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Research Article

Gastric pH circadian rhythm in the rural Canzibe area of the Eastern Cape Province, South Africa: a preliminary pilot study

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Keywords:
Gastric pH; circadian rhythm; esophageal cancer; esophageal impedance

ABSTRACT

Objective: In this study, an attempt has been made to describe the normal circadian rhythm of gastric pH in the dwellers of Canzibe. The high incidence of esophageal cancer in this region is one of the motivating factors to undertake this study. Esophageal impedance studies carried out earlier has supported this finding. **Methods:** Gastric pH signals were recorded in 14 healthy volunteers during a 24Hr period using Ohmega ambulatory data logger attached to a unisensor dual pH probe. **Results:** The gastric pH circadian rhythm for males was characterized by 2 alkaline peaks at 09H00 and 12H00 and 2 nadir points at 15H00 and 03H00, while that for females were defined by only 1 alkaline peak at 09H00 and 1nadir point at 05H00. There were great fluctuations in gastric pH within the nycthemeral in males than in femalesbut with females presenting with higher gastric pH than males (ANOVA, P<0.0001). **Conclusion:** The peak and nadir of the gastric pH circadian rhythm are noted at 09H00 and 05H00 respectively.

.INTRODUCTION

Canzibe, a rural district in Transkei, a part of the Eastern cape province in South Africa, is one of the three areas of the world with a high incidence of squamous cancer of the oesophagus (Doll, 1969). In this population, 76.6 per 100,000 males and 36.5 per 100,000 females were reported between 1991 and 1995 to have esophageal cancer (Somdyala *et al.,* 2003). It is further reported that people residing in Eastern Cape Province of South Africa present a high incidence of squamous esophageal cancer (Sammon, 2009). Consequently, it was of great interest to carry out esophageal pH and impedence studies in this region. Our previous unpublished reports recorded and documented a deviance from published norms of esophageal impedance (Bekwa et al., 2010). This study reported an increase in reflux frequency, decrease in acid reflux and increased presence of non-acid reflux content from the stomach in the esophagus. This may, perhaps be a contributive factor to the high incidence of squamous esophageal cancer in the Eastern Cape Province (Bekwa *et al.,* 2010). Knowledge of the normal 24-hr ambulatory gastric pH is beneficial. This study examines gastric pH rhythm within 24 hour (chronobiological of gastric pH) according to gender.

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METHODS

Ethical permission was obtained from Walter Sisulu University faculty of Health Sciences Ethical research committee (reference 00011A-04). The sampling method used was one of convenience and the participants cannot be regarded as truly representative of the population. A questionnaire was used to review their medical, endoscopic, motility, and histological records; and informed consent obtained. All participating volunteers were free of symptoms of gastro-esophageal reflux, gastro-esophageal reflux disease (GERD), or gastritis. Those who were on symptomatic medications that can alter intragastric acidity or have a history of neurological disorder or gastrointestinal disease or are pregnant or nursing mothers were excluded from this study.

Twenty-four-hour pH monitoring was performed using a dual sensor pH catheter (K0011-E1-0782) connected

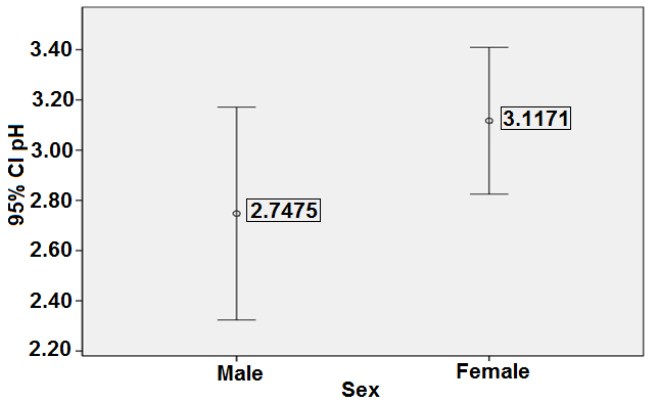

Figure 1. Mean ± 95% CI of Gastric pH in men and women.

to a portable digital data recorder (Ohmega ambulatory pH-impedance recorder) that stored pH data for up to 24 h. This procedure was performed on an out-patient basis after an overnight fast. Before the start of the recordings, the pH sensors are calibrated using pH 4.0 and pH 7.0 buffer solutions. Then the catheter was passed transnasally and positioned in the stomach.

The positioning of the catheter was established based on two techniques: on the pH differential between the distal (intra-gastric) and proximal (intra-esophageal) sensors and previous LES identification by esophageal manometer to ensure that the distance or position of the intra-esophageal sensor was located approximately 5 cm above the gastro-esophageal junction and the intra-gastric sensor in the gastric fundus approximately 5 cm below the gastro-esophageal junction. Participants then returned home with instructions to carry out normal daily activities without dietary restrictions. Measurements were carried out with the catheter in the participant for a period of 24hrs (for example from 8am the present morning to 8am the following morning). Gastric pH data were captured into the Medical Measurement Systems (MMS) Data Base (version 8.7) and analyzed using the software and confirmed by visual inspection that came integrated with the system.

The change of intra-gastric pH with time within the nycthemeral was visually drawn from the pH2 tracings. The reading for each hour was manually copied and a circadian rhythm for the study sample presented. The peak and nadir points on the circadian rhythm were clearly identified. Data was analysed by using the Statistical Package for the Social Sciences (SPSS) Version 19.0 for Windows (SPSS, Chicago, U.S.A.).

RESULTS

As this was a preliminary study, a sample size of 14 was considered adequate, although not ideal. This is one of the limitations of the study.

There was a high discrepancy of mean values of pH between men and women (Fig 1).

Females presented higher levels of gastric pH without statistical difference in comparison with men (P> 0.05). (Table 1)

Table 1. Comparison of pH by gender.

Variables of Interest	Men (N=5) Mean ± SD	Women (N= 9) Mean ± SD	P - values
pH	2.7± 2.3	3.1 ±2.2	0.148

The gastric pH circadian curve observed in males was totally different from that observed in females. Males were characterized by 2 alkaline peaks at 09H00 and 12H00, whilst females were defined by only 1 alkaline peak at 09H00.

Males had 2 nadir points at 15H00 and 03H00, whilst females had only 1nadir point at 05H00.(see fig 2 and 3)

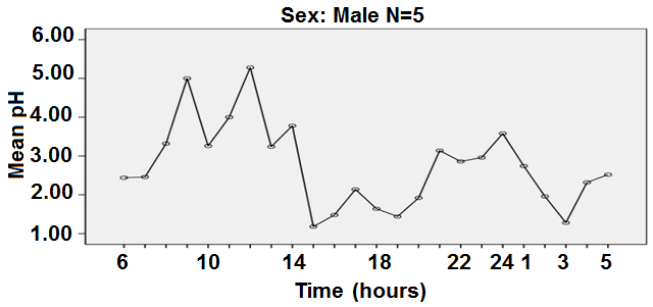

Fig. 2. Gastric pH circadian rhythm of males during the nycthemeral.

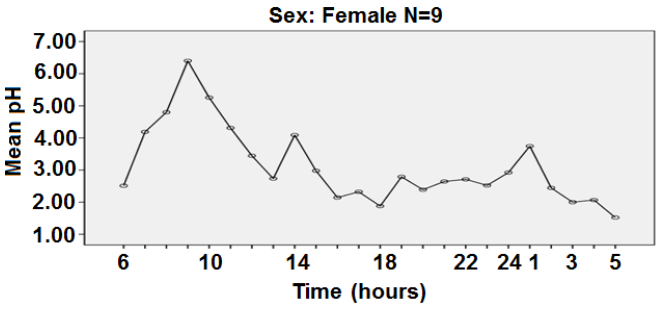

Fig. 3. Gastric pH circadian rhythm of females during the nycthemeral.

Higher variability of pH values were observed during the nycthemeral in males than in females (Fig 4 and 5). The mean intragastric pH value peak for males was between 4 and 6, whilst the mean intragastric pH value peak for females was higher than 6.

Despite the great variability of the pH values in males, females did not show a statistically significant difference across the hours of the nycthemeral (ANOVA, P=0.369). However, there was an unequal

and highly significant (ANOVA, P<0.0001) distribution of pH values across the hours of the nycthemeral in females.

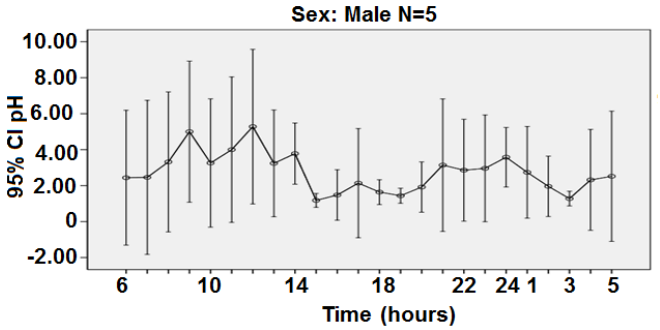

Fig. 4. Variability of intragastric pH values in males during the nycthemeral.

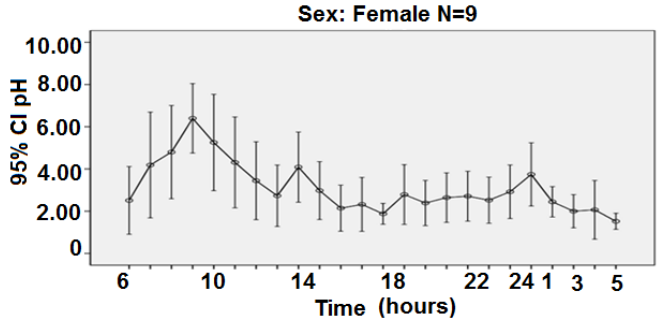

Fig. 5. Variability of intragastric pH values in females during the nycthemeral.

DISCUSSION

The main findings of this study are the revelation of the peak and nadir points of gastric pH noted at 09H00 and 05H00 respectively. The study also found out that within hours of the day, there is a great variability or fluctuations in gastric pH values in males than in females, but with females presenting with higher gastric pH than males.

The rhythm presented by males during the nycthemeral was different from that observed in women. Males had 2 alkaline peaks at 09H00 and 12H00, while females had only 1 alkaline peak at 09H00. These peak points are in accordance to the peak pH points reported by Stein *et al.,* (1994); which is documented to be related to meal. Males also presented with two nadir points at 15H00 and 03H00, while females had only 1 nadir point at 05H00. These nadir points of the gastric pH circadian rhythms for the dwellers of Canzibe correspond with that documented by Stein *et al.,* (1994). The nadir point (increased acid secretion) at 15H00 as reported by (Stein *et al.,* 1994) is stimulated by lunch meal. Nadir points at 03H00 and 05H00 did not correspond with either the human circadian peak hour of acid secretion (Bisht, 2011) nor with the circadian nadir point as documented by Stein *et al.,* (1994).

Unexpectedly, neither upright postprandial alkalinization (12H30 and 16H45) nor supine alkalinization (03H00 and 04H30) as reported by Stein *et al.,* (1994) was noted on the gastric pH rhythm of the dwellers of Canzibe. This may be attributed to the diet consumed which was not analyzed in this study.

Gaisberg (1981) estimated that, approximately four to eight hours after a meal, there is a steady and continuous rise in intragastric pH. Since our results presented alkaline points at 09H00 and 12H00, the alkaline point at 12H00 could be attributed to early breakfast.

The alkaline point at 09H00 could be due to the time of meal (late dinner) as suggested by Duroux *et al.,* (1989) or the type of meal as suggested by Sammon (2009). These variables would have been clearly analyzed if the diet of all the participants were prepared by us and served at the same times.

There was no significant difference of pH between the genders although females presented higher levels of pH in comparison with men.A high variability or fluctuations of the 24 hour gastric pH values was noted in males than in females.

However, the mean value of peak pH for males was between 4 and 6, while that for females is higher than 6.

Most importantly, the circadian rhythm of males and females in this region is now known and can be used as a reference in chronobiological studies involving inhabitants with similar lifestyle. Also this database could be used to compare the gastric pH circadian with other parts of the world; thus setting a foundation to elucidating the cause of GERD in this region.

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