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Effect of Sugar Free Gum Chewing on Thirst and Interdialytic Weight Gain among Patients Undergoing Hemodialysis

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Abstract: Thirst is a frustrating symptom for patients on hemodialysis; mechanisms that contribute to its development include low saliva flow. An increased intake of fluids secondary to thirst in patients on hemodialysis will result in excessive interdialytic weigh gain. Increased mastication in the form of gum chewing can increase saliva flow rates, decrease thirst and interdialytic weight. **Purpose**: to examine the effect of sugar free gum chewing on thirst and interdialytic weight gain (IWG) among patients undergoing hemodialysis. **Design:** A quasi-experimental design was utilized. **Setting:** Hemodialysis unit in Menouf general hospital, Egypt. **Sampling:** Consecutive sample of 90 adult patients of both genders were divided alternatively into three equal groups 30 patients in each (study group 1, study group 2 and control group). **Instruments:** (1) Structured Interview questionnaire, (2) Dialysis Thirst Inventory and (3) Bio-physiological measurements. **Results:** There was a significant improvement in thirst sensation and significant decrease in interdialytic weight among studied groups than control group. **Conclusions:** Using of gum chewing alleviate thirst sensation and significantly decreases interdialytic weight gain among patients undergoing hemodialysis. **Recommendations**: Gum chewing should be encouraged and added to the management protocol for patients undergoing hemodialysis for positive effect on, alleviate thirst sensation, help compliance to fluid restriction, control of interdialytic weight gain and improve the quality of life moreover; further research studies using a larger sample and different geographical areas.

Key words*: Sugar free chewing Gum, Thirst, Interdialytic Weight Gain, Hemodialysis*

Introduction

End-stage renal disease (ESRD) treated by either dialysis or kidney transplantation, so the onset of ESRD is a turning point during chronic kidney disease. Most patients are treated by hemodialysis or peritoneal dialysis. Patients on hemodialysis account for nearly 92% of the overall

dialysis population (Saglimbene, et al., 2022; and Rosansky, et al., 2017).

Both chronic kidney diseases and its treatment can cause tissue and systemic alterations and directly affect the flow, concentration, and salivary composition. As a result of kidney failure, subsequently excess fluid intake leads to edema that affects the weight among patients undergoing hemodialysis (Rodrigues et al., 2021; and Mahmoodi et al., 2017).

Hemodialysis is a life-saving treatment for end-stage renal disease (ESRD) but is burdensome, invasive and expensive. Dialysis is the process of removing waste products and excess fluids from the body. It can perform two of the principal functions of the kidney through removal of endogenous waste products and maintenance of water balance. Adequacy of dialysis is a term that has been used for many years based on measurement of small solute clearance using urea and creatinine (Putr, et al., 2022; and EL Shemy et al., 2016).

Thirst is a subjective sensation that can be defined as the desire to drink water and has identifiable signs that alter the physical, mental and social functioning of the patient. A complex mechanism composed of osmo, baro, mecano and thermo-receptors signals the need for water intake to specific areas of the brain, triggering a subjective and uncomfortable thirst. Severe thirst distress is frequent in hemodialysis patients, and some studies have noted a positive relationship between thirst and an increased interdialytic weight gain (Hsu et al., 2022; and Silva et al., 2016).

Interdialytic weight gain is an indicator of compliance with the fluid–restricted diet, and is influenced by social and psychological factors, but foremost by physical factors like excessive thirst. In chronic hemodialysis, a patient's fluid status is reflected by their interdialytic weight gain. In the United States, 10–20% of chronic hemodialysis patients routinely experience high interdialytic weight gain, often defined as ≥ 5.7% of a patient's estimated dry weight (Maurizio et al., 2020; and Pavani et al., 2016).

Interdialytic weight gain (IDWG) is the result of salt and water intake between two hemodialysis sessions, and it is used as a parameter for fluid intake while taking the daily urine output into consideration. Increased interdialytic weight in hemodialysis patients causes increased risk of death due to cerebrovascular events, cardiovascular diseases and leads to an increase in morbidity and mortality together with a deterioration of the patient's quality of life. Interdialytic weight gain reflects incompliance with fluid control because of the secondary excessive consumption of liquid and food and is an important surrogate outcome (Ozen et al., 2021).

Patients on hemodialysis must maintain a fluid-restricted diet to prevent fluid overload. During hemodialysis, excess fluid is removed to normalize extracellular fluid volume and blood pressure. For many hemodialysis patients, however, it is difficult to adhere to this fluid restriction. Chronic fluid overload can result in hypertension, acute pulmonary edema, congestive heart failure, and early death (Chang, et al., 2021; and Kahkhaie et al., 2017).

Because saliva is extremely important, strategies have been developed to reduce the discomfort of dry mouth - the main and most uncomfortable attribute linked to thirst. These strategies can be divided into stimulants and salivary substitutes. Chewing gum is among the major salivary stimulants, The benefits of chewing gum are known mainly

because they promote the increase of salivary pH and salivary flow through a combination of gustatory and mechanical stimulation, thus reducing the thirst and the maladies that this symptom brings which decrease the consumption of water intake and decrease of interdialytic weight gain (Ozen et al., 2021).

Significance of study:

Chronic kidney disease (CKD) is a major emerging global public health problem that affects > 850 million people in 2019 and is currently one of the most common diseases worldwide, globally; all-age mortality rate from CKD increased 41.5% between 1990 and 2017 (Jager et al. 2019), In Egypt up to 90% of patients diagnosed with end-stage renal disease regularly receive hemodialysis as a renal replacement therapy. According to the latest World Health Organization (WHO) data published in 2018 kidney diseases' deaths in Egypt reached 3.98% of total death (WHO, 2018), In Menoufia University Hospital the statistical records reported that 2032 cases were on hemodialysis in 2017 and 2079 case were on hemodialysis in 2018 (Statistical admission records of Menoufia University Hospital, 2018).

Thirst is common in hemodialysis patients due to both volumetric and osmo-metric causes, but the primary mechanism is osmo-metric. The osmolality of the extracellular fluid increases with the dietary salt and the hypothalamus is stimulated by the shrinkage of the osmo-receptor cells, leading to the desire to ingest liquids. Volumetric thirst develops secondary to water, salt loss and the resultant stimulation of cardiac baroreceptors, with the cardiac return volume decreasing gradually toward the end of the hemodialysis session (Kurita et al., 2017).

Most hemodialysis patients have to maintain a fluid restricted diet since they have no residual urine output and have been allowed to drink at maximum 500 ml per day. In addition, hemodialysis has a direct effect on the amount of saliva. Furthermore, both feeling of oral dryness and thirst are associated with increase the amount of fluid consumed between dialysis sessions. Maintaining this fluid restricted diet can be very difficult resulting in a high interdialytic weight gain. Also, patients suffer from thirst find it difficult to speak, chew, or swallow, and run an increased risk of dental caries or oral infection (Kahkhaie et al., 2017).

Consequently, this study was carried out to examine the effect of sugar free gum chewing on thirst and interdialytic weight gain (IWG) among patients undergoing hemodialysis.

Purpose of the study:

To examine the effect of sugar free gum chewing on thirst and interdialytic weight gain (IWG) among patients undergoing hemodialysis.

Research hypotheses:

The following research hypotheses were formulated in an attempt to achieve the purpose of the study:

1) Patients who use sugar free gum chewing (study group 1 and 2) will exhibit a significant reduction in perceived thirst compared to patient who don't (control group).

2) Patients who use a sugar free gum chewing (study group 1 and 2) will exhibit a significant reduction in interdialytic weight gain (IWG) compared to patient who don't (control group).

Subjects

Research Design:

A quasi-experimental research design (study and control) was utilized to achieve the purpose of the current study.

Setting:

The study was conducted in the hemodialysis unit of Menouf General Hospital, where Hemodialysis unit consists of waiting area for patients and three stations for hemodialysis:

- Stations No. (1 and 3): have sixteen hemodialysis machines for patient HCV –ve
- Station No. (2): has twelve hemodialysis machines for patient HCV +ve

Sample:

Consecutive samples of 90 adult patients of both genders were divided alternatively into three equal groups 30 patients in each group (study group I, study group II and control group III). Consecutive sampling is one of the most used kinds of nonprobability sampling in which every subject meeting the criteria of inclusion is selected until the required sample size is achieved (Suresh and Sharma, 2017).

- **Study group (1):** patients who received flavored sugar free gum chewing for fifteen minutes three times/day along with routine hospital care (instructions about diet that rich in calcium and low in phosphorus, taken phosphorus binders and benefits of phosphorus binders in decreasing complications).
- **Study group (2):** patients who received flavored sugar free gum chewing for fifteen minutes five times/day along with routine hospital care (instructions about diet that rich in calcium and low in phosphorus, taken phosphorus binders and benefits of phosphorus binders in decreasing complications).
- **Control group:** patients were exposed to routine medical care from hospital only (instructions about diet that rich in calcium and low phosphorus, taken phosphorus binders and benefits of phosphorus binders in decreasing complications).

The sample size was assumed that the expected effect size is six and the standard deviation of outcome variable was ten. To achieve 80% power to detect this difference with a significance level of 0.05 by the following equation:

$$n = [(Z\alpha/2 + Z\beta)2 \times \{2(ó)2\}]/ (\mu1 - \mu2)2$$

for where:

- Z is the Z score
- N is population size
- μ population mean
- (ó)2 population variable (SD)

Based on this assumption, the sample size was estimated that 30 subjects per group were required so the total sample size that used 90 subjects.

Inclusion criteria:

Subjects were considered eligible for the study if they had the following criteria:

- Adult conscious patients aged 18-60 years.
- Patients who accept to participate in the study regardless educational level and were able to follow instructions.

- Patients free from any mental disabilities to facilitate cooperation.
- Received hemodialysis three times/ week for more than 12 month, for a period of four hours to ensure that the changes of thirst sensation, serum calcium and phosphorus level combined with hemodialysis.
- Patients free from any dental problems to be able to perform chewing gum.
- Free from co-morbid diseases such as diabetes mellitus, cancer, hemodynamic instability, dementia and terminal diseases to control all variables that may affect thirst, serum calcium and serum phosphorus.

Instruments:

Three instruments were used by the researcher to collect the necessary data and achieving the purpose of the study these instruments were as the following:

Instrument I: -Structured Interview Questionnaire:

It was developed by the researcher based on extensive and relevant literature review (Ozen et al. 2021 and Said & Mohammed, 2013) and guidance of consulting expertise in medical and nursing field; it was designed in English language to collect sociodemographic data, medical data and patient's knowledge. It covered the following three parts:

- **Part one:** sociodemographic characteristics: it was designed to collect specific information of the study sample such as patient's age, gender, level of education, occupation, and marital status, etc…
- **Part two:** medical history and medication regimen: it was compromised of questions to assess patient's medical history and medical regimen such as regular medication and the period of hemodialysis.
- **Part three:** knowledge assessment: it was compromised of questions to assess patient's knowledge regarding factors that lead to end stage renal disease, dialysis, and its complications.

Scoring system: - Each item was scored as following:

- Zero score was given for the questions with incorrect answer or unknown,
- One score was given for each question with an incomplete correct answer.
- Two score was given for each question with complete and correct answer.

Then all scores were summed given a score of:

- The total score < 50% considered poor or unsatisfactory knowledge,
- The total score from 50-65 considered partially accepted knowledge,
- The total score > 65 considered satisfactory knowledge.

Instrument II: - Dialysis Thirst Inventory:

It is a five point Likert scale, adopted by Brand (2004) and was used to quantify the perceived thirst. The Dialysis Thirst Inventory (DTI) is a questionnaire with seven items as thirst is considered a problem, period of thirst per day, presence of night thirsty, feeling of thirsty before, during and after dialysis.

Scoring system:

- Each item had a five-point Likert scale (score of 1 denoted never, 2 denoted almost never, 3 denoted

occasionally, 4 denoted often, while 5 denoted very often).

- When the subjects reported "occasionally" until "very often" on an item of DTI, it was judged as "present". In all other cases, "never" and "almost never" were judged as "absent".
- The scores were summed and provided a DTI score ranged from seven (no thirst) to 35 (very thirsty).

Instrument III: -Bio-physiological measurements:

It was developed by the researcher to assess and measure interdialytic weight gain.

Procedure

Ethical considration

- **Written approval: -**

A written approval from the ethical committee was obtained to carry out the study; then an official letter from the Faculty of Nursing Menoufia University was delivered to the responsible authorities of hospital chief executive (the director of hemodialysis unit, hospital administrators and the head nurses of the unit) to obtain written approval to conduct this study after explaining its importance and purpose (The hospital chief executive granted an approval for the study).

- **Protection of human rights: -**

Patient's verbal and written agreement to participate in this study was obtained after explanation the purpose of the study. Each patient was reassured that any information obtained would be confidential and only used for the study purpose. The researcher emphasized that participation in the study is entirely voluntary, and anonymity of the patients were assured through coding data. Patients were also informed that refusal to participate would not affect their care.

- **Instruments development:**

The first and third instruments were developed by the researcher, while the second instrument adopted by Brand (2004) and was used to quantify the perceived thirst.

- **Validity**

All instruments were tested for its content validity by jury of 7 expertise in fields of Medical Surgical Nursing (five expertise), Medical "Nephrology" fields (one expertise) and nephrology nurses' staff (one nephrology nurse) who reviewed the study instrument for clarity, relevance, comprehensiveness, understanding, applicability, and language faculty of English department for translation of instrument and modifications were be carried out accordingly.

- **Reliability**

Test re-test method and a Pearson correlation coefficient formula were used to ascertain reliability of instruments. The period between both tests was two weeks. It was 0.82, 0.88 and 0.80 alpha for first, second and third instruments respectively.

- **Pilot study:**

Pilot study was conducted on 10% from the setting at hemodialysis unit at Menouf General Hospital to check the clarity, applicability, relevance, and feasibility of the instruments to identify difficulties that would be faced the researcher during the applications. In addition to the estimate, patients who shared in the pilot study were excluded from the main study sample.

Data collection:

- The researcher collected the data from patients in dialysis unit twice a week; Saturday for the control group and Sunday for the study group until data was completed.
- Each patient who fulfilled the inclusion criteria and agreed to participate in the study was interviewed individually before hemodialysis session by the researcher in the reception area of hemodialysis unit for 15 minutes.
- The researcher introduced himself to each patient, explained the purpose of the study and described the instruments for patients prior to data collection.
- The patients were divided alternatively into three equal groups: study group (1), study group (2) and control group 30 patients in each group.
- Pre study data, sociodemographic data were assessed by the researcher using part one of instrument I for the three groups.
- Knowledge assessment was assessed before given any instructions using part two of instrument I (knowledge assessment sheet) for all groups to determine the patients' needs.
- The patient's thirst level was assessed by using instrument II (The Dialysis Thirst Inventory (DTI)) for all groups.
- The interdialytic weight gain was measured by using bio-physiological measurement (instrument III) for all groups.
- Each patient of study groups was scheduled individually in the reception area for the teaching session. It took about 20 minutes for every patient. The instructions was given as following:
- Study group I was instructed to chew two pieces of flavored sugar free gum (2-7 gm.) for fifteen minutes three times /day for four weeks along with routine hospital care.
- Study group II was instructed to chew two pieces of flavored sugar free gum (2-7 gm.) for fifteen minutes five times/day for four weeks along with routine hospital care.
- Control group was exposed to routine hospital care only.
- The weight of all studied groups was assessed twice every session (pre and post hemodialysis session) for three days per week over four weeks to calculate interdialytic weight gain using instrument III for all groups.
- After four weeks, the patient's thirst was assessed by using instrument II (The Dialysis Thirst Inventory (DTI). Also, the interdialytic weight gain was measured by bio-physiological measurement instrument (instrument III) for all groups.
- The comparison was done among all groups to examine the effect of sugar free gum chewing on thirst and interdialytic weight gain (IWG) among patients undergoing hemodialysis.

Statistical analysis:

The data collected were tabulated & analyzed by SPSS (statistical package for the social science software) statistical package version 20 on IBM compatible computer. Two types of statistics were done:

- **Descriptive statistics:** were expressed as mean and standard deviation (X+SD) for quantitative data or number and percentage (No & %) for qualitative data.
- **Analytic statistics:**
  - Pearson Chi-square test ($\chi 2$): It is the test of significance used to study association between two qualitative variables.
  - ANOVA test (parametric test): is a test of significance used for comparison between more than two independent groups of normally distributed quantitative variables. Post hoc tests are used to uncover specific differences between three or more group means when ANOVA test is significant.
  - Paired sample t- test (parametric test): is a test of significance used for comparison between two related groups of normally distributed quantitative variables.

- **P-value at 0.05 was used to determine significance regarding:**
  - P-value > 0.05 to be statistically insignificant.
  - P-value ≤ 0.05 to be statistically significant.
  - P-value ≤ 0.001 to be highly statistically significant.

Results

Table (1): this table shows the socio-demographic characteristics for all studied groups' participants. These findings revealed that the mean age of all studied participants were 47.33 ± 8.40, 43.93 ± 9.95 and 41.76 ±10.50 years for study group 1, 2 and control group respectively. 60%, 53.3%, and 56.7% of study group 1, 2 and control group respectively were male, and most of the studied participants were married and lived in rural area, as regards to educational level around half of studied groups participants have secondary education, in addition to around one third of studied groups participants worked in manual work. The findings revealed that no statistically significant differences existed among study group 1, 2 and control group regarding their sociodemographic characteristics.

Table (2): this table showed the medical history and drug regimen of the studied groups. These findings revealed that more than three quarters of studied participants have no family history of dialysis. Moreover; 73.3%, 80.0% and 90.0% of study group 1, 2 and control group respectively didn't take any cardiac medications, while near to two thirds of studied groups were take antihypertensive medications, around half of studied groups taken one alpha (renal medication) and 26.7%, 50% and 43.3% of study group 1, 2 and control group respectively take Epoetin, in addition to less than the half of studied groups was on hemodialysis between 3-6 years.

Table (3): this table shows the total knowledge level of study participants' pre and post intervention. The results revealed that there was no statistically significant difference in the knowledge level among studied group participants' pre intervention. While post

intervention, the mean value of knowledge level was significantly higher among study group 1 and study group 2 (22.90 ± 1.97, and 22.40 ± 2.51) compared to control group (15.96 ± 2.55). However, there was statistically insignificant difference in the mean value of knowledge level in the post intervention phase when comparing study group 1 and study group 2. When comparing the knowledge level among studied groups in pre intervention and post intervention the results revealed that, the mean value of knowledge level was significantly higher in the post intervention phase among all the studied groups participants (study group 1 and study group 2 and control group) compared to pre intervention phase (22.90 ± 1.97 Vs. 13.06 ± 2.95, 22.40 ± 2.51 Vs. 14.43 ± 3.03 and 15.96 ±2.55 Vs. 14.03 ±2.90) respectively.

Table (4): this table shows the mean of thirst degree among studied groups pre and post intervention. The results showed that there was no statistically significant difference in the thirst degree among all studied group participants pre intervention. On the other hands, at post intervention phase the mean value of thirst degree was significantly lower in the study group 2 compared to study group 1 (11.06 ± 1.41 Vs. 13.60 ± 2.62) respectively. Also, the mean value of thirst degree was significantly lower in the study group 1 and 2 when compared to control group (19.06 ± 1.99). When comparing the pre intervention and post intervention results of the thirst degree among studied groups the results revealed that, the mean value of thirst degree was lower in post intervention than pre intervention among study group 1 and study group 2 participants; while the mean value of thirst degree was higher in post intervention compared to pre intervention among control group participants (19.06 ±1.99 Vs.18.43 ±2.20) respectively.

Figure (1): this figure illustrated the thirst degree of the studied group participants. The mean scores of thirst degree were decreased post intervention than pre intervention in both study groups 1 and 2. As illustrated, the thirst degree was decreased among study group 2 (chewing gum for five times /day) than among study group 1 post intervention. While in comparing with control group the thirst degree was increased post intervention than pre-intervention.

Table (5): this table shows the distribution of interdialytic weight gain among studied participants' pre and post intervention at different intervals. The results showed that, there was no statistically significant differences existed in the interdialytic weight gain means in all studied group participants at first week of intervention (before dialysis session), while when comparing results at first week of intervention (after dialysis session) the results showed that; the mean of interdialytic weight gain was significantly lower among study group 2 than study group 1 (2.07 ± 0.43 Vs. 2.45 ± 0.61) respectively. In addition, the mean of interdialytic weight gain was significantly lower in the study group 2 compared to control group (2.07 ± 0.43Vs. 2.66 ±0.58) respectively. However, there was statistically insignificant difference in interdialytic weight gain when comparing study group 1 with control group. When comparing results at fourth week of intervention (before dialysis session) the results showed that; there were no statistically significant differences existed in the interdialytic weight gain means in all studied group participants.

Table (6): this table showed correlation between thirst sensation level and the interdialytic weight gain mean among the studied groups. The results revealed that there was a positive correlation between patients` thirst level and the mean of interdialytic weight in the study group 1 while a negative correlation was existed between thirst level and the mean of interdialytic weight in the study group 2 and control group subjects with no statistically significant differences between groups.

Table (1): Frequency distribution of socio-demographic characteristics for the studied participants who undergoing hemodialysis (N=90)

Demographic characteristics	Studied groups						χ2	P value
	Study group 1 (N=30)		Study group 2 (N=30)		Control group (N=30)			
	No.	%	No.	%	No.	%		
Age (years):								
Mean±SD	47.33 ± 8.40		43.93 ± 9.95		41.76 ±10.50		**F =**	0.08
Range	33.0 – 60.0		21.0 – 59.0		20.0 – 59.0		2.53	NS
Age categories:								
18<30	0	0.0	3	10.0	4	13.3	8.0	0.23
30<40	7	23.3	5	16.7	9	30.0		NS
40<50	10	33.3	14	46.7	8	26.7		
50≤ 60	13	43.3	8	26.7	9	30.0		
Gender:								
Male	18	60.0	16	53.3	17	56.7	0.27	0.87
Female	12	40.0	14	46.7	13	43.3		NS
Marital status:								
Married	25	83.3	22	73.3	22	73.3		
Divorced	0	0.0	2	6.7	3	10.0	4.87	0.56
Widowed	4	13.3	3	10.0	2	6.7		NS
Single	1	3.3	3	10.0	3	10.0		
Residence:								
Rural	21	70.0	22	73.3	23	76.7	0.34	0.84
Urban	9	30.0	8	26.7	7	23.3		NS
Education level:								
Illiterate	4	13.3	3	10.0	1	3.3		0.91
Read and write	3	10.0	3	10.0	3	10.0	3.30	NS
Basic	7	23.3	5	16.7	6	20.0		
Secondary	13	43.3	15	50.0	14	46.7		
University	3	10.0	4	13.3	6	20.0		
Occupation:								
Administrative work	2	6.7	3	10.0	7	23.3	9.89	0.12
Manual work	14	46.7	7	23.3	7	23.3		NS
Not work	5	16.7	11	36.7	6	20.0		
Housewife	9	30.0	9	30.0	10	33.3		

χ2: chi square test, **t-test**: students` t test, **NS**: not significant,
NS: not significant
S: significant

Table (2): Frequency distribution of medical history and medication regimen of studied groups (the study group 1, study group 2 and control group) (N=90)

Health status and patient history	Studied groups						χ2	P value
	Study group 1 (N=30)		Study group 2 (N=30)		Control group (n=30)			
	No.	%	No.	%	No.	%		
Family history of dialysis:								
Yes	4	13.3	5	16.7	5	16.7	0.16	0.91
No	26	86.7	25	83.3	25	83.3		NS
Cardiac medications taken regularly:								
No	22	73.3	24	80.0	27	90.0		
Cardura	4	13.3	0	0.0	0	0.0	11.02	0.08
Concor	4	13.3	5	16.7	3	10.0		NS
Inderal	0	0.0	1	3.3	0	0.0		
Antihypertensive medications taken regularly:								
No	6	20.0	10	33.3	13	43.3		0.12
Capoten	13	43.3	12	40.0	15	50.0	10.04	NS
Aldomet	8	26.7	7	23.3	2	6.7		
Norvasc	3	10.0	1	3.3	0	0.0		
Renal medications:								
One alpha	18	60.0	13	43.3	14	46.7		0.43
Calcimate	4	13.3	2	6.7	3	10.0	3.76	NS
Epoetin	8	26.7	15	50.0	13	43.3		
When did you start hemodialysis?								
one year ≤ 3 years	14	46.7	9	30.0	17	56.7		
3 years ≤ 6 years	11	36.7	15	50.0	11	36.7	7.71	0.26
6 years ≤ 9 years	4	13.3	4	13.3	0	0.0		NS
More than 9 years	1	3.3	2	6.7	2	6.7		

NS: not significant

Table (3): Total Knowledge level pre and post intervention among study group 1, study group 2 and control group participants (N=90)

Knowledge level	Studied groups						ANOVA	P value	Post hoc test
	Study group 1 (N=30)		Study group 2 (N =30)		Control group (N =30)				
	No.	%	No.	%	No.	%			
Pre intervention									
Poor knowledge	16	53.3	10	33.3	13	43.3	**χ2**	0.61	
Partially accepted knowledge	13	43.3	18	60.0	16	53.3	=2.69	NS	
Satisfactory knowledge	1	3.3	2	6.7	1	3.3			
Mean ± SD	13.06 ± 2.95		14.43 ± 3.03		14.03 ±2.90		1.68	0.19 NS	---------
Post intervention									
Poor knowledge	0	0.0	0	0.0	5	16.7	**χ2**	<0.001	
Partially accepted knowledge	0	0.0	3	10.0	21	70.0	=62.15	HS	
Satisfactory knowledge	30	100	27	90.0	4	13.3			
Mean ± SD	22.90 ± 1.97		22.40 ± 2.51		15.96 ±2.55		80.48	<0.001 HS	P1= 0.41 NS P2= <0.001 HS P3= <0.001 HS
Paired t test	18.48		11.85		5.88				
P value	<0.001 HS		<0.001 HS		<0.001 HS				

P1: comparison of study group 1 vs. study group 2
P2: comparison of study group 1 vs. control group
P3: comparison of study group 2 vs. control group

χ2: chi square test
NS: not significant
HS: highly significant

Table (4): Mean of thirst degree among studied group participants' pre and post intervention (the study group 1, study group 2 and control group) (N=90)

Thirst degree	Studied groups			ANOVA	P value	Post hoc test
	Study group 1 (N=30)	Study group 2 (N =30)	Control group (N =30)			
	Mean ± SD	Mean ± SD	Mean ± SD			
Pre-intervention	19.20 ± 3.63	19.03 ± 1.82	18.43 ±2.20	0.68	0.50 NS	---------
Post-intervention	13.60 ± 2.62	11.06 ± 1.41	19.06 ±1.99	116.99	<0.001 HS	P1= <0.001 HS P2= <0.001 HS P3= <0.001 HS
Paired t test	16.10	22.51	2.43			
P value	<0.001 HS	<0.001 HS	0.02 S			

P1: comparison of study group 1 vs. study group 2
P2: comparison of study group 1 vs. control group
P3: comparison of study group 2 vs. control group

NS: not significant
S: significant
HS: highly significant

Figure (1): Mean of thirst degree of the studied groups participants' pre and post intervention

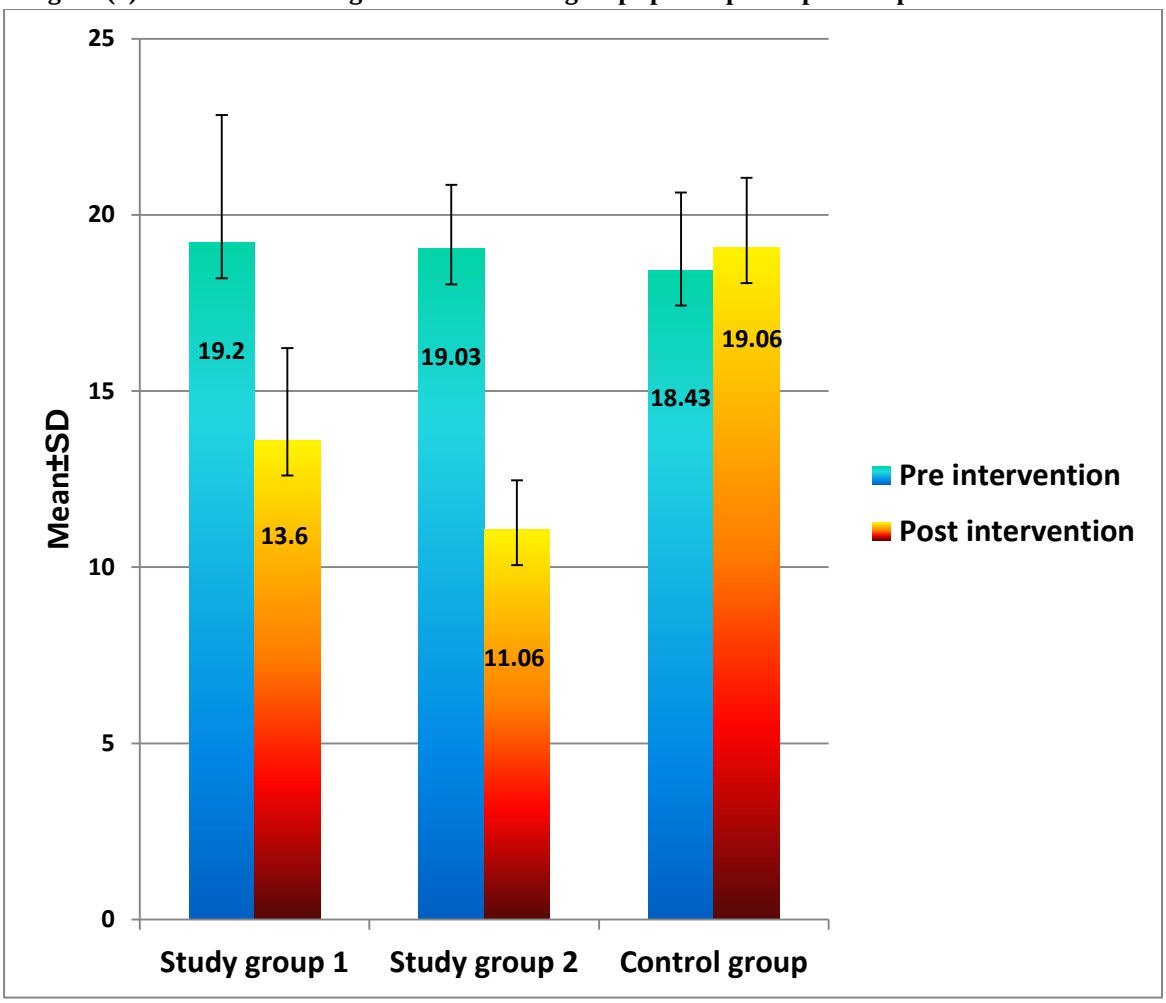

Table (5): Distribution of interdialytic weight gain among studied group participants' pre and post intervention at different intervals (N=90)

	Studied groups			ANOVA	P value	Post hoc test
	Study group 1 (N=30)	Study group 2 (N=30)	Control group (N=30)			
	Mean ± SD	Mean ± SD	Mean ± SD			
Mean interdialytic weight gain at first week (before session)	2.79 ± 0.60	2.61 ± 0.46	2.65 ±0.52	0.85	0.42 NS	---------
Mean interdialytic weight gain at first week (after session)	2.45 ± 0.61	2.07 ± 0.43	2.66 ±0.58	8.81	<0.001 HS	P1= 0.01 S P2= 0.13 NS P3= <0.001 HS
Paired t test	6.61	9.42	0.09			
P value	<0.001 HS	<0.001 HS	0.92 NS			
Mean interdialytic weight gain at fourth week (before session)	2.80 ± 0.58	2.60 ± 0.43	2.76 ±0.48	1.28	0.28 NS	--------
Mean interdialytic weight gain at fourth week (after session)	2.31 ± 0.72	2.05 ± 0.42	2.57 ±0.54	5.12	0.008 S	P1= 0.13 NS P2= 0.09 NS P3= 0.002 S
Paired t test	5.79	6.33	2.70			
P value	<0.001 HS	<0.001 HS	0.01 S			

P1: comparison of study group 1 vs. study group 2
P2: comparison of study group 1 vs. control group
P3: comparison of study group 2 vs. control group
NS: not significant
S: significant
HS: highly significant

Table (6): Correlation between patients` thirst and the mean interdialytic weight gain of the studied groups:

Weight	Patients` thirst among studied groups					
	Study group 1 (N=30)		Study group 2 (N=30)		Control group (N=30)	
	r	P value	r	P value	r	P value
Mean interdialytic weight gain	**0.01**	**0.92 NS**	**-0.27**	**0.14 NS**	**-0.02**	**0.89 NS**

NS: not significant

Discussion

Most patients with end-stage renal disease (ESRD) on hemodialysis (HD) must maintain a fluid restriction to prevent fluid overload between dialysis sessions. High fluid intake through beverages and food results in high interdialytic weight gain (IWG); Long-term incompliance to the fluid-restricted diet can induce complications, such as hypertension and acute pulmonary edema (Petrosino and Dush, 2021). So, the current study aimed to examine the effect of sugar free gum chewing on thirst and interdialytic weight gain (IWG) among patients undergoing hemodialysis.

Regarding sociodemographic characteristics, the current study showed that around one third of all groups their age ranged from 50-60 years, with a mean age of (47.33±8.40, 43.93±9.95 and 41.76±10.50

respectively) and around two thirds of studied subjects were male, married and lived in rural area, in relation to educational level; around half of studied groups were have secondary education, in addition to around one third of studied groups participants worked in manual work. This result was consistent with Hassan, et al., (2019) who reported in their study that a predominance of male in both groups, more than two fifth of both groups their age ranged from 51-65 years, with a mean age of (46.8±12.7, 46.3±12.6 respectively). Also, the results were in the same line with Bossola, (2019); who studied "Xerostomia in patients on chronic hemodialysis" and reported that majority of patients were married, male and had secondary level of education.

Conversely, this result disagreed with Fonseca, et al., (2019) who studied the "Effect of chewing gum on thirst in patient with hemodialysis" and reported that more than half of patients were lived in urban area, and more than one third of them had high education and free business.

Regarding medical history, the current study revealed that around three quarters of studied participants have no family history of dialysis, and more than two thirds of study group 1, 2 and control group subjects didn't take any cardiac medications. Moreover, near to two thirds of studied groups were take antihypertensive medications, around half of studied groups taken one alpha (renal medication) in addition to around half of the study group 1 and control group participants and around one third of the study group 2 participants undergoing hemodialysis from less than 3 years. These results were supported by Pepe et al., (2018) who conducted a study to examine the frustrating attempt to limit the interdialytic weight gain in patients on chronic hemodialysis" and the participants of their study had hypertension and follow treatment for hypertension and renal failure. On the other hand, this result disagreed with Dehghanmehr et al., (2018) who investigating the impact of sugar free gum on the thirst and dry mouth of patients undergoing hemodialysis" and report that one third of patients of their study group were suffered from heart diseases.

In relation to total knowledge scores of the studied groups, the current study showed that the means of total knowledge scores pre intervention were 13.06±2.95, 14.43±3.03 and 14.03±2.90 for study group 1, 2 and control group respectively while post intervention the means of knowledge scores improved among studied groups to 22.90±1.97, 22.40±2.51 for study group 1, 2 respectively and control group remained at the same level post intervention. From the researcher's point of view, these results may be because of teaching for patients as an important item to enhance and acquisition of knowledge. This is also supported by the results of Huang et al., (2019) who reported that patients' knowledge about hemodialysis were low at pre-intervention phase and improved after implementation their intervention. Moreover Perez, (2021) added that there was an improvement of knowledge level of patients undergoing hemodialysis after implementation a training program.

Regarding thirst level, the current study showed that there was no statistically significant difference existed among all groups in relation to thirst degree pre-intervention, while post intervention there were highly statistically significant differences were existed among all of them. From the researcher point of view, these results may be attributed to the

stimulation of saliva production by mastication when use sugar free gum chewing that can decrease thirst sensation and reduce consumption of fluids.

These results were in consistent with Garcia, et al., (2019) who conducted a study entitled "Menthol chewing gum on preoperative thirst management" and found that chewing gum for patients reduced a sense of thirst. Also, this result was supported by the results of Fonseca, et al., (2019) study which examine the effect of chewing gum on thirst in patient with hemodialysis and report that there was a statistically significant relation between chewing gum and thirst in patient with hemodialysis after implementation of their designed intervention. Moreover, results of Said and Mohammed, (2013) revealed that, there was an improvement in the thirst sensation among the patients chewed sugar-free gum for more than 10 minutes six times a day during six hemodialysis sessions. On the other hand, the current study results were inconsistent with the results of Duruk and Eser, (2016) who reported that, no change was existed in the sensation of dry mouth that reported by patients undergoing hemodialysis who chewed sugar-free gum 15 minutes per hour for 15 days. This discrepancy may be attributed to the shorter duration for the study.

Regarding interdialytic weight gain results of the present study showed that the mean of interdialytic weight in both studied groups was decreased post intervention. This result was consistent with Ozen, et al., (2021) who conducted a study entitled "The effect of chewing gum on dry mouth, interdialytic weight gain, and intradialytic symptoms" and found that there was a decrease in interdialytic weight after implementation of training program. Conversely, this result was congruent with Kusumawardhani and Yetti, (2020) who conducted a study entitled "Manajemen Xerostomia dan Interdialytic Weight Gain" and found that there was no change in interdialytic weight among patients undergoing hemodialysis. The researcher refers this discrepancy to differences between patients' compliance level to self-mentoring primarily as precaution to ensure the adherence to recommendation of fluid restriction with using sugar free gum chewing and may be due to differences in educational level among the participants in both studied groups.

Regarding correlation between pre intervention patients` thirst and the mean interdialytic weight gain of the studied groups, the current study showed that there was a positive correlation between pre interventions patients' thirst and mean interdialytic weight gain among study group 1 study group 2 and control group. This result was accordance with Ozen, et al., (2021) who found that there was no relation between pre interventions patients' thirst and mean interdialytic weight gain. Conversely, this result was congruent with Fonseca, et al., (2019) who conducted a study entitled "Effect of chewing gum on thirst in patient with hemodialysis" and found that there was a statistically significant relation between pre interventions patients' thirst and mean interdialytic weight gain. These differences may be related to differences in sampling methods and age of participants in addition to the environmental and climate differences.

So, the study hypotheses which revealed that patients who use a sugar free gum chewing (study group 1 and 2) were exhibit a significant reduction in perceived thirst and reduction in interdialytic weight gain (IWG) compared to patient who don't (control

group) it was accepted and supported through the current research findings.

Conclusion:

Based on the results of current study, it was concluded that:

Using of sugar free gum chewing alleviate thirst sensation and significantly decreases interdialytic weight gain among patients undergoing hemodialysis.

Recommendations:

Based on the findings of the current study, the following recommendations can be suggested:

1. Sugar free gum chewing should be encouraged and added to the management protocol for patients undergoing hemodialysis for positive effect on, alleviating thirst sensation, help compliance to fluid restriction, control of interdialytic weight gain and improve the quality of life.
2. Further research studies using a larger sample and different geographical areas.

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