%) were in Group I (IDWG less than 3% body weight) and 13 patients (40.6%) were in Group II (IDWG equal or greater than 3% body weight). There were no differences between the two groups with respect to sociodemographic features (Table 1).

Table 2. Laboratory and cardiovascular features of the groups

| Parameter                  | Group I (n=19) (IDWG < 3%) | Group II (n=13) (IDKA ≥ 3%) | P   |
|----------------------------|-----------------------------|-----------------------------|-----|
| BUN (mg/dL)                | 53.3±14.3                   | 56.4±7.6                    | 0.156|
| Creatinine (mg/dL)         | 6.7±1.8                     | 7.8±2.1                     | 0.140|
| Total protein (gr/dL)      | 6.9±0.4                     | 7.9±0.5                     | 0.758|
| Albumin (gr/dL)            | 3.4±0.4                     | 3.7±0.2                     | 0.026*|
| CRP (ng/dL)                | 10.6±10.6                   | 8.1±7.1                     | 0.759|
| Phosphorus (mg/dL)         | 4.1±1.3                     | 4.7±0.9                     | 0.040*|
| Potassium (mg/dL)          | 4.5±0.7                     | 4.9±0.5                     | 0.025*|
| Total cholesterol (mg/dL)  | 193.6±82.5                  | 193.5±52.8                  | 1    |
| Triglycerides (mg/dL)      | 180.2±143.6                 | 180.6±96.8                  | 0.242|
| Hemoglobin (g/dL)          | 11.4±1.5                    | 11.2±1.6                    | 0.734|
| Fe (mg/dL)                 | 61.7±26                     | 68.9±20                     | 0.234|
| Transferrin saturation (%) | 28.6±10                     | 32.2±12                     | 0.274|
| Ferritin (ng/dL)           | 524±527                     | 386±274                     | 0.454|
| HCO₃ (mEq/L)               | 20.5±2.0                    | 21.6±1.8                    | 0.124|
| Kt/V                       | 1.7±0.3                     | 1.75±0.2                    | 0.847|
| URR (%)                    | 77.7±6.9                    | 77.4±4.1                    | 0.478|
| nPCR (gr/kg/day)           | 0.9±0.2                     | 1.1±0.1                     | 0.032*|
| Systolic BP (mmHg)         | 120.3±18.6                  | 115.2±14.2                  | 0.398|
| Diastolic BP (mmHg)        | 70.3±8.5                    | 68.3±6.4                    | 0.551|
| MAP (mmHg)                 | 90.8±13.1                   | 94.6±13.2                   | 0.425|
| Ejection fraction (%)      | 58.1±6.2                    | 56.0±10.7                   | 0.654|
| LVMI (gr/m²)               | 115.9±52.4                  | 105.4±29.2                  | 0.939|
| Cardiothoracic ratio (%)   | 47.1±4.1                    | 49.4±4.4                    | 0.123|

Abbreviations: BUN - Blood urea nitrogen, CRP- C-reactive protein, URR - Urea reduction rate; nPCR - normalized protein catabolic rate; BP - Blood pressure; MAP - Mean arterial pressure; LVMI - Left ventricle mass index
The rate of well-nourished patients (A) was 68.4% in Group I (13/19) and 69.2% (9/13) in Group II; there was no difference between the two groups with respect to SGA. There were no severely malnourished (C) patients in either group.

The SF-36 overall score in Group I and Group II was 52.1±21.6 and 63.3±29.5, respectively (p=0.173). Compared to Group I, Group II had a significantly higher Physical function (PF) (p=0.04), Role limitations caused by physical problems (p=0.04), General health (p=0.03) scores among the quality of life sub-dimensions, and a significantly higher physical quality of life (p=0.04) from the main topic (Table 3). In correlation analysis, IDWG was positively correlated with total protein, albumin and potassium (Figure 2). In addition, IDWG was positively correlated with the main topics of quality of life (physical and mental quality of life). The IDWG was not correlated with the anthropometric measurements, and cardiovascular findings (Table 4).
Impact of interdialytic weight gain in hemodialysis patients

Fig. 2. Intradialytic weight gain (IDWG) correlation between the variables

Table 4. Interdialytic weight gain correlation with laboratory, anthropometric, cardiovascular parameters and SF-36 scores

| Parameter                        | R   | P     | Parameter                        | R   | P     |
|----------------------------------|-----|-------|----------------------------------|-----|-------|
| Age (year)                       | 0.195 | 0.284 | Cardiothoracic ratio (%)         | 0.205 | 0.262 |
| BUN (mg/dL)                      | 0.09  | 0.625 | Triceps skinfold thickness (cm)  | -0.097 | 0.599 |
| Creatinine (mg/dL)               | 0.304 | 0.091 | Mid-arm muscle circumference (cm)| -0.065 | 0.722 |
| Total protein (gr/dL)            | 0.351 | 0.049*| Arm muscle area (cm²)            | 0.020 | 0.913 |
| Albumin (g/dL)                   | 0.468 | 0.007*| Mid-arm fat area (cm²)           | -0.131 | 0.476 |
| Phosphorus (mg/dL)               | 0.325 | 0.069 | Mid-arm circumference (cm)       | -0.069 | 0.706 |
| Potassium (mg/dL)                | 0.393 | 0.026*| Physical function                | 0.433 | 0.013*|
| Kt/V                             | -0.013 | 0.943 | Role limitations physical (RP)   | 0.572 | 0.001*|
| URR                              | -0.126 | 0.494 | Pain                             | 0.146 | 0.425 |
| nPCR (gr/kg/day)                 | 0.300 | 0.095 | General health                   | 0.365 | 0.040*|
| Total cholesterol (mg/dL)        | -0.008 | 0.966 | Vitality/Energy                  | 0.277 | 0.125 |
| HCO₃ (mEq/L)                     | -0.280 | 0.120 | Social function                  | -0.139 | 0.447 |
| BMI (kg/m²)                      | 0.091 | 0.621 | Emotional                        | 0.466 | 0.007*|
| LVMI (gr/m²)                     | -0.009 | 0.960 | Mental health (MH)               | 0.275 | 0.128 |
| Ejection fraction (%)            | -0.185 | 0.310 | Physical component summary       | 0.436 | 0.013*|
| Systolic BP (mmHg)               | -0.011 | 0.983 | Mental component summary         | 0.357 | 0.045*|
| Diastolic BP (mmHg)              | 0.083 | 0.652 | Total score of SF-36             | 0.358 | 0.044*|

**Abbreviations:** BUN - Blood urea nitrogen; URR - Urea reduction rate; nPCR - Normalized protein catabolic rate; BMI - Body mass index; LVMI - Left ventricle mass index; BP - Blood pressure; RP - Role limitations caused by physical problems; MH - Mental health/emotional well-being

Discussion

Interdialytic weight gain is regarded as an indicator for treatment compliance for a long time [2,3]. The effect of IDGW is unclear in the dialysis patients. No consensus was achieved on the fact that a higher IDWG was beneficial for the dialysis patients [3,5,9,20,21]. Various trials have reported on the association between the nutritional parameters and the IDWG [2,3,6,9,14,21]. A study reported better five-year actuarial survival with high IDWG [3]. However, in a retrospective study, 255 patients who had recently started hemodialysis, a high IDWG was reported not to be an indicator of nutrition; and in contrast, a high IDWG was indicated to
increase mortality by resulting in LVH, hypertension and intradialytic hypotension [20]. The mean IDWG was 2.7±1.1 in our study and IDWG values presented similarity with the other studies [3-5,9]. As previous studies have defined IDWG a cutoff value of 3% showed that less than 3% have poor prognosis and poor nutrition [3,9]. Therefore, in our study this 3% value was used as a cutoff value for identifying the groups. Interdialytic weight gain is directly in line with the body weight; this explains the higher absolute IDGW (expressed in kg) in males [5] Lopez et al. [3] detected that IGWG was higher in males than in females. Patients below 65 years of age were reported to have a higher appetite; in addition, younger patients were observed to have a quite high level of sodium and fluid loading and thus their IDWG were higher [1,3-5,14,21]. Even if this is true for the overall population, it may also result from a low comorbidity associated with young age [3].

Various methods are applied to detect malnutrition. These primarily include the anthropometric measurements, assessment of serum albumin level, SGA and nPCR [10]. Particularly, serum albumin level is a valuable parameter in hemodialysis patients; a low serum albumin level (<3.5 gr/dl) is known to be a significant indicator of malnutrition and thus mortality [7]. Mortality and morbidity is high in hemodialysis patients with a low serum urea and albumin level [8]. Many studies have reported a high albumin level in patients with a high IDWG; on the other hand a retrospective study in 283 patients detected a negative correlation between IDWG and albumin [3,4,6,9,21]. While albumin is used as an indicator in assessment of nutrition, there is a considerable extent of suspicion on its sensitivity. Albumin is a negative acute phase reactant; under conditions of inflammation, sepsis or stress, serum albumin level generally does not respond to nutritional support or responds slightly [8,10]. In our study, the level of CRP, an inflammation indicator, was similar between the two groups. Albumin levels were detected to be significantly high in the high IDWG group. We attributed it to good nutritional status. Likewise, nPCR, measured via kinetic urea model, is an index of protein intake [3]. It is also a practically ideal nutrition parameter since it is mildly affected by inflammation [8,10,17]. Patients with a high IDWG were shown to have a higher nPCR [3,4,6,9,21]. Phosphorus level is an indicator of protein intake; potassium level is likewise related to nutritional state. We found significantly high levels of nPCR, phosphorus and potassium levels in the high IDWG group. These findings supported the fact that patients were well-nourished. There are relevant studies with findings that are in line with ours [3,4,9]. There are a large number of studies reporting a positive correlation between IDWG and the nutritional indicators of pre-dialysis BUN, creatinine and pre-albumin levels [3,9,21].

Kt/V indicates the sufficiency of dialysis. Severely high levels may result from a reduced urea distribution volume, due to a latent malnutrition presence. Kt/V values >1.7 were reported to potentially indicate malnutrition [22,23]. While a negative correlation was detected between IDWG and Kt/V, there are also studies reporting a positive correlation [3,4,6,21]. In our study, the groups did not differ in Kt/V and URR values and the values were above the target value; and thus additional factors such as dialysis insufficiency, which could impair the analysis of IDWG and nutrition correlation, were excluded. Dialysis patients with a higher IDWG were detected to have lower serum HCO3 values compared to those with a low IDGW. This was attributed to the high acid production in concomitance with higher protein intake and dilution was indicated to potentially contribute to this reduction [2,3,24]. In contrast, we detected no relationship between HCO3 and IDWG.

Subjective global assessment is a simple method used to demonstrate the state of nutrition in ESRD patients, which involves parameters such as medical history, state of nutrition, and acute stress. The subjective global assessment was reported to be closely associated with morbidity and mortality [8,11,15]. Modified SGA score was shown to be negatively correlated with triceps skinfold thickness, mid-arm muscle circumference, pre-albumin, ferritin, transferrin and the total iron binding capacity in hemodialysis patients [15,25]. The IDWG% values were detected to be high in hemodialysis patients with malnutrition as defined by SGA [26]. In our study, we did not find a correlation between SGA and IDGW. Anthropometric measurements are convenient, fast and safe to administer [8,11]. The body mass index is an important indicator of the state of nutrition [3]. Different from the general population, dialysis patients are reported to have a reduction in mortality as the BMI increases; this has been potentially attributed to better nutrition [11]. Another study revealed a mortality in the form of j curve in similarity to the general society and the mortality was the lowest in those with a BMI of 25-27.5 kg/m² [27]. A strong correlation was detected between BMI and IDWG% [9]. In patients IDWG less than 3% were found significantly lower BMI. Considering that the changes in BMI occur slowly in each patient, one could assume IDWG has a large effect on the state of nutrition in hemodialysis patients. There was no difference between the two groups in anthropometric measurements in our study and there was no correlation with IDWG. Similarly, in a previous study, there was a negative correlation between IDWG and mid-arm circumference and no association found with IDWG and arm muscle area. It was indicated that the findings could be misleading in ESRD patients due to the inadequacy of the sensitivity of the anthropometric measurements and the variable tissue hydration or myopathy [4]. We agree with this opinion.
The risk of cardiovascular events has increased 5 to 30-fold in dialysis patients relative to the overall population [28,29]. The target blood pressure values in the absence of cardiovascular risk, recommended for renal patients are as follows: systolic <130 mmHg, diastolic <80 mmHg. We detected systolic and diastolic blood pressure values as 120.3±18.6, 115.2±14.2, 70.3±8.5, 68.3±6.4 mmHg in group I and II, respectively; the values were within the target range. Blood pressure did not significantly differ between the two groups. There are trials showing no relationship between blood pressure and IDWG, and interdialytic blood pressure in normotensive or hypertensive patients does not correlate with the rise in IDWG [2,28,30]. There are also studies indicating that blood pressure was positively correlated with IDWG [3,21,31]. Cardiovascular and overall mortality was observed to be high in those with an IDGW > 5.7 [1]. Each 1% increase in IDGW was detected to increase the blood pressure by 1 mmHg; however, patients with IDGW less than 3% were observed to have a higher mortality after 5 years [31]. A prospective, observational study reported that the 5-year survival increased with the IDWG increase and the two-year mortality rate was higher in patients with a lower IDGW [3,9]. The investigators concluded that the favorable effects of IDGW on nutrition outweighed the unfavorable effects of blood pressure. They also underlined the fact that patients needed to maintain dietary salt restriction for blood pressure management [3].

In dialysis patients, LVH is the first condition occurring with a potential to lead to other complications over time including ischemic cardiac disease and cardiac failure. Anemia, hypertension, secondary hyperparathyroidism, volume overload, AV fistula, uremia and malnutrition are among the factors that contribute to the development of LVH. Repetitive volume overload may lead to early mortality by contributing to LVH and left ventricular dilatation [10,12].

There was no significant difference between the groups with respect to LVH. In a different study, LVH was observed to be significantly high in patients with an IDWG > 5%; IDGW was reported to potentially cause LVH via non-blood pressure-mediated mechanisms [32]. We used the 3% value; therefore, the results were considered to lack similarity with 5% of findings. Our study showed no correlation between LVMI and IDWG; this finding is consistent with those from the previous study [32]. There are no quality of life comparisons with IDWG in the literature. However, association between state of nutrition and quality of life showed that patients with a better nutritional state had a better physical condition [33-35]. In diabetic patients, an adequate maintenance of life is defined as fulfillment of all individual requirements, satisfaction with life, adequate social behaviors, enough recreational time spared, sufficient emotional and physical state, and maintenance of interindividual relations. The quality of life is lower in ESRD with regard to the normal population due to the dialysis procedure, nutrition, and other risk factors such as the presence of concomitant diseases [33].

In our high-IDWG group (group II), physical function, role limitations caused by physical problems, general health and physical quality of life, included in the quality of life scale were detected to be higher. Physical and mental quality of life items of the quality of life scale, and overall SF-36 score were significantly correlated with IDWG. Our findings suggest a potential correlation between the increase in quality of life and the IDWG.

Conclusions

Based on our results, we can conclude that an IDWG less than 3% of the body weight could result in undesirable nutritional effects and secondary malnutrition and reduced quality of life. Therefore, awareness of the fact that IDWG% is a good indicator of nutrition should be established, and caution exercised to avoid the potential negative effects of nutrition. 3-5% IDWG seems to be most suitable weight gain due to mortality and nutrition.

Conflict of interest statement. None declared.

References

1. Lindberg M, Prutz K, Lindberg P, Wikstrom B. Interdialytic weight gain and ultrafiltration rate in hemodialysis: lessons about fluid adherence from anational registry of clinical practise. Hemodial Int 2009; 13: 181-188.
2. Sarkar SR, Kotanko P, Levin NW. Interdialytic Weight Gain: Implications in Hemodialysis Patients. Semin Dial 2006; 19: 429-433.
3. Lopez-Gomez JM, Villaverde M, Jofre R, et al. Interdialytic weight gain as a marker of blood pressure, nutrition, and survival in hemodialysis patients. Kidney Int Suppl 2005; 93: 63-68.
4. Kimmel PL, Varela MP, Peterson RA, et al. Interdialytic weight gain and survival in hemodialysis patients: Effects of duration of ERSD and diabetes mellitus. Kidney Int 2000; 57: 1141-1451.
5. Ifadu O, Uribarri J, Rajwani I, et al. Relation between interdialytic weight gain, body weight and nutrition in hemodialysis patients. Am J Nephrol 2002; 22: 363-368.
6. Sherman RA, Cady RP, Rogers ME, Solanchick JC. Interdialytic weight gain and nutritional parameters in chronic hemodialysis patients. Am J Kidney Dis 1995; 25: 579-583.
7. Duranay M, Ozdemir O, Guler SC, Ecemis Z. Evaluation of nutritional parameters in hemodialysis patients. Turk Neph Dial Transpl 2004; 13: 16-20.
8. Sezer S, Arat Z, Ozdemir FN. Malnutrition in chronic renal failure. Turk Neph Dial Transpl 2000; 3: 125-129.
9. Sezer S, Ozdemir FN, Arat Z, et al. The Association of interdialytic weight gain with nutritional parameters and mortality risk in hemodialysis patients. Ren Fail 2002; 24: 37-48.
10. Demir M, Tonbul ZH. Malnutrition-Inflammation-Atherosclerosis (MIA Syndrome) in ESRD Patients. Turk Neph Dial Transpl 2005; 14: 160-165.
11. Kalantar-Zadeh K, Block G, Humphreys MH, Kopple JD. Reverse epidemiology of cardiovascular risk factors in maintenance dialysis patients. Kidney Int 2003; 63: 793-808.
24. Schnirin E.L., Lipman M.L., Mann J.F. Chronic kidney disease: effects on the cardiovascular system. *Circulation* 2007; 116: 85-97.
25. Heymsfield S.B., McManus C., Smith J., et al. Anthropometric measurement of muscle mass: revised equations for calculating bone-free arm muscle area. *Am J Clin Nutr* 1982; 36: 680-690.
26. Yang S.C., Chiang C.K., Hsu S.P., Hung K.Y. Relationship between interdialytic weight gain and nutritional markers in younger and older hemodialysis patients. *J Ren Nutr* 2008; 18: 210-222.
27. Steiber A.L., Kalantar-Zadeh K., Secker D., et al. Subjective Global Assessment in chronic kidney disease: a review. *J Ren Nutr* 2004; 14: 191-200.
28. Ware J.E., Sherbourne C.D. The MOS 36-item short form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992; 30: 473-483.
29. Daugirdas J.T. Second generation logarithmic estimates of single-pool variable volume KT/V: An analysis of error. *J Am Soc Nephrol* 1993; 4: 1205-1213.
30. Devereux R.B., Alonso D.R., Lutas E.M., et al. Echocardiographic assessment of left ventricular hypertrophy: comparison to necropsy findings. *Am J Cardiol* 1986; 57: 450.
31. Savage D.D., Garrison R.J., Kannel W.B. The spectrum of left ventricular hypertrophy in a general population sample: the Framingham Study. *Circulation* 1987; 75: 126-33.
32. Chen Y.W., Chen H.H., Pan C.F., et al. Interdialytic weight gain does not influence the nutrition of new hemodialysis patients. *J Ren Nutr* 2012; 22: 41-49.
33. Testa A., Beaud J.M. The other side of the coin: Interdialytic weight gain as an index of good nutrition. *Am J Kidney Dis* 1998; 31: 830-834.
34. Chertow G.M., Owen W.F., Lazarus J.M., et al. Exploring the reverse J-shaped curve between urea reduction ratio and mortality. *Kidney Int* 1999; 56: 1872-1878.
35. Salahudeen A.K., Dykes P., May W. Risk factors for higher mortality at the highest levels of spkt/V in haemodialysis patients. *Nephrol Dial Transplant* 2003; 18: 1339-1344.
36. Agroyannis B., Fourtounas C., Tzanatos H., et al. Relationship between interdialytic weight gain and acid-base status in hemodialysis by bicarbonate. *Artif Organs* 2002; 26: 385-387.
37. Janardhan V., Soundararajan P., Rani N.V., et al. Prediction of Malnutrition Using Modified Subjective Global Assessment-dialysis Malnutrition Score in Patients on Hemodialysis. *Indian J Pharm Sci* 2011; 73: 38-45.
38. Nerbass F.B., Morais J.G., Santos R.G., et al. Factors related to interdialytic weight gain in hemodialysis patients. *J Bras Nefrol* 2011; 33: 300-305.
39. de Mutsert R., Snijder M.B., van der Sman-de Beer F., et al. Association between body mass index and mortality is similar in the hemodialysis population and the general population at high age and equal duration of follow-up. *J Am Soc Nephrol* 2007; 18: 967-974.
40. Tural E., Sezer S., Arat Z., Ozdemir F.N. Comparison of Hemodialysis Patients With Continuous Ambulatory Peritoneal Dialysis Patients in Terms of Cardiovascular Disease Risk Factors: A Three-Year Follow-up. *Turk Neph Dial Transpl* 2005; 14: 5-13.
41. de Jager D.J., Grootendorst D.C., Jager K.J., et al. Cardiovascular and Noncardiovascular Mortality Among Patients Starting Dialysis. *JAMA* 2009; 302: 1782-1789.
42. Luik A.J., Gladziva J.P., Kooman J.P., et al. Influence of interdialytic weight gain on blood pressure in hemodialysis patients. *Blood Purif* 1994; 12: 259-266.
43. Ingrig J.K., Patel U.D., Gillespie B.S., et al. Relationship between interdialytic weight gain and blood pressure among prevalent hemodialysis patients. *Am J Kidney Dis* 2007; 50: 108-118.
44. Wu S.C., Jeng F.R. Relationship between increased interdialytic body weight and left ventricular hypertrophy in maintenance dialysis patients. *Nephrolology* 2001; 6, 85-88.
45. Dwyer J.T., Larive B., Leung J., et al. Hemodialysis Study Group. Nutritional status affects quality of life in Hemodialysis (HEMO) Study patients at baseline. *J Ren Nutr* 2002; 12: 213-223.
46. Rambod M., Bross R., Zitterkoph J., et al. Association of Malnutrition-Inflammation Score with quality of life and mortality in hemodialysis patients: a 5-year prospective cohort study. *Am J Kidney Dis* 2009; 53: 298-309.
47. Kalantar-Zadeh K., Kopple J.D., Block G., Humphreys M.H. Association among SF36 quality of life measures and nutrition, hospitalization, and mortality in hemodialysis. *J Am Soc Nephrol* 2001; 12: 2797-2806.