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RESEARCH ARTICLE

COMPARISON OF THE EFFECTS OF A STRICT DIET AND MEDICATION ON RELIEF OF GASTROESOPHAGEAL SYMPTOMS

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ABSTRACT

Gastro oesophageal reflux disease GERD has a global impact on health and it impairs the quality of life of a substantial proportion of the world's population. This study focuses on assessing the dietary regimen, medication and placebo on relieving gastroesophageal symptoms caused by excessive production of gastric acids in the body. It is also caused by the backward flow or regurgitation of stomach contents passing up into the oesophagus. Obesity and overweight are risk factors of heartburn and oesophageal erosions. Body Mass Index (BMI) of participants were determined. *Helicobacter pylori* test were done in all 15 patients since *H.pylori* causes some of the symptoms of heartburn. Questionnaires were used to gather information on diet and GERD symptoms of participants. Physical observations on lifestyle of participants were made. The consent forms were signed by all participants for ethical considerations at United Bulawayo Hospitals in Zimbabwe. The participants were divided into 3 groups, (group 1 on strict diet and timed exercise, group 2 on medication and diet, group 3 on placebo and diet). The nutrient content of a strict diet was analysed, food test established the amount of nutrients (vitamins, mineral elements, proteins, fats and carbohydrates) in breakfast, lunch and supper. This study established that the nutrients in a strict diet were provided in adequate amounts. The nutrient -nutrient interaction was also recognised. A one way ANOVA was used to analyse the significance of the regimen.

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INTRODUCTION

Heartburn is the backward flow or regurgitation of stomach contents passing up into the oesophagus (Berardi, 2006). Heartburn and GERD are used interchangeably in this research. Heartburn begins as a burning pain in the middle of the chest, behind the breast bone, often after a big meal. Since different foods contain many different nutrients, it is important to select food wisely, plan diets properly and come up with methods of preparing foods for maximum absorption. Consumption of fast foods is on the increase in Zimbabwe perhaps because more and more women are sedentary workers and prefer fast and convenient foods that save them from the labour of selecting, planning and preparing of family meals. Apart from diet, heartburn can also be caused by some medical drugs (Silverman, 1992). Some medications such as bisphosphalates, iron salts, potassium salts, non-steroidal anti-inflammatory drugs (NSAIDS) and antibiotics potentially make people more susceptible to heartburn (Berardi, 2006). Burgess (Silverman, 1992), Vakil (Burgess, 2007-2008), (Alvarenga *et al.,* 2009) and (Vakil, 2010) revealed that obesity ranks high on the list of contributing causes of heartburn because the adipose tissue in the abdomen crowds the stomach, so that food does not settle down totally into the stomach area. Several recent cross-sectional studies have demonstrated an association between heartburn and high body mass index (BMI). The physiopathology for the association of heartburn and BMI can be explained by inappropriate lower oesophageal sphincter relaxation arising from hiatal herniaor increase in intra-abdominal pressure, both leading to increase in acid reflux (Vakil, 2010).

Serious heartburn if not taken care of could cause burning chest pains, blotted full stomach, experience of early satiety, an acid or bitter taste at the back of the throat, bad breath, an increase in pain severity when lying down or bending over, headache, nausea, vomiting, weakness of the body and could develop into ulcers of the oesophagus and cancer (Silverman, 1992).

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Hopewood (Hampel *et al*., 2005) recommended intake of foods such as avocados, bananas, grapes, honey, lemons, maple fruit, millet, mellows, molasses, oranges, raisins, white meat and all types of vegetables. These foods are alkaline forming foods that neutralize body acids thereby reducing changes for the development of heartburn. Phosphorus and sulphur act as buffers to maintain pH so it is highly recommended to eat 50% of raw fresh fruits and vegetables especially cabbage.

Lifestyle interventions have been reported in literature as one way of reducing GERD. Avoiding chocolate, alcohol, coffee and tobacco is recommended for relieving GERD symptoms (Hopewood, 1996). Medications such as antacids (Kaltenbach *et al*., 2006), Histamine H2-receptor (Pettit, 2005) antagonists (ranitidine, famotidine, cimetidine, nizatidine) and proton pump inhibitors (PPI) such as pantoprazole, lansoprazole, esomeprazole, omeprazole and rabeprazole (Khan *et al*., 2007). Antacids and histamine H2-receptor antagonists provide temporary relief. The use of these medicines for treatment induces body tolerances within two weeks. PPIs are more effective for the treatment of GERD than antacids. Surgical interventions were cited as another way of treating GERD (Shaheen *et al*., 2006). A low carbohydrate diet has been reported to alleviate GERD symptoms (Ip *et al*., 2005; Yancy *et al*., 2001; Yudkin *et al*., 1972).

This study designed a diet suitable for heartburn sufferers. A selection of foods that prevent heartburn and those which aid digestion of foods has been outlined by many researchers (Berardi, 2006). Certain food stuffs contain nutrients that help eliminate or reduce heartburn. A balanced diet maintains healthy body systems and alleviates heartburn. Some of the symptoms associated with heartburn include hoarseness of voice, persistent need for clearing of the throat, excess throat mucus of postnatal drip, coughing after eating or lying down, breathing difficulties or chocking episodes, troublesome or annoying cough, sensation of something sticking in the throat, heartburn, chest pain, indigestion or stomach acids (Silverman, 1992).

All these symptoms can be relieved by a diet containing antioxidants. Some of the antioxidants include fat soluble vitamins (ADEK) in addition to water soluble vitamin C (Yancy *et al*., 2001). Some bactericidal chemicals contained in onion, pistachio nuts, ginger, oregano and thyme that are used when preparing meals destroy bacteria that are responsible for producing toxins associated with heartburn (Austin *et al*., 2006). Oregano contains phytochemicals likethymol, pinene, limonene, carvacrol, ocimene, and caryophyllene. There are also a substantial number of health claims associated with its potent antioxidants and anti-bacterial properties (Steirna *et al*., 2013) (Heidal *et al*., 2001).

The herb is used to treat respiratory tract disorders, gastrointestinal (GI) disorders, menstrual cramps, and urinary tract disorders. Oregano contains: fiber, iron, manganese, vitamin E, calcium, omega fatty acids, manganese, and tryptophan. Antioxidants help protect cells against the effects of free radicals and improve the body's ability to fight infection. Oregano has shown antimicrobial activity in a number of studies. A group of Portuguese researchers found that *Oreganum vulgare* essential oils were effective against 41 strains of the food pathogen including *Listeria monocytogenes*. Oregano oil is a powerful antimicrobial, because it contains an essential compound called carvacol (Leonor *et al*., 2013). Biologists at the United Arab Emirates University reported in the journal that oregano exhibits anticancer activity through cell cycle arrest and apoptosis (cancer cells commit suicide) of the MDA-MB-231 breast cancer line thus it is a potentialchemo preventive and therapeutic herb (Yusra *et al*., 2013).

Onions contain quercetin that relieves cough, asthma, and some associated chest pains. The onion mineral salts are converted to carbonates which are alkaline, and when absorbed in the circulation system have a buffering effect of maintaining an optimum blood pH. Onions are also known to reduce blood glucose level and they contain enzymatic substances such as polyphenol oxidase and diastase which are beneficial for the digestive system. Onions contain sulphur which is required for the synthesis of essential fatty acids. These fatty acids are known to break down heavy mucus thereby facilitating expectoration of bronchial secretions. Ginger is good for digestion for the quick movement of the food through the digestive system (Femia *et al*., 2003).

Okra is rich in soluble mucilage fibre which is good for a protective and emollient function within the digestive system (Savello *et al*., 1980). Okra is a rich source of vitamin A, vitamin C, and vitamin B group except B12. Okra is rich in mineral salts such as calcium, magnesium, iron, potassium and sodium. Okra is good for relieving stomach ulcer, throat, and bronchitis. Okra has an alkalizing effect to the blood because of its mineral salts.

Spinach is rich in vitamins and minerals (Duodu *et al*., 1999). It contains lutein and zeaxanthin, antioxidants that protects the retina of the eye. Spinach is good for iron deficiency anaemia. Spinach protein reduces the absorption of cholesterol and bile acids. Lettuce is a remedy for obesity because of its ability to satisfy appetite. It is rich in vitamins and minerals (Nicolle *et al*., 2004) and has a sedative or sleep inducing effect which is vital for patients with insomnia. Lettuce improves digestion when eaten before a meal and is very low in carbohydrate making it suitable for people who overweight and diabetic.

Broccoli is a rich source of vitamins and minerals (Vasanthi *et al*., 2009). Broccoli also contains anti-carcinogenic phytochemicals. It is suitable for people who are obese and diabetic, because it has low calories, and it produces a certain feeling of satiety. Broccoli contains antibiotics that destroys *Helicobacter pylori.*

Lemon when mixed in the mouth with starchy foods, such as chestnut, potatoes, or bananas is useful in weight reduction. The acid in lemon inhibits the action of ptyalin, an enzyme in saliva that initiates carbohydrate digestion in the mouth (Sun *et al*., 2002). Lemons contain phytochemicals which prevent cancer and other diseases the greatest achievement of advanced nutrition science. Lemon contains organic acids, such as citric acid, formic acid, ascorbic acid, which have antiseptic effects. Flavonoids in lemon serve as antioxidants potentiating vitamin C. The antioxidants neutralizes free radicals, prevent cell

damage, and also relieve heartburn and associated symptoms. Various minerals in the body have diverse functions (Thompson *et al.,* 2013). Phosphorus is required in the regulation of acid based balance in body cells. Calcium, sodium and potassium are essential role in the transmission of nerve impulses and muscle contractions thus they control oesophageal sphincter movements (He & MacGregor, 2008).

In this paper the nutrient composition and nutrient-nutrient interaction for the prescribed heartburn diet is explored. Previous work by (Wu *et al.,* 2008) reported the use of strict diet in providing adequate mineral salts to maintain homeostatic mechanism especially acid base balance to heartburn sufferers (Usai *et al.,* 2013).

II. Methods

2.1 Population and sampling

In this study the researcher selected 15 participants from United Bulawayo Hospital in Zimbabwe using convenient sampling. A questionnaire was used to gather information on diet from the participants. The reflux score index (RSI) was used to determine the severity of heartburn among participants. The participants were divided into 3groups, group1 were on strict diet and timed exercise, group 2 were on medication and diet, group 3 were on placebo and diet. For the strict diet the breakfast diet was selected from foods like maize/millet porridge, cereal, 1 slice of bread, teaspoon margarine or peanut butter, rooibos tea with milk, thyme and oregano tea, 1 egg, cheese slice for breakfast. Lunch was selected from sandwiches, cucumber, sausage rolls, rice, lemon tea, boiled potatoes, chicken, thyme, oregano, macaroni, baked chips, and fruit juice, mixed green salads, fruits and fish. Respondents were supposed to take pistachio nuts, biscuits, fruits, popcorn as snacks. Dinner was selected from rice, maize meal (sadza), pasta, chicken, fish, beef, cabbage, green vegetables, beetroot, broccoli, thyme, oregano and fruits. The group 2 participants were on cimetidine therapy for 4 weeks and diet, group 3 were on placebo and diet. The participants in group2 and 3 were given a list of foods suitable for reliving heartburn symptoms and they were also advised to engage in regularphysical activities.

2.2 Body Mass Index (BMI)

The BMI assessment was carried out for all the 15 participants to see if the weight of heartburn sufferers is the contributing factor to heartburn problems. A cohort method of analysis was used that would show the difference on those on the dietary intervention and those who were not, this was done before, during and after the intervention (the designing of the dietary regimen). The body mass index was calculated before, during and after the intervention. The BMI is important for heartburn sufferers so that they keep a healthy weight, because overweight increases pressure in the stomach and causes oesophageal reflux which will cause heartburn hence the need to exercise and to reduce the amount of starchy foods which in turn will be stored as adipose tissue.

2.3 *Helicobacter pylori* analysis

Microbiological analysis was done for *Helicobacter pylori*in all the 15 participants. An antigen blood and urine test method was used in screening patients for *H.pylori.* This was done before and after the interventions were implemented. Bacterial overgrowth of *Helicobacter pylori* is particularly dangerous, most of the fibre consumed escape digestion and become intestinal food for bacteria. *H. pylori*damages the mucosal lining and produces toxins that damage the mucosal lining of the oesophagus causing heartburn and causing ulcers and may develop in to cancer, hence the need to design a diet which reduces microbial load. The foods incorporated thyme, oregano, ginger, broccoli and mastic-a resin from a Mediterranean and Middle Eastern variety of Pistachio tree these contain bactericidal chemicals (Steirna *et al.,* 2013).

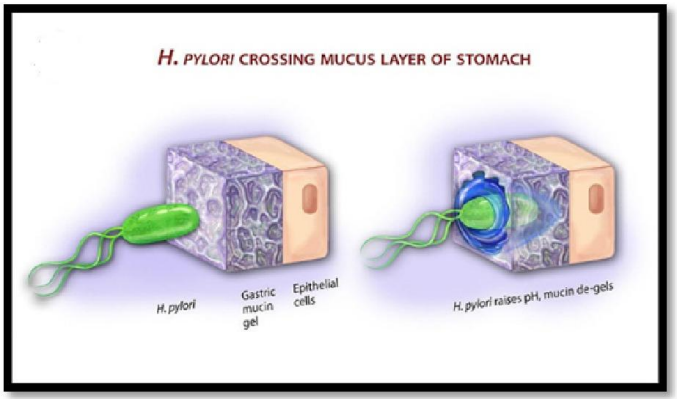

Figure 1. Picture showing *H.pylori* crossing the epithelial cells

2.4 Analysis of nutrients in food

Diet prescribed for breakfast, lunch and supper was analysed for nutrient content.

2.5 Moisture content

About 3.0 g food samples were separately weighed on an analytical balance and transferred into crucibles. The samples were dried for 12 h in an oven set at 50^{o}C. The dried samples were ground, reweighed and re-dried until constant mass was attained. The samples were cooled and stored in a dessicator. The percentage moisture content was calculated using Equation 1.

$$Moisture\ content\ (\%) = \frac{Weight\ of\ dried\ sample \times 100}{Weight\ of\ original\ sample} \quad (1)$$

2.6 Crude fibre content

Crude fibre was determined following Weende method (Henneberg *et al.,* 1865). Solid food samples (3 g) were weighed into pyrex crucibles. The samples were then transferred to the boiling position in the hot extraction unit (Fibertec system 1). To each sample, 150 ml of 1.25% sulphuric acid preheated on a hot plate was added. This was followed by addition of 2-3 drops of n-octanol to prevent foaming, and the mixtures were gently boiled for 30 minutes. Any sediments formed were filtered by applying reverse pressure. The fibres were washed thrice times with hot deionised water (50 mL each wash) using the spray device from the top of the boiling tubes. The water was sucked to leave fibre as dry as possible. To each sample 150 ml of 1.25%

NaOH solution, preheated on a hot plate was added. This was followed by addition of 2-3 drops of n-octanol to prevent foaming, and the mixtures were gently boiled for 30 minutes. Any sediment formed were filtered by applying reverse pressure. The fibres were washed thrice times with hot deionised water (50 mL each wash) using the spray device from the top of the boiling tubes. The samples were transferred to the cold extraction unit, washed three times with acetone (about 25 ml each time) and vacuum dried. The samples in crucibles were removed, dried in oven at 130°C for 2 h. The crucibles were cooled in a desiccator and weighed. The weighed samples were ashed in a muffle furnace at 550°C for 3 hours. The ashed samples were cooled to room temperature and weighed. The percentage ash content was determined according to Equation 2.

$$Crude\ fibre\ (\%) = \frac{(Weight\ of\ ashed\ sample - weight\ of\ dried\ sample)\ 100}{Weight\ of\ original\ sample} \quad (2)$$

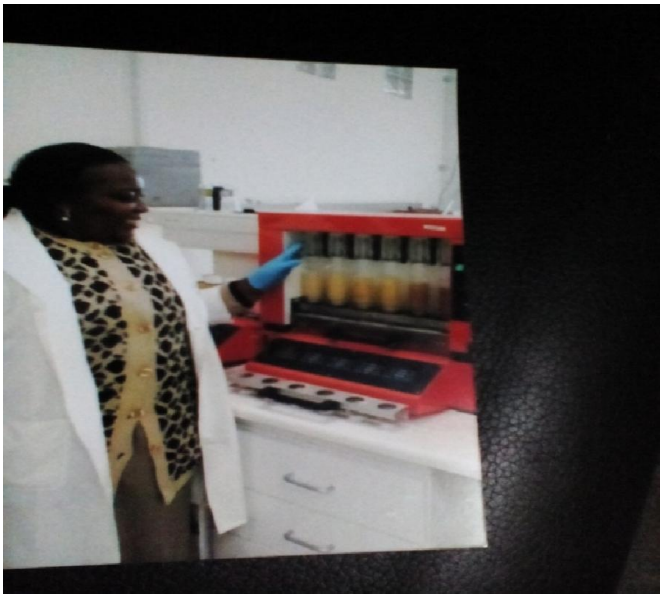

Figure 2. Picture showing student carrying out crude fibre analysis

2.7 Crude fat content

Approximately 3.0 g samples were transferred into 25 mL round bottomed flasks containing 150 ml petroleum ether. The samples were extracted in a soxhlet extractor for approximately 4-6 h before removing the extracted fat using a rotary evaporator. Any excess solvent in sample flasks was removed in an oven (105°C) for 30 minutes. The samples were placed in desiccators, cooled and weighed. Crude fat weight was determined according to Equation 3.

$$Crude\ fat\ (\%) = \frac{Weight\ of\ extracted\ fat \times 100}{Original\ mass\ of\ sample} \quad (3)$$

2.8 Ash content

Milled food samples (1 g) in crucibles were placed on a hot plate and heated until there was no smoking. The crucibles were placed in a in a Muffle furnace (550°C) for 3 hours. The crucibles were cooled to room temperature in a desiccator and the weight of ash determined (Equation 4).

$$Ash\ content\ (\%) = \frac{Weight\ of\ ashed\ sampled \times 100}{Weight\ of\ original\ sample} \quad (4)$$

2.9 Mineral content

The mineral content in food samples were determined by atomic absorption spectrometer (Perkin-Elmer Model 214) following AOAC 999-10 international method of 2012.

2.10 Vitamin content

Vitamins were analysed using high performance liquid chromatography (Shimadzu LC-10AVP). The standards were prepared by weighing 15 mg of each vitamin powder and dissolving in methanol making stock solutions of 1.0 mg/mL in volumetric flasks. Fat soluble vitamins were extracted from 0.125 g of grounded samples and placed in 10 ml volumetric flasks containing 8 ml of dichloroethanol. After 15 min of ultra sonication extraction dichloroethanolic acid was added (1:1) and the mixture stored in the dark.

Ground water soluble vitamin samples (0.125 g) were added to 8 mL of water in 100 mL volumetric flask. After 15 min of ultrasonication extraction a further 8 mL of water was added. Water and fat soluble vitamins were then injected into HPLC. Prior to injection each solution was filtered through 0.2 µm filter. Samples (20 µL) were injected at 25°C and 1.0 mL/min flow rates. Vitamins A was analysed using acetonitrile mobile phase. Other vitamins were analysed with phosphate buffer (3.4 g potassium hydrogen phosphate in 1 L of water) at pH 3.2. The vitamins were detected on UV detection at 210, 245, 265 and 280 nm wavelengths.

2.11 Protein and carbohydrate content

The quantities of proteins and carbohydratesin food samples were determined according a previously reported method (Suzanne Nielsen, 2009).

III. RESULTS

3.1 BMI

Table 1 shows BMI data of respondents before and after a 2 week strict diet and exercise. The weight of all the respondents decreased after taking the diet and scheduled exercises resulting in a lowered BMI. A low carbohydrate diet resulted in burning of some of the stored fats. Decreased amounts of protein intake to the required level also contributed to a decrease in weight.

Table 1. BMI of strict diet and timed exercise respondents before and after diet

Respondents	A	B	C	D	E
Height (m)	1.65	1.65	1.7	1.65	1.65
Weight before diet(kg)	63	78.9	103	79	106
Weight after diet(kg)	61	70.7	90	75	95
BMI before(kgm^{-2})	24	29	36	33	40
BMI after(kgm^{-2})	23	26	31	30	35

3.2 The reflux symptom index

Table 2 shows the effect of the diet on GERD symptoms. Reflux symptom index scale rates the symptoms on a scale of 1-5. A score of 5 shows a severe problem while a score of 0 shows no problem. All the respondents did not have a hoarse voice which is associated with erosion of the oesophagus. All the respondents had problems with clearing of throat which disappeared after taking the diet. Excess throat mucus disappeared after taking the diet except for respondent E. Symptoms such as difficult in swallowing food, annoying cough and coughing after eating completely disappeared for all patients after taking the diet. All except for respondent E experienced complete clearance of symptoms of breathing difficulties, sensations of something sticking in throat and chest pains. This could be explained by the fact that participant E was very obese. Respondents C and D show slight problems with clearing throat (score 1) after taking the diet. The other respondents had completely clear throat after taking the diet.

Table 2. GERD symptoms before and after strict diet and timed exercise

Symptoms	Strict diet score									
	Before					After				
	A	B	C	D	E	A	B	C	D	E
Hoarseness or a problem with your voice	0	0	0	0	0	0	0	0	0	0
Clearing your throat	2	4	3	3	4	0	0	1	1	0
Excess throat mucus or postnatal drip	0	5	4	1	3	0	0	0	0	3
Difficulty swallowing food, liquids or pills	3	4	4	3	0	0	0	0	0	0
Coughing after you ate or lie down	1	1	1	3	0	0	0	0	0	0
Breathing difficulties or choking episodes	2	2	2	3	3	0	0	0	0	2
Troublesome or annoying cough	0	2	4	1	1	0	0	0	0	0
Sensations of something sticking in your throat A lump in your throat	3	3	0	3	4	0	0	0	0	4
Heartburn, chest pain, indigestion, or stomach acid coming up	4	4	4	4	5	0	0	0	0	4

Figure 3 shows the composite scores for the symptoms. The composite of these scores should be 10 or below. If it is more than 10, you should consider an evaluation to check for GERD. All the participants had a score above 10. However after taking the di*et* all except E had scores below 10. This could be explained by fact that the participant E was very obese.

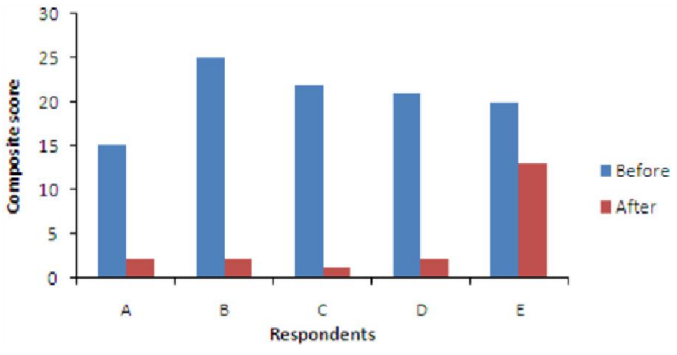

Figure 3. Composite reflux score for GERD

3.3 Responses to prescribed diet

Table 3 shows the list of foods which cause heartburn to the respondents before taking the prescribed diet. The foods that were cited by respondents are in agreement with the foods that were previously reported by Berardi (1). The main symptoms that were induced by these foods include heartburn and chest pain, indigestion and stomach acid coming up.

Table 3. Food causing GERD symptoms before diet

Respondent	A	B	C	D	E
Food causing heart burn	Chocolate, coffee, sugar beans	Mayonnaise, peanut butter	Alcoholic beverages Fizzy drinks	Dried vegetables, spicy foods	Sweet potatoes, round nuts

Table 4 shows some of the prescribed foods that caused GERD symptoms from the prescribed diet. Different patients experienced GERD on taking different food stuffs. The respondents were advised to withdraw from foods that aggravate GERD symptoms. Some of them experienced the symptoms after taking large amounts of the prescribed foods during breakfast, lunch or supper.

Table 4. Food aggravating GERD symptoms to different respondents during intervention

Respondent	A	B	C	D	E
Food causing heart burn	buns, baked beans	Pumpkin pudding, sweet potato	Maize porridge, dried vegetables	Sour milk	Spicy beef

Table 5. Symptoms of gastro esophageal complication scores before and after medication and diet

Symptoms	Scores									
	Before					After				
	A	B	C	D	E	A	B	C	D	E
Hoarse voice	0	0	0	0	1	0	0	0	0	0
Throat clearance	1	1	5	0	2	0	0	2	0	1
Excess mucus	0	0	0	2	3	0	0	0	1	2
Swallowing problems	0	3	0	0	0	0	1	0	0	0
Coughing after lying down	0	0	3	0	4	0	0	1	0	2
Chocking episodes	5	0	0	1	0	2	0	0	1	0
Annoying cough	0	0	2	2	3	0	0	1	1	1
Throat lump	1	3	0	3	4	1	2	0	1	2
Heartburn	4	5	3	3	3	2	2	2	1	2

The symptoms of participants on diet and medication before and after treatment are shown in Table 5. Respondent E had a hoarse voice problem before treatment which disappeared after administering medication. There was an improvement on throat clearance for C and E whilst there was absolute recovery for A and B after taking medication. The problem of excess throat mucus for respondents D and E improved significantly after taking medication. Swallowing of food problems improved for respondent B after taking medication. Breathing difficulties or choking episodes, annoying cough, sensation of something sticking in the throat, chest pain, heartburn and indigestion improved significantly from severe to mild for

afflicted respondents after treatment. The relief can be attributed to the effect of cimetidine, improved diet and lifestyle. Cimetidine is an H2 blocker which decreases acid production in the body. Following prescribed diet eliminatesbacteria, improves digestion and decreases excess nutrients. Regular exercises burns excessive calories and improves blood flow.

Table 6. Symptoms of gastro esophageal complication scores before and after treatment with placebo and diet

Symptoms	Scores									
	Before					After				
	F	G	H	I	J	F	G	H	I	J
Hoarse voice	3	0	0	0	0	2	0	0	0	0
Throat clearance	2	1	0	1	1	1	0	0	0	0
Excess mucus	1	1	2	3	3	0	0	2	2	1
Swallowing problems	1	3	0	0	1	0	3	0	0	0
Coughing after lying down	1	0	0	2	2	0	0	0	1	0
Chocking	2	0	0	2	2	2	0	0	1	0
Annoying cough	3	0	0	2	0	1	0	0	1	0
Throat lump	2	2	4	4	1	0	1	3	3	1
Heartburn	1	4	4	4	4	2	3	2	3	1

Comparative effects of medication and diet versus placebo and diet on symptoms

Table 7. Comparison of symptoms reflux cumulative score results for individuals on different GERD treatment

Respondent	Score (drug and diet)		Decrease (%)	Score (placebo and diet)		Decrease (%)
	Before	After		Before	After	
A	11	5	63.6	-	-	-
B	12	5	58.3	-	-	-
C	13	6	53.8	-	-	-
D	11	5	63.6	-	-	-
E	20	10	50.0	-	-	-
F	-	-	-	14	8	34.9
G	-	-	-	11	7	36.4
H	-	-	-	11	8	27.3
I	-	-	-	18	11	38.5
J	-	-	-	14	3	78.6

Table 7 shows the cumulate scores on the reflux symptom index for respondents on different treatment regimes. Respondents on medication and diet had lower symptoms than those on diet and placebo except for respondent E. Symptoms for respondent E reduced markedly (78.6%). This could be explained in terms of different people responding differently to diet. Diet with medication was more effective because cimetidine decreases acid production. However the drug provides short term relief.

BMI measurements

Table 8 shows anthropometric measurements of respondents that were under cimetidine treatment and the prescribed diet. There was a slight weight drop for respondents C and E while BMI of respondents A and B remained constant before and after taking medication. The BMI of participant D increased from 14 to 18. The increase in BMI can be attributed to consumption of a balanced diet during the assessment period.

Table 8. BMI measurements for respondents on diet and cimetidine

Measurement	Score	Respondents				
		A	B	C	D	E
Height (m)	Before	1.60	1.70	1.65	1.66	1.61
	After	1.60	1.70	1.65	1.66	1.61
Weight (kg)	Before	95.0	67	79.6	40.1	105.0
	After	95.0	67	75.0	48.0	95.1
BMI (kg/m^{-2})	Before	38	24	30	14	40
	After	38	24	28	18	38

Table 9. BMI measurements for respondents on diet and placebo

Measurement	Score	Respondents				
		F	G	H	I	J
Height (m)	Before	1.65	1.65	1.56	1.60	1.60
	After	1.65	1.65	1.56	1.60	1.60
Weight (kg)	Before	76.0	78.0	74.0	59.7	75.0
	After	68.0	78.0	67.0	60.0	72.0
BMI (kg/m^{-2})	Before	29	29	32	24	30
	After	25	29	28	24	29

Table 9 shows BMI measurements for participants on placebo and the prescribed diet. The placebo was taken thrice daily, after taking a meal in the morning, afternoon and supper at least an hour before bedtime. There was no change in BMI for respondents G and I while that of F, H and J decreased. The decrease in BMI was due to taking of a balanced diet and changes of lifestyle.

3.4 Helicobacter pylori

Screening for *Helicobacter pylori* was done using the blood antigen test and urine analysis showed that 14 out of 15 participants tested *H.pylori* positive before administering the diet. However after administering the diet a urine test *H.pylori* metabolite analysis was done to all respondents and the results showed that 10 out of 15 patients tested negative for *H.pylori*. The diet was administered for two weeks. All the correspondents on the strict diet and timed exercise regimen were taking pistachio nuts, thyme, broccoli and oregano that are responsible for destroying bacteria in the stomach. *Helicobacter pylori* is responsible for causing digestive illnesses including gastritis and peptic ulcer disease (Steirna *et al.,* 2013). Heidal (Austin *et al*., 2006), suggested using mastic (a resin from a Mediterranean and Middle Eastern variety of pistachio tree to treat *H. pylori*. Pistachios are a rich source of essential nutrients, fibre and protein, low in saturated fat and cholesterol free.

3.5 Moisture content

Table shows some of the nutritional elements in the daily strict diet that were consumed by the participants. Moisture content was higher for breakfast compared to lunch and supper this is attributed to the liquid nature of most foods taken during breakfast namely rooibos or thyme and oregano tea and oats porridge prepared with milk. Lunch and supper consisted of mostly semi-solid foods. Breakfast as the first meal of the day

should contain foods that are easy to digest and the meal should be balanced, containing all the nutrients required by the body in adequate amounts. The body needs foods that are soft. Water dissolves nutrients for easy digestion and absorption by the body.

Crude fibre is important for the movement of food through the intestines as it increases bulk. Breakfast and supper provide adequate daily fibre of at least 4%. High fibre content (4.22%) for breakfast was attributed to whole wheat bread and oats porridge while fibre content for supper (4.43%) was due to a lot of vegetables and fruits consumed. The fibre provided for lunch is lower (2.84%) since the meal is taken as a light meal during working hours. Fibre is important for the diet of people who are overweight as it makes them feel that they are full but with fewer nutrients available to the body. Fibre prevents constipation and diseases such as hernia, varicose veins and diverticulosis (Winge *et al.,* 2003).

Total crude fat content for the day was approximately 29%. This amount was adequate for important body functions. Most of the fats taken by the body are natural since a minute amount of cooking oil was added during cooking. Food contains fats and oils which are essential for the body. Fruits and vegetables have invisible fats found inside cell structures. Metabolic fats such as cholesterol are important for the synthesis of steroid hormones. Fats and oils help with cellular development and the formation of healthy cell membranes. Essential fatty acids assist in the development and function of the brain and nervous system.

Lunch and supper contains high ash content (at least 6%) than breakfast (4.42%) since these two meals contain higher amounts of solid foods. Ash shows that there are other nutrients such as minerals, vitamins, proteins and carbohydrates in the diet. Vitamins and minerals are important for prevention of diseases. Proteins and carbohydrates are essential for body growth and for metabolic energy used by the body.

Table 10. Some elements of a daily strict diet

Meals	Content (%)t			
	Moisture	Crude fibre	Crude fat	Ash
Breakfast	80.95	4.22	10.51	4.42
Lunch	78.27	2.84	2.50	6.55
Supper	77.82	4.43	16.18	6.29

3.6. Vitamin content

Vitamins are essential micro nutrients that are required by the body in small amounts for various functions therefore must be provided by the diet (Insel *et al.,* 2011), (Wardlaw *et al.,* 2004) and (Traber, 2007). The fat soluble antioxidants helps maintain cell membrane, red blood cell integrity, protects vitamin A and fatty acids from oxidation. Vitamin A maintains epithelial tissues /cells and is also essential for immune functions for blood cells as T-lymphocytes and killer cells which play a critical role in the defence against pathogensit also prevents peroxidative damage of cell membranes, in the mitochondria. Circulation and respiratory chain helps eliminate some of the heartburn symptoms. The strict diet prescribed to patients contained various amounts of vitamin elements as shown in the graphs below.

Daily vitamin intake from breakfast, lunch and super

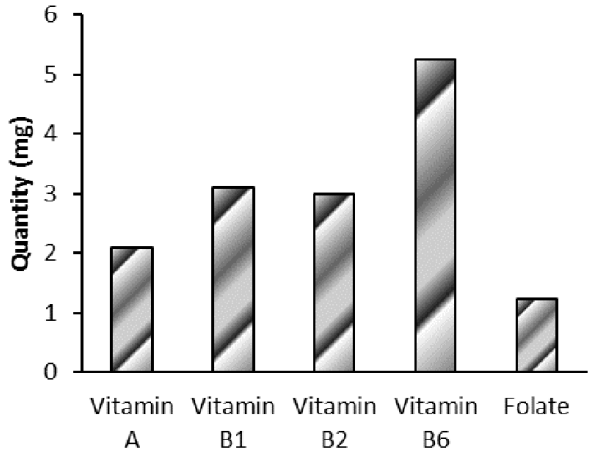

Figure 4. Daily vitamin intake

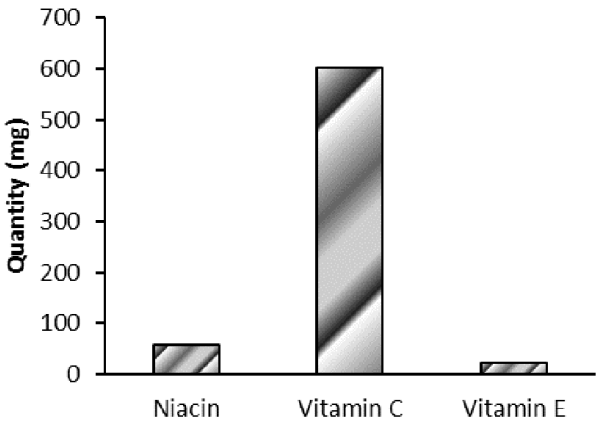

Figure 5. Daily vitamin intake

3.3 Mineral content

The mineral content of meals taken for breakfast, lunch and supper are shown in Table 2. The mineral nutrient levels fall within the recommended daily intake according to WHO 2009. Mineral are vital elements that are essential for certain physiological processes in body cells especially maintaining the acid base balance thereby eliminating GERD symptoms. These include potassium, calcium, sodium, phosphorus, iron and magnesium (Matsumura *et al.,* 2000), (Vormann, 2003), (Nicholls, 2009), (Holberg *et al.,* 1997) and (Much & Wilcox, 1982). The mineral composition of the strict diet was analysed and the results of a daily intake from breakfast, lunch, and supper are shown in the tables below;

3.4 Proteins and carbohydrates content

The strict diet supplied 303.6 g per 100 g of carbohydrate and 142 g per 100 g of protein. These quantities were adequate for the normal daily body functions.

Table 11. Mineral content in the strict diet

Mineral	Quantity mg/100 g			
	Breakfast	Lunch	Supper	Total
Potassium	27.88	7.1	8.22	43.2
Sodium	40.45	44.71	52.34	137.5
Calcium	10.62	4.67	4.68	19.97
Iron	0.358	0.0739	0.142	0.5739
Magnesium	5.91	2.07	3.63	11.61
Phosphorus	1036.4	694	667	2397.4

3.5 Nutrient-nutrient interaction

Table 3 gives a summary of nutrient-nutrient interaction from the diet supplied to heartburn sufferers. Table 3 also gives some functions of the nutrients upon interaction. Most of the nutrients influence the absorption of each other and the interactions are vital in alleviating some of the symptoms of GERD.

Table 12. Nutrient-nutrient interaction summary

Vitamin	Interaction
B complex	Pantothenic acid oxidizes fats, carbohydrates and some amino acids Pyridoxine is essential for red blood cells formation and maintenance of nervous immune system Folacin is essential for erythrocytes production Cobalamin is useful for formation of red blood cells, nervous system, Coenzyme in the intermediary metabolism, neurotransmitters. Folate is converted to coenzyme tetrahydrofolic acid that is used in brain neurotransmitters formation Folate works together with magnesium to stimulate enzymes That catalyze the reactions between phosphate ions and adenosine triphosphate (ATP). Magnesium also assists in cardiac and skeletal muscle contraction and helps transport sodium and potassium across cell membranes.
Vitamin C	Influences iron and calcium absorption. Calcium influences potassium and phosphorus absorption. Heals wounds since it is an antioxidant that donates electrons to free radicals Present is high concentrations in white blood cells for protection against free radicals produced during immune function.
Vitamin D	Regulates serum calcium phosphorous levels Regulates parathyroid hormone, Aids function of Mg, Fe and phosphate
Vitamin E	Fat soluble that helps maintain cell membrane. Red blood cell integrity and protects Vitamin A from peroxidative damage of cell membranes in the mitochondria. The circulatory and respiratory chain helps to eliminate some heartburn symptoms
Vitamin A	Interacts with folate, vitamin E and vitamin K

Table 13. One-way analysis of variance

P value	0.0186
P value summary	*
Are means significantly different?(P<0.05) at 95% confidence interval	Yes
Number of groups	3
F	5.652
R squared	0.4851

Table 14. Bartlett's test for equal variances

Bartlett's statistic (corrected)	7.469
P value	0.0239
P value summary	*
Do the variances differ significantly (P<0.05) at 95% confidence interval	Yes

Key: Asterisks (*) means that the groups being compared are significantly different from one another at the P<0.05 at 95% confidence interval.

Table 15. ANOVA table

ANOVA table	SS	df	MS
Treatment (between columns)	4629	2	2314
Residual (within columns)	4913	12	409.5
Total	9542	14	

Comparison of percentage decrease of symptoms

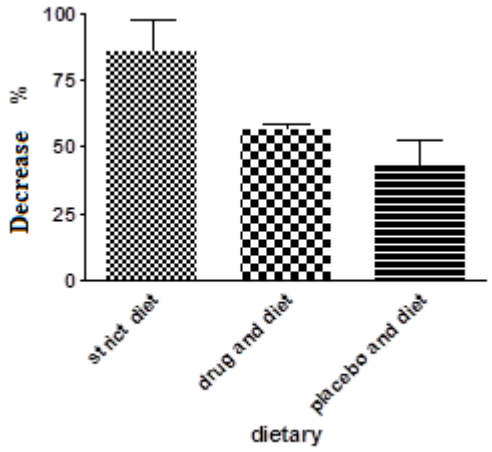

Figure 6. Percentage decrease of the symptoms

Conclusion

This study has demonstrated that the nutrients provided to five participants on the strict diet were in adequate proportions. The nutrients in the diet helped to reduce or eliminate heartburn and associated symptoms through their interactions in the body metabolic processes. Some of the nutrients neutralized the stomach and blood acids that were produced during digestion and metabolism. The proteins, fats and carbohydrate content were in adequate amounts to ensure normal function of the body system. Observations suggested that reducing fats, carbohydrates and proteins contributed to symptom relief. However, this conclusion is confounded by concurrent reduction of caffeine, alcoholic beverages, fatty, spicy and sweet foods. The diet contained lots of fruits and vegetables ensuring that the respondents were filled up most of the times. Fruits also provided vitamins and fibres that help in food digestion. Drinking lots of water also made the digestion and absorption of food easy. Also timed daily exercises improved the BMI of respondents. All the correspondents on the strict diet and timed exercise regimen were taking pistachio nuts, thyme, broccoli and oregano that are responsible for destroying

Helicobacter pylori which is responsible for causing digestive illnesses including gastritis and peptic ulcer disease. Medication played a crucial role in relieving GERD symptoms. The human mind also played a part in helping the respondents on placebo to recover as they thought that there were on GERD treatment. Also the selection of suitable foods from the list given to them helped them to recover. Lifestyle changes such as daily exercises, taking moderate alcohol, eating small frequent meals, cessation of smoking were vital in eliminating GERD symptoms. Heartburn sufferers are recommended to adopt the prescribed diet.

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