

## Diet affects reflux in a rural African community

Ndebia E.J., Sammon A.M., Umapathy E., Iputo J.E.

Department of Human Biology, School of Medicine, Walter Sisulu University

### Abstract

Reflux in this region of South Africa is known to be more frequent and less acidic than in other countries. We investigated the relationship between reflux and diet. We recruited 57 healthy participants. We carried out ambulant oesophageal pH-impedance monitoring for 24 hours. We used software and visual review to analyse data and to identify episodes of reflux and rapid alkaline rises in the stomach. A usual pattern diet questionnaire provided data on frequency of consumption of common foods. Associations between reflux, gastric pH and dietary components were sought using analysis of variance, and regression analyses. Diet was strongly based on maize. Protein was principally from milk, eggs, chicken and beans. Fat was principally from cooking oil. Fruit and vegetables were consumed moderately frequently. Milk consumption was associated with an increase in total reflux ( $P = .022$ ), weakly acid reflux ( $P = 0.015$ ) and supine reflux ( $P = 0.001$ ), and a decrease in the time that gastric pH was higher than 4 ( $P = 0.030$ ). Fat was associated with an increase in acid reflux ( $P = 0.046$ ) and a decrease in time that gastric pH was higher than 4 ( $P = 0.005$ ). Fruit consumption was associated with increases in liquid-only refluxes ( $P = 0.007$ ), and upright refluxes ( $P = 0.048$ ). Maize meal was associated with a reduction in rapid alkaline rises in the gastric lumen ( $P = 0.015$ ). Diet significantly affects reflux in this community. What is normal in apparently healthy people in various parts of the world differs significantly. (*Acta gastroenterol. belg.*, 2017, 80, 357-360).

**Key words :** Diet, Impedance-pH, non-acid reflux, milk, maize, Africa.

### Introduction

There is now a growing body of data about reflux, based on 24-hour ambulatory oesophageal impedance-pH monitoring, which gives fuller details of type and extent of reflux compared with older measuring models. Its ability to demonstrate weakly acid and non-acid reflux allows comparison not only of the amount of reflux, but also the type and extent of reflux. There is limited published data on the influence of diet on patterns of reflux in healthy people.

South Africa is cited as a country with a high incidence of cancer of the oesophagus (1). The Transkei region of the Eastern Cape Province in South Africa, where this study was carried out, is well known as one of the three high-incidence areas in the world for squamous cancer of the oesophagus (2). Studies into possible aetiology have consistently reported the use of the traditional diet of maize, pumpkin and beans in affected communities, and also in patients with cancer of the oesophagus (3). The diet has also been noted to be low in fats, vegetables and fruit. We have recently reported on the patterns of reflux in this rural population (4, 5). We have now analysed the relationship between reflux parameters and diet.

### Materials and methods

Ethical clearance for the study was granted by the Research Committee of Walter Sisulu University to carry out the investigation (reference 00011A-04). Healthy adult volunteers were recruited in the area surrounding Canzibe hospital in the rural Transkei region of the Eastern Cape Province in South Africa using a self-exclusion questionnaire. They were not chosen on the basis of diet, education or income. Those with upper gastrointestinal complaints were excluded. Volunteers aged between 18 and 65 years with no past medical history of digestive disease or associated symptoms, diabetes or neurological disease were recruited. None were consuming therapeutic drugs at the time of the investigation.

A pressure transducer (Model ICT/B, Gaeltec, Dunvegan, Isle of Skye, Scotland) was used to define upper and lower oesophageal sphincters using the station pull through technique (6). A catheter (K6011-EI-0782: Medical Measurement Systems, Enschede, The Netherlands) was passed transnasally until the upper pH electrode was positioned 5cm above the lower oesophageal sphincter (LES), the lower pH electrode 10cm below the LES, and the impedance rings at 3, 5, 7, 9 and 15 cm above the LES. The participant was then allowed to go home for the 24 hours of the study. Data was recorded in an Ohmega ambulatory pH-impedance recorder (Medical Measurement Systems) and downloaded to a computer at the end of the recording period. The analyses were carried out visually by two blinded observers, and also using Medical Measurement Systems software version 8.19.

A usual pattern food frequency questionnaire (7) was compiled which included all dietary components commonly eaten locally. The questionnaire was administered by a research worker who recorded how many days of each month each dietary component was consumed.

Correspondence to : Professor Alastair M Sammon  
Department of Human Biology, School of Medicine, Walter Sisulu University,  
Private Bag X1, Mthatha, Eastern Cape 5100, South Africa.  
E-mail : alastair.sammon@gmail.com  
Telephone +44 1452 341688

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### Data analysis

Meal time was excluded from analysis. Episodes of reflux were as defined in the Oporto consensus (8) and modified by Zerbib et al, 2005 (9). pH 4 and pH 6.5 were used as the thresholds between acid, weakly acid, and weakly alkaline reflux (9). We defined a rapid alkaline rise in the stomach as a rise in less than 10 seconds from a baseline of pH 2 or less, to a pH of 4 or more (5). Rapid alkaline rises were measured visually. Other measures were provided by the software analysis programme and each reflux episode examined visually and confirmed or excluded. We expressed non parametric data as median, 25th and 75th centiles.

Dietary components were considered in groups which contain major components of the local diet: foods containing maize meal ; cooking fat and margarine ; fruit ; vegetables ; beans ; milk and milk products. A score for each component was calculated on the basis of the number of days on which it was consumed per month.

### Statistical analysis

Analysis of variance of reflux parameters against commonly consumed foods was carried out by a biomedical statistician and those with significant associations (maize meal foods, milk products, margarine and cooking fats, total vegetables, total fruit) were included in a regression analysis (SPSS: IBM corporation, New York, United States). Statistical significance is expressed as the P value. Values greater than P = 0.05 are reported as not significant.

## Results

### Food survey

**Carbohydrates :** Maize based food was the most frequently consumed carbohydrate in the study population (Table 1). The commonest forms of maize consumed were porridge (28 times per month) and fermented maize drink (13 times per month). The median frequency of consumption of maize products was 66 times per month.

**Proteins :** Cow's milk (as fresh milk, sour milk or from milk powder: 26 times per month), chicken and eggs (19 times per month) were the most frequently consumed proteins in the study population. Fish was consumed 6 times per month. Beef, pork and mutton were rarely eaten.

**Beans :** Beans were consumed 6 times per month.

**Fats :** Cooking oil was used by most subjects every day (29 times per month). Margarine was used frequently, (19 times per month). Other types of fat were poorly represented and were not taken into consideration.

**Fruits and vegetables :** Cabbage was the most frequently consumed vegetable with a consumption of 16 times/month. Wild vegetables (imifino) were consumed frequently (11 times per month). Spinach was

Table 1. — Frequency of consumption of common foods

Food component	Per month	Food component	Per month
Carbohydrate		Protein	
Maize porridge	15	Milk and milk products	26
Fermented maize drink (marewu)	13	Chicken Eggs	10 9
Stiff maize porridge	8	Fish	6
Maize porridge with wild vegetables	8	Fish Beef, pork, mutton	6 4
Stamped maize and beans	6		
Maize meal and pumpkin	6	Vegetables	
Maize porridge with milk	5	Cabbage	16
Potatoes	18	Pumpkin	9
Rice	14	Wild vegetables	11
		Spinach	10
Fruit		Carrots	8
Apples Oranges	13 10	Solanum nigrum (umsobo)	8
Bananas	10	Beans	6
Fats			
Margarine	19		
Cooking oil	29		

Table 2. — Regression analysis of reflux and food categories

	Milk	Maize meal	Fruit	Fat
Total reflux	.022	ns*	ns	ns
Total liquid reflux	.047	ns	.007	ns
Acid reflux	ns	ns	ns	.046
Weakly acid reflux	.015	ns	ns	ns
Non-acid reflux	ns	ns	ns	ns
Liquid reflux	ns	ns	ns	.047
Mixed reflux	.022	ns	ns	.034
Time gastric pH>4	.030	ns	ns	.005 (negative)
Rapid Alkaline Rises	ns	.015 (negative)	ns	ns
Upright reflux	ns	ns	.048	ns
Supine reflux	.001	ns	ns	ns

Statistical significance is expressed as the P value. Values greater than P = 0.05 are reported as ns (not significant).

consumed moderately. Pumpkin, carrot and umsobo (the wild vegetable *Solanum nigrum*) were also eaten moderately. Apples were the most frequently eaten fruit (13 times per month). Oranges and bananas were also eaten moderately (10 times per month).

### Gastro-oesophageal reflux pattern and food (Table 2)

Using P equal to or less than 0.05 as the threshold of statistical significance, diet had significant effects

on total reflux, total liquid reflux, acid reflux, liquid reflux, mixed reflux, the length of time the gastric pH was greater than 4, upright reflux, supine reflux, and the number of rapid alkaline rises.

Milk consumption was the most influential of dietary components, and showed associations with 6 reflux parameters. Fat showed associations with 4 reflux parameters, and fruit and maize meal with 2 and 1 reflux parameters respectively.

No dietary component showed a significant effect on non-acid reflux.

*Carbohydrate* : Maize meal was associated with a reduction in rapid alkaline rises in the gastric lumen ( $P = 0.015$ ). Substituting the traditional diet of maize, pumpkin and beans for maize meal in the statistical analysis made no significant difference to the findings, and there were no other significant associations.

*Milk* : Milk consumption was associated with increases in total reflux ( $P = 0.022$ ), total liquid reflux ( $P = 0.47$ ), weakly acid reflux ( $P = 0.015$ ), mixed reflux ( $P = 0.022$ ) and supine reflux ( $P = 0.001$ ), and a decrease in the time that gastric pH was higher than 4 ( $P = 0.030$ ). (See Table 2)

*Fats* : Fat was associated with an increase in acid reflux ( $P = 0.046$ ), liquid and mixed reflux and a decrease in the time that gastric pH was over 4 ( $P = 0.005$ ).

*Fruit and vegetable* : Fruit was associated with increases in the number of liquid-only refluxes ( $P = 0.007$ ), and the number of upright refluxes ( $P = 0.048$ ).

## Discussion

The pattern and frequency of oesophageal reflux and gastric pH in this community have been reported fully in our recent papers (4, 5). Data showed that the median number of refluxes was 49 per 24h. The median numbers of acid, weakly acid and non-acid refluxes were 15, 17, 8 respectively (4). Also, gastric alkalinisation was commonly reported, particularly at night (5).

The use of food frequency as a measure of consumption does not take account of quantity, and may therefore over-represent foods usually taken in small quantities such as milk in tea, and may underestimate the staple cereal. However the results of this type of questionnaire are reliable and reproducible.

There is little published evidence about reflux in healthy subjects and its relation to diet. Zentilin et al, 2006 (10) studied 25 healthy Italians eating a Mediterranean diet who had comparatively little reflux. Their results for median acid/weakly acid/weakly alkaline reflux were 18/14/4. Zentilin et al noted the discrepancies between their results and those of Zerbib et al (9) and Shay et al (11), and attributed this to diet. Balaji et al (12) working in USA asked 17 healthy volunteers to eat what they described as a 'refluxogenic meal; hamburger, fries and milkshake'. These subjects had a median total reflux count of 44, of which 39.4 % were acidic. This was not their normal diet, and data is not available for their normal frequency or type of reflux.

Our study with its results of 15/17/8 demonstrated a shift away from acid reflux. Xiao et al, 2009 (13) in China showed a ratio of 22/16/0. The findings of Shay et al, 2004 (11) in USA and Belgium were 18/9/0 and for Zerbib et al, 2005 (9) in Belgium were 22/11/3. This places our study as the least acid-dominated of studies so far published. The results are to some extent affected by the differing alkaline thresholds of pH 6.5 in South Africa and Belgium, pH 7 for the others. With a median total reflux episodes of 49, our study also exceeds those in China (40); USA and Belgium (30); Belgium (44); and Italy (16).

There has been wider research into diet and symptoms in those who suffer gastro-oesophageal reflux disease (GORD). Mone et al, 2015 (14) confirmed that those on a Mediterranean diet have less reflux disease than those whose diet includes red meat, fried food, sweets and junk/fast food. They were unable to identify specific items in the Mediterranean diet which reduced GORD, but noted that the main source of lipids was olive oil. There are studies which suggest a positive association between reflux and obesity (15), and an independent positive association with high-fat and high-calorie intake (16, 17).

The community which we studied is in transition from dependence on subsistence farming and milled maize, to a much greater percentage of bought foods. There is no longer a predominance of those eating the traditional diet of maize, pumpkin and beans which has been reported in previous dietary studies of this region (3, 18). There is still heavy reliance on maize but with increasing consumption of fruit, vegetables and meat. Compared to other studies the diet is low in red meat, and possibly has a higher percentage origin from cereal and a lower percentage origin from fats.

The diet of the participants of this study is predominantly maize-based, with moderate to low animal protein, and low fat content, and there is a high level of reflux, predominantly weak- or non-acid. The median maize and maize-product consumption of 66 times per month makes maize a likely factor in a high incidence of reflux, predominantly weakly or non-acid. Statistical analysis may not demonstrate this in a situation where almost all are frequent consumers. The results also showed that milk and fats are associated with a rise in numbers of reflux episodes, and a swing towards acid predominance.

The only demonstrated significant association of maize meal is a reduction of rapid alkaline rises in the gastric lumen. This could be due to a better pyloric sphincter competence, but alternatively is consistent with a reduction in sphincter tone, allowing relatively unrestricted backflow from duodenum to stomach, and therefore no intermittent rapid flow of enteric fluid entering the gastric lumen.

Studies so far published have established norms for reflux for healthy subjects in certain countries. It can now be recognised that these are not universal standards

but vary from country to country, dependent on diet as the likely main determinant. In view of varying results from Europe, North America, China, and South Africa, it is too early to be sure of what is a normal, or more specifically a healthy or acceptable amount and type of reflux. This part of the Eastern Cape of South Africa may not represent a healthy norm since it suffers from a high incidence of oesophageal cancer.

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