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# Normal 24-hour ambulatory proximal and distal gastroesophageal reflux parameters in Chinese

## 正常華人24小時便攜式胃食道反流近遠端參考值

**Objective.** To quantify normal proximal and distal oesophageal acid parameters in healthy Chinese.

**Design.** Observational study.

**Setting.** University teaching hospital, Hong Kong.

**Subjects and methods.** Twenty healthy adults who were not on medication and were free from gastrointestinal symptoms were recruited by advertisement. Ambulatory oesophageal acid (pH <4) exposure parameters were recorded at distal and proximal sites, 5 and 20 cm, respectively above the lower oesophageal sphincter.

**Results.** The 95th percentile for reflux parameters assessed in the distal/proximal oesophagus were: percent total time pH <4, 4.6/0.7%; percent upright time pH <4, 7.0/1.1%; percent supine time pH <4, 4.5/0.5%; number of reflux episodes, 73/12; number of reflux episodes with pH <4 for >5 minutes, 4/0; and the longest single acid exposure episode, 11.2/3.0 minutes.

**Conclusion.** Physiological gastroesophageal reflux occurs in healthy Chinese. These initial data provide a preliminary reference range that could be utilised by laboratories studying Chinese subjects.

**目的：**確定正常華人食道酸反流近端和遠端的正常數據。

**設計：**觀察性研究。

**安排：**大學教學醫院，香港。

**參與者與方法：**挑選20名沒有腸胃病症狀和無長期服用藥物的健康華人，經過攜帶24小時pH記錄儀，將記錄探測器擺放於受試者食道下段括約肌以上的20cm(近端)及5cm(遠端)，記錄24小時中受試者的胃食道反流數據。

**結果：**食道遠端及近端95%的百分位數是：總pH值<4的百分數是4.6/0.7%，立位pH值<4的百分數是7.0/1.1%，臥位pH值<4的百分數是4.5/0.5%，總體酸反流次數是73/12，總pH值<4的反流時間長於5分鐘是4/0，單一最長反流時間是11.2/3.0分鐘。

**結論：**正常華人存在生理性胃食道反流，以上初步數據可為將來更多有關方面的實驗研究提供一個原始的參考值。

### Key words:

Gastroesophageal reflux;  
 Hong Kong

### 關鍵詞：

胃食管逆流；  
 香港

HKMJ 2002;8:168-71

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### Introduction

Ambulatory oesophageal pH recording, using a catheter with built-in pH electrode connected to a digitised solid-state recorder, is a commonly employed test. It provides quantitative data on both oesophageal acid exposure as well as the temporal correlation between symptoms and actual reflux events. Since reflux is a physiological event even in normal subjects,<sup>1</sup> delineation between physiological and pathological reflux is often difficult. Good temporal correlation between a well-defined pathological event such as chest pain, and a decrease in pH shown on the recording provides evidence of pathogenicity.<sup>2,3</sup> However, in the absence of symptomatic correlation, oesophageal acid exposure may be the only quantifiable parameter to determine abnormality. Johnson and Demeester<sup>4</sup> have derived a composite score for oesophageal acid exposure based on six variables:

- (1) percent total time pH <4;
- (2) percent upright time pH <4;
- (3) percent recumbent time pH <4;

- (4) number of reflux episodes;
- (5) number of reflux episodes with pH <4 for more than 5 minutes; and
- (6) the longest single acid exposure episode.

Richter et al<sup>5</sup> defined a similar set of normal values in another population studied.

It is possible that population differences in gastroesophageal reflux may exist and it is important that standard reference ranges are established for different populations. There is no previously published study on normal reflux parameters in Chinese. This study aims to establish normal values for gastroesophageal acid exposure in healthy Hong Kong residents.

## Methods

### *Patients*

The study design was approved by the research and ethics committee of the Faculty of Medicine, University of Hong Kong. Healthy subjects were recruited by advertisement. Each volunteer was carefully interviewed and underwent physical examination. Additional laboratory investigations were performed where appropriate to exclude systemic disorders affecting oesophageal motility and reflux. Volunteers were excluded if there was a history of heartburn more than once a month, dysphagia, regurgitation, odynophagia, chest pain, or dyspepsia. They were free of any significant medical diseases or gastric surgery, and had not taken any medication in the week prior to the study. Upper endoscopy was performed on all volunteers to exclude hiatus hernia.

### *Procedure*

The ambulatory oesophageal pH studies were completed as an out-patient procedure. Patients arrived at the motility laboratory, Queen Mary Hospital after an overnight fast. The location of the lower oesophageal sphincter was first determined using a low-compliance pneumohydraulic capillary infusion system (Dentsleeve Pty Ltd, Belair, Australia) and the station-pull-through technique. A sleeve catheter with 5 cm spacing (Dentsleeve Pty Ltd, Belair, Australia) was used. The upper border of the lower oesophageal sphincter was defined by the pressure inversion point. Patients were excluded if they had abnormal motility patterns in the oesophageal body (simultaneous contractions  $\geq 20\%$ , non-propagated contractions  $\geq 30\%$ , retrograde contractions  $\geq 10\%$ ).

Two channel antimony pH probes with internal references were spaced 15 cm apart. Before and after each study, the pH electrodes were calibrated using buffer solutions at pH=7 and pH=4. The probes were connected to a solid-state data logger (Synectics microdigitrapper Mk 3, Synectics, Stockholm, Sweden) with an event marker to document meals, symptoms, and body recumbency. The pH probe was inserted transnasally and advanced until an acidic gastric pH <2.5 was reached. The pH probe was subsequently

withdrawn slowly until the distal sensor was positioned 5 cm above the previously determined upper border of the lower oesophageal sphincter. The proximal sensor was thus 20 cm above the lower oesophageal sphincter. Subjects were encouraged to undergo normal activities, sleep schedules, and meal times. A normal diet was encouraged, but subjects were asked to refrain from acidic food or drinks, as well as alcohol and smoking. They were also asked to remain as upright as possible when awake, and to lie down flat when asleep.

After an interval of 24 hours, subjects were asked to return and the pH assembly was removed. Data were downloaded into a personal computer. Each individual trace was inspected by one of the authors to ensure good quality and the absence of artefacts. Data were analysed by proprietary software (Multigram version 6.31, Gastrosoft Inc., Stockholm, Sweden). Acid reflux was defined as an oesophageal pH <4 for at least 7.5 seconds. The reflux episode was considered to have terminated if pH  $\geq 4$ . The six pH parameters proposed by Johnson and Demeester<sup>4</sup> were evaluated for both the proximal and distal channels. Other parameters were also included for comparison.

### *Statistical analysis*

Normal values for each of the above parameters were assessed by calculating the 95th percentile for the subject group. Relation between age, sex, and weight to the various reflux parameters was tested by multivariate regression analysis. Correlation between proximal and distal reflux parameters was obtained by Kendall's tau. Statistical analyses were performed using the Statistical Package for Social Science (Windows version 7.5, SPSS Inc., Chicago, US).

## Results

Twenty healthy subjects (70% male; mean age, 36 years; age range, 20-50 years) were recruited. Values for distal pH parameters are shown in Table 1 and for proximal pH parameters in Table 2. Corresponding values from western studies are included for comparison.

Age was found to be associated with an increased percent total time pH <4 ( $P=0.01$ ), and with the number of acid reflux episodes ( $P=0.02$ ). These data are illustrated in the Fig. Men had a significantly greater percent total time pH <4 ( $P=0.02$ ), but there was no sex difference seen in the number of reflux episodes. Weight was not associated with differences in the reflux parameters. Proximal and distal acid exposure measurements were well correlated (Table 3).

## Discussion

Since the introduction of intraoesophageal pH monitoring by Miller<sup>6</sup> in 1964, this method has become the gold standard for documenting gastroesophageal reflux. Reflux is a normal physiological event and occurs with a greater frequency postprandially. In healthy individuals, reflux occurs mainly due to transient relaxation of the lower oesophageal

**Table 1. Distal reflux parameters measured 5 cm above the lower oesophageal sphincter**

Reflux parameter	Data from this study*	Richter et al study <sup>5</sup>	Johnson and Demeester study <sup>4</sup>
Percent time <4, total period	4.6 (0-6.2)	5.78	4.2
Number of episodes >5 min, total period	4.0 (0-6.9)	4.00	3.0
Duration of longest episode (min), total period	11.2 (0-34.0)	18.45	9.2
Number of reflux episodes, total period	73.0 (0-90.0)	46.00	50.0
Percent time <4, upright period	7.0 (0-7.9)	8.15	6.3
Number of long episodes >5 min, upright period	3.0 (0-4.0)	-	-
Duration of longest episode (min), upright period	11.0 (0-11.2)	-	-
Number of reflux episodes, upright period	62.0 (0-86.0)	-	-
Percent time <4, supine period	4.5 (0-6.0)	1.20	1.2
Number of long episodes >5 min, supine period	0 (0-1.0)	-	-
Duration of longest episode (min), supine period	4.0 (0-34.0)	-	-
Number of reflux episodes, supine period	4.0 (0-30.0)	-	-

\* Data are shown as 95th percentile (range)

**Table 2. Proximal reflux parameters measured 20 cm above the lower oesophageal sphincter**

Reflux parameter	Data from this study*	Dobhan and Castell study <sup>11</sup>
Percent time <4, total period	0.7 (0-0.80)	0.9
Number of episodes >5 min, total period	0 (0-0)	0 (0-2.0)
Duration of longest episode (min), total period	3.0 (0-5.0)	N/A†
Number of reflux episodes, total period	12.0 (0-18.0)	18.0
Percent time <4, upright period	1.1 (0-1.7)	1.3
Number of long episodes >5 min, upright period	0 (0-0)	0 (0-2.0)
Duration of longest episode (min), upright period	1.4 (0-5.0)	3.0 (0-32.0)
Number of reflux episodes, upright period	12.0 (0-17.0)	18.0
Percent time <4, supine period	0.5 (0-1.10)	0
Number of long episodes >5 min, supine period	0 (0-0)	0 (0-0)
Duration of longest episode (min), supine period	0.4 (0-3.0)	0 (0-3.0)
Number of reflux episodes, supine period	8.0 (0-9.0)	1.0

\* Data are shown as 95th percentile (range)

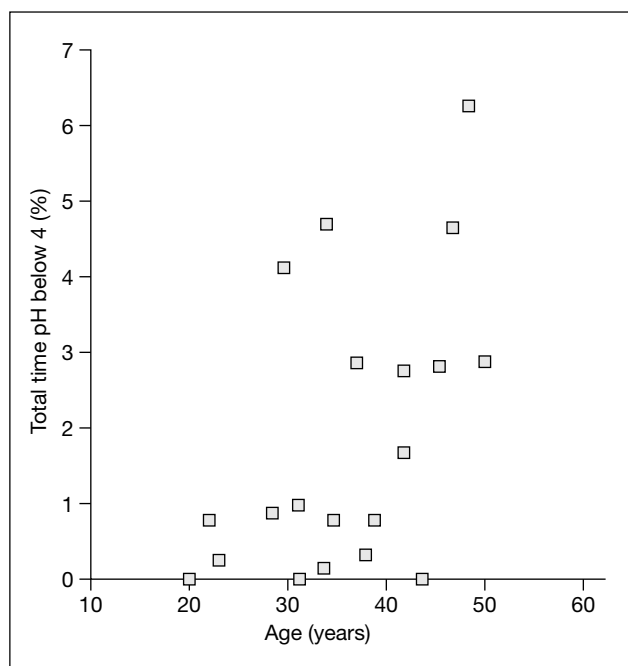
† N/A not applicable

sphincter.<sup>7</sup> Studies have generally demonstrated some overlap of reflux parameters between patients with symptomatic gastroesophageal reflux disease and normal controls. This study identified a normal reference range for reflux in healthy Chinese subjects. A study comparing reflux parameters across three different centres did not show any difference in parameters obtained,<sup>5</sup> and thus the use of

normal values from this study by different centres across the territory appears appropriate.

Although 12 different reflux parameters can be generated from total, supine, and upright periods, early studies have established that the six parameters measured in this study are the most useful. There is intrasubject variability seen on retesting, however. Later studies have generally found time pH <4 (total, upright, supine) to be the most reproducible of these parameters.<sup>8,9</sup>

Dual channel pH monitoring is most useful in the study of atypical reflux presentations, such as asthma, chronic cough, and non-cardiac chest pain,<sup>10</sup> especially if micro-aspiration of the refluxate into airways is considered. An additional pH sensor situated more proximally in the oesophagus allows for documentation of the extent of travel



**Fig. Correlation between age and total percent acid exposure measured at the distal oesophageal site (5 cm above the lower oesophageal sphincter)**

**Table 3. Correlation between reflux parameters at proximal and distal channels**

Reflux parameter	P value
Percent time <4, total period	0.02
Number of episodes >5 min, total period	N/A*
Duration of longest episode (min), total period	<0.01
Number of reflux episodes, total period	<0.01
Percent time <4, upright period	0.04
Number of long episodes >5 min, upright period	N/A
Duration of longest episode (min), upright period	0.02
Number of reflux episodes, upright period	<0.01
Percent time <4, supine period	<0.01
Number of long episodes >5 min, supine period	N/A
Duration of longest episode (min), supine period	<0.01
Number of reflux episodes, supine period	<0.01

\* N/A not applicable

of refluxate. A good correlation between proximal and distal oesophageal acid exposure parameters was seen in this study, indicating the source and mechanism of acid reflux to be the same for both sites.

Age and male sex were associated with increased acid exposure according to this study. A western study reported an association between age and total acid exposure, reflux episodes, and duration of the longest reflux episode which was close to being statistically significant.<sup>5</sup> Whether age-related changes seen are due to increased transient lower oesophageal sphincter relaxation or other mechanisms deserves further investigation.

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