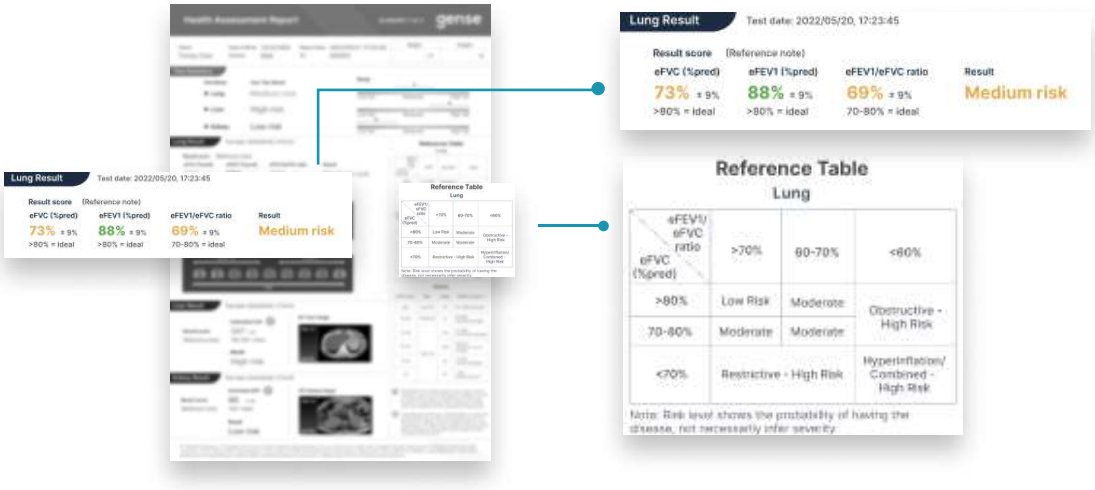
Your Test Result is High Risk

The test results show that some of your scores are unsatisfactory, please improve your lifestyle habits, such as reducing or quitting smoking; frequent outdoor exercise, construction workers, and people exposed to pollution should be checked every 3 weeks. In addition, this test is not diagnostic, please consult your doctor immediatley. The test can also help you monitor your health condition after improving your habits and help you adjust your health care plan.

01 Understanding Your Personal Lung Report

Sample



Lung Index

Spirometry is the gold standard for measuring lung function and is the most common lung function test used to aid in the diagnosis and monitoring of lung conditions. It involves measuring the amount of air a subject can forcefully exhale in one breath[1]. The following are commonly used data in spirometry:

1. **Forced Vital Capacity (FVC)**：Forced vital capacity refers to the maximum amount of air that can be exhaled as quickly as possible after taking a deep breath. The normal value for forced vital capacity (FVC) is 80% or more[2].
2. **Forced Expiratory Volume in 1 second (FEV1)**：The forced expiratory volume in 1 second is the amount of air a person can forcefully exhale in the first second after taking a deep breath. The normal value for FEV1 is 80% or more[3].
3. **Forced Expiratory Volume in 1 second/ Forced Vital Capacity (FEV1/FVC)**：The ratio represents the proportion of a person's lung capacity that can be forcefully exhaled[4]. The FEV1/FVC ratio can be used to distinguishes obstructive and restrictive lung diseases. In obstructive diseases, increased airway resistance reduces FEV1 hence sometimes FVC as well, resulting in FEV1/FVC ratio below 70%. In restrictive diseases, such as chest wall deformity and idiopathic pulmonary fibrosis, FVC may decrease more than FEV1, resulting in an FEV1/FVC ratio above 70%[4].

*Predicted values based on clinical research gold standards and comparisons

Chart Index

We can determine lung health using three clinical measurements: FVC, FEV1, and FEV1/FVC ratio.

1. **Estimated Forced Vital Capacity (eFVC)**：Forced vital capacity refers to the maximum amount of air that can be exhaled as quickly as possible after taking a deep breath[2]. The normal value for forced vital capacity (FVC) is 80% or more of the predicted value*, which is calculated based on age, sex, and height.
2. **Estimated Forced Expiratory Volume in 1 second (FEV1)**：The forced expiratory volume in 1 second is the amount of air a person can forcefully exhale during the first second after taking a deep breath[3]. The normal value for FEV1 is 80% or more of the predicted value*, which is calculated based on age, sex, and height.
3. **Estimated Forced Expiratory Volume in 1 second / Estimated Forced Vital Capacity (FEV1/FVC)**：The ratio represents the proportion of a person's lung capacity that can be forcefully exhaled[4]. If it is less than 70%, it is indicative of a high risk of lung disease, such as COPD[4].

Explanation

We combine eFVC (% pred) with eFEV1/eFVC ratio for analyzing lung health.

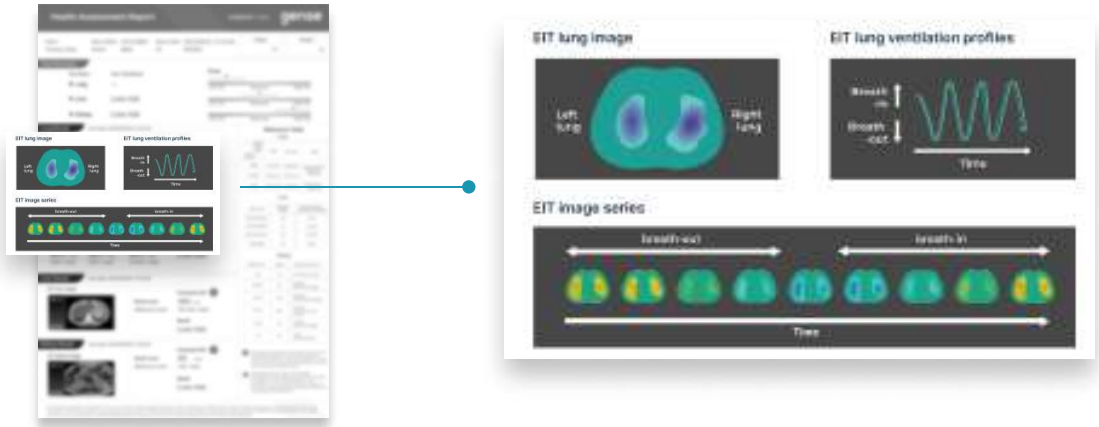
eFEV1/eFVC ratio / eFVC(%pred)	>70%	60-70%	
>80%	Low Risk	Moderate Risk	Obstructive Disease - High Risk
70-80%	Moderate Risk	Moderate Risk	
<70%	Restrictive Disease - High Risk		Hyperinflation/Combined - High Risk

*Risk level indicates the risk level of getting the disease, but cannot be used to infer the severity of the illness.

First, we can look at the ratio of eFEV1/eFVC at the top row. If the ratio of eFEV1/eFVC is greater than 70%, then your value is in the low-risk range. However, if the eFEV1/eFVC is less than 70%, you should pay special attention to your lung health.

Next, let's try to understand eFVC (% pred) on the left column of the chart. When your test result is 80% or more of the expected value, your score is in the low-risk range. The lower the eFVC (estimated percentage) value, the less optimal the lung function, and treatment regarding your lung health should be implemented as soon as possible.

Finally, we combine the two indicators to check your overall lung health.
Example：If your eFEV1/eFVC ratio is 80% and eFVC is 73%, your lung health score is under moderate-risk.



Lung Image

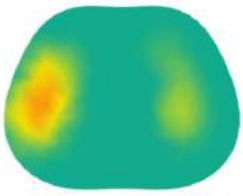
The image ① EIT lung image shows the ventilation capacity of the left and right lungs, with greater ventilation resulting in larger changes in impedance and hence the darker colors. In a normal EIT lung image, the left and right clusters have uniform color changes and similar sizes. If there is a lung dysfunction, there will be significant difference in color and size between left and right clusters.

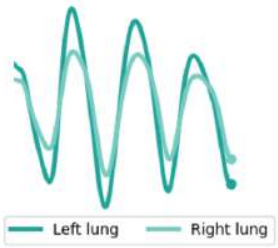
The image ② EIT lung ventilation profiles shows two curves representing the respiratory trajectories of left and right lungs of testing subject. For normal lung function, two curves should be well overlapped as two lungs breath simultaneously; for lung dysfunction, two curves will be asynchrony with clear difference in amplitude across time.

The image ③ EIT image series represents the testing subject during guided breathing. The colour changes in the lung clusters indicate the breathing ability and the lung volume changes overtime.

Abnormal Lung Images

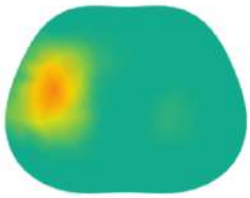
Situation 1

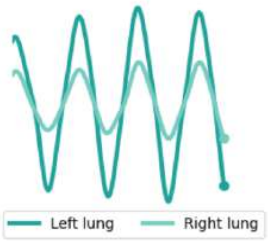




When lungs are damaged, the contraction of left and right lungs are not synchronized, and the remaining air volume in each lung is also different. Therefore, the two curves are not aligned and do not overlap in height.

Situation 2





As shown in the left figure, if the right lung has undergone surgical resection, it can result in weaker breathing in the right lung.

03 Symptoms, Causes, and Daily Prevention

Symptoms of lung disease

Long-lasting cough	Chronic coughing is defined as a continual cough for more than eight weeks. It can be further aggravated by an increase in the frequency of coughing or even cough with blood, which can be a symptom of COPD, pneumonia, long covid, and cancer[29].
Chest Pain	Continuous coughing strains the muscles and/or causes the lungs to collapse resulting in chest pain. Chest pain can also be caused if lung disease affects the rib cage[30]. Chest pain can be a symptom of lung problems, such as pneumonia and pleurisy; heart problems, such as heart attacks and angina[31].
Difficulty in breathing during light activities	Smoking over a long period of time can damage the windpipe, leading to blocked and narrowed airways that make it difficult for the lungs to inhale and exhale air[32]. Exercise-induced asthma causes shortness of breath, wheezing, coughing, and other symptoms during or after exercise. This is due to airways narrows during hard physical activity[33].
Unexplained shortness of breath	COPD is a condition that gradually worsens, causing lung inflammation, damaging lung tissue, and obstructing small airways. With disease progression, exhalation takes longer, the lungs are overinflated, and breathing becomes increasingly difficult[34].

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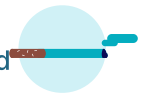
Reasons for increased risk of lung disease[35]

Smoking or prolonged exposure to secondhand smoke

Smoking, including cigarettes, cigars, and shisha, can induce inflammatory responses in the lungs. A large number of cells become inflamed, which causes damage or even tissue death. A healthy lungs have a healthy repair mechanisms, but smoking impair the process. The lungs are subjected to a prolonged period of abnormal inflammatory response and failing to repair, resulting in enlarged alveoli and increased emphysema, which can seriously damage lung health.



Infection and other complications

A decline in lung function is associated with previous history of respiratory infections during childhood. Complications such as Long-COVID can also result in long term damage to a patient's lung function.

Indoor and outdoor air pollution

Indoor air pollution includes gas stoves and fireplaces, while outdoor air pollution includes vehicle exhausts, industrial emissions, and wildfires. Vehicle emissions are dominated by nitrous oxide, and prolonged exposure to nitrous oxide weakens the respiratory system's resistance.

Occupational exposure to dust, smoke, or chemicals

Long-term exposure to toxic environments can lead to lung damage as a result of inhaling dust, smoke, and other harmful chemicals.

Consequences of delayed detection of Lung Disease

Delayed detection and treament in lung disease in a timely manner may result in serious health consequences, including difficulty breathing, chronic cough, COPD, and the development of lung cancer. Lung disease also negatively impacts quality of life. **For example:**

- Complications such as **pulmonary hypertension can** limit lung blood flow, worsen over time, and cause heart failure, such as right heart failure due to pulmonary arterial hypertension[36].
- When suffering from lung disease, the **respiratory system** is also affected, and patients are more susceptible to a respiratory infections. This can further lead to the deterioration of lung tissue and ultimately result in respiratory failure[37].
- Lung disease may develope into **lung cancer**[38].
- Severe cases of lung disease may require an **oxygen tank** to sustain normal breathing[39]. An oxygen tank carried around during normal activities is very restrictive.
- Later-stage lung disease is associated with shortened life expectancy - A study has shown, life expectancy is reduced by an additional 8-9 years. In advanced cases, surgery such as lung transplantation is required to extend life expectancy[40].

How to reduce the risk of developing lung disease

Regular screening	Regular screening and physical examinations can help you understand your body and health. Prevent disease development by increasing disease awareness, and have an active lifestyle. 
Quit smoking or avoid smoking	After the age of 30, non-smokers FEV1 decrease ~ 30 ml per year. People who develop COPD decrease ~ 60 ml per year. Quitting smoking can slow down the rate of deterioration in lung function[41]. 
Regularly clean your room	Fine dust can cause respiratory damage when inhaled, especially PM2.5 particles which can penetrate deep into the lungs. The main sources of these particles (size PM2.5) are factory emissions, vehicle emissions and demolition work, as well as indoor pollutants such as dust and smoke. In addition, dust tends to form hosts for mites, which, in addition to causing respiratory problems, are also allergens to many respiratory diseases such as asthma[42]. 
Exercise	Both aerobic exercise and weight training are good for your lungs. Exercise forces your heart and lungs to work harder to meet the extra oxygen demand that your muscles require. The Centers for Disease Control and Prevention (CDC) recommends that adults obtain at least 150 minutes of exercise per week, for example 30 minutes of moderate physical exercise per day for five days[43,44]. 
Reduce exposure to dusty environ-ments	Avoid dusty environments as much as possible to reduce inhalation of substances harmful to the lungs. If this is not possible, wear a mask and take proper precaution. Miners are at high risk of pneumoconiosis due to the presence of excessive coal ash in the work environment[45]. 

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Foods for Healthy Lungs

Quercetin (Onions)

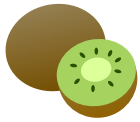
Quercetin is a flavonoid found in many fruits and vegetables, including apples and onions. It is an antioxidant with anti-inflammatory properties and some studies suggest that quercetin may help to reduce respiratory inflammation and improve lung function in respiratory diseases such as asthma[46]. Adults can consume approximately 14.90-16.39 mg of quercetin a day[46] .100g of onions contain approx. 28.4-48.6 mg of quercetin[47]. The weight of half an onion is about 100 grams.

Omega-3 (Salmon)

Fatty fish such as salmon and tuna are rich in Omega-3 fatty acids, which can reduce lung infection, increase respiratory resistance[48]. Adult males are recommended to consume 1.6 grams and females 1.1 grams of Omega-3 per day[49]. A 3-ounce (85-gram) serving of wild salmon contains approximately 1.57 grams of Omega-3, while a 3-ounce (85-gram) serving of farmed salmon contains about 1.83 grams of Omega-3[49]. (The weight of a salmon fillet is about 200 grams)

Vitamin C (Kiwi)

Vitamin C is an antioxidant that helps to reduce oxidative stress in the lungs, helping to reduce lung damage and disease. Many fruits and vegetables are rich in vitamin C, such as kiwi, orange and broccoli[50]. A daily intake of 90 mg is recommended for adult men and 75 mg for adult women[51]. One medium-sized kiwi contains 64 mg of vitamin C[52].



04 Targeted Advice for Lung Abnormalities

Tips for Managing Lung Abnormalities

Incorporating proper exercise and physical activity

- Exercise can help improve lung function and heart health by increasing endurance and reducing symptoms such as fatigue and shortness of breath. Every individual is different and should set feasible exercise goals based on their own condition and expectations, and if unsure can consult a health professional. In general, patients with COPD are instructed to exercise **3-4 days a week with 20-30 minutes of exercise**. Aerobic exercises such as walking, swimming, and cycling have been shown to be beneficial in lung function. Weight training can also improve breathing ability. Weight training can also strengthen the breathing ability of patients, but it is not necessary to go to the gym. Patients can consult with healthcare professionals to learn about related exercises. Experiences of **fever, chest pain, shortness of breath, weakness**, or other conditions with exercise **should be stopped immediately**[53].

- Similar to other muscles, respiratory muscles can also be trained to improve strength and endurance. Exercises such as sit-ups and bicep curls in non-respiratory movements can improve inspiratory and expiratory muscles[54]. These movements not only strengthen the muscles of the ribcage, but also provide sufficient strength training stimulus for the diaphragm[55].

Sit-ups	Bend the knees to perform sit-ups, starting with 20 sit-ups per session and increasing the number as tolerated by the individual. During this movement, inhale as you lift your torso. Each exercise should be performed at least 4 days per week, and maintain this routine for 8 weeks[55].	
Bicep curls	Bicep curls can be performed using dumbbells, gradually increasing the weight according to personal ability. Three sets of 8-10 repetitions can be done daily, with a 5-minute rest between sets. Training can be done 4-5 times per week for 8 weeks[55].	

- Patients with respiratory conditions such as asthma, pulmonary fibrosis, lung cancer, and COPD may benefit from various **pulmonary rehabilitation programs** offered by different hospitals and clinics. These programs combine education and exercise to help patients improve their understanding of lung health and respiratory diseases, as well as their physical and mental well-being. Some common activities in pulmonary rehabilitation programs include light training, cycling, walking on a treadmill, and stretching exercises[56].
- For individuals recovering from COVID-19, it may be helpful to seek out prevention and improvement recommendations from nearby hospitals, clinics, and wellness centers. Gradual reintroduction of physical activity is recommended, starting with gentle stretching exercises in the initial stages and progressing to aerobic exercises such as walking, dancing, and resistance training such as light weightlifting. Finally, individuals can increase the intensity of their exercise routine and engage in sporting activities.

Maintain a healthy weight and enhance immunity

Eating a balanced diet is essential for maintaining a healthy weight and boosting immunity, which in turn increases your body's energy. Overweight or underweight can both affect the respiratory system, leading to breathing difficulties and weakened respiratory muscles, BMI should be controlled within the standard range of 18.5-22.9 as much as possible Within the standard range. Consuming sufficient amounts of protein, carbohydrates, essential fats, vitamins, and minerals can strengthen the immune system, greatly aiding in the prevention of infection and other diseases. Patients with lung diseases often require more energy to maintain controlled breathing, so it is important to include adequate amounts of protein in your daily meals and consume high-protein foods such as meat and dairy products (such as yogurt and cheese), and drink 2~3 liters of water per day. These dietary recommendations are intended to maintain normal physical strength and aid in breathing and recovery[57].

Don't smoke or quit smoking

Smoking is a major cause of COPD, and smoking can cause lung abnormalities to continue to worsen, so it is beneficial for patients to quit smoking at any time[58].

To reduce exposure, it is recommended to wear a mask in areas with high pollution.

Air pollution can worsen symptoms of respiratory diseases. It is recommended to limit outdoor activities in areas with high pollution or to wear a mask while outdoors to reduce inhalation of air pollutants[59].