

Effectiveness of Diet and Lifestyle Changes for the Treatment of Laryngopharyngeal Reflux Disease: A Prospective Study[☆]

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SUMMARY: Objective. To investigate the effectiveness of diet and lifestyle changes as a single treatment for laryngopharyngeal reflux disease (LPRD).

Methods. Forty-eight patients with LPRD confirmed by 24-hour hypopharyngeal-esophageal multichannel intraluminal impedance-pH monitoring (HEMII-pH) were prospectively recruited from two European hospitals between January 2022 and January 2025. Patients were treated with a standardized anti-reflux diet for 3 months. Reflux symptom score (RSS) and reflux sign assessment (RSA) were used to evaluate pre-diet to post-diet changes in symptoms and findings.

Results. Forty-four patients completed the 3-month diet and lifestyle recommendations (mean age 50.2 ± 16.5; 63.6% female). There were 14 (52.3%) mild, 8 (18.2%) moderate, and 13 (29.5%) severe LPRD according to IFOS classification. Most pharyngeal reflux events were non-acid. After dietary and lifestyle modifications, significant improvements occurred in otolaryngological, digestive, and respiratory symptom (items and RSS) scores. Symptom relief occurred in 88.6% of cases, with complete symptom resolution in 40.9% of patients. Laryngeal signs and RSA scores significantly decreased. Nine patients (20.5%) required additional medication despite adherence to recommendations. No baseline predictors of response were identified.

Conclusion. A low-fat, high-protein, and low-high-release sugar diet combined with lifestyle changes may be an effective single treatment for LPRD. Future controlled studies are needed to compare diet versus medication in LPRD populations, with consideration of mid- to long-term effects of diet on general health.

Key Words: Otolaryngology–Head neck surgery–Diet–Laryngopharyngeal reflux–Gastroesophageal reflux.

INTRODUCTION

Laryngopharyngeal reflux disease (LPRD) is a disease of the upper aerodigestive tract resulting from the direct and/or indirect effects of gastroduodenal content reflux, inducing morphological and/or neurological changes in the upper aerodigestive tract.¹ The deposit of gastroduodenal enzymes into the upper aerodigestive tract mucosa is related to low and upper esophageal sphincter relaxation and some variable degrees of esophageal dysmotility, which is associated with diet and autonomic nerve dysfunction triggered by lifestyle factors (eg, stress, anxiety, depression).^{2–4} The key role of foods and beverages in the occurrence of gastroesophageal and laryngopharyngeal reflux events has led to the development of anti-reflux diets, which are commonly based on the consumption of alkaline, Mediterranean-based, low-fat, low-high-release sugar, and high-protein foods and beverages.^{5,6} Despite some evidence

suggesting the cost- and clinical effectiveness of diet and lifestyle changes as a primary therapeutic approach in LPRD, the number of studies investigating its effectiveness as a single first-line treatment remains low.

The aim of this preliminary study was to investigate the effectiveness of anti-reflux diet and lifestyle changes as a single treatment for LPRD patients.

MATERIALS AND METHODS

Patients with LPRD symptoms and findings were consecutively recruited from January 2022 to January 2025 at two European medical centers (CHU Saint-Pierre, Brussels, Belgium and Elsan Polyclinic of Poitiers, Poitiers, France). Consistent with the Dubai consensus¹ and European Clinical Practice Guidelines,⁷ the LPRD diagnosis was based on symptoms, findings, and more than one hypopharyngeal reflux event at 24-hour hypopharyngeal-esophageal multichannel intraluminal impedance-pH monitoring (HEMII-pH) monitoring. A gastrointestinal endoscopy was indicated in patients ≥60 years, those with GERD symptoms/findings, and individuals with a history of GERD-related complications. The following exclusion criteria were considered: excessive smoking (> 5 cigarettes/day), alcohol dependence (> 3 units/day), neurological disease affecting the upper respiratory or digestive tract, current psychiatric illness affecting the participation agreement and questionnaire completion, upper respiratory tract infections within the last month, current or 3-month history use of anti-reflux treatments (proton pump inhibitors, antihistamines, alginates, antacids) or inhaled corticosteroids, previous neck surgery/trauma, vocal fold

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benign or malignant lesions, history of head and neck radiotherapy, untreated active seasonal allergies, chronic obstructive pulmonary disease, asthma, and other non-LPRD chronic cough etiologies.

The study protocol was approved by the local ethics committee (CHU Saint-Pierre board, protocol no. BE076201837630 and Elsan ID-RCB: 2020-A02789-30). Patients were invited to participate, and informed consent was obtained.

Ambulator pharyngeal reflux monitoring systems

The HEMII-pH probes used were from Medtronic (Versaflex Z[®], LPR ZNID22+8R FGS 9000-19; Hauts-de-France, France). The length of the probe was based on the patient's height and estimated esophageal length. The catheter was composed of 8 impedance ring pairs and 2 pH electrodes. Six impedance segments were positioned along the esophageal zones (Z1 to Z6) below the upper esophageal sphincter (UES). Two pharyngeal impedance segments were positioned 1 and 2 cm above the UES, with one impedance ring above the upper pH sensor. Probe placement was standardized across both clinical settings, with placement in the morning (8:00 AM) under fasting conditions, followed by verification of proper positioning through either chest radiography or nasofibroscopy. No manometry was carried out. LPRD was diagnosed when more than one acid (pH < 4.0), weakly acid (pH between 4.0 and 7.0), or alkaline (pH > 7.0) pharyngeal reflux event was detected at the 24-hour HEMII-pH. A pharyngeal reflux event was defined as an episode reaching the pharyngeal sensors. According to the Dubai consensus,¹ the analysis of the 24-hour recordings considered the following points: exclusion of reflux events occurring during meals; diagnosis of pharyngeal reflux events only when reflux originating from the distal-most impedance channel reached the pharyngeal channels in a retrograde fashion (full esophageal column to pharynx); and implementation of manual computer analysis for accurate identification of reflux events. Note that patients were not recommended to change their daily diet during the testing period while they were off PPIs, alginates, or antacids.

GERD diagnosis was based on the Lyon guidelines, which consisted of Los Angeles grade C and D esophagitis, long-segment Barrett's mucosa, peptic esophageal stricture, and acid exposure time in the distal esophagus > 6% of 24 hours.⁸

Anti-reflux diet and lifestyle changes

Patients were recommended to adhere to a 3-month low-fat, low quick-release sugar, high-protein, alkaline, and plant-based diet (Table 1).^{9,10} The consumption of fish and meat was authorized but reduced to low-fat fish and meat. The Mediterranean diet was partly considered because some commonly consumed foods/beverages in the Mediterranean diet may be associated with GERD and LPRD,

including tomatoes, spices, wine, and fatty cheese. In summary, this anti-reflux diet was established considering the pH and composition (quick-release sugars, proteins, and lipids) of foods and beverages, leading to the development of a valid and published mathematical model⁹ predicting the refluxogenic potential of food/beverage.¹⁰ The anti-reflux diet considered the exclusion/reduction of additional triggers such as caffeine or theine, spices, alcohol, and sparkling beverages. Patients received a grid reporting the refluxogenic foods and beverages and the potential anti-reflux alternatives (Table 1). Because most pharyngeal reflux events are commonly weakly acid or non-acid, two alkaline waters with pH 8.0 and 8.4 were only proposed to patients with an acid LPRD. Patient adherence to diet and behavioral changes was assessed through a 10-point scale, ranging from 0 (=no diet adherence) to 10 (=perfect diet adherence). Only patients reporting an adherence > 7/10 were included at the follow-up consultation.

Concerning lifestyle recommendations, patients were recommended to control their stress and anxiety through sport, yoga, meditation, or other alternative activities that may reduce the autonomic nerve dysfunction.⁷

Clinical evaluations and therapeutic responses

The French versions of the Reflux Symptom Score (RSS)¹¹ and the Reflux Sign Assessment (RSA)¹² were used to assess the pretreatment to post treatment symptoms and findings. The RSA was evaluated by two board-certified otolaryngologists (JRL and a retired laryngologist) in a blinded manner. The two otolaryngologists reported adequate interrater reliability ($r_s = 0.663$) consistent with previous studies.¹² The RSS changes were used to evaluate the therapeutic response.¹³ Non-responders were patients with increased, unchanged, or 1% to 20% reduced RSS after 3 months of diet and lifestyle changes. Reductions of 20.1% to 40%, 40.1% to 60%, and 60.1% to 80% of the baseline RSS consisted of mild, moderate, and high therapeutic responses. A reduction of more than 80.1% was defined as a complete response.¹³ The severity of reflux was based on the IFOS classification, which identified three primary clinical patterns of LPRD: mild (RSS-QoL < 26), moderate (RSS-QoL = 26-38), and severe (RSS-QoL > 38).¹⁴

Statistical methods

Statistical analyses were performed using the Statistical Package for the Social Sciences for Windows (SPSS version 29.0; IBM Corp, Armonk, NY, USA). The prediet to postdiet RSS and RSA changes were evaluated with the Wilcoxon signed-rank test. The Spearman correlation coefficient was used to investigate potential associations between clinical outcomes. A level of significance of $P < 0.05$ was used.

TABLE 1.
Recommendation Grid (Diet and Lifestyle Modifications)

Lifestyle habits	Foods to favor	Foods to avoid
1. Stress control	1. <i>Meat, fish, chicken, eggs</i>	1. <i>Meat, fish, chicken, eggs</i>
2. Tobacco & other addiction(s) reduction	Fresh & thin fish	Fat fish, fish oil (sardines, cods, herrings)
3. Reduction of size of meals (GERD)	Shrimps, lobster, shellfishes	Fat chicken
4. Do not talk while eating	Chicken fillet (without skin)	High-fat meat*
5. Eat slowly	Turkey (without skin & fat)	- <i>kidneys, bacon, ground meat,</i>
6. Avoid tight clothing (GERD only)	Duck (without skin & fat)	- <i>Pâté, tripes, lamb</i>
7. Avoid post-meal sport (GERD only)	Low fat meat*	- <i>Lamb chops, shoulder or legs of lamb</i>
	- <i>Veal cutlet, pork tenderloin,</i>	- <i>Ribs, rib steak</i>
	- <i>Rindless, fatless, cooked ham</i>	- <i>Pork chops, roast, and shoulder</i>
	- <i>Steak, fillet, striploin</i>	- <i>Foie gras</i>
	- <i>Roast veal, veal chop, horse</i>	Delis, sausage, salami
	*Remove fat from meat	
	Egg white	
	Other:.....	Other:.....
<i>If heartburn/acid brash (GERD only)</i>	2. <i>Dairy products</i>	2. <i>Dairy products</i>
1. Reduction of overweight	Low-fat cheese	Chocolate, ice cream, whole milk
2. Elevating the head of the bed	Skim milk	Hard cheese, full-fat cheese
	Other:.....	- <i>Goat cheese, cheddar, Roquefort,</i>
		- <i>Fontina, gruyere, parmesan,</i>
		<i>munster, etc.</i>
		Other:.....
<i>Laryngopharyngeal reflux treatment</i>	3. <i>Cereals & Starches</i>	3. <i>Cereals & Starches</i>
Drug:	Oat, wheat, cracker, dark/whole pasta,	Chocolate cookies, peanut, white bread,
	Whole meal bread, brown bread,	French fries & frying
<i>To take: before - during - after</i>	Boiled potatoes, rice, brown rice	Nut, cashew, hazelnut
	Sourdough bread	Other:.....
	4. <i>Fruit & vegetables</i>	4. <i>Fruit & vegetables</i>
<i>Meals (circle the adequate response):</i>	Agave, asparagus,	Shallot
-Breakfast	Banana, melon	Spicy
	Broccoli, celery, fennel	Onion
-Lunch	Cooked mushrooms	Chilli
	Cauliflower, green beans, ginger	Tomato (sauce or raw tomato)
-Diner	Turnip, parsley, tofu	Raw vegetable
	Other:.....	
Drug:	<i>Vegetable preparation:</i>	
	Cooked by steaming or boiling in water	
	5. <i>Beverage</i>	5. <i>Beverage</i>
<i>To take: before - during - after</i>	Chamomile	Strong alcohol, red & rosé wines
	Water, alkaline water	Sparkling beverage (water, soda, beer, etc.)
		Coffee, tea
<i>Meals (circle the adequate response):</i>	Appel/pear juices (no sugar added)	Citrus juices (orange, grapefruit) & apple
	Melon/banana juices (no sugar added)	Other:.....
-Breakfast	Other:.....	
	6. <i>Greasy substances</i>	6. <i>Greasy substances</i>
-Lunch	Olive oil	Butter, spicy oils
	Other:.....	Sauces (mayonnaise, mustard, ketchup, etc.)
		Other:.....
-Diner	7. <i>Sugar</i>	7. <i>Sugar</i>
	Honey	Sweets, viennoiseries

This grid was established for clinical practice and studies for evaluating the diet recommendations effectiveness in laryngopharyngeal reflux disease.

TABLE 2.
Demographics and Clinical Features

Characteristics	N = 44
Mean age (range, years)	50.2 ± 16.5
Gender	
Females (n, %)	28 (63.6)
Males (n, %)	16 (36.4)
Body mass index	24.2 ± 4.1
Severity of reflux (RSS-QoL)	
Mild reflux (<26)	23 (52.3)
Moderate reflux (26-38)	8 (18.2)
Severe reflux (>38)	13 (29.5)
Gastrointestinal endoscopy	n = 26
Normal	8 (30.8)
Esophagitis	10 (38.5)
Hiatal hernia	5 (19.2)
LES insufficiency	9 (34.6)
Gastritis	9 (34.6)
Helicobacter Pylori infection	4 (15.4)
HEMII-pH feature (mean, SD)	
Pharyngeal events	
Pharyngeal acid reflux events	10.3 ± 14.8
Pharyngeal non-acid reflux events	37.0 ± 49.9
Total number of pharyngeal events	47.0 ± 49.7
Position events	
Pharyngeal event upright	38.3 ± 6.2
Pharyngeal event supine	6.2 ± 12.8
GERD	
Number of patients (%)	15 (34.1)
Percentage of time with distal pH < 4	8.0 ± 11.8

Abbreviations: HEMII-pH, hypopharyngeal-esophageal multichannel intraluminal impedance-pH testing; LES, lower esophageal sphincter; GERD, gastroesophageal reflux disease; RSS-QoL, reflux symptom score quality-of-life; SD, standard deviation.

RESULTS

Forty-eight patients were consecutively recruited. Of them, four patients were lost to follow-up. The demographic and clinical findings of the 44 patients are described in Table 2. Hiatal hernia, lower esophageal insufficiency, and esophagitis were found in 5 (19.2%), 9 (34.6%), and 10 (38.5%) patients, respectively. The mean age was 50.2 ± 16.5. There were 28 females (63.6%). According to the IFOS classification,¹⁴ there were 23 (52.3%) mild, 8 (18.2%) moderate, and 13 (29.5%) severe diseases. Twenty-six patients underwent GI endoscopy, with 8 (30.8%) examinations considered as normal. Most pharyngeal reflux events at the 24-hour HEMII-pH were non-acid, occurring during daytime and in the upright position. Fifteen patients met the Lyon criteria for GERD diagnosis⁸ (Table 2).

Most otolaryngological, digestive, and respiratory symptoms and overall scores demonstrated a significant pretreatment to post treatment reduction (Table 3). Abdominal pain and nausea did not change throughout treatment. Diet and lifestyle changes were particularly effective in the relief of the following symptoms: throat clearing, globus sensation, excess throat mucus, heartburn, abdominal distension, and breathing difficulties (Table 3).

The blinded evaluation of sign changes throughout treatment is described in Table 4. The total RSA scores reported significant reduction after 3 months of diet and lifestyle changes. Considering the oral, pharyngeal, and laryngeal RSA subscores, only the laryngeal sign subscore demonstrated significant reduction after 3 months of diet and lifestyle changes. The proportion of responders is highlighted in Table 5. Only 5 (11.4%) patients did not respond to diet and lifestyle changes. A complete symptom relief occurred in 18 (40.9%) patients.

Nine patients required medication treatment despite the adherence to the diet and lifestyle changes, including once daily pantoprazole/esomeprazole (40 mg) + thrice daily postmeal alginates (n = 5), pantoprazole/esomeprazole (40 mg) + thrice daily post-meal antacids (n = 1), and thrice daily post-meal alginates (n = 3). Note that the prescription of PPIs was based on the presence of GERD or acid pharyngeal reflux events at the 24-hour HEMII-pH. The presence of non-acid reflux led to the prescription of alginate or antacids.

The Spearman correlation analysis did not report significant association between the diet and lifestyle change response and the baseline demographic and clinical features.

DISCUSSION

The American cost burden associated with the diagnostic and medical treatment of LPRD was estimated to be 5.6 times the cost for treating GERD, with a total expenditure estimated at > \$50 billion annually.¹⁵ In Western Europe, the lack of knowledge related to the LPRD etiological factors, clinical presentations, and therapeutic findings led to similar cost burden for public healthcare systems,¹⁶ with an increase of annual cost in both world regions in the past decades.^{15,16} The annual cost burden associated with the diagnostic and the management of LPRD has significantly increased in the past decades. These economic trends were partly related to the chronic use of PPIs and other LPRD medications, which reported a 233% increase of consumption or prescription in the past few years,¹⁶ leading to potential adverse events.¹⁷ The investigation of the effectiveness of diet and lifestyle changes as a primary treatment of LPRD or as prevention factors is therefore mandatory to reduce cost burden and adverse events in LPRD patients.

The primary findings of the present case series suggest that diet and lifestyle recommendations may be associated with a significant reduction of symptoms in 88.6% of cases, with 40.9% of patients reporting total relief of symptoms. These findings corroborate the results of the few studies assessing the effectiveness of diet and lifestyle changes as single treatment of LPRD.¹⁸⁻²⁰ In 2011, Koufman reported in 20 patients with acid LPRD at the dual-probe pH monitoring that the adherence to an alkaline, low-fat, and high-protein diet led to a significant decrease of the reflux symptom index 2 weeks after the diet onset.¹⁸ In a

TABLE 3.
Symptom Changes Throughout Diet and Lifestyle Changes

RSS items	Pretreatment	Post treatment	Z	P value
Otolaryngological Symptoms				
1. Voice disorder	5.9 ± 8.1	3.0 ± 5.6	−2.6	0.009
2. Throat pain	6.3 ± 7.4	3.7 ± 6.0	−2.8	0.006
3. Pain during swallowing time	2.3 ± 3.5	0.8 ± 1.9	−2.8	0.006
4. Dysphagia	3.0 ± 4.7	1.4 ± 4.1	−2.3	0.019
5. Throat clearing	7.5 ± 8.1	3.3 ± 5.2	−3.5	0.001
6. Globus sensation	7.8 ± 8.9	2.5 ± 4.1	−3.8	0.001
7. Excess throat mucus	9.0 ± 8.5	4.6 ± 6.5	−3.5	0.001
8. Ear pressure/pain	4.1 ± 5.4	2.1 ± 4.5	−2.1	0.038
9. Tongue burning	2.5 ± 5.8	1.2 ± 4.0	−2.3	0.020
<i>Ear, nose and throat total score</i>	48.2 ± 34.1	22.8 ± 24.5	−4.9	0.001
Digestive symptoms				
1. Heartburn	7.8 ± 8.3	3.0 ± 4.3	−3.2	0.001
2. Regurgitations or burps	4.5 ± 6.3	1.8 ± 3.7	−2.9	0.004
3. Abdominal pain	2.7 ± 5.1	2.0 ± 5.5	−1.5	NS
4. Diarrheas	1.6 ± 2.8	0.7 ± 1.8	−2.4	0.015
5. Constipation	3.4 ± 6.1	2.1 ± 3.9	−2.1	0.035
6. Indigestion	2.6 ± 4.9	0.8 ± 2.7	−3.0	0.003
7. Abdominal distension/flatul	6.6 ± 7.8	2.8 ± 5.7	−3.9	0.001
8. Halitosis	4.5 ± 6.8	3.4 ± 6.6	−2.1	0.039
9. Nausea	2.2 ± 5.1	1.0 ± 2.5	−1.5	NS
<i>Digestive total score</i>	35.8 ± 29.7	17.0 ± 21.8	−4.5	0.001
Respiratory symptoms				
1. Cough after eating/lying down	3.9 ± 7.0	1.5 ± 4.6	−2.3	0.024
2. Cough	3.7 ± 6.7	1.2 ± 2.9	−3.0	0.003
3. Breathing difficulties	1.5 ± 4.5	0.4 ± 2.4	−3.3	0.001
4. Chest pain	3.8 ± 7.0	1.3 ± 3.5	−2.4	0.018
<i>Respiratory total score</i>	12.9 ± 17.9	4.4 ± 9.5	−4.0	0.001
RSS - Total score	96.9 ± 61.6	44.2 ± 47.9	−5.4	0.001
RSS quality-of-life	29.7 ± 19.6	18.7 ± 24.7	−4.7	0.001

Wilcoxon Rank test was used for the prediet to postdiet change assessment. *Abbreviations:* NS, non-significant; RSS, reflux symptom score; Z, difference.

TABLE 4.
Reflux Sign Assessment Evolution

Characteristics	Pretreatment	Post treatment	Z	P value
Oral Reflux Sign Assessment	5.0 ± 2.4	4.3 ± 2.3	−1.1	NS
Pharyngeal Reflux Sign Assessment	9.5 ± 4.2	7.9 ± 3.4	−1.6	NS
Laryngeal Reflux Sign Assessment	11.4 ± 5.0	8.3 ± 5.6	−2.9	0.004
Total Reflux Sign Assessment	26.4 ± 8.1	20.3 ± 8.2	−3.5	0.001

Wilcoxon Rank test was used for the prediet to postdiet change assessment. *Abbreviations:* NS, non-significant; RSA, reflux sign assessment; Z, difference.

cross-over study of 50 LPRD patients at the HEMII-pH, our group reported that 74% of patients experienced symptom improvement or relief at 6 weeks postdiet, with a 3-month therapeutic success rate of 54% of cases.¹⁹ Compared to these previous studies that did not include the same patients, the higher success rate (88.6%) found in this study may be attributed to a longer therapeutic period with 3 months versus 6 weeks of diet and lifestyle changes. The effectiveness of a low-fat, high-protein, and alkaline diet has been suggested in other studies combining or not combining the diet with medication.^{5,6,20,21} Among the potential predictors of diet effectiveness, Giacchi et al

suggested that the degree of patient adherence to the diet was a positive predictor of the symptom relief.²² In our previous study, a significant association was found between the baseline refluxogenic diet score, highlighting the refluxogenic potential of the patient diet, and the severity of symptoms at the initial clinical presentation.¹⁹ While most studies reported a significant impact of diet on LPRD symptoms, some diet recommendations may subtly vary from one study to another. Zalvan et al recommended a Mediterranean plant-based diet, which was associated with a similar therapeutic effectiveness rate compared to PPIs.⁵ However, this diet includes some Mediterranean foods,

TABLE 5.
Responder Rates

Types of reflux patients	Therapeutic response	N	%
Mild reflux (<i>n</i> = 23)	No response	2	8.7
	Mild response	2	8.7
	Moderate response	5	21.7
	High response	2	8.7
	Complete response	12	52.2
Moderate reflux (<i>n</i> = 8)	No response	0	0.0
	Mild response	1	12.5
	Moderate response	3	37.5
	High response	2	25.0
	Complete response	2	25.0
Severe reflux (<i>n</i> = 13)	No response	3	23.1
	Mild response	2	15.4
	Moderate response	2	15.4
	High response	2	15.4
	Complete response	4	30.8

The proportion of responders did not differ across groups. Abbreviation: N, number.

such as tomatoes, raw vegetables, Italian spices, or onions that could be associated with esophageal sphincter relaxation or dysmotility.^{23,24} Koufman and Johnston recommended drinking alkaline water in their patients who demonstrated acid LPRD at the pH monitoring,^{6,18} which was not recommended in the present study in patients with a demonstrated non-acid LPRD at the HEMII-pH. Future studies are needed to investigate the benefit of alkaline foods and beverages in LPRD patients who commonly have weakly acid or non-acid reflux events and a more alkaline salivary pH compared to healthy controls.^{25,26} In summary, most physiological mechanisms underlying the effectiveness of low-fat, high-protein, and low high-release sugar diet on reflux have been studied in GERD patients, while the literature considering LPRD remains scarce.²⁷

Finally, particular attention should be paid to the lifestyle change recommendations, which consist of the reduction of triggers of autonomic nerve dysfunction, including stress, anxiety or depression.^{4,28} This part of the treatment is based on studies demonstrating that LPRD patients commonly have higher findings of autonomic nerve dysfunction (eg, heart rate variability), which may be physiologically associated with a decrease of the vagus nerve activity and related esophageal sphincter transient relaxations.²⁹ The level of autonomic nerve dysfunction and the potential impact of lifestyle changes on symptoms were not evaluated in the present study, which constitutes its primary limitation. Future studies may evaluate the autonomic nerve dysfunction using movisense (a medical wearable device for capturing raw ECG, Heart Rate, Heart Rate Variability) or sudoscan (a medical device providing sudation-related sympathetic function) devices that report objective results of sympathetic nerve activity.^{30,31} This potential confounding factor in the therapeutic effectiveness may be indirectly supported by a

recent study observing a significant positive association between the perceived stress scale score of LPRD patients and the level of some salivary biomarkers (cholesterol).²⁵ The low number of patients is an additional limitation of this study. Given that patients were included after providing agreement to be treated with only a diet, a potential selection bias cannot be excluded, with most severe patients refusing participation in the study to benefit from medication treatment. Finally, the lack of high-resolution manometry can be considered as an additional limitation because this examination may provide additional information about the patient profile (esophageal motility, sphincter tonicity), and the identification of response patterns/influencing factors. Moreover, manometry should be valuable to explore pre-intervention and postintervention comparisons, particularly in relation to the theory of autonomic nerve modulation through stress-reduction practices (eg, meditation, yoga, and sport).

CONCLUSION

Low-fat, high-protein, low-high released sugar, and alkaline diet may be an effective single therapy for patients with LPRD, achieving 88.6% partial or total symptom relief after 3 months. Future prospective controlled studies are needed to compare diet versus medication in LPRD populations, while considering lifestyle changes and related autonomic nerve dysfunction. The mid- to long-term effects of diet and lifestyle recommendations on the general health of patients may be also investigated through longitudinal studies.

Sponsorships

None.

Author Contributions

Jerome R. Lechien: design, acquisition of data, data analysis & interpretation, drafting, final approval, and accountability for the work; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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