- *Basic Research*

The Effect of Sugar-Free Gum Chewing on Xerostomia and Clinical Health-Outcomes for Children in Hemodialysis Unit

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Abstract

Background: Xerostomia is a subjective sense of dry mouth, which is relatively frequent among children on long term hemodialysis**. aim**: Determine the impact of sugar-free gum (SFG) chewing on xerostomia and-clinical health-outcomes for children in hemodialysis unit. **Settings**: At the "pediatric hemodialysis unit at Menoufia University Hospital in Shebin El-Koom City". **Subjects**: A Probability simple random sample. The study involved 60 children thirty (controls) and other thirty use sugar-free gum chewing (study group). **Tools:** data collected by using structured interview questionnaire, dialysis thirst inventory (DTI), xerostomia inventory (XI) and bio-physiological measurement. Research ethics were implemented. **Result**s: the mean score of dialysis thirst and xerostomia also intradialytic weight gain were considerably improved during the intervention weeks than the controls in 1st, 2nd ,3rd and 4th weeks post the sugar-free gum chewing ($p < 0.05$). **Conclusion**: chewing free sugar gum during hemodialysis session had a potential reduction in the overall scores of xerostomias, thirst and weight gain than before. Also, there was obvious improvement of health-related outcomes such as potassium and phosphorus levels. **Recommendation:** the sugar-free gum chewing should be incorporated in the protocol of care for children undergoing hemodialysis.

Keywords: xerostomia, thirst, hemodialysis, children, intradialytic weight, nursing, chewing gum

Introduction

End-Stage Renal Disease (ESRD) is a progressive illness that results from the irreversible deterioration of renal function caused by chronic renal failure (CRF) (Hockenberry et al., 2021) . Renal failure is a turning point during chronic kidney disease because it is an end stage renal disease that is treated by either dialysis treatment or kidney transplantation. Peritoneal or hemodialysis is the most predominant forms of therapy for patients. Approximately 92% of dialysis patients are hemodialysis patients (Zhang et al., 2020). Globally, every year, more than 30 out of every 100,000 children suffer from CRF, and the rate rose as children aged 4 to 6 Abdelsamie et al., 2022) . In Egypt up to 90% of cases diagnosed with ESRD treated by hemodialysis as one of renal replacement therapies (Kim H-J, et al., 2021).

Hemodialysis is a medical procedure that involves using a special machine to filter waste products from the blood and restore normal constituents to it (National Kidney Foundation [NKF], 2021). It can eliminate endogenous waste products and maintain water balance, which are two of the kidney's primary functions (Guzzo, Picca, & Askenazi, 2023). Treatment for chronic renal disease can also cause localized and systemic tissue destruction, which can have an immediate impact on salivary flow, concentration, composition, and quality. Renal failure causes edema, which impacts weight in subjects receiving hemodialysis due to excessive fluid consumption (Szulimowska, et al., 2023).

Thirst is one common, severe, and often untreated symptom in children utilizing HD. Children naturally have an urge for fluids, triggering them to drink a greater amount of water than they need. It's a crucial mechanism in fluid balancing (Said & Mohammed, 2019). Thirst sensation has an essential role in water consumption or drinking other fluids for body rehydration to keep it functioning working properly; it arises due to elevation of osmolytes level and/or lack of fluids (Said & Mohammed, 2019). Thirst leads to more fluids drinking and inter-dialytic weight gain in subjects undergoing HD that may result in severe consequences such as hypertension, congestive heart failure and mortality (Ashrafi et al., 2023).

Xerostomia is a subjective sense of dry mouth; it is relatively frequent among children on long term HD. It can be aggregative by decreasing salivary flow secondary to salivary glands fibrosis and atrophy, use of certain drugs, and restriction of fluid intake. Xerostomia is linked to several issues in hemodialysis children; including difficulties in swallowing, speaking, and tasting; elevated risk of oral complications, such as mucosal, tongue and gingival lesions; fungal and bacterial infections, like dental caries, and candidiasis (Bossola, 2019). Greater than 30% of dialysis cases suffer from uncontrollable xerostomia (Dry mouth). Thirst and xerostomia are two of the most significant and frequently observed signs in children performing hemodialysis (Yemina et al., 2023).

CRF patients experience xerostomia and thirst, but they also experience excess fluid in their bodies. Excess fluid can lead to weight gain, edema, elevated blood pressure, breath shortness, and cardiac disorders, all of which can worsen the child's quality of life (QOL) and slow down the heart's rhythm. For this reason, fluid restriction must be applied to hemodialysis subjects to achieve fluid balance. Moreover, hemodialysis therapy is not performed daily, thus resulting in fluid accumulation between the two dialysis sessions, so fluid restriction is required (Canaud, et al., 2019).

Fluid restriction causes thirst; if the thirst is not managed, it will result in an elevation in fluid consumption, which leads to fluid issues causing several adverse outcomes. Conversely, a

high interdialytic weight gain (IDWG) results in more weekly dialysis sessions, which raises expenses and lowers QOL. As a result, it is thought that knowledge of thirst in CRF subjects receiving HD is crucial to promoting sufficient IDWG regulation in standard clinical practice (Perez, 2021).

Hyperphosphatemia is a common consequence of ESRD and hemodialysis. It is a potentially life-threatening disorder causes cardiovascular calcifications that cause death. Furthermore, hyperphosphatemia and calcium deficiency cause the progression of renal osteodystrophy, metabolic bone disease, renal bone disease, and secondary hyperparathyroidism. In pediatrics, such illnesses are linked with growth issues, and various oral manifestations, encompassing enamel hypoplasia, permanent teeth delayed eruption, and malocclusion progression (Lalayiannis, et al., 2023).

Since phosphates are typically expelled through the parotid gland and pancreatic juice, a compensatory increase in phosphate excretion in saliva will occur with a decline in renal function (Peacock, 2021). Children with chronic kidney disease and those receiving hemodialysis have been shown to have increased salivary excretion of phosphates, regardless of dietary phosphate intake. Ingested with saliva, salivary phosphates are absorbed through the gastrointestinal tract (GIT), adding to the phosphate load from diet, and impeding the effectiveness of oral phosphate binders (Salem, et al., 2021).

Digestion is started with chewing. Saliva is secreted during chewing to lubricate and moisten the food. While it has been demonstrated that chewing and saliva are related. Mechanical receptors in the gingival tissues will be activated during mastication, potentially causing saliva to flow . Saliva secretion is known to be stimulated by chewing but when there's a decrease in saliva production, it makes chewing more difficult. Exercise with the tongue stimulated the secretion of saliva (Krop, 2019).

Saliva plays a major role in reducing the unpleasant sensation of mouth dryness, which is the predominant and worst symptom of thirst. Several strategies have been developed for dealing with this concern. Chewing gum is one of the main salivary stimulants. The positive effects are chiefly acknowledged for stimulating salivary flow and elevating salivary ph. via gustatory and mechanical stimulation, which consequently reduces thirst, dry mouth, water consumption, and interdialytic gain of weight (Mohamed et al., 2023).

Chewing low-sugar gum has been shown to increase the amount of saliva to reduce thirsty and xerostomia. Chewing gum is an alternative therapy that can be used to stimulate salivary glands in patients undergoing hemodialysis. Chewing gum reduces thirst more effectively as it activates the parasympathetic nervous system and stimulates the salivary glands to secrete more saliva (Jung, & Chang, 2020).

Salivary phosphorus excretion is greater in hemodialysis cases than in healthy ones. According to studies, chewing gum increases the amount of saliva that contains phosphorus, thus offering a further option in the fight against phosphate accumulation (Hassan et al., 2019). Consequently, this research was carried out to identify the impact of SFG chewing on xerostomia and clinical health-outcomes among children in hemodialysis unit.

In pediatric hemodialysis units, nurses play a pivotal role in applying non-pharmacological strategies, such as sugar-free gum chewing, to alleviate xerostomia and reduce excessive thirst. Their responsibilities include guiding children and caregivers on proper gum use (duration and frequency), monitoring both subjective complaints like dry mouth or

discomfort and objective indicators such as salivary flow and interdialytic weight gain, whenever possible (Chen et al., 2024).

Chewing gum easily available to help in sustaining the fluid restricted diet; it is safe, inexpensive, and easily applicable with no side impacts. Also, it is able to prevent oral infections. Hence, they participate in better HD children outcome and improve their QOL. For these reasons, this research study was conducted to assess the impact of SFG on xerostomia and clinical health-outcomes among children in hemodialysis unit.

Significance of the Study:
Globally, every year, more than 30 out of every 100,000 pediatrics suffer from CRF, and the rate rose as children aged 4 to 6 (Abdelsamie et al.,2022). In Egypt up to 90% of cases diagnosed with ESRD treated by hemodialysis as one of renal replacement therapies. Complications from chronic kidney disease do not only result in end-stage renal diseases. It can increase risk factors for heart disease, impede growth and development, and alter the lifestyles of both parents and their offspring (Hassaballa et al., 2022).

A common side effect of hemodialysis and ESRD is hyperphosphatemia, a potentially fatal condition that is linked to cardiac mortality and vascular calcification in ESRD patients. Additionally, renal osteodystrophy and secondary hyperparathyroidism can develop as a result of hyperphosphatemia and calcium depletion, so controlling the phosphate level is crucial for improving the prognosis of hemodialysis children (Portales-Castillo, et al., 2023). By understanding the effect of sugar-free gum chewing on xerostomia and clinical health-outcomes, pediatric nurses can provide effective, patient-centered care and improve patient outcomes.

Aim
To identify the impact of SFG usage on xerostomia and clinical health-outcomes for children in hemodialysis unit.

Research Hypotheses
H1-Children who use sugar-free gum chewing during hemodialysis would have lowest xerostomia and thirst scores compared to the control.

H2- Children who use sugar-free gum chewing during hemodialysis would have better clinical health-outcomes scores compared to the control.

Operational Definition
Clinical health-outcomes are biochemical values; calcium, and phosphorus level were assessed by the researchers from child medical record and Interdialytic Weight Gain (IWG) was measured by using an electronic chair monitor.

Materials and Method
Design:
A quasi-experiment was utilized to study two categories (control and study category pre/ posttest) to achieve the research aim.

Setting:
The current study was established in the "pediatric hemodialysis unit at Menoufia University Hospital in Shebin El-Koom" in Egypt . There were 13 hemodialysis machines, 3 for positive hepatitis C cases and the others for negative ones. Children received dialysis sessions from 8.30 am to 12.30 pm or from 1 pm to 5 pm.

Subjects

A Probability simple random sample of sixty pediatrics with chronic renal illness on hemodialysis was recruited from the previously stated setting. The subjects were categorized into study and control categories using a simple random sample. The sample size assumed that the expected impact size is six and the standard deviation (SD) of outcome variable was ten. To achieve 80% power to detect this variance with a significance level of 0.05 by the following formula:

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

for where:

Z is the Z score.

N is population size.

μ population mean.

(ó)2 population variable (SD)

According to this assumption, the size was evaluated that 30 participants per group were required so the total sample that used 60 subjects.

Inclusion criteria:

Children aged from 6-18 years, diagnosed as end stage renal disease. received hemodialysis three or four times per week for more than 12 months, for a period of four hours using the same type of dialysis machine (Fersineus 4008A) and filter (F5) to ensure that the changes of thirst sensation, serum calcium and phosphorus level combined with hemodialysis. Children free from any oral & dental problems to be able to perform chewing gum and absences of diseases such as diabetes mellitus, cancer, hemodynamic instability, dementia, and terminal diseases.

Tools for data collection:

Four tools were used by the researchers to collect the necessary data as the following:

Tool I: Structured Interview

It was designed by researchers to obtain socio-demographic data and medical information of children undergoing hemodialysis. A questionnaire consists of demographics of children and children's medical information as disease onset, hemodialysis frequency and hemodialysis duration.

Tool II: Dialysis Thirst Inventory (DTI)

It was adopted from Bots et al., (2005) to evaluate the level of perceived thirst for hemodialysis subjects. It is a survey with seven items; each one has a five-point Likert scale (never = 1, to very often = 5). The answers to the seven questions will be defined as follows: Never thirsty=1 point, almost never =2 points, occasionally = 3, often= 4 and very often=5 points. The scores were summed and provided a DTI score ranged from seven (No thirst) to 35 (Very thirsty). Score %= (the observed score/ the maximum score) x 100. Attitude consists of 7 items and final score ranging 7-35 grades: mild thirsty< 60% (score 7-21); average thirsty 60-75% (score 22-26); high thirsty > 75 % (score 27-35).

Tool III: Xerostomia Inventory (XI)
It was adopted from Dirix et al.(2008) to quantifing the perceived xerostomia pre and post dialysis session. It involves 11-items using a rating scale with each answer assigned a score of 1-5 and the sum of score calculated into a sum ranging from 11 to 55, reflecting xerostomia severity. A score of 11 denotes very mild, score 55 denote sever condition. Score %= (the observed score/ the maximum score) x 100 . Attitude included 11 items and overall score ranging 11-55 were mild dry mouth, < 60% (score 11-33); moderate dry mouth, 60-75% (score 34-41); severe, extremely dry mouth, > 75 % (score 41-55).

Tool IV: Bio-physiological measurement: It was established by the researcher to measure interdialytic weight gain and biochemical results. It consists of two parts.
Part one: -Interdialytic Weight Gain (IWG):
The body weight was measured using an electronic chair monitor. The weight of the subjects was evaluated pre-and post each session using a specially designed sheet. The IWG was estimated as the mean IWG during 4 weeks duration.
Part two: The researcher established a sheet to record the biochemical values in blood, including calcium, and phosphorus, and the results were compared at the end of data collection period.

Validity of the tools
All tools were tested for its validity by jury of 5 expertise in field of pediatric nursing (three expertise), Medical “Nephrology” field (one expertise) and nephrology nurses’ staff (one nephrology nurse) who revised the study tools for clarity, relevance, comprehensiveness, understanding, applicability, and modifications were carried out accordingly.

Reliability of the tools
Test re-test method and a Pearson correlation coefficient formula were used to ascertain reliability of the study tools. The period between both tests was two weeks. It was 0.82, 0.88 and 0.80 alpha for first, second and third tools respectively (Mohamed, et al., 2023).

Pilot study
Pilot study was conducted on 10% (6 hemodialysis child) from the setting at hemodialysis unit at Menoufia Hospital to check the clarity, applicability, relevance, and feasibility of the tools to identify difficulties that would be faced the researchers during the applications, no essential adjustments were made. Consequently, the pilot study was involved in the entire sample.

Ethical considerations
A written approval from the "Research Ethical Committee" (Reference No. 924) was received to conduct the study. An official letter from "the Faculty of Nursing, Menoufia University" was provided to the responsible authorities of hospital chief executive (the director of hemodialysis unit, hospital administrators and the head nurses of the unit) to gain written approval to establish the study after explaining its importance and purpose (The hospital chief executive granted an approval for the study). Formal written consent was taken from the children and their parents to be involved in this study after explanation the study aim. Each child was reported that any information would be confidential and only used for research purposes. The researchers confirmed that children's involvement is totally voluntary, and anonymity of the children was confirmed through coding data. It was declared that refusal to participate would not affect their care.

The study procedure

The researchers collected data from children in dialysis unit twice a week; Saturday for the controls and Sunday for the study category until data were completed. Data were collected over duration of four months from the beginning of February 2023 to the end of May 2023. The data collection done in three phases:

Assessment Phase:

- Children who fulfilled inclusion criteria were randomly categorized into two groups of SFG chewing and controls, At the beginning of the study, the researchers gave explanations about the research aim for children before data collection for 10 minutes of face-to-face conversation.
- The researchers deal with the study group first then control group to prevent data contamination.
- Pre work data, socio-demographic data and medical information were assessed by the researcher using tool I for the two groups.
- The children's thirst level was assessed by using tool II (DTI) for two groups.
- Xerostomia level was evaluated before and after each dialysis session by using instrument III (The Xerostomia Inventory (XI)) for both groups.
- 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 tool IV for all groups. Before, using the chair monitors, the children were asked to remove their shoes, and use a clean gown. IWG was estimated as the weight at the beginning (pre-weight) minus the weight after (post – weight) each session.
- The nephrologist set the ultra- filtration rate based on the weight gain and corrected the post- dialysis weight to the target dry weight in each session. The post –weight of the subjects was comparable with their target dry weight throughout the research by using part one of bio-physiological measurement (tool IV) for both groups.
- Blood chemistry: Pre-dialysis session blood samples were obtained from all the children through the venous catheter placed for hemodialysis, and analyzed for serum phosphates, calcium level and results were recorded using part two of bio physiological measurements (tool IV) for both groups.

Implementation phase:

- The children were requested to attend to the dialysis unit 1 hour earlier; they received the assessment and were interviewed individually before hemodialysis session by the researchers in the reception of hemodialysis unit for 10 minutes.
- For the study group; after filling the interview questionnaire. The researchers were instructed the children to chew two pieces of gum gently, for 10 minutes, 6 times a day and when the mouth felt dry or when they were thirst for four weeks and to use of phosphate binder with meals for 4weeks along with routine hospital care.
- Two pieces of flavored sugar free gum 2-7 gm (Strawberry: mild, peppermint: strong) were chosen and given to the children.
- The researchers visited the children during each session to investigate their gum-chewing status and provide reminders as necessary.
- During the week, a message was sent to each child every morning by the researchers to remind them about the intervention.
- Children and their parents were trained about food and items which will affect their mouth and thirst, and they were asked to avoid these substances and activities during

a week (instructions about diet that rich in calcium and low in phosphorus, the phosphorus binders and their benefits).

- Calcium is found in many foods, including dairy products, legumes, tofu and soy products, dark green leafy vegetables, and food additives.
- Restrict foods that are naturally very rich in phosphorus such as milk, yogurt, cheese, dried beans and peas. Read labels to avoid consumption of phosphate containing additives.
- The controls received routine hospital care.

Evaluation phase: -

- After four weeks, the children's thirst was evaluated by using tool II (DTI).
- Xerostomia level was assessed by using tool III (The Xerostomia Inventory (VI)) for two groups.
- Also, serum phosphorus, calcium level and the interdialytic weight gain were measured by bio-physiological measurement (tool IV) for all groups.

Statistical analysis

Recorded data were processed using the "statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA)". Quantitative parameters were expressed as mean± SD. Qualitative ones were expressed as frequency and proportions. The Comparison between categories regarding qualitative variables was performed using the Chi-square test. The t-test of significance was used when comparing between two means. Pearson's correlation coefficient (r) test was used to assess the degree of association between two sets of variables. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: P-value $\leq$0.05 was considered significant.

Results

Table (1) revealed that the mean age of children was 11.60±2.90 & 12.40±3.12 of study and control groups respectively.(70% , 56.7%) were male respectively, as regards to education, 63.3% of children in study group have primary education while 46.7% of control group participants have preparatory education in the controls, and more than half of the studied children (56.7% & 60%) respectively were lived in rural area. The two groups had no considerable variations in socio-economic parameters.

Table (2) Showed that one third (33.3%) disease onset of the study category were 2<3years and >5 years respectively while 46.7% of the control group were 3<5 years. Moreover; 86.7% of children in both groups undergo hemodialysis three times/week. The vast majority of subjects in the controls and study groups (93.3%,90.0% respectively take 3 hours in hemodialysis session, in addition half of studied groups 56.7% and 50.0% respectively was on hemodialysis between 3-6 years

Regarding to overall scores of Xerostomias pre and post sugar free gum chewing table (3) revealed that. Both groups had severed Xerostomia (66.7% ,86% respectively) pre the intervention. While post intervention the study group (73.3%) had mild Xerostomia and control group (76.7%) had sever Xerostomia with statistically significant difference as $p < 0.001$.

Regarding the overall scores of thirsty pre and post sugar free gum chewing table (4) revealed that. Both groups had severed thirst (63.3%, 73.3% respectively) pre the intervention. While post intervention the study group (13.3%) had highly thirsty and control group (70.0%) had high thirsty with potential difference as $p < 0.001$

Table (5) indicate that the total mean scores of intradialytic weight gain was significant between both groups at 2nd , 3rd and 4th weeks post sugar free gum chewing at P<0.001.
Table (6) displayed no significant variation between both groups regarding serum calcium and phosphorus level pre sugar free gum, while there were considerable variance between both categories post intervention as P<0.001.
Table (7) revealed significant relation between children xerostomia and their age, gender, educational level, and residence among study group post sugar fee chewing gum.
Table (8) showed significant relation between children thirst and their age, gender, educational level, and residence among study group post sugar fee chewing gum.
Table (9) this table showed a highly significant correlation between children xerostomia inventory and dialysis thirst inventory post intervention in the study category. Also, there was no marked correlation between children xerostomia inventory and dialysis thirst inventory pre and post intervention in the controls.

Table (1): Distribution of study and control groups according to their characteristics (n=60).

Children's character tics	Study		Control		Test of Significance	
	No.	%	No.	%	x2	P
Child Age (y)						
6<12	17	56.7	13	43.3	1.067	0.302
12 ≤18	13	43.3	17	56.7		
Mean±SD	11.60±2.90		12.40±3.12			
Gender						
Male	21	70.0	17	56.7	1.148	0.284
Female	9	30.0	13	43.3		
Educational level						
Primary	19	63.3	12	40.0	4.892	0.087
Preparatory	6	20.0	14	46.7		
Secondary	5	16.7	4	13.3		
Residence:						
Rural	17	56.7	18	60.0	0.069	0.793
Urban	13	43.3	12	40.0		

p-value >0.05 NS

Table (2): Comparison of both groups regarding thier medical history (n=60).

History	Study		Control		Test of Significance	
	No.	%	No.	%	x2	P
Onset of disease (y)						
<1	1	3.3	3	10.0	7.468	0.058
2<3	10	33.3	11	36.7		
3<5	9	30.0	14	46.7		
>5	10	33.3	2	6.7		
Frequency of hemodialysis (week)						
Twice	3	10.0	1	3.3	2.000	0.368
Three times	26	86.7	26	86.7		
Four times	1	3.3	3	10.0		
Duration of hemodialysis (h) session						
3	28	93.3	27	90.0	0.218	0.640
4	2	6.7	3	10.0		
Duration of hemodialysis (y)						
1 < 3	8	26.7	12	40.0	1.458	0.692
3 < 6	17	56.7	15	50.0		
6 < 9	3	10.0	2	6.7		
9 ≤13	2	6.7	1	3.3		

p-value >0.05 NS

Table (3): Overall score of xerostomia pre and post sugar free gum chewing between the study and control groups

Overall score of xerostomia	Groups	Xerostomia total scores						Test of Significance	
		Mild Xerostomia		Moderate Xerostomia		Severe Xerostomia			
		No.	%	No.	%	No.	%	x2	P
Pre sugar free gum	Study	2	6.7	8	26.7	20	66.7	4.116	0.128
	Control	0	0.0	4	13.3	26	86.7		
Post sugar free gum	Study	22	73.3	7	23.3	1	3.3	39.418	<0.001**
	Control	1	3.3	6	20.0	23	76.7		

p-value >0.05 NS, **p-value <0.001 HS

Table (4): Total score of thirsty pre and post sugar free gum chewing between both groups

Total score of thirsty	Groups	Thirsty total scores						Test of Significance	
		Mild thirsty		Average thirsty		High thirsty			
		No.	%	No.	%	No.	%	x2	P
Pre sugar free gum	Study	1	3.3	10	33.3	19	63.3	2.886	0.236
	Control	3	10.0	5	16.7	22	73.3		
Post sugar free gum	Study	21	70.0	5	16.7	4	13.3	30.432	<0.001**
	Control	1	3.3	8	26.7	21	70.0		

p-value >0.05 NS; **p-value <0.001 HS

Table (5): Comparison of total mean scores of intradialytic weight gain pre and post sugar free gum chewing between study and control groups (n=60).

Total score of intradialytic weight gain / week	Study	Control	t-test	P
	$\bar{x}$ ±SD	$\bar{x}$ ±SD		
First Week 1st pre sugar free gum	2.99±0.61	3.10±0.3	-0.881	
Second Week 2nd post sugar free gum	2.25±0.55	3.47±0.30	-10.716	<0.001**
Third Week 3rd post sugar free gum	1.67±0.48	3.86±0.39	-19.584	<0.001**
Fourth Week 4th post sugar free gum	1.00±0.49	4.14±0.58	-22.486	<0.001**

****p-value <0.001 HS**

Table (6): Comparison of total mean scores of serum calcium and phosphorus level pre and post sugar free gum chewing between study and control groups (n=60).

Calcium & Phosphorus levels	Study	Control	t-test	P
	$\bar{x}$ ±SD	$\bar{x}$ ±SD		
Calcium Level				
Pre	7.53±1.16	7.45±0.49	0.374	0.710
Post	10.00±1.04	6.72±0.53	15.347	<0.001**
Phosphorus level				
Pre	7.00±2.06	7.54±1.56	-1.143	0.258
Post	3.92±1.57	9.19±1.75	-12.258	<0.001**

p-value >0.05 NS; **p-value <0.001 HS

Table (7): Relation between study and control groups xerostomia based on children's characteristics.

Children's characteristics	Pre (n=30)				Post (n=30)			
	Study		Control		Study		Control	
	x^2	p-value	x^2	p-value	x^2	p-value	x^2	p-value
Child Age (y)	2.377	0.266	2.179	0.316	7.976	0.009*	0.876	0.672
Gender	2.351	0.279	0.861	0.685	8.646	0.018*	1.718	0.428
Educational level	1.866	0.345	3.690	0.086	9.020	0.019*	3.143	0.169
Residence	0.794	0.691	2.924	0.229	6.954	0.010*	3.597	0.063

P-value >0.05 NS; *p-value <0.05

Table (8): Relation between children dialysis thirst and their characteristics among both groups

children characteristics	Pre-Intervention (n=30)				Post- Intervention (n=30)			
	Study		Control		Study		Control	
	x^2	p-value	x^2	p-value	x^2	p-value	x^2	p-value
Child Age (y)	3.616	0.056	2.333	0.288	9.332	0.008*	2.442	0.248
Gender	0.379	0.837	3.200	0.157	10.116	0.017*	2.998	0.212
Educational level	0.422	0.801	0.662	0.762	10.553	0.014*	1.741	0.417
Residence	0.871	0.683	1.128	0.669	8.136	0.010*	0.758	0.747

p-value >0.05 NS; *p-value <0.05 S

Table (9): Correlation between children's xerostomia and thier dialysis thirst and pre post sugar free gum in study group and control groups (n=60).

Correlation(r)		Xerostomia Inventory			
		Pre-Intervention		Post-Intervention	
		r-value	p-value	r-value	P
Dialysis Thirst Inventory (DTI)	Study Group	0.168	0.386	0.582	<0.001**
	Control Group	0.205	0.176	0.215	0.131

p-value >0.05 NS;p-value <0.001 HS**

Discussion

Xerostomia is a frequent issue in renal disease children managed by hemodialysis. The SFG has been widely used in hemodialysis children owing to its good taste and low economic cost. However, its clinical impact is still controversial. Chewing SFG can improve the dry mouth in hemodialysis children and it influences thirst and weight gain during hemodialysis also calcium and phosphorus level. This leads to acceptance of the set research hypotheses.

In this research, the mean age was almost equal in both groups (11.60±2.90&12.40±3.12 respectively). Such findings were disagreed with a study by Nasseripour , et al.,(2022) who found that the mean age of the pediatrics was 14.73 ± 4.56 years.

This work demonstrated that more than half of children in both groups were male. This finding was contradicted with the study about a previous analysis of the role of SFG on plaque quantity in the oral cavity by Nasseripour et al., (2022) who discussed a high prevalence of kidney disorders among females. Based on the study, more than half of children in both categories came from rural regions. This is due to the hospital referral from "Menoufia University Hospital at Shebin El-Koom City" due to the free charge and better services.

The present findings demonstrated that the highest percentage of children in both categories undergoing hemodialysis three sessions per week for three hours duration for each session. This is related to the treatment protocol at hemodialysis unit. In addition, half of the studied groups 56.7% and 50.0% respectively were on hemodialysis between 3-6 years. This result

goes in an agreement with Hassan & Khalafallha (2019) who illustrated that more than two fifths (42%) of children had undergone hemodialysis for 4 to 6 years.

It is apparent from the current study that children in both groups had severed xerostomia pre sugar free gum chewing. While post-intervention, the highest percent of subjects in study group had mild xerostomia compared to the control group. This research discovered that the use of gum potentially reduced xerostomia severity which consistent with Saheer et al., (2019) who found reduction in xerostomia among cases in study category than in controls throughout the six sessions.

Regarding the overall mean scores of thirsty, pre and post SFG chewing. Both groups had high thirsty pre the intervention. While post intervention the study group had mild thirst compared to the controls. Findings of this study are in an agreement with Dehghanmehr et al., (2018) who discovered that the mean reduction in severity and duration of thirst and dry mouth in gum chewing study was markedly greater than that of the control, revealing that SFG has a potential impacts on thirst and dry mouth of the cases.

The researchers found that the total mean scores of intradialytic weight gain were decreased among children in the study group at 2^{nd} , 3^{rd} and 4^{th} weeks post the intervention, whereas the total mean intradialytic weight gain was increased on the first week pre and post 2^{nd}, 3^{rd} and 4^{th} day among the control. This result was matched with Ozen, et al., (2021) who conducted a study entitled “The effect of chewing gum on dry mouth, interdialytic weight gain, and intradialytic symptoms: A prospective, randomized controlled trial” and found that there was a decrease in interdialytic weight post intervention. The explanation for these findings include: chewing gum may stimulate saliva production, which can help to reduce dry mouth and potentially decrease IDWG.

The results showed that, among children receiving hemodialysis, the overall mean scores of serum calcium and phosphorus levels were unchanged prior to chewing sugar-free gum in two groups and remained within normal range after the intervention in the study group but showed increased phosphorus and decreased calcium levels in the control group. The present result is contradicted with Mahy et al., (2021) who found a marked reduction in mean serum Phosphate levels at the end of the trial. Also, there was a potential reduction in mean serum Calcium concentration. The act of chewing gum may provide a sense of comfort, relaxation, contributing to improved child health-related outcomes.

Results indicated a strong positive correlation between children's xerostomia and their ages, gender, levels of education, and place of residence in the study group after chewing sugar free gum. This finding agreed with Chen et al., (2024) who stated that gum chewing is correlated with improvements in self-reported xerostomia levels. The study findings highlight the importance of considering demographic factors in the management xerostomia. Nurses may need to tailor their approach to individual children's needs based on their age, gender, and place of residence.

Findings demonstrated a highly significant correlation between dialysis thirst and xerostomia mean score among studied children post intervention. These results supported by Huang, et al., (2019) who conducted study entitled "Intervention effect of chewing sugar-free gum on xerostomia in hemodialysis patients" reported that strong positive association between thirst score and xerostomia score.The intervention may have led to improved outcomes ,such as reduced symptoms of xerostomia , improved oral health.

Children were chewing free sugar gum during hemodialysis session had a considerable reduction in total scores of xerostomias, thirst and weight gain than before. Also, there was obvious improvement of health-related outcomes such as potassium and phosphorus levels.

Recommendation

1-SFG chewing should be incorporated in to the protocol of care for children undergoing hemodialysis.

2- Further studies with a larger sample and different geographical regions

Ethical Approval

This research was reviewed and approved by the "Ethics Committee of Faculty of nursing, Menoufia university" …… 924- (18/1/2023)

Conflict of interest

The authors declared that there is no affiliation with or involvement in any organization with any financial or non-financial interest in the subject matter or materials dismissed in this research.

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References

1. Abdelsamie, E., Mansy, G., Khamis, G., Fathy, H. M., & Gaber, W. M. (2022). Effect of Acupressure on Thirst among Children Undergoing Hemodialysis. Alexandria Scientific Nursing Journal, 24(1), 67-76. doi: 10.21608/asalexu.2022.246011
2. Ashrafi, S. A., Phansikar, M.,& Wilund, K. R., Subjective Thirst in Relation to Interdialytic Weight Gain: A Systematic Review of Observational Studies. Blood Purification, 2023; 52 (2): 201-209. doi: 10.1159/000525498.
3. Bossola, M., Pepe, G., Vulpio, C., The Frustrating Attempt to Limit the Interdialytic Weight Gain in Patients on Chronic Hemodialysis: New Insights into an Old Problem. Journal of Renal Nutrition: the official journal of the Council on Renal Nutrition of the National Kidney Foundation, 2018; 28 (5): 293-301. doi: 10.1053/j.jrn.2018.01.015.
4. Bossola, M., Xerostomia in patients on chronic hemodialysis: an update. In Seminars in Dialysis 2019; 32: 467-474.
5. Bots, C. P., Brand, H.S, Veerman,C.I et al. Chewing gum and a saliva substitute alleviate thirst and xerostomia in patients on hemodialysis. Nephrology Dialysis Transplantation, (20) 20(3), 578-584. doi: 10.1093/ndt/gfh675.
6. Canaud, B., Chazot, C., Koomans, J., & Collins, A., Fluid and hemodynamic management in hemodialysis patients: challenges and opportunities. Brazilian Journal of Nephrology, 2019; 41: 550-559. doi: 10.1590/2175-8239
7. Chen Y.Q, Wang C.L, Chiu A.H, Yeh M.C, & Chiang T.I. Chewing Gum May Alleviate Degree of Thirst in Patients on Hemodialysis. Medicina. 2024; 60(1):2. https://doi.org/10.3390/medicina60010002
8. Dehghanmehr S., et al S: Investigating the impact of sugar free gum on the thirst and dry mouth of patients undergoing hemodialysis. Bark. Int J Pharm Sci & Res 2018; 9(5): 2062-66. doi: 10.13040/ IJPSR.0975-8232.9(5).2062-66.
9. Dirix P., Nuyts S., Vander Poorten V., Delaere P.,& Van den Bogaert W. The influence of xerostomia after radiotherapy on quality of life: results of a questionnaire in head and neck cancer; 2008;16(2):171-9. doi: 10.1007/s00520-007-0300-5
10. Guzzo, I., Picca, S.,& Askenazi, D., Neonatal Kidney Dysfunction. In Pediatric Kidney Disease. Cham: Springer International Publishing., 2023; 1437-1468.

11. Hassaballa, M., El-Wakil, H., Elsharkawy, M., Khamis, S., El Tantawy, T., Wahby, W., & Gawad, M. A. (2022). Egyptian renal data system (ERDS) 2020: an annual report of end-stage kidney disease patients on regular hemodialysis. Journal of the Egyptian Society of Nephrology and Transplantation, 22(1). doi: 10.34067/KID.0007482021
12. Hassaballa, M., El-Wakil,H ., Elsharkawy, M., et al., Egyptian renal data system (ERDS) 2020: an annual report of end-stage kidney disease patients on regular hemodialysis. Journal of the Egyptian Society of Nephrology and Transplantation, 2022; 22(1). DOI: 10.4103/jesnt.jesnt_37_21
13. Hassan, G., Thabet, G.,& Abd El-Razik, H., IOSR Journal of Nursing and Health Science (IOSR-JNHS) e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 8, Issue 3 Ser. IV.), 2019; 28-33. https://doi.org/10.21608/menj.2023.315264.
14. Hassan,A.E. & Khalafallha, D.H. Self-Care Activities of Adolescents Undergoing Hemodialysis. IOSR Journal of Nursing and Health Science (IOSR-JNHS) e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 8, Issue 5 Ser. III. (Sep-Oct), 2019; 07-16 www.iosrjournals.org
15. Hockenberry, M., Wilson, D., Rodgers, C., Wong's Essentials of Pediatric Nursing (11th Ed.). Missouri: Mosby., 2021.
16. https://api.semanticscholar.org/CorpusID:35840123
17. Huang Y.Q, Xiong S.Q, & Jin C.D, Intervention effect of chewing sugar-free gum on xerostomia in hemodialysis patients: A meta-analysis. TMR Integrative Nursing,2019, 3(6):207-213. doi: 10.12032/TMRIN20190405.
18. Jung, E. S., Chang, A. K., Effects of auricular acupressure in patients on hemodialysis. Journal of Nursing Research, 2020; 28(4): 106.
19. Kim H-J,Lee,J.Y,lee,E.S., et al. Simple oral exercise with chewing gum for improving oral function in older adults. Aging Clin Exp Res. 2021;33:1023–31 doi: 10.1007/s40520-020-01606-z
20. Krop, E. M. The influence of chewing and oral lubrication on satiety using hydrogels (Doctoral dissertation, University of Leeds) 2019.
21. Lalayiannis, A. D., Soeiro, E., Moysés, R., & Shroff, R., Chronic kidney disease mineral bone disorder in childhood and young adulthood: a ‘growing 'understanding. Pediatric Nephrology, 2023; 1-17. http://dx.doi.org/10.1007/s00467-023-06109-3
22. Mahy G. , Fawzy,I. , Mohamed H.,et al.,. The Effect of Chewable Chitosan on Phosphate Levels in Serum and Saliva in Hemodialysis Pediatric Patients. ADJ-for Girls, Vol. 8, No. 2, April 2021 — PP. 307:314. doi: 10.21608/adjg.2021.20612.1206
23. Mohamed, M. B., Abdullah, W. H., Ameen, O., & Masry, S. E. Effect of Sugar Free Gum Chewing on Thirst and Interdialytic Weight Gain among Patients Undergoing Hemodialysis. Menoufia Nursing Journal, 2023; 8(2): 309-326.
24. Nasseripour M, Newton, ,J.T, Warburton, F.,et al., A Systematic Review and Meta-Analysis of the Role of Sugar-Free Chewing Gum on Plaque Quantity in the Oral Cavity. Front. Oral. Health, 2022; 3:845921. doi: 10.3389/froh.2022.845921
25. National Kidney Foundation [NKF]. Hemodialysis. NKF 2021. Available from: https://www.kidney.org/atoz/content/hemodialysis.
26. Nayak, A., & Khare, J., Pediatric Chronic Kidney Disease–A Child is not a Young Adult. J Pediatric Health Care Med, 2017;1(1):16-19.
27. Ozen, N., Aylin, A., Mut, D., Sayilan, S., Avcioglu, Z., & Kulakac, N. The effect of chewing gum on dry mouth, interdialytic weight gain, and intradialytic symptoms: A prospective, randomized controlled trial, Jan, 2021; 25(1):94-103. doi: 10.1111/hdi.12878
28. Peacock, M., Phosphate metabolism in health and disease. Calcified tissue international, 2020; 108: 3-15. doi: 10.1007/s00223-020-00686-3.
29. Perez, L. M. Dietary interventions, and strategies to reduce sodium consumption and volume overload in hemodialysis patients, Doctoral dissertation, 2021.
30. Portales-Castillo, I., Rieg, T., Khalid, S. B., Nigwekar, S. U., & Neyra, J. A., Physiopathology of phosphate disorders. Advances in Kidney Disease and Health, 2023; 30(2): 177-188. doi: 10.1053/j.akdh.2022.12.011.
31. Saheer P, et al. Effect of sugar-free chewing gum on plaque and gingivitis among 14-15-yearold school children: a randomized controlled trial. Indian J Dent Res. 2019 30:61–6. doi: 10.4103/ijdr.IJDR_247_17
32. Said, H., & Mohammed, H., Effect of chewing gum on xerostomia, thirst and interdialytic weight gain in patients on hemodialysis. Life Science Journal, 2019; 2(10), 1767-1777. http://www.lifesciencesite.com
33. Salem, M. G., Fawzy, M. I., Mostafa, M. H., & Rabea, M. M., The Effect of Chewable Chitosan on Phosphate Levels in Serum and Saliva in Hemodialysis Pediatric Patients. Al-Azhar Dental Journal for Girls, 2021; 8(2-A): 307-314. doi: 10.21608/ADJG.2021.20612.1206

34. Szulimowska, J., Zalewska, A., Taranta-Janusz, K., Marczuk-Kolada, G., Żendzian-Piotrowska, M., Maciejczyk, M. Association between Salivary Cytokines, Chemokines and Growth Factors and Salivary Gland Function in Children with Chronic Kidney Disease. Journal of Inflammation Research, 2023; 1103-1120. doi: 10.2147/JIR.S399786
35. Yemina, L., Pangaribuan, S. M., Butar-butar, S., Effect of Chewing Gum on Thirst in Kidney Failure Patients. Jurnal Keperawatan Komprehensif Comprehensive Nursing Journal, 2023; 9(2). https://doi.org/10.33755/jkk.v9i2
36. Zhang, L., Guo, Y., Ming, H., Effects of hemodialysis, peritoneal dialysis, and renal transplantation on the quality of life of patients with end-stage renal disease. Revista da Associação Médica Brasileira, 2020; 66: 1229-1234. doi: 10.1590/1806-9282.66.9.1229.

الملخص العربى

تأثير مضغ العلكة الخالية من السكر على جفاف الفم والنتائج الصحية السريرية للأطفال في وحدة غسيل الكلى

مقدمة : جفاف الفم هو شعور شخصي بجفاف الفم، وهو أمر شائع نسبيً بين الأطفال الذين يخضعون لغسيل الكلى طويل الأمد.

الهدف: تحديد تأثير مضغ العلكة الخالية من السكر على جفاف الفم والنتائج الصحية السريرية للأطفال في وحدة غسيل الكلى.

العينة : أُجريت الدراسة في وحدة غسيل الكلى للأطفال في مستشفى جامعة المنوفية في مدينة شبين الكوم. شملت الدراسة 60 طفلاً، ثلاثون منهم (مجموعة ضابطة) اتبعوا الرعاية الروتينية في المستشفى وثلاثون آخرون استخدموا مضغ العلكة الخالية من السكر (مجموعة الدراسة).

الأدوات: جُمعت البيانات باستخدام استبيان المقابلة المنظم، ومقياس عطش غسيل الكلى (DTI ، ومقياس جفاف الفم XI) (، والقياسات البيوفسيولوجية)

.النتائج: تحسّن متوسط درجات العطش وجفاف الفم أثناء غسيل الكلى، وكذلك زيادة الوزن أثناء غسيل الكلى، إحصائيًا خلال أسابيع التدخل مقارنةً بالمجموعة الضابطة في الأسابيع الأول والثاني والثالث والرابع بعد مضغ العلكة الخالية من السكر، بمستوى دلالة إحصائية (.($p < 0.05$)

الخلاصة والتوصيات : أدى مضغ العلكة الخالية من السكر أثناء جلسة غسيل الكلى إلى انخفاض ملحوظ في إجمالي درجات جفاف الفم والعطش وزيادة الوزن مقارنةً بالسابق. كما كان هناك تحسن واضح في النتائج الصحية، مثل مستويات البوتاسيوم والفوسفور لذلك يوصى بأضافة مضغ العلكة الخالية من السكر إلى بروتوكول رعاية الأطفال الخاضعين لغسيل الكلى.