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Home Full-Body In-Bed Workout Rejuvenates a Sedentary Elderly Person: A 10 Year Case Report and Discussion on the Questionable Conclusion of the Daily Training

Ugo Carraro[1,2,3*], Maria Chiara Maccarone[4], Barbara Ravara[1,2,3], Walter Giurati[1], Stefano Masiero[2,4,5]

[1]Department of Biomedical Sciences, University of Padova, Padua, Italy

[2]CIR-Myo-Interdepartmental Research Center of Myology, University of Padova, Padua, Italy

[3]A&CM-C Foundation for Translational Myology, Padua, Italy

[4]Department of Neuroscience, Section of Rehabilitation, University of Padova, Padua, Italy

[5]Physical Medicine and Rehabilitation School, University of Padova, Padua, Italy

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[*]**Corresponding author:** Ugo Carraro, Department of Biomedical Sciences, University of Padova, Padua, Italy

ABSTRACT

Sarcopenia, characterized by muscle loss and fat infiltration, represents a significant health burden for aging populations. This Case Report evaluates the impact of a ten-year home Full-Body In-Bed exercise intervention on muscle function and structure in a sedentary elderly person. Case Presentation: a 70-year-old man began a home-based full-body in-bed exercise program in 2013 and progressively increased its volume and intensity during the next ten years. Clinical imaging data on muscle structure performed at baseline and after ten years, together with the functional results reported here strongly support the approach. Indeed the analyses by 2D and 3D color Imaging showed significant improvements in muscle volume observed in the knee-to-ankle region, indicating substantial preservation of muscle quality despite the expected decay of ten-year aging. Functionally, the number of arm push-ups continued to improve during the 10 years from less than 10 to more than 40 at 80 years, while the opposite is expected even from the behaviours of the Masters Athletes. A previous study conducted by the University of Padua has shown that incorporating physical activity into the daily lives of older adults not only serves to mitigate the effects of age-related muscle changes, but also allows them to maintain active, engaged and fulfilling lives. That study provided evidence that a short daily sequence of full-body in-bed exercises at home has a positive impact not only on muscle tissue, but also on overall quality of life in sedentary older individuals. Attention is drawn to the way of completing daily training to exhaustion, the validity and mechanisms of which are discussed, together with the role of pulse oximetry results. Regardless, the findings suggest potential applications in personalized health

strategies to at least improve muscle preservation of aging populations. However, although the results are promising, further research with larger sample sizes, control groups, and longer follow-up periods is needed to confirm the potential benefits of these approaches and provide more complete information on their role in promoting healthy aging by delaying decline of functional activity to the point of rejuvenating octogenarians.

Key Words: Sarcopenia, Elderly, Rehabilitation, Exercise, Home Full-Body in-Bed Workout, Exercise to exhaustion, Pulse oximetry, Brain hyperoxigenation.

INTRODUCTION

Older adults often face significant health challenges due to sedentary lifestyles and periods of immobilization, frequently caused by aging or concurrent medical conditions.[1-4] Reduced physical activity not only diminishes their independence but also increases their vulnerability to extended hospital stays and associated complications. [1,5-11] Specifically, immobility can lead to a variety of concerns including neuromuscular weakening, functional limitations, thromboembolism risks and related large healthcare costs. [11,12] Consequently, addressing these progressive muscle-related conditions requires ongoing attention. While research on pharmaceutical interventions is ongoing, exercise protocols emerge as a highly promising option. [2,13,14] Programs promoting physical activity within communities, using multidimensional strategies, have been shown to enhance physical function and address critical factors that elevate disability risk in older populations. [15-18] However, participation in such programs is often limited by barriers such as financial costs, reduced accessibility, transportation challenges, time constraints, psychological resistance to exercise in older adults, and insufficient specialized care. [15] Therefore, educating individuals to adopt home-based physical exercise, both during and following hospitalization, could present a practical and cost-efficient solution.

The “Home Full-Body In-Bed Workout” was designed as a tailored series of simple exercises, lasting 15 to 30 minutes, that can be performed in bed. This approach provides a sustainable way to combat the adverse effects of immobility and improve the overall physical well-being of sedentary individuals, thereby enhancing their quality of life.[7,13,19] Building on principles established in cardio-respiratory rehabilitation, the program incorporates movements that activate and strengthen muscles across the body. [4,20,22] The proposed exercises contribute to improving cardiac, respiratory, and vascular function, as well as strengthening the muscles of the limbs and trunk, possibly contributing to a delay in the aging process. [7,13]

Previous experiences, including those gained during the pandemic, have shown that a time-efficient home-based exercise protocol can benefit sedentary individuals by increasing function and improving quality of life. [7,19] A real-life study involving 22 elderly participants demonstrated that engaging in a Full-Body In-Bed Workout three times weekly for two months led to significant improvements in their quality of life. These benefits were particularly evident in the Mental Component Summary of the SF-12 Health Survey, where participants reported notable improvements. These findings highlighted that this kind of exercise not only improves physical health but also can contribute to enhancing emotional and mental well-being.

Although a previous comprehensive study has already demonstrated the benefits of this approach in a real-world patient population, showing the positive effects of a brief daily sequence of full-body bed-based exercises performed at home on pain management, sarcopenia prevention, and quality of life in a sedentary elderly cohort [23], it is still worthwhile to present an additional clinical case.

This case involves an octogenarian who, starting at the age of 70, consistently adhered to a 10-year routine of daily Full-Body Workouts performed in bed at home. This protocol included ending each session with an exhaustion exercise, a method that is often debated or even discouraged by many experts. The positive value and the proposed mechanisms of this approach are debated.

MATERIALS AND METHODS

Study design

This study focused on a 70-year-old male subject who undertook a home-based exercise regimen for over 10 years. The home-based Full-Body In-Bed program employed here consisted of exercises performed six times per week. This home-based exercise routine is designed to allow people to engage in physical activity directly from their beds, making it an ideal option for those with mobility challenges or for anyone who prefers to exercise without the need to leave their bed. This program typically involves a series of low-impact exercises that can be performed while lying down, sitting, or even standing next to the bed **(Tables 1,2)**. The protocol may include strength training and stretching activities, which are performed either following or alongside a set of warm-up activities completed in bed **(Tables 3 and 4)**.

Table 1. The 4 Stages of Continuous Progress of Work Ability in People Who Persevere in the home Full-Body in-Bed Workout.

First Stage	
Exercise 1: Ankle Flexion-Extension	Perform ankle flexion and extension while lying in bed. Simultaneously, bend your arms over your head from a starting position with your arms outstretched along your sides.
Exercise 2: Arm extension on frontal plane	Position your arms with an abduction, flex your elbows, and clench your fists while lying on the bed. Proceed to extend your arms forward while opening your fists, and then return to the initial position.
Exercise 3: Bed cycling	Replicate a pedaling motion by flexing and extending your hips and knees while lying on the bed. Begin by performing the movement with one leg and subsequently progress to using both legs simultaneously.
Exercise 4: Arms flexion-extension while breathing deeply	Initiate the exercise by extending your arms along the sides while lying on the bed. Proceed to bend the arms over your head, taking a deep breath as your arms are raised, and exhale as you return to the initial position.

Exercise 5: Pelvis lift	Elevate your pelvis off the bed surface and maintain this raised position for 2 seconds while lying in bed.
Exercise 6: Abdominal Exercise	Engage your abdominal muscles and raise your upper body while lying on the bed, simultaneously extending your arms in front of you. Then, return to the initial position.
Exercise 7: Cervical stretching	While sitting on the edge of the bed, flex and extend your head, tilt it, and then rotate it in both directions.
Exercise 8: Trunk lift	While seated at the edge of the bed, use your arms to push against the mattress and lift your upper body in a trunk lift.
Exercise 9: Leg extension	While sitting at the edge of the bed, raise your leg by extending your knee and lifting it off the floor in a leg extension.
Exercise 10: Stand on tiptoe	While sitting at the edge of the bed, rise onto your tiptoes to stand up and then return to a seated position in a stand on tiptoe movement.

Table 2. The 4r Stages of Continuous Progress of Work Ability in People Who Persevere in the home Full-Body in-Bed Workout.

Second Stage

This phase begins when, at the end of the exercises in bed, the person carefully performs push-ups on the floor starting with three repetitions. Over the next four weeks the repetitions will increase by three each time, until 12 repetitions are reached. The real beginning of the Second Stage corresponds to the ability to perform at least 10 push-ups of the arms on the floor and will end when the muscular fatigue of the arm muscles and of the whole body, kept as straight as possible, appears at the twentieth repetition.

Since we are talking about SEPTUAGENARIANS or even OCTOGENARIANS who are initially sedentary, this is already a notable muscular capacity which will be accompanied by the growth of the volume of the muscles which will no longer be thin and flaccid, but more voluminous and of considerable hardness during the exercises (sign of valid contractions). The ability to reach up to thirty push-ups on the floor before the onset of muscular fatigue will be part of the Second Stage, accompanied by a notable increase in the depth of spontaneous breathing, a notable increase in the frequency of heartbeats, which the person will be able to feel it in his chest for several minutes after the end of the exercise. Except in very cold environments, with muscular fatigue, sweating of the forehead will appear, a sign of heat dissipation that is being produced by muscular contractions throughout the body.

Table 3. The 4 Stages of Continuous Progress of Work Ability in People Who Persevere in the home Full-Body in-Bed Workout.

Third Stage

Exercise 5, bis: Lying on the bed, lift the pelvis from the surface of the bed and maintain this raised position for 5 breaths. Slowly return to the starting position.

Exercise 11: Alternately lift your legs off the bed 10 times.

Exercise 12: alternately stretch your legs so as to flex your pelvis

Exercise 13: resting your arms on the bed, raise your shoulders, hold the position for 5 breaths and slowly return to the starting position.

Exercise 14: Raise the two legs above the bed and maintain this position for 10 breaths. Extend your arms. Slow return to the starting position.

Exercise 15: alternately bend your legs, pushing with your heels against the bed for 5 breaths. Slowly return to the starting position.

Exercise 16: Extend your arms over your head, touching the bed for 10 breaths.

Exercise 17: Bend your arms in a cross shape, pushing them against the bed to raise your shoulders 10 times

Exercise 18: With legs extended, flex and extend the ankles as much as possible 10 times

Exercise 19: Extend your arms and raise both legs above the bed. Maintain this position for 10 breaths. Slow return to the starting position.

Table 4. The 4 Stages of Continuous Progress of Work Ability in People Who Persevere in the home Full-Body in-Bed Workout.

Fourth Stage

Exercise 20: Stand up from the bed touching the bed with your calves, and with your arms bent at chest height, stand on tiptoe. Then place your heels on the ground and bend forward to slowly return to your seat.

Exercise 21: Standing, touching the bed with your calves, stand on tiptoe and hold the position for 10 breaths. Place your heels on the floor.

Exercise 22: From the previous standing position, lean forward and bend your knees, stopping just before touching the surface of the bed. Hold this position for 10 breaths. Then continue slowly until you sit on the bed.

Exercise 23: Standing with your back against the wall and your arms bent at chest height. Stand on tiptoe and lower to your knees, keeping your shoulders against the wall. Climb up slowly, touching the wall. Repeat 10 times.

Exercise 24: Standing with your back against the wall and your arms bent at chest height. Stand on tiptoe and lower yourself by bending your knees with your back to the wall. Hold this position for 10 breaths. Back up.

Exercise 25: Push-ups on the floor with the body stretched out and raised on the hands and feet. Flex your arms as many times as possible. **To avoid overloading the lumbar paravertebral muscles, after**

having performed at least 10 push-ups, you can continue until all your strength is exhausted, taking care to rest your knees on a cushion which, as a precaution, you will have placed on the ground in a position suitable for curling your knees. Take into account the number of push-ups without and with the cushion.

Exercise 26: After getting up, always with caution to avoid disastrous falls, lie down in bed and with a finger oximeter check the oximetry values (above 98) and the heart rate (between 100 and 130) . Count the incoercible ventilations with the mouth open and then count those with the mouth closed until the oximeter gives normal values of 95-96 and finally the nocturnal rest values of 90-92. Reports also heart rate changes in the daily sheet.

Exercise 27 A GOOD HOT SHOWER, will contribute, together with hyperoxygenation of the brain, to starting the day with a boost of optimism.

(Table 1) shows exercises of the home Full-Body In-Bed Gym Workout, specifically those the UC octuagenarian performed 12 years ago for several months at the beginning of his daily training experience. The **(Tables 2, 3 and 4**) present the Second, Third and Fourth Stages of the progressive protocols of the home Full-Body In-Bed Gym Workout. Even from the begining the daily session ends with a very demanding workout: push ups at exhaustion.

Medical History of the Octogenarian

The subject of this case study is UC, a male born on February 23, 1943, in Abano Terme, Padua, Italy. At the beginning of the study his medical history was collected, with the following main pathological events.

In 1969, he was involved in a car accident that led to fractures in both legs and ankles. One of the major complications of the incident was a ruptured spleen, which necessitated surgical removal to control internal bleeding. His survival was made possible through intravenous fluid administration and blood transfusions. Unfortunately, the transfusions resulted in hepatitis, delaying the recovery process for his skeletal injuries. Over the next 40 years, he experienced only two episodes of viral influenza and has not contracted COVID-19 to date, having received five doses of COVID-19 vaccines. At the age of 40, he was diagnosed with asymptomatic arterial hypertension. However, delays in addressing this condition ultimately led to the development of severe coronary artery disease. Additional relevant details from his medical history include the following:

An 80-year-old man with a history of hypertension and mixed dyslipidemia, treated pharmacologically since age 45, began experiencing symptomatic angina at age 68. Coronary angiography revealed significant disease in the right coronary artery, left circumflex artery, and first diagonal branch, leading to percutaneous coronary intervention and a drug-eluting stent placement. Three years later, he developed also a symptomatic popliteal artery aneurysm requiring surgical exclusion. At successive follow-up, a transthoracic echocardiogram indicated chronic ischemic/hypertensive car capacity (number of repetitions diomyopathy with preserved left ventricular function. Holter monitoring showed initial conduction system impairment, including first- and second-degree atrioventricular blocks and frequent ectopic beats. Follow-up coronary angiography demonstrated good patency of the previously implanted stents. His optimized outpatient cardiology regimen include aspirin 100mg, Irbesartan 300 mg once a day,

calcium antagonist 10 mg once a day, and rosuvastatin 10mg. Despite this strong evidence of a slowly progressive cardiomyopathy, the subject still performs all regular activities of daily living, engages in light voluntary exercise (home Full-Body In-Bed Workout), and undertakes heavy gardening work at his country house.

Starting in 2013, the subject performed 5 repetitions of each exercise, which he gradually increased in intensity and volume over time. The daily session of the Stage First of the home Full-Body In-Bed Workout lasted between 5 and 15 min. Going through years of progressive increases of the workout from stage second, third and presently fourth the subject exercise according the workout described in Table four for less than 30 minutes every morning. Even during last year at 80 years of age the subject ends the morning workout with the very demanding exercise of floor Push Ups that he is able to repeat even 40 and slightly more times before exhaustion.

For the details of the progression of the work capacity (number of repetitions) of the more demanding exercise and of the changes of muscle quality and quantity of the subjects during ten years of home Full-Body In-Bed Workout, the interested readers can download for free from PubMed some recently published publications listed in the references.[7,13,19,23,24] The only example we show here is related to interruption due to fever or even low back pain, demonstrating that it is easy to recover previous muscular capabilities after weeks or months of training interruptions **(Figure 1)**.[7]

Figure 1. Left abscissa: Minutes or Number of repetitions of exercises Number of repetitions of push-ups; Right abscissa: Total number of muscle events per day.

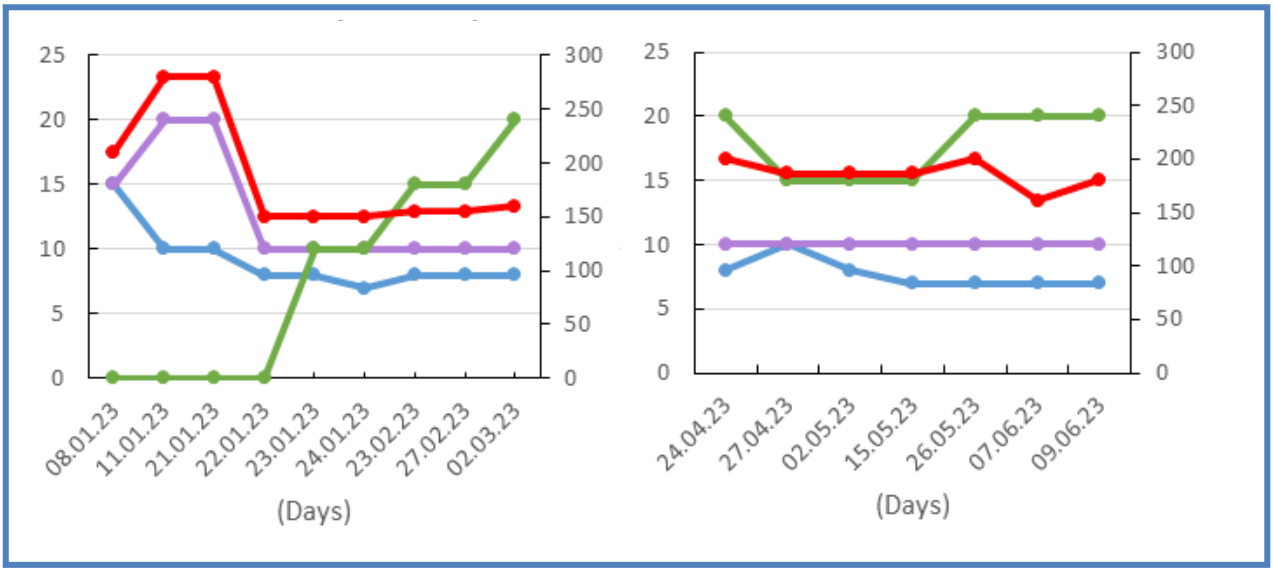

Figure 1. Left abscissa: Minutes or Number of repetitions of exercises Number of repetitions of push-ups; Right abscissa: Total number of muscle events per day.

Naturally these strenuous exercises deepen spontaneous breaths that occur 30 or more times with the mouth open and hundred - hundred and fifty times with the mouth closed before the heart frequency and the oximetric values returns to pre-exhaustion values. [7]

The subject has recently begun to use a digital oximetry to follow the changes in percentage of oxygenation of the peripheral blood, collecting values during night rest, after the exhaustion of push-up exercise, and again after one hundred to one hundred and fifty spontaneous ventilations with the mouth closed, that is, until the oxygenation of the peripheral blood and the heart rate return to the values of night rest.

Recent oximetric observations are reported in **(Table 5)**, for measuremets made either at 50 meters (Padova, Italy) or at 1500 meters (San Martino di Castrozza, Trient, Italy).

Table 5. Percent Oximetry (Oxy) and Cardiac Frequency (CF) before and after daily exercise session to exhaustion.

	Oxy or CF (Mean +/- SD)	
Values collected at 50 meters above sea level		
Oximetry at night rest	91.9 +/- 0.4	
Oximetry at exhaustion	98.4+/- 0.5	
Oximetry at new rest	92.7+/- 0.6	
Cardiac Frequency at night rest	55.9+/- 2.6	
Cardiac Frequency at exhaustion	114.4+/- 9.8	
Cardiac Frequency at new rest	60.9+/- 3.7	
Values collected at 1500 meters above sea level		**p (50 vs 1500 m)**
Oximetry at night rest	87.9+/- 0.9	< **0.001**
Oximetry at exhaustion	98.1+/- 0.4	0.209
Oximetry at new rest	91.4+/- 2.3	0.060
Cardiac Frequency at night rest	56.7+/- 1.1	0.456
Cardiac Frequency at exhaustion	117.3+/- 5.5	0.484
Cardiac Frequency at new rest	59.1+/- 1.6	0.254

At sea level 90-92% oxygenation was observed during night rest and 95% during normal daily activities, while the percentage of peripheral blood oxygenation rise to almost 100% immediately after push-ups until exhaustion. Peripheral blood oxygen saturation slowly decreased over the next 10 to 20 minutes under 92 %, if the subject remain immobile in bed, but stabilized at the level of 94-96% as soon he moves around for daily activities.

Obviously at 1500 meters above sea level some values are slightly lower due to the high altitude, but only for the values at night rest. Indeed they are 3-5% lover that the related values collected at sea level.

It should be underlined that 1500 meters above see level, even a heart patient, like the study subject, can continue his daily training with only a slight temporary decrease of repetitions in the final exercise to exhaustion. For recent reviews on this topic see Orcioli-Silva et al. [25], and Quaresima et al. [26]

DISCUSSION

The importance of an active lifestyle in older adults cannot be overstated, as it is closely linked to well-being and quality of life. [27-29] As the global population ages, older individuals often experience physiological changes such as reduced muscle strength, decreased bone density, and a decline in cardiovascular health, which can negatively impact their functional capacity. These changes can lead to frailty, increased injury risk, and a reduced quality of life. Promoting an active lifestyle is therefore essential for mitigating these effects and improving public health.[1,27,28,29–31] Exercise, particularly strength training and aerobic activity, helps maintain muscle mass, improve bone health, and enhance cardiovascular function, contributing to greater mobility and reduced risk of age-related conditions. Furthermore, physical activity has significant mental health benefits, such as improved mood, reduced anxiety, and enhanced cognitive function, which together promote overall well-being. Therefore, integrating exercise into daily routines for older adults can help maintain their autonomy, reduce healthcare costs, and enable them to live healthier lives.[2,10,28,33–37]

The exercises we have proposed in the Full-Body in Bed Gym protocol target multiple systems, including cardiovascular, respiratory and muscular function. In addition, as previously demonstrated, regularly following the home-based Full-Body in Bed Gym protocol resulted in significant improvements in quality of life, psychological well-being, and pain management. [23]The mechanisms underlying these effects are multifactorial, including the release of endorphins. Additionally, physical activity contributes to physiological improvements, including better body temperature regulation, increased cerebral blood flow, and balanced activity of the hypothalamic-pituitary-adrenal axis, all of which collectively support emotional resilience and stress management. [38,39] The physical and psychological improvements determined by exercise are closely intertwined, as better physical health tends to enhance self-esteem and the ability to engage in social and recreational activities, which are fundamental for mental health and can lead to a reduction in anxiety and depression. [40-46] In addition, physical activity, particularly aerobic and resistance exercises, has demonstrated significant potential in enhancing brain health and mitigating cognitive decline in older adults. [47] Research has highlighted that exercise promotes neuroplasticity, with structural and functional changes in brain regions such as the hippocampus and prefrontal cortex, which are particularly vulnerable to aging. [47,48] Furthermore, aerobic exercise is consistently associated with increased levels of brain-derived neurotrophic factor (BDNF) and improved functional connectivity, while resistance training has been linked to elevated insulin-like growth factor-1 (IGF-1) levels, both of which contribute to cognitive performance. Additionally, exercise reduces systemic inflammation by lowering proinflammatory markers such as C-reactive protein (CRP) and interleukin (IL)-6, mechanisms that may protect against neurodegenerative processes. [50,51] In

addition, enhanced cardiovascular and cerebrovascular function from regular physical activity supports improved cerebral blood flow, oxygenation, and nutrient delivery, which are essential for cognitive efficiency. [48]

The presented home-based full-body exercise protocol, designed to be performed in bed, incorporates a comprehensive program of exercises that engage both upper and lower body muscles, primarily consisting of rhythmic aerobic movements. This program aligns closely with the type of exercise known to promote cognitive and psychological improvements. Additionally, it is important to highlight that the training, as practiced consistently for nearly ten years by the UC subject, concludes with an exercise performed to exhaustion (a demanding push-up routine). This final element not only challenges the subject's endurance but also likely contributes to enhanced physical resilience. Furthermore, there is substantial evidence supporting the positive effects of this protocol on muscle function and structure, as demonstrated by objective findings recently reported in an associated study. [52] This suggests that the program is effective in maintaining and potentially improving physical and cognitive health over the long term.

We are also particularly interested in exploring the hypothesis that hyperoxygenation of the brain could contribute to the observed benefits, complementing the other well-established mechanisms associated with this exercise program. While this remains a hypothesis, it opens a fascinating avenue for further investigation into the potential interplay between oxygen delivery to the brain and the neurocognitive and psychological enhancements observed in the UC subject.

Of course, it is important to acknowledge the limitations of this clinical case. The lack of a longitudinal study with carefully controlled time intervals, including standardized baseline and follow-up assessments, limits the ability to draw definitive conclusions. Nevertheless, the observations collected suggest that sustained physical activity may play an important role in promoting an active lifestyle, even in the context of certain medical conditions such as heart disease and under demanding circumstances. Specifically, the octogenarian UC subject demonstrated the capacity to persist in regular physical activity at relatively high altitudes above sea level (up to 1500 meters, as detailed in **(Table 5)**, highlighting the adaptability and resilience achievable through consistent exercise regimens.

Although this clinical case is promising, further studies with larger sample sizes, control groups, and extended follow-up periods are required to validate the benefits of this exercise-based approach. Specifically, the inclusion of a phase of cerebral hyperoxygenation warrants confirmatory evidence to understand its role in promoting healthy aging and potentially reversing the decline in functional activities associated with advancing age. Such studies, designed in Padua, are currently awaiting definitive ethical approval. Once approved, they will be conducted at the University of Padua and extended to other Italian and, ideally, international universities, enabling a broader investigation into this innovative approach to aging and functional health.

In conclusion, incorporating physical activity, with a program that can be performed at home and comfortably in bed, into the daily lives of older adults not only helps mitigate the effects of age-related changes but also provides them with the opportunity to maintain an active, engaged, and fulfilling lifestyle. In particular, it has the potential to “rejuvenate” even individuals in their eighties, promoting both physical vitality and overall well-being.

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