

# Long COVID Hyposmia/Parosmia and subluxation: A case report

Charles S Masarsky and Marion Todres-Masarsky

**Abstract:** A 58-year-old woman with long COVID manifestations is described. Her symptoms included hyposmia, parosmia, brain fog, fatigue, and dry mouth. On examination, Weber's test was positive, with lateralization to the right ear. Reverse digit span was 5. On the Gupta et al olfactory scale of "0" (unable to smell anything) to "5" (completely normal sense of smell), she rated her ability to smell as "1". She was generally able to smell most aromas for one to two "sniffs" only. At various times, with no apparent pattern or external cause, she would experience a "house on fire" odor. Palpation augmented by Applied Kinesiology challenge revealed upper cervical, right first rib, right sacroiliac, and sphenoid subluxation. Ten adjustments were administered over a six-week period, consisting of high velocity low amplitude maneuvers, and various minimal force adjustments and reflex therapies. The levels of intervention varied according to the treating doctor's findings on a visit-to-visit basis. The patient was also advised to take coenzyme Q-10 and B-complex supplements to compensate for the effect of her statin prescription on coenzyme Q-10 biosynthesis. By her tenth visit, Weber's test was negative, her brain fog was gone, reverse digit span was 6, she rated her sense of smell between 2 and 3 out of a possible 5, she was able to detect aromas for as many as 4 "sniffs" in a row. The "house on fire" odor had transformed into a "burnt popcorn" odor. The patient's experience of dry mouth and fatigue were no longer more pronounced than they had been before COVID-19 infection. Possible mechanisms of the patient's recovery are discussed, with hypotheses relevant to future long COVID research.

**Indexing Terms:** Chiropractic; Long Haul COVID; Hyposmia; Parosmia; subluxation

## Introduction

The phenomenon of long COVID-19 is relatively new to science. Therefore, its precise definition varies. A reasonable working definition is '*Signs and symptoms remaining at least 90 days after acute COVID infection diagnosis*'.

The body systems involved vary widely, therefore characterising long COVID by clinical manifestation is problematic. If you have seen one long COVID patient, you have seen exactly one long COVID patient.

Researchers at the *University of Michigan* conducted a meta-analysis of 50 epidemiological studies on long COVID. (Van Beusekom, 2022. These studies included a combined 1,680,003 COVID-19 patients. They found the estimated prevalence of long COVID symptoms at 90 days post-diagnosis to be 32%, although estimates by individual studies vary from 9% to 81%.

... If you have seen one long COVID patient, you have seen exactly one long COVID patient'



We previously presented a case report of a long COVID patient with mainly cognitive manifestations. (*Masarsky & Todres-Masarsky, 2022*) The patient described in this paper responded to the same call for subjects (*Appendix 1 in that paper*) and executed the same informed consent document. (*Appendix 2 in that paper*)

### Acute Infection

The patient, a 58-year-old real estate agent, responded to a call for research volunteers with long COVID on May 6, 2022. She had been visiting the practice since 1997 for various musculoskeletal pain problems. Her most recent visits prior to research intake were December 6 and December 15, 2021. She made no mention of having had a COVID-19 infection at these visits.

On October 11, 2021, the patient was diagnosed with the delta variant of COVID-19 and was treated with infusion of monoclonal antibodies. She had been previously vaccinated and stated she '*really didn't feel that sick*'. Her symptoms during the acute illness consisted of fatigue and '*cold-like symptoms*' followed by loss of the sense of smell.

### Findings at Presentation

Initial intake and progress examinations were performed by CSM. Chiropractic analyses and adjustments were performed by MT-M. The history questioning was partially guided by a list of topics drawn from the *COMPASS-31 questionnaire* and a subjective scale of olfactory function, along with our general knowledge of long COVID. (Appendix 1 in this paper; Sletten et al, 2021; Gupta et al 2013).

At presentation, when asked whether she experienced dry mouth more often now than before COVID, she reported being thirsty more often than before, so probably 'yes'. She reported the presence of dry eye but felt it may have been pre-existing. Taken together, these were suggestive of possible sympathetic hypertonicity.

Her sense of smell was not totally absent at this point. On the Gupta et al scale of '0' (unable to smell anything) and '5' (completely normal sense of smell), her self-rating was '1'. (Gupta et al 2013) She further explained that she could generally smell something for one sniff, but then the aroma disappeared. Very occasionally, she was able to detect an aroma for two sniffs. She was also experiencing a '*house on fire*' aroma. This sensation lasted for at least one week when it first appeared. At presentation, it surfaced occasionally with no definite pattern and no external cause and lasted for '*a couple of sniffs*'. It had happened most recently the day of presentation. In an effort to chart her recovery from hyposmia and parosmia, the patient had purchased a commercial kit that contained rose, eucalyptus, lemon, and clove essential oils. Her most recent trial with these aromas took place the morning of presentation. She found the intensity of each aroma to be '*about the same*', and her ability to detect each aroma lasted 1-2 sniffs, as was the case with aromas encountered during her everyday life. Aromas seemed to be more intense in the left nostril than the right. She reported no change in her sense of taste.

In terms of cognitive function, she stated that she felt more forgetful and '*foggy*' now and had more trouble concentrating than before COVID. When asked whether she found herself tiring more easily now than before COVID, she answered in the affirmative, and added that she had to take more naps.

She was currently taking the statin *Lipitor*<sup>™</sup> but was not supplementing with *coenzyme Q-10* or the *B-complex* vitamins.

The patient's reported asymmetry in her sense of smell (left nostril more sensitive than right) suggested possible nasal congestion, prompting the performance of Weber's test. With a vibrating tuning fork placed in the centre of her skull, the patient found the sound to be louder in her right

ear, consistent with a conductive loss on that side, possibly related to a more generalised ear-nose-throat congestion.

Reverse digit span was 5, which is within normal range for an adult. Palpation augmented by challenge according to Applied Kinesiology protocols revealed subluxations involving the C1-2, T1-first rib, and left and right sacroiliac motion segments. (Walther, 1988) Challenge also revealed a sphenoid cranial fault, and therapy localisation indicated an active neurovascular reflex at the anterior fontanelle.

## Care

### *First adjustment*

Manoeuvres other than high velocity low amplitude adjustments follow *Applied Kinesiology* protocols unless otherwise stated. (Walther, 1988) C1, the right first rib, the left and right sacroiliac joints were adjusted with high velocity low amplitude manoeuvres. Respiratory assist adjusting according to *Applied Kinesiology* protocols was administered at the greater wings of the sphenoid. Light reflex work at the anterior fontanelle was administered following standard protocols for a neurovascular reflex. 'Damon', a gentle stress-relief manoeuvre, was administered. (Damon and Damon, 1939) The patient was scheduled to return in 3 days for her next visit.

### *Second visit*

On May 9, 2022 the patient came for a second visit. At this time, she mentioned several medical history items previously not mentioned. In 2019 or early 2020 she had experienced tachycardia. After a cardiac stress test, she was kept overnight for ventricular tachycardia ablation. She was subsequently monitored on an out-patient basis for 15 months.

Also, in 2019 or early 2020 she experienced a number of vision problems, which she attributed to possible 'small strokes'. Symptoms included visual 'zig-zags', floaters, and blurriness in the right eye. Vision in the right eye seemed darker than the left. These visual problems occasionally recur. She stated she seldom sees her primary medical doctor and was overdue for a check-up. She was advised to schedule a follow-up visit promptly.

At dinner the day before the second visit, she was able to smell the aroma of bread on two separate attempts.

Respiratory-assist adjustments were delivered to correct dysfunction at the and coronal suture, with high velocity low amplitude manoeuvres for the left sacroiliac, left glenohumeral, and left sternoclavicular joints. The left acromioclavicular joint was gently mobilised.

### *Third visit*

On May 11, 2022 the patient visited with complaints of neck, inter-scapular, and left hip pain. She reported that she was now able to smell a litter box and possibly mildew at a friend's house. High velocity low amplitude adjustments were administered to the right occiput, right atlas, T7, T9, L5, and the left sacroiliac joint. Neurolymphatic reflexes (Chapman's reflexes) were administered for the right *teres minor* and left *piriformis* muscles. Sphenoid and glabellar corrections were accomplished with respiratory assist adjusting. Visual righting reflexes were treated with a light digital contact. With the patient supine, the adjustor's fingers were curled to gently traction the skull in a superior direction (suboccipital release).

### *Fourth visit*

On May 18, 2022 the patient noted that it had been a very heavy pollen season, possibly aggravating her symptoms. Her increased thirst and possible dry mouth were still present. Her memory and concentration problems were unchanged, and her reverse digit span was 4. Fatigue, with the need for more naps was still present. Weber's test was negative, and she rated her sense of smell as between '1' and '2' out of a possible '5'.

High velocity low amplitude adjustments were administered at the levels of C6-7, L5, T3-6 (anteriority adjustment), and both sacroiliac joints. Sphenoid and glabellar corrections were accomplished with respiratory assist adjusting.

With the patient's sense of smell apparently responding, it was decided to continue adjustments for a few more visits. She was advised to supplement with *coenzyme Q-10* and *B-complex* to compensate for the dampening effect of her statin use on mitochondrial function, as long as the prescribing doctor had no objection.

#### *Fifth visit*

On May 23, 2022 the patient reported she was able to detect the odour of her daughter's underarms for two consecutive sniffs. She complained of pain in both hips, which she attributed to recent gardening. High velocity, low amplitude adjustments were delivered at L5, T5 and C6. Respiratory assist adjusting was done to correct a sphenoid fault and right temporal bulge. *Damon* technique was administered.

#### *Sixth visit*

On May 25, 2022 the patient reported that she '*jammed both feet, up the legs, and into the low back*' after exiting a new truck that was higher than what she was used to. She rated her low back pain at '6-7' on a scale where '10' is the worst pain imaginable. She had found no relief from *Acetaminophen*<sup>TM</sup>. She noted the ability to detect the odour of tobacco in a used car. High velocity, low amplitude adjusting was performed at L5 and both sacroiliac joints. Respiratory assist adjustments were administered to correct sphenoid and glabellar faults. Stimulation to the neurolymphatic reflex for the diaphragm was applied.

#### *Seventh visit*

On June 1, 2022 the patient stated she no longer experienced dry mouth or thirst to a greater degree than before COVID. She reported the ability to detect the aromas of honeysuckle, oleander, and mildew for anywhere from 2-3 sniffs in a row. She was still experiencing the '*house on fire*' odour, but not as often as before, and with no clear pattern. She rated her sense of smell overall as '2' where '5 is normal.

She reported no more trouble with concentration or memory than before COVID, and no longer suffered from a mentally '*foggy*' feeling. Her reverse digit span was 6.

She did continue to experience more fatigue and required more frequent naps than before COVID.

She had not yet begun taking *Coenzyme Q-10* or *B-complex*.

High velocity, low amplitude adjustments were administered to both sacroiliac joints, L5, T1, and C5. Respiratory assist adjustments to correct nasal torque and glabellar fault were performed. An open ileocecal valve was treated. Neurolymphatic reflexes for both gluteus maximus muscles were treated. *Damon* technique was performed.

#### *Eighth visit*

On June 6, 2022 the patient reported the ability to smell shampoo and a wet dog. The '*house on fire*' odour had changed into an odour reminiscent of burnt popcorn. She was now able to smell most foods and some perfumes. Her low back pain was noticeably reduced.

High velocity, low amplitude adjustments were performed at both sacroiliac joints, L5, L3, T12, and C6. Neurolymphatic reflexes were addressed for both psoas major muscles. Acupressure was administered to the K27 points bilaterally.

### *Ninth visit*

On June 13, 2022 the patient reported that she was taking *Coenzyme Q-10* and *B-complex* supplements daily as of June 7, 2022 (amounts not specified; she was taking the 'bottle dosage' of each).

She reported no more fatigue and need for naps than before COVID. She was now able to smell most aromas for 3 and sometimes 4 sniffs at a time. She reported the ability to smell mildew on a sponge, garlic, eucalyptus in the shower, and grass while gardening. The 'burnt popcorn' odour still surfaced at unpredictable intervals. Overall, she rated her sense of smell as '3' out of a possible '5'.

Her low back pain was much better.

High velocity, low amplitude adjustments were administered at L5 and L3. The left psoas major neurolymphatic reflex and the K27 acupressure point were addressed on the left side. *Gluteus maximus* neurolymphatic reflexes were stimulated bilaterally. The left tibia-femur articulation was mobilised. An imbrication correction was performed, consisting of a brief axial manual traction of the left leg.

The patient stated that she was preparing for a camping trip with her family.

### *Tenth visit*

On June 22, 2022 the patient reported some return of her fatigue, which she attributed to the recently completed camping trip. This trip had involved a great deal of work on her part, which she found quite tiring.

She was able to detect aromas for 2-3 sniffs. The 'burnt popcorn' aroma was still occurring, but with less frequency than before, and with no apparent pattern. Overall, she rated her sense of smell as '2' out of '5'.

The examiner (CSM) asked her to smell a jar of instant espresso; she was able to detect this for one sniff only. This was very old espresso, and the examiner found it difficult to smell himself. She was also asked to smell a surface coolant gel, the main ingredient of which is menthol, with some lemon peel oil, grapefruit seed oil, and other 'inactive ingredients' (Sombra™). At first, she was able to detect the aroma of this gel for only one sniff. Then, on *Applied Kinesiology* challenge, she was found to have a glabellar fault. After this was addressed with respiratory assist adjusting, she was then able to detect the gel's aroma for 4 sniffs in a row.

High velocity, low amplitude adjustments were performed at the left sacroiliac joint, T3-6 (anteriority), and C3. In addition to the previously corrected glabellar fault, respiratory assist adjustments were performed to correct nasal torque and a frontal bone fault. The right temporomandibular joint was addressed by digital release of the external *pterygoid* muscle.

The patient was scheduled for a progress examination in one week. She later cancelled that appointment due to scheduling problems. Since she failed to reschedule for several weeks thereafter, the research was deemed to be complete for this patient.

### **Discussion**

While patients with heart disorders are at risk for severe COVID-19 infections, this patient's tachycardia was apparently resolved prior to infection. While the patient's acute infection was not particularly severe, it is not known whether or not this previous cardiac history rendered her vulnerable to long COVID.

In a case report there is the possibility that the apparent benefits of the intervention were actually due to a spontaneous recovery. We believe spontaneous recovery is not a plausible explanation for the current case. For one thing, the patient's long COVID symptoms had lingered for more than six months without significant improvement, but substantial recovery was



observed with only six weeks of chiropractic care. Secondly, her ability to smell surface coolant went from one sniff to four sniffs immediately after an adjustment to correct a glabellar fault. This time frame is much more consistent with a bona fide physiological benefit of the chiropractic adjustment than it is with a spontaneous recovery.

While it is not known whether or not ear-nose-throat congestion was a significant aggravating factor in this patient's olfactory dysfunction, the fact that the patient's olfactory improvement coincided with the resolution of the previously positive Weber's test points in that direction. The use of this simple examination step may prove useful as an outcome measure in future long COVID cases with olfactory involvement.

The '*number of sniffs*' metric was introduced by the patient herself. We have found no reference to this method of tracking olfactory recovery in the bio-clinical literature. Although apparently unconventional, when '*number of sniffs*' is combined with the 0-5 scale (Gupta et al, 2013) and the patient's description of her olfactory experiences, we are equipped with multiple indicators of the patient's progress.

The patient's early recovery of olfaction involved mostly disagreeable odours, with appreciation of pleasant aromas becoming more frequent later in her care. Her spontaneous perception of a '*house on fire*' odour at unpredictable times and without external cause is an example of this. The early return of unpleasant olfactory perception may reflect an evolutionary priority. The capacity to perceive such odours as smoke, mildew, and rotten food is an ability with clear survival value. It makes physiological sense that the circuitry related to these perceptions would come back 'on line' first.

The patient's partial setback reported on her 10<sup>th</sup> visit may be related to the fatigue of her busy camping trip, as the patient suspects. This seems reminiscent of a phenomenon often seen in chronic post-concussion victims. Concussion victims sometimes seem fully recovered, passing every test in a clinical setting. Yet, some or all concussion-related symptoms re-emerge on vigorous physical activity, mental exertion, exposure to a visually complex environment, or mild hypoxia. (Ewing et al, 1980; Temme et al 2010; Temme et al 2013; Collins and Misukanis 2005; Pfefer et al, 2011) It could be that a pathophysiological mechanism similar to the one that renders the post-concussive nervous system vulnerable to such challenges is also at work in the long COVID patient. A history of concussion may be a risk factor for long COVID. On the other side of the coin, a history of long COVID prior to concussion may increase the risk of concussive chronicity. It is hoped that future epidemiological research will investigate these hypothetical interactions.

Recent studies have identified the ability of the COVID-19 virus to commit '*mitochondrial hijacking*'. This consists of a reduced ability of the body's cells to remove damaged and aged mitochondria, along with a reduced biosynthesis of *Co-enzyme Q-10 (ubiquinone)*. It has been proposed that mitochondrial hijacking may be one of the mechanisms (or perhaps *the* mechanism) behind brain fog and infertility in both acute and long COVID. (Stephano et al, 2021; Sun et al, 2022) Since sensory organs and the neural circuitry supporting them are dependent on a robust energy supply, it seems plausible that mitochondrial hijacking could be one mechanism underlying such disturbances of sensorium as hyposmia and parosmia.

Our patient was taking statins which interfere with coenzyme Q-10 biosynthesis (Tan and Barry, 2017). At the time of presentation, she was not compensating with coenzyme Q-10 and B-complex supplementation. The patient's 9<sup>th</sup> visit took place six days after she initiated supplementation. Her olfactory function and energy levels were markedly better at this visit than at previous visits.

If mitochondrial hijacking is in fact a major cause of long COVID, it seems reasonable to assume that any factor that interferes with *Coenzyme Q-10* biosynthesis such as statin use could be a risk

factor for long COVID. This hypothetical interaction is another possible topic for future epidemiological investigation.

It also seems reasonable that all measures to support respiration, from the musculoskeletal level to the cellular level, could be useful in alleviating long COVID symptoms. In this regard, it should be mentioned that the chiropractic adjustment has been shown to improve breathing capacity in a number of published studies. (Engel and Vemulapad, 2007; Kessinger 1997; Masarsky and Weber, 1991; Masarsky and Weber, 1989; Masarsky and Weber, 1988; Masarsky and Weber, 1986)

Our previous case report on a long COVID patient discussed some possible mechanisms by which the chiropractic adjustment could relieve long COVID symptoms. These included improved dural mechanics, correction of ischemic penumbra, and alleviation of hypothyroidism among others. (Masarsky and Todres-Masarsky, 2022) In light of the above discussion of mitochondrial hijacking we should probably add improved breathing capacity as an additional mechanism. While this does not address cellular respiration directly, enriched oxygenation due to improved breathing capacity could possibly ease the burden of cellular respiration distressed by mitochondrial hijacking. It may be prudent to include outcome measures such as forced vital capacity and/or single breath count test in future cases, whether or not the patient is complaining of respiratory distress.

For our patient, while the levels adjusted varied from visit to visit, cervical and cranial adjustments seemed to be of particular importance. Deranged dural mechanics and/or ischemic penumbra may have caused or aggravated her fatigue, brain fog, hyposmia, and parosmia. Her olfactory function may also have been disturbed by distorted cranial mechanics. For example, we are reminded that the dendrites of the olfactory nerve must pass through the openings of the cribriform plate of the *ethmoid* bone on the way to the brain. Adjustment of the glabellar fault may have had a beneficial effect on ethmoid biomechanics.

In a previous paper, a patient's description of olfactory experiences during their regular activities has been referred to as '*the olfaction of daily living*'. (Masarsky, 2021) This is the sort of narrative data found at the heart of a case report. If this patient had been a subject in a randomised controlled trial (RCT), this descriptive data may have been missed entirely. In particular, the nature of her distorted olfaction, parosmia, would probably have been reduced to a numerical data point. The same can be said of her response to questions inspired by the COMPASS questionnaire, which we used rather than the questionnaire itself. (Sletten et al, 2021)

While we appreciate the precision of the fastidious RCT, we urge the clinical research community to also value the important contributions available from descriptive studies. The RCT focuses on statistical significance for groups of patients, while the case report focuses on clinical significance for an individual. Progress in health science requires both. Descriptive and experimental research can and should complement and strengthen each other.

Marion Todres-Masarsky  
BA, MA, DC  
Private Practice of Chiropractic, Vienna, VA

Charles S. Masarsky  
B.S. Biology, DC  
Private Practice of Chiropractic, Vienna, VA  
e: [viennachiropractic@verizon.net](mailto:viennachiropractic@verizon.net)

**Cite:** Masarsky CS, Todres-Masarsky M. Long COVID Hyposmia/Parosmia and subluxation: A case report. *Asia-Pac Chiropr J.* 2022;3.2. URL [apcj.net/Papers-Issue-3-2/#MasarskyHyposmia](http://apcj.net/Papers-Issue-3-2/#MasarskyHyposmia)

## References

Collins ME, Misukanis TM. Chiropractic Management of a Patient with Post Traumatic Vertigo of Complex Origin. *J Chiropr Med.* 2005; 4: 32-38. Full text: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2647031/>

Damon Claude, Damon Carrie. *The Damon Method and How the Authors Use It In Their Practice.* Damon and Damon, North Hollywood, California, 1939.

Engel RM, Vemulapad S. The Effects of Combining Manual Therapy with Exercise on Respiratory Function of Normal Individuals: A Randomized Control Trial. *J Manipulative Physiol Ther.* 2007; 30: 509-513. Full text: <http://lib.ajau.ac.ir/booklist/508220.pdf>

Ewing R, McCarthy D, Gronwall D, Wrightson P. Persisting Effects of Minor Head Injuries Observable During Hypoxic Stress. *J Clin Neuropsychol.* 1980; 2 (2): 147-155.

Gupta N, Singh PP, Goyal A, Bhatia D. Assessment of Olfaction Using the “I-Smell” Test in an Indian Population: A Pilot Study. *Indian J Otolaryngol Head Neck Surg.* 2013; 65(1): 6-11. Full text: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3585564/>

Kessinger R. Changes in Pulmonary Function Associated with Upper Cervical Specific Chiropractic Care. *J Vertebr Sublux Res.* 1997; 1(3): 43-49.

Masarsky CS. The wide-angle lens: The post-pandemic research era. *Asia-Pac Chiropr J.* 2021;1.4. Full text: [https://www.apcj.net/site\\_files/4725/upload\\_files/MasarskyViewpoint-Education,Evidence&Pandemic\(1\).pdf?dl=1](https://www.apcj.net/site_files/4725/upload_files/MasarskyViewpoint-Education,Evidence&Pandemic(1).pdf?dl=1)

Masarsky CS, Todres-Masarsky M. Long Haul COVID-19 and Subluxation: A case report. *Asia-Pac Chiropr J.* 2022;2.6. URL <http://apcj.net/papers-issue-2-6/#MasarskyLongCovid>

Masarsky CS, Weber M. Chiropractic and Lung Volumes – A Retrospective Study. *ACA J Chiropr.* 1986; 20(9): 65.

Masarsky CS, Weber M. Chiropractic Management of Chronic Obstructive Pulmonary Disease. *J Manipulative Physiol Ther.* 1988; 11: 505-510. Abstract: <http://www.ncbi.nlm.nih.gov/pubmed/3253396>

Masarsky CS, Weber M. Screening Spirometry in the Chiropractic Examination. *ACA J Chiropr.* 1989 (Feb); 23: 67-68.

Masarsky CS, Weber M. Somatic Dyspnea and the Orthopedics of Respiration. *Chiropr Tech.* 1991; 3: 26-29.

Pfefer MT, Cooper SR, Boyazis AM. Chiropractic Management of Post-Concussion Headache and Neck Pain in a Young Athlete and Implications for Return-To-Play. *Topics in Integrative Health Care.* 2011; 2(3): 1-5. Full text: <http://www.tihcij.com/Articles/Chiropractic-Management-of-Post-concussion-Headache-and-Neck-Pain-In-a-Young-Athlete-and-Implications-For-Return-To-Play.aspx?id=0000307>

Sletten DM, Suarez GA, Low PA, Mandrekar J, Singer W. COMPASS 31: A Refined and Abbreviated Composite Autonomic Symptom Score. *Mayo Clin Proc.* 2021; 87(12): 1196-1201. Full Text: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3541923/>

Stefano GB, Buttiker P, Weissenberger S, Martin A, Ptacek R, Kream RM. Editorial: The Pathogenesis of Long-Term Neuropsychiatric COVID-19 and the Role of Microglia, Mitochondria, and Persistent Neuroinflammation: A Hypothesis. *Med Sci Monit.* 2021 (May 10); 27: e933015. Full text: <https://www.medscimonit.com/abstract/full/idArt/933015>

Sun J, Liu Q, Zhang X, Dun S, Liu L. Mitochondrial hijacking: A potential mechanism for SARS-CoV-2 to impair female fertility. *Medical Hypotheses.* 2022 (March); 160: 110778. Full text: <https://www.sciencedirect.com/science/article/pii/S0306987722000184?via%3Dihub>.

Tan JT, Barry AR. Coenzyme Q10 in the management of statin-associated myalgia. *American Journal of Health-System Pharmacy.* 2017; 74(11): 786-793. Abstract: [Coenzyme Q10 supplementation in the management of statin-associated myalgia | American Journal of Health-System Pharmacy | Oxford Academic \(oup.com\)](https://pubmed.ncbi.nlm.nih.gov/abstract/31111111/)

Temme LS, Still DL, Acromite MT. Hypoxia and Flight Performance of Military Instructor Pilots in a Flight Simulator. *Aviat Space Environ Med.* 2010 (Jul); 81(7): 654-659. Abstract: <http://www.ncbi.nlm.nih.gov/pubmed/20597244/>

Temme L, Bleiberg J, Reeves D, Still DL, Levinson D, Browning R. Uncovering Latent Deficits Due to Mild Traumatic Brain Injury by Using Normobaric Hypoxia Stress. *Front Neurol.* 2013; 4: 41. Full text: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3639430>



## Appendix

### **Some History Questions Relevant to Long COVID (discuss frequency, severity, + whatever other details patient can add)**

#### **Autonomic Function**

Since COVID, when standing after sitting or lying down do you feel:

- Dizzy?
- Shaky/weak?
- Do you break into a sweat?
- Does your vision blur?
- Does your heart race (palpitations)?

Do you get dry mouth more than you used to? Excess salivation more than you used to?

Do you get dry eye more than you used to? More tearing up than you used to?

Are you experiencing more diarrhea than you used to? More constipation than you used to?

Do you have more difficulty emptying your bladder than you used to?

Are you more sensitive to bright light than you used to be?

Do you have more difficulty seeing/driving at night than you used to?

#### **Olfactory Function**

Since COVID, what score would you give your sense of smell if “0” means you are unable to smell anything, and “5” is completely normal sense of smell?

If your score is less than “5”, do you find yourself using more salt and other seasonings?

#### **Cognitive Function**

Do you have more trouble concentrating than you used to?

Do you have more trouble with your memory than you used to?

Do you feel more mentally “foggy” than you used to?

#### **Breathing**

Do you have more trouble than before taking a deep breath?

Do you have to stop to take a breath when speaking more often than you used to?

#### **Endocrine (Glandular)**

Do you get tired more easily than you used to?

Do you have less sex drive than you used to?

Are you more sensitive to heat or cold than you used to be?

Do you have more of a craving for salt than you used to?

**(Sletten et al, 2012; Gupta et al, 2013)**