The OMED Health Breath Analyzer

Monitor Patient Gastrointestinal Health Through At-Home Breath Sampling

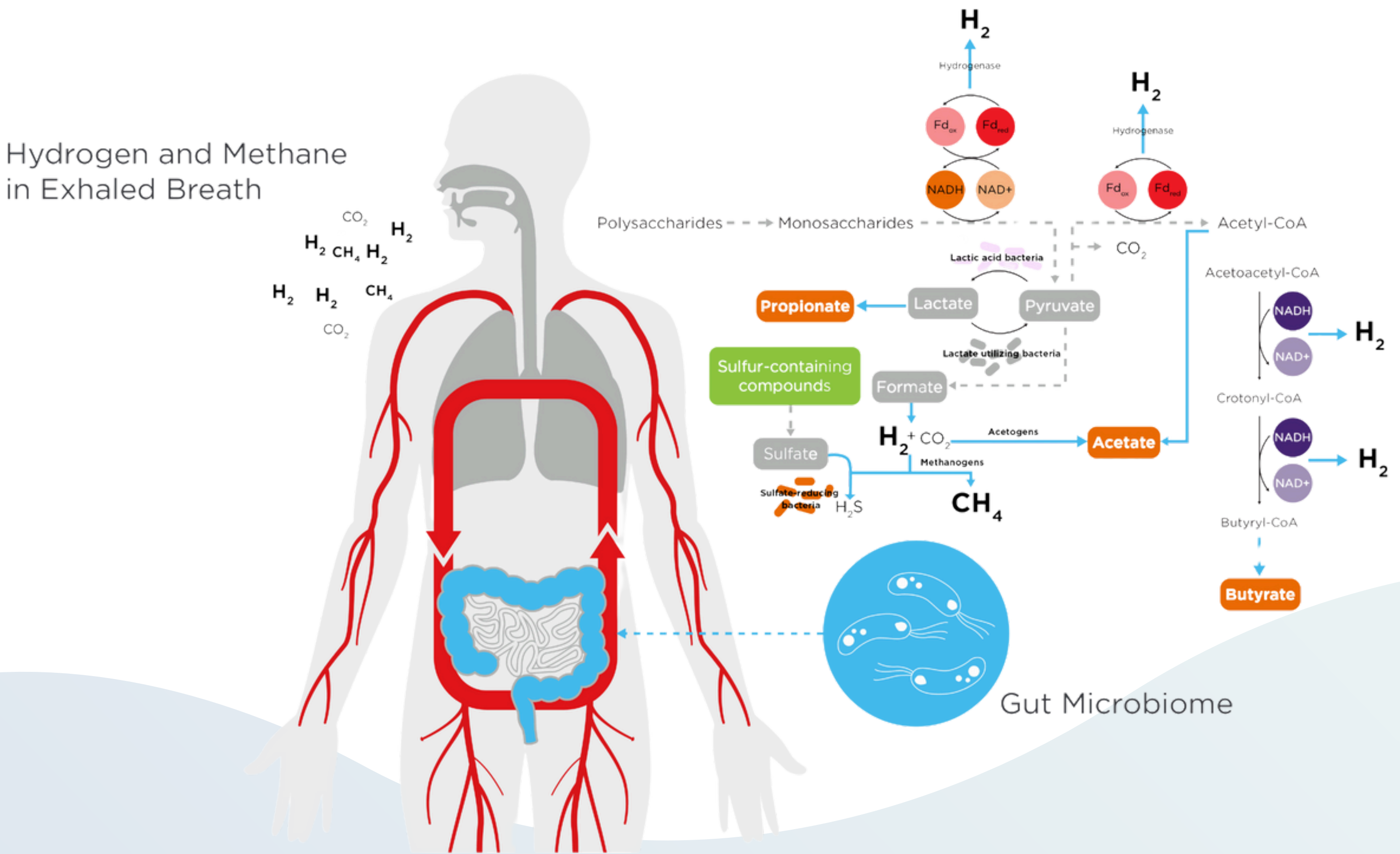
Introduction to the OMED Health Breath Analyzer

The OMED Health Breath Analyzer is a handheld sensor-based device for the at-home quantitative analysis of hydrogen and methane in exhaled breath, which are clinically validated biomarkers for gut microbiota activity and certain gastrointestinal diseases. The device uses metal-oxide sensor (MOS)-based technology to accurately analyze the levels of hydrogen and methane in the breath, with comparable performance to in-clinic hydrogen and methane devices used for diagnostic purposes at a much lower cost.

The device is paired with a mobile app that describes the breath sampling protocol for users, records breath measurements, and can log key interpretative factors such as food/drink, lifestyle factors (like stress, sleep quality, and exercise), and symptoms (including 0 – 10 scales for bloating, abdominal pain, nausea, and flatulence). Researchers can access the data to enable longitudinal monitoring of the response of the gut microbiome in various clinical study designs. The app can also enable compliance monitoring for clinical trials, and detailed interrogation of the data to identify key trends and associations between hydrogen and methane, and research endpoints. It takes around two minutes to collect and analyze a breath sample, and the device only needs a 15-minute interval between samples. Importantly, no consumables are needed to support the device. The OMED device can therefore support de-centralized trials, longitudinal analysis, remote monitoring, serial measurements, and home-based analysis of hydrogen and methane.

Where do Hydrogen and Methane Originate From in the Body?

Hydrogen (H_2) is the dominant gas produced by gut microbes through anaerobic respiration (fermentation) of dietary fiber and other substrates (1). Many genera and species in the phyla *Bacteriodetes* and *Firmicutes*, (two of the most abundant phyla in the gut microbiome in healthy adults) can produce hydrogen (2–5). Other microbes (mostly archaea) can further metabolize H_2 into methane (CH_4). These archaea can use H_2 as electron donors in the reduction of CO_2 to CH_4. While methanogens are present in virtually all healthy adults' flora, just one to two-thirds of healthy adults have sufficient levels of methanogens to produce detectable breath levels of CH4 (6). There are also relatively fewer species responsible for these reactions, with *M.smithii,* making up the vast majority of contributions (~94%) (7–9). It is thought that some breath methane may originate from human metabolism, with elevated levels of reactive oxygen species (ROS) potentially capable of producing methane via oxidative demethylation from methylated sulfur or nitrogen compounds (10–12).



Elevated levels of these exhaled gases have been consistently associated with various gastrointestinal conditions and symptoms involving intestinal dysbiosis, where there are changes in the density, composition, and function of the microbiota. Data indicates that patients who tested positive for breath tests following lactulose or glucose administration are more likely to suffer from bloating, or nausea respectively (13). There is also evidence linking different symptoms with high hydrogen compared to those with high methane: high hydrogen levels may be associated with increased abdominal distance, flatulence, and increased incidence of loose stools, whereas high methane levels may be associated with increased incidence of constipation (14,15).

How to Collect an Enriched Dataset of Breath

1. **Take a fasted baseline sample.** Analyze a breath sample first thing after waking up before any food or drink has been consumed.
2. **Take a breath sample every three hours until going to bed.** Taking regular samples throughout the day can track normal variation and understand how the time of day, and meals affect the data.
3. **Document all meals.** Document breakfast, lunch, dinner, and any snacks throughout the day in the app.
4. **Describe symptoms once a day.** Symptoms should be documented once a day (minimum), even to track if no symptoms are present.
5. **Describe lifestyle factors once a day.** Lifestyle factors such as stress levels and sleep should be documented once a day.

This collection protocol should be undertaken for all research studies conducted with the OMED Health Breath Analyzer for the highest-quality, enriched dataset, unless there are specific adjustments recommended due to study design.

What Breath Data is Useful to Collect?

A greater understanding of the gut microbiome has revolutionized the way we think about our digestive health (1–3), however, it is currently very challenging to predict how one individual's gut microbiome will react in response to many important variables such as diet, stress, disease, and more. Determining long-term action plans for patients suffering from ongoing digestive health symptoms is difficult especially when follow-ups are only periodic.

Currently available tools to research GI issues are time-consuming, costly, inconvenient, and can be invasive. No current tool allows for effective longitudinal analysis, resulting in difficulty in linking lifestyle factors with objective measures of gut health. Despite the benefit of breath as a sampling medium, hydrogen and methane in the breath are usually measured using one-off kits or using expensive in-clinic equipment that lack any routine tracking of lifestyle factors. This means that linking a trialed probiotic, supplement, or other health intervention or lifestyle adjustment to the reduction of digestive symptoms and other health effects is challenging.

The OMED device is easy to use, non-invasive, and safe, making it suitable with almost any subject group across a variety of settings. Home testing available via OMED devices reduces patient burden enabling faster access to results and easier repeat testing for longitudinal analysis, with no extra cost per sample.

In this booklet, we will go over some suggested trial designs that you could utilize an OMED device within to collect interesting, and clinically useful data. Where available, example data from internal preliminary studies will be shown.

Access comprehensive data reports

Input symptoms such as bloating, abdominal pain, and nausea

Input lifestyle factors such as stress, sleep, and exercise

How Can You Use the Device in Research?

Establishing a baseline of normal fluctuation throughout time

The levels of hydrogen and methane in the breath are known to fluctuate over time, even dynamically throughout a single day. To progress our understanding of breath hydrogen and methane levels in relation to gastrointestinal symptoms, it is of critical importance to understand what a normal breath profile looks like over time. This includes hydrogen and methane fluctuations in response to food, circadian rhythms including sleep-wake cycles, lifestyle factors such as stress and exercise, and minor illnesses. Figure 1 shows internal data of the average hydrogen and methane levels collected with the OMED device.

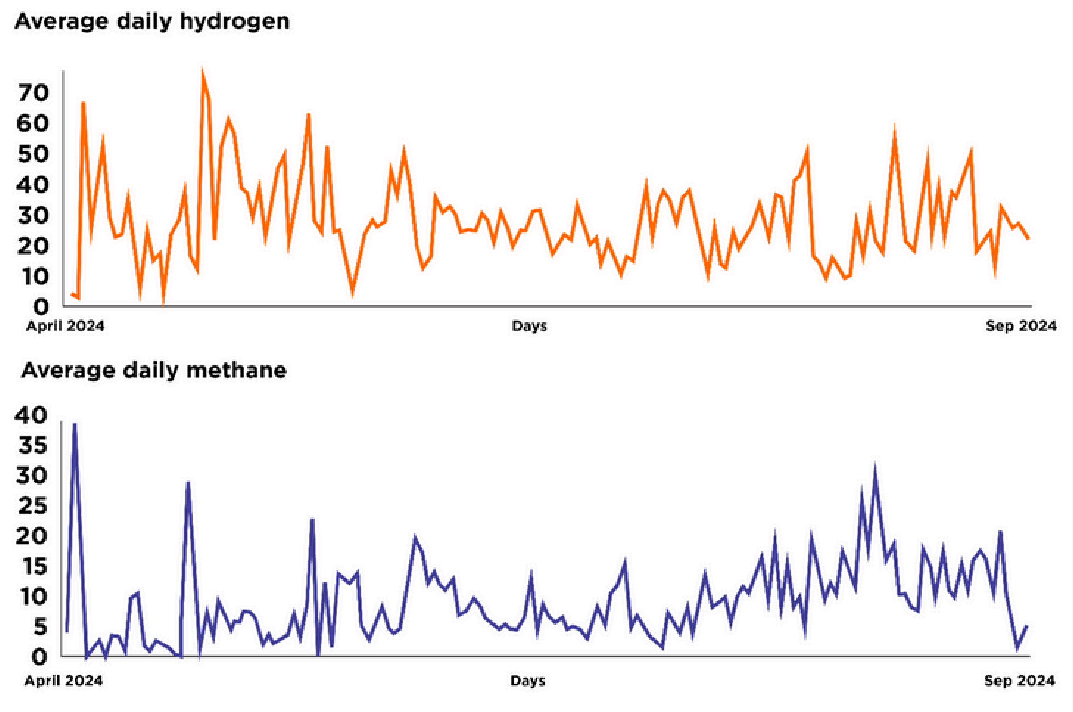


Figure 1 – Average daily hydrogen and methane levels for over 50 OMED users between April and September 2024. A total of 3126 breath samples were collected throughout this time period.

As everyone's gut microbiota and internal biology are different, mapping the normal responses of a large population of people is of significant value to better infer when hydrogen and methane breath abundance is abnormal, especially when paired with the presence of gastrointestinal symptoms, or in response to lifestyle disruptions such as stress and travel.

Investigate the impact of antibiotic SIBO treatment

A significant proportion of patients with IBS are estimated to have SIBO, a dysbiosis condition that is treatable with antibiotics, such as rifaximin. Several key factors are associated with the development of SIBO in IBS patients, including subtype, population demographic, medications, gut microbiome composition, and dysbiosis (16,17). As SIBO is treatable, the ability to quickly detect occurrences with ongoing monitoring in those with chronic digestive symptoms could significantly improve their quality of life. Recurrence is common, with reported rates up to 44% within nine months of antibiotic therapy (18), and catching this early is important for timely treatment. Assessing how the OMED device could support better monitoring of treatment response, compliance, and the early detection of the recurrence of SIBO/IMO (signaling the need for treatment) would be of significant clinical benefit.

An individual who was part of a larger study investigating the incidence of small intestinal bacterial overgrowth (SIBO) was analyzing their breath hydrogen multiple times a day with the OMED device (Figure 2). They were sent an antimicrobial treatment on the 13th of June (indicated by a purple line). At this point, their average hydrogen has dropped substantially, with a clear difference in hydrogen levels pre- and post-treatment. This can help to understand the response of the microbiome to different variables and give an example of how the OMED device can be utilized in clinical study designs.

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'Real-time, Home-based Analysis of Microbiome Metabolites with the OMED Health Breath Analyzer'

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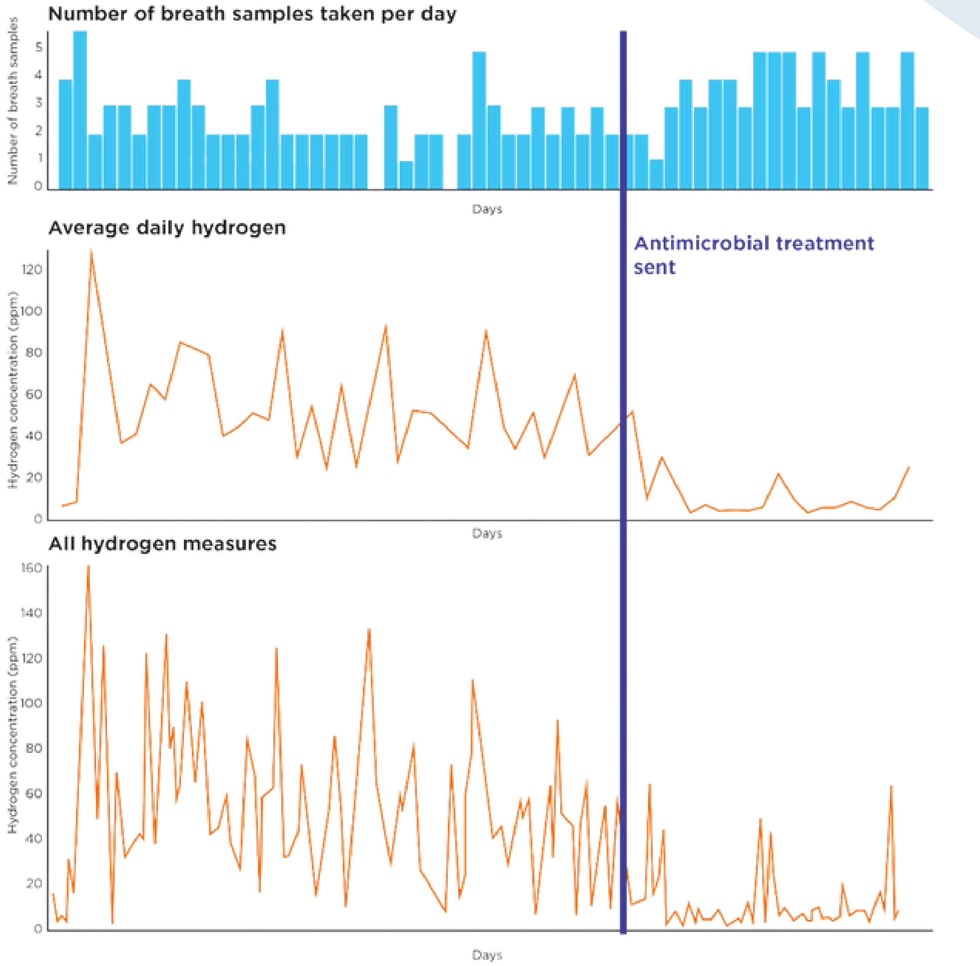


Figure 2 - Hydrogen measurements of one individual. The frequency of sampling across different days is shown in the top graph. The middle graph indicates average daily hydrogen levels. The bottom graph indicates all hydrogen measures taken. The purple vertical line indicates when an antimicrobial treatment was sent to the patient.

An overall example of several OMED users' data collated after SIBO and IMO treatment in shown in Figure 3.

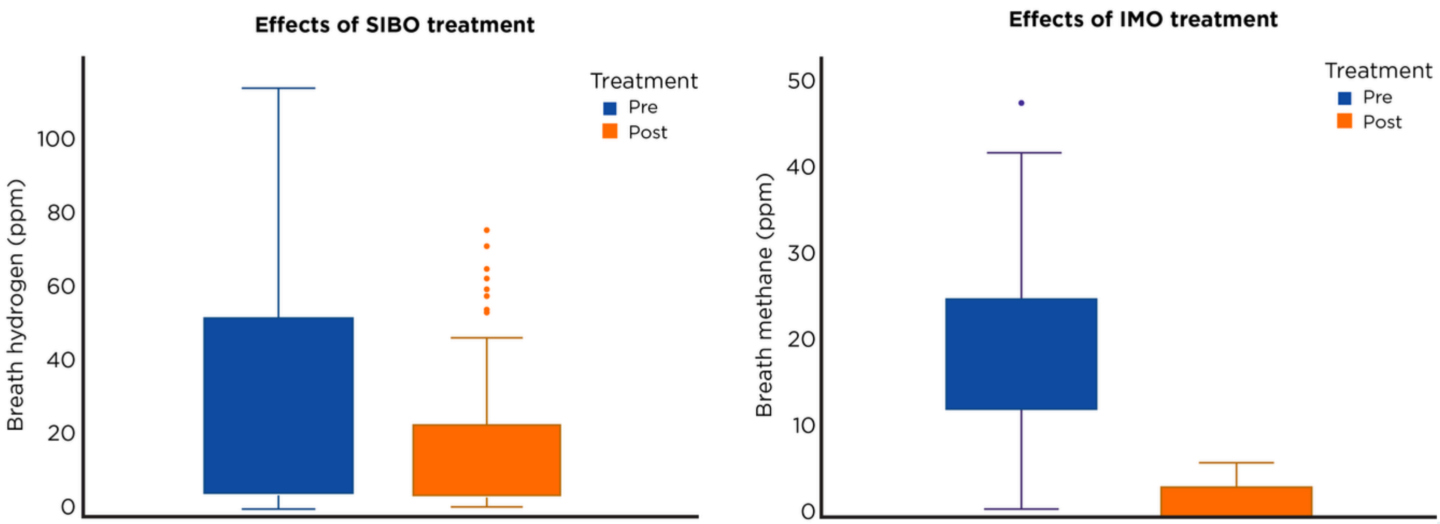


Figure 3 - The effects of SIBO and IMO treatment on breath hydrogen and breath methane respectively.

Assess the impact of a dietary change

The changing composition of breath over time in response to a food ingredient can provide a more detailed assessment of the activity of the gut microbiome. Some specific examples are discussed below.

FODMAPs

Fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAPs) have long been understood to be associated with IBS, and consequently, the FODMAP diet was developed in 2004 by scientists at Monash University. The FODMAP diet works by excluding certain carbohydrates from the diet to establish whether they are causing dysbiosis in the gut microbiome, leading to painful and uncomfortable symptoms. Pairing the FODMAP diet with hydrogen and methane levels in the breath can provide a quantitative platform to assess alongside symptoms over time. An elimination, reintroduction, and personalized phase of the FODMAP diet can be assessed alongside hydrogen and methane levels to make more causative associations between gases produced by the microbiome and gastrointestinal symptoms (example schema is shown in Figure 4).

	Elimination Phase	Reintroduction Phase	Personalization Phase
Weeks 1 -2	Eliminate FODMAPs from the diet under the guidance of a registered dietitian or nutritional therapist Begin daily breath collection protocol.	Initiate FODMAP reintroduction into the diet under the guidance of a registered dietitian or nutritional therapist. Continue daily breath collection protocol.	Begin personalized diet under the guidance of a registered dietitian or nutritional therapist, continue daily breath collection protocol.
Weeks 3 - 4	Continue diet and breath collection, reflect on any symptom changes and consult the registered dietitian or nutritional therapist if needed for adjustments.	Continue diet and breath collection, reflect on any symptom changes and consult the registered dietitian or nutritional therapist if needed for adjustments.	Continue diet and breath collection, Check in with the registered dietitian or nutritional therapist to discuss how body responds to different foods and make any necessary adjustments
Weeks 5 - 6	Continue diet and breath collection, consult with registered dietician or nutritional therapist about transitioning to reintroduction phase and plan the diet change.	Continue diet and breath collection, consult the registered dietitian or nutritional therapist to identify specific FODMAPs that trigger symptoms and discuss possible modifications.	Reflect on Low FODMAP journey and confirm a sustainable dietary plan. Conclude the Personalization Phase. Portable breath analyzer and companion mobile app available for ongoing use as required.
Weeks 7 - 8		Continue diet and breath collection, consult with registered dietician or nutritional therapist to summerize findings, and plan transitioning to personalization phase and the diet change.	

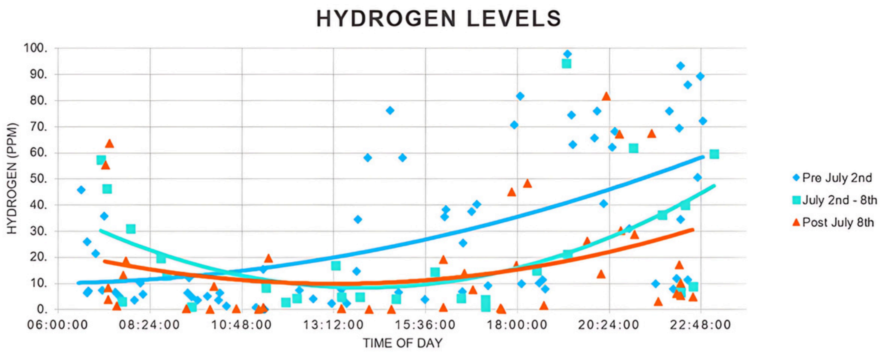
Figure 4 - An example schema for incorporating the OMED Health Breath Analyzer into a FODMAP elimination diet to connect hydrogen and methane levels to FODMAP consumption, gastrointestinal symptoms, and improvements.

Collecting regular serial measurements (one sample every 3 hours, as suggested) can reduce the noise of hydrogen and methane variability in discrete sampling, and longitudinal monitoring therefore can support a "real-time" confirmation of the intervention effect. As FODMAPs are highly fermentable, even in those without IBS the gut microbiota will produce more gas after eating a meal rich in FODMAPs. Therefore, if you are evaluating the device and not currently suffering from GI symptoms, eating a highly fermentable meal and watching the change in breath hydrogen and methane levels can map out the normal response of the gut microbiota to highly fermentable substrates.

Pre- and pro-biotic supplements

The main purpose of supplementing the diet with pre- and pro-biotics is to maintain a state of eubiosis in the gut, which is associated with many health benefits, including the improvement of gastrointestinal symptoms. Studies have found that improving the gut microbiota balance by consuming probiotics can improve dysbiosis symptoms in some patients, for example, Saccharomyces boulardii for SIBO and IBS (19,20). However, confidentially concluding that a pre- or pro-biotic is having a beneficial effect is difficult given how variable the activity of individual gut microbiota is. To claim the beneficial effect of food or a specific ingredient on labels, in marketing, or in advertising, this must first be approved by certain regulatory bodies, such as the European Food Safety Authority (EFSA). For a company to be successfully granted the ability to make such a claim, strong scientific evidence is needed. Ideally, this would be patient/volunteer-reported outcomes on their health, however, this can be very subjective and challenging to measure where small benefits are seen – very large (and costly) clinical trials would be needed to overcome this. Thus, molecular biomarkers well-linked to specific aspects of health can provide a method to demonstrate a food is having an effect in a smaller clinical study. For example, it is known that gas production is related to patient gut discomfort (21). To assess the levels of gas being produced in the gut, a hydrogen and methane breath test (HMBT) is the current gold standard.

As an example of what data from this form of study design could look like, a participant started taking a probiotic supplement on the 2nd of July, and took hydrogen and methane breath measurements regularly (Figure 5). Pre-July 2nd (blue line and data points in below graphs) the user's hydrogen showed a pattern of low in the morning and higher later on in the day, consistent with expected diet-led variations. Their methane levels showed some fluctuation but were consistently low. The first week of taking the probiotic July 2nd to July 8th (turquoise) there was no change in methane, but a slight rise in hydrogen in the mornings, and lower hydrogen than their normal in the evenings. After July 8th continuing the probiotic, the user had an overall lowering of their hydrogen levels, and a jump in their methane levels in the breath, both of which could have potentially exciting biological interpretations.



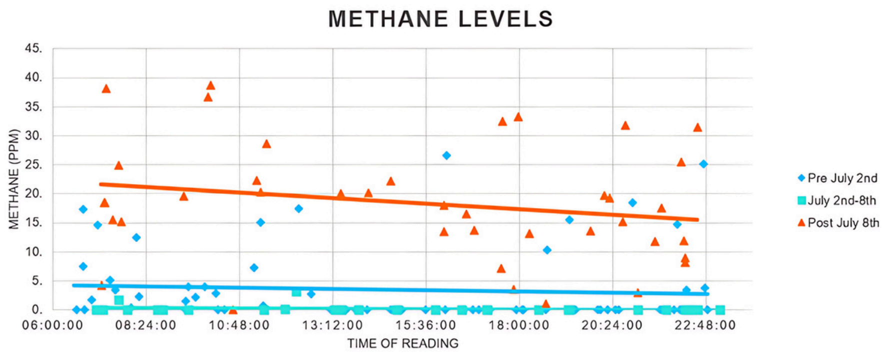


Figure 5 - The hydrogen and methane levels of an OMED Health device user before (pre-July 2nd) and regularly taking a probiotic treatment (July 2nd - 8th first week, and post July 8th).

Assess the Impact of Exercise on the Gut Microbiome, and Management of Chronic Digestive Symptoms

Worse IBS symptoms are typically associated with adults with a more sedentary lifestyle, and studies have demonstrated that physical activity can improve gastrointestinal symptoms such as excess gas, bloating, and disruptions to regular bowel movements. Low to moderate exercise such as yoga can help relieve symptoms such as bloating and gas (22), potentially by promoting gut muscle contractions that improve gastrointestinal motility, causing a decrease in colonic transit time (23,24). However, intense, long-lasting forms of exercise such as endurance running and cycling may trigger IBS symptoms. Analysis of the breath of ultramarathon runners suggests an altered gut microbiome in response to exhaustive exercise (25). This altered gut microbiome can cause excess gas to be produced and in turn, result in bloating and abdominal pain.

The OMED device could be used to monitor the impact of specific exercise regimes, or regular exercise on gastrointestinal symptoms paired alongside quantitative hydrogen and methane levels. This could be used in comparison to those with a more sedentary lifestyle, to see what impact this has on breath composition, and breath composition in response to other factors such as food. The device and paired app allow for the collection of multivariate data, and this more in-depth, longitudinal study can provide insight into the complex relationship between the gut microbiome, gut health symptoms, and lifestyle.

Accessing the OMED Health Breath Analyzer

To obtain the OMED Health Breath Analyzer for your patients, please reach out to us for personalized assistance. Our team is available to discuss your specific needs and determine the best way to integrate our services based on your patients' requirements and the preferred approach for your business.

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Contact us to find out more about collaborating with Owlstone Medical and to discuss incorporating the OMED Health Breath Analyzer in your research

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