Eur J Transl Myol 33 (3) 11780, 2023 doi: 10.4081/ejtm.2023.11780

Effects of the Full-Body in-Bed Gym program on quality of life, pain and risk of sarcopenia in elderly sedentary individuals: preliminary positive results of a Padua prospective observational study

Maria Chiara Maccarone (1), Allegra Caregnato (1), Gianluca Regazzo (1), Alessandra Carriero (1), Giacomo Casellato (1), Claudia Finamoni (1), Rossella Jirillo (1), Olena Laskova (1), Elena Marigo (1), Daniela Yolanda Sánchez (1), Irene Seno (1), Chiara Venturin (1), Hillary Veronese (1), Barbara Ravara (2,3,4), Walter Giurati (2), Ugo Carraro (2,3,4), Stefano Masiero (1,3,5)

(1) Physical Medicine and Rehabilitation School, University of Padova, Padua, Italy; (2) Department of Biomedical Sciences, University of Padova, Padua, Italy; (3) CIR-Myo-Interdepartmental Research Center of Myology, University of Padova, Padua, Italy; (4) A&CM-C Foundation for Translational Myology, Padua, Italy; (5) Department of Neuroscience, Section of Rehabilitation, University of Padova, Padua, Italy.

Abstract

Age-related muscle loss poses a significant health concern in an aging population. This study aimed to assess the impact of a home Full-Body in-Bed Gym protocol on quality of life, pain and risk of sarcopenia in elderly subjects. A total of 22 subjects with a median age of 71.90 years were included in the study. Patients participating in the Full-Body in-Bed Gym program, with a frequency of three times a week for two months, demonstrated a significant enhancement in their quality of life, as indicated by the 12-Item Short Form Health Survey (SF-12) Mental Component Summary ($p = 0.04$), and an improvement in pain levels ($p = 0.03$). Although not statistically significant, there was also an improvement in sarcopenia risk. Patients were given the freedom to decide whether to continue treatment after the evaluation of outcomes. Patient compliance with the exercise protocol over six months indicated its feasibility and sustainability, even in the long term. These findings suggest that the Full-Body in-Bed Gym protocol may play a valuable role in mitigating age-related muscle loss, emphasizing the importance of further investigation into such rehabilitation and prevention strategies.

Key Words: frailty; rehabilitation; sarcopenia; elderly; exercise; home Full-Body in-Bed Gym.

Eur J Transl Myol 33 (3) 11780, 2023 doi: 10.4081/ejtm.2023.11780

The challenges posed by immobility among elderly individuals, often due to advanced age or concurrent medical conditions, have significant implications for their overall health and independence.[1–4] This lack of physical activity not only restricts their autonomy but also increases the risk of extended hospitalization and associated complications.[1,5–11] The consequences of immobility encompass a range of issues including neuromuscular weakening, functional limitations, thromboembolism, and substantial healthcare costs.[11,12] Consequently, the management of all these progressive muscle-related impairments demands continuous attention. While pharmaceutical interventions remain a consideration, the potential of physical exercise regimens stands as a promising option.[2,13,14] Community-based physical activity initiatives, employing multifaceted physical activity strategies, have demonstrated significant enhancements in physical function, addressing key factors associated with disability risk in older individuals.[15–18] However, frequently encountered obstacles in the adoption and engagement of community-based exercise initiatives encompass expenses associated with program participation, accessibility and transportation challenges, time constraints, psychological barriers stemming from age-related exercise stigmas, and a shortage of specialized guidance.[15] Therefore, educating individuals about being engaged in home-based physical exercises, both during and post-hospitalization, could represent a practical and cost-effective alternative.

By tailoring a series of 10 easy-to-perform exercises, lasting 15 to 30 minutes, that can be executed while lying

in bed, the home "Full-Body in-Bed Gym" aims to provide a feasible and sustainable solution to mitigate the consequences of immobility and enhance the physical well-being of sedentary individuals, thereby improving their overall quality of life.[7,13,19] This approach extends the principles of established in-bed cardio-respiratory rehabilitation techniques to engage and enhance muscles throughout 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 convenient and time-efficient exercise protocol can benefit sedentary individuals by increasing function and improving quality of life.[7,19]

Nevertheless, so far individual cases only have been assessed, and a comprehensive study validating the benefits of this approach within a real patient cohort has never been conducted. Therefore, this study aims to comprehensively investigate the impact and effectiveness of a short daily sequence of 10 home Full-Body in-Bed Gym exercises on pain, risk of sarcopenia, and quality of life in a real-life cohort of elderly sedentary individuals.

Materials and methods

Study design

This prospective, observational, single-arm study was conducted between September 2022 and August 2023, involving patients referred to the Neurorehabilitation Unit, University of Padua, Padua, Veneto, Italy. Outcomes were assessed before and after two months of training, after which patients were given the freedom to decide whether to continue the treatment.

Participants

Participants of both sexes aged over 65 were included. The study included sedentary patients who did not engage in regular physical activity (less than one hour per week). Enrolled subjects were required to be capable of maintaining a sitting and standing position. Individuals under the age of 65 were excluded. Additionally, individuals with orthopedic conditions, such as recent fractures requiring limb immobilization, a history of severe cardiovascular disease or oncological disease, and those with significant neurological disorders, including limb plegia, were also excluded from participation.

Intervention

The Full-Body in-Bed Gym program consisted of 10 exercises to be performed at home three times per week on non-consecutive days for two months. The exercise protocol includes a series of exercises performed while lying on the bed, sitting on the edge of the bed, and standing up, targeting various muscle groups and movements to improve overall physical function (Table 1).

After receiving guidance from their Physical Medicine and Rehabilitation physician to mitigate the minimal risks of exercise-induced discomfort, pain, or potential muscle and joint strain, sedentary individuals initiated the program by performing five repetitions of each exercise. Over the course of one to two weeks of training, participants gradually added groups of five additional repetitions, reaching up to 30 repetitions per exercise per session within the successive weeks.

The exercises were recommended to be initiated at a slow pace as a cautious approach. However, once participants reached the maximum prescribed repetitions, they had the option to further enhance their outcomes by gradually increasing the speed of each exercise. This strategy aimed to amplify both the volume and intensity of the workout, consequently leading to a reduction in the time needed for each session. Therefore, the duration of the daily exercise routine could vary, beginning at approximately 15 minutes and extending to around 25-30 minutes for individuals who were accustomed to completing full sessions.

Each participant received an explanatory document and a video demonstrating the correct execution of the exercises. Figure 1 shows an example of the Full-Body in-Bed Gym exercises The quality and quantity of exercises were monitored through weekly phone calls.

For a dynamic depiction of the Full-Body in-Bed Gym sessions refer to the video accessible through this link: https://youtu.be/pcHKmxCLYFs.

More information about the intervention program's characteristics is reported in Table 1.

Outcomes evaluations

Every outcome measure was assessed prior to the beginning of the intervention (T0) and after two months of training (T1). For each patient, the following parameters were evaluated: gender, age, weight, height, Body Mass Index (BMI). Moreover, three different evaluation scales were utilized in the validated Italian version:

- The 12-Item Short Form Health Survey (SF-12): this questionnaire is a modified version of the larger 36-Item Short Form Health Survey (SF-36) and is commonly used to assess individuals' perceptions of their psychophysical conditions, particularly in the rehabilitation context. The SF-12 yields results in two dimensions, represented by the Physical Component Summary (PCS) and the Mental Component Summary (MCS), capturing the extent of a patient's impairment from both physical and mental perspectives (23).
- Numeric Rating Scale (NRSp): an ordinal scale measuring pain intensity on a range from 0 to 10, where 0 represents "no noticeable pain" and 10 indicates "the worst pain imaginable".
- Sarc-F questionnaire (SARC-F): a five-item questionnaire centered around key features or

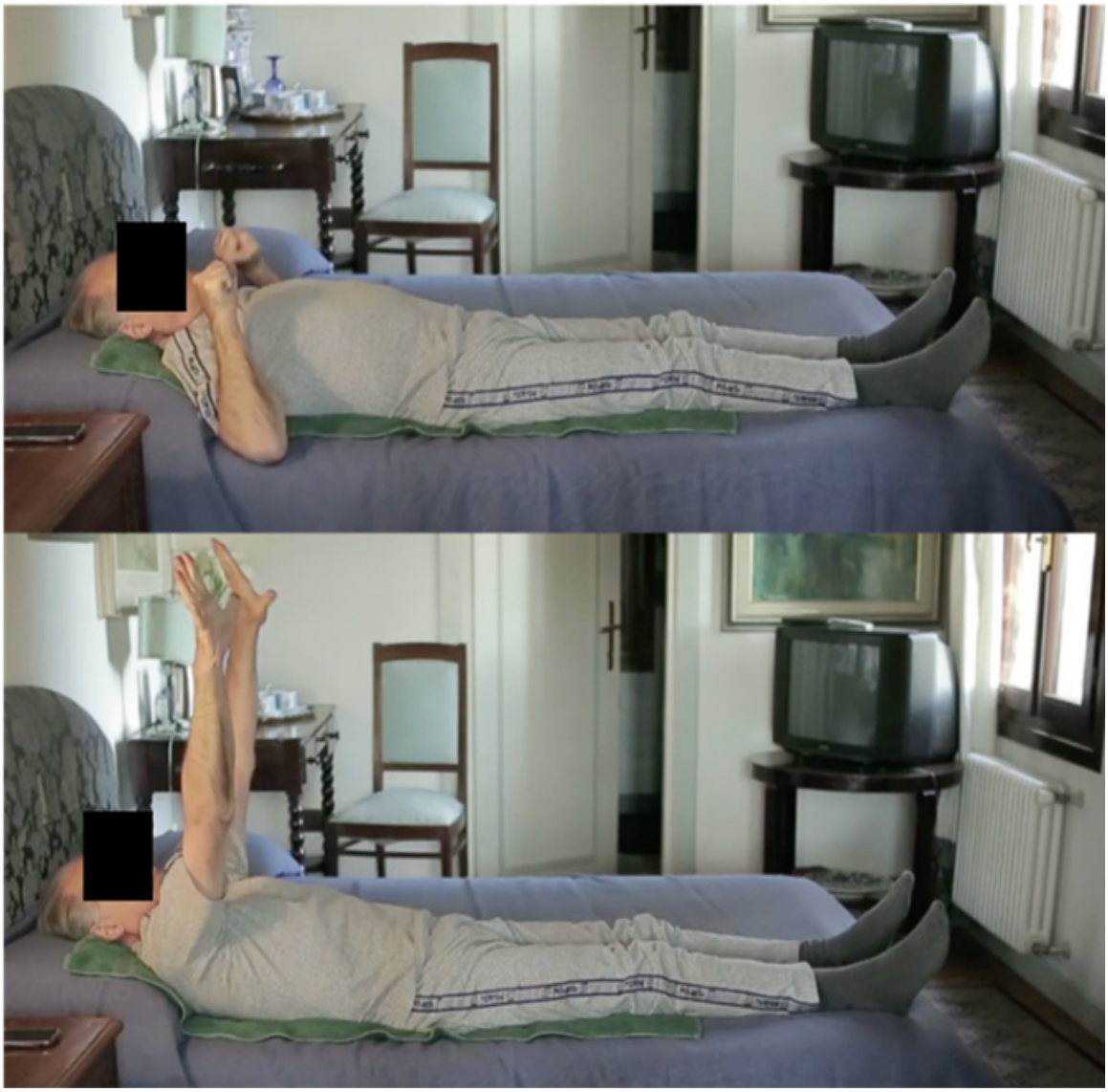

Fig 1. *One of the ten exercise shown as example of the home Full-Body in-Bed Gym protocol.*

consequences of sarcopenia, including muscle strength, walking, rising from a chair, climbing stairs, and the number of falls within the past year (24). Each aspect is assessed by instructing the patient to perform the specified activity and subsequently evaluating their perceived level of difficulty in completing it, as well as any requirement for assistance or aids. A score of 4 or higher indicates a diagnosis of sarcopenia.

Moreover, a Likert scale questionnaire was given to the enrolled subjects to evaluate their satisfaction with the provided treatment, with the total sum of values equating to 40. Furthermore, any adverse events that occurred during the training were assessed.

Six months after the start of the treatments, the patients were contacted again to assess treatment compliance.

Statistical analysis

The statistical analysis was performed using Microsoft Excel software. Data were presented as medians with interquartile ranges based on the distribution of the variables. The normality of the data distribution was assessed using the Shapiro-Wilk test. Changes between baseline (T0) and two months of training (T1) were evaluated using paired t-tests or Wilcoxon signed-rank tests for normally distributed and non-normally distributed continuous variables, respectively. The significance level was set at $\alpha<0.05$ for all analyses.

Table 1. The home Full-Body in-Bed Gym protocol.

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.

Results

Overall, 37 sedentary individuals were enrolled, of whom 9 were excluded from the study because they met exclusion criteria (n=3 had significant cardiovascular pathologies, n=5 had recent orthopedic surgical interventions, and n=1 had an oncological disease). A total of 22 patients successfully completed the study, with a median age of 71.90 years (minimum: 65 years, maximum: 85 years) and a median BMI of 25.78 (minimum: 18.75, maximum: 39.21). Among these, 12 were females, constituting 54.5% of the sample, and 10 were males, determining the remaining 45.5%.

Regarding the quality of life, the mean score of the SF-12 PCS was 42.41, while at T1, it increased to 48.39. The change in SF-12 PCS from T0 to T1 showed a p-value of 0.07, suggesting a trend towards improvement but not reaching statistical significance. In contrast, SF-12 MCS showed a statistically significant improvement with a mean score of 45.28 at T0 that increased to 50.85 at T1 ($p = 0.04$). Regarding pain, the NRSp baseline mean score was 3.32, which decreased to a mean score of 2.14 at T1. The change was statistically significant, with a p-value of 0.03.

The mean SARC-F score at T0 was 1.55 and it decreased to 1.33 at T1 ($p = 0.6$).

The treatment evaluation revealed a median value of 37.78 (range: 35 to 40).

Table 2. The table shows the median, minimum, and maximum values obtained before and after the two-month training period for the considered outcomes.

Outcomes	T0			T1			P-value
	Median	Min value	Max value	Median	Min value	Max value	
SF-12 PCS	42.41	25.26	59.8	48.39	31.64	59.6	0.07
SF-12 MCS	45.28	22.36	60.7	50.85	31.8	60.7	0.04
NRS	3.32	0	6	2.14	0	7	0.03
SARC-F	1.55	0	8	1.33	0	6	0.6

At the six-month evaluation, 9 (40.9%) patients reported continuing to perform the exercises according to the provided protocol, while 3 (13.64%) patients mentioned that they had reduced their sessions to twice a week.
No adverse effects were reported by the population under investigation.
The results of the study are summarized in Table 2.

Discussion

The importance of maintaining an active lifestyle in the elderly cannot be overstated, as it is closely linked to their overall well-being and quality of life.[25–27] As societies continue to experience demographic shifts with an increasing aging population and the aging process brings physiological changes that can lead to a decline in muscle strength, bone density, cardiovascular health, and overall functional capacity, promoting an active lifestyle should be a crucial public health effort.[1,25,26,28–30]
For the first time, we have examined a real-life cohort of patients who participated in a home-based program of easily performed in-bed exercises. The positive outcomes of the application of home-based functional electrical stimulation (h-bFES) for the recovery of muscle function, particularly in cases of severe neuromuscular traumatic injuries,[13,19] have encouraged the exploration of similar principles applied to a broader demographic, specifically targeting sedentary individuals who may face challenges in engaging in conventional physical activity routines. Therefore, our exercise program was specifically designed to address the limitations imposed by advanced age and associated health conditions. The exercises we proposed target multiple systems, including cardiovascular, respiratory, and muscular function, which are crucial for maintaining independence and delaying the aging process.[2,10,26,31–35]
The evaluations conducted on patients, using validated, easily administered, and widely used outcome measures in clinical practice and research, have resulted in the documentation of certain improvements in patients. Specifically, patients undergoing the Full-Body in-Bed Gym program for two months demonstrated an enhancement in their quality of life and a reduced risk of sarcopenia. In particular, despite not reaching statistical significance, the rapid improvement achieved in the risk of sarcopenia, through the execution of a simple exercise protocol, deserves further investigation, as it is promising. Indeed, given the rising prevalence among the aging population, it is essential to find rehabilitative and preventive strategies for managing sarcopenia that can be carried out outside the hospital environment.[5,12,29,36]
Simple exercises, suitable for daily home use, even by patients with limited mobility, appear to contribute to reducing age-associated muscle loss and its consequences. Furthermore, participants showed improvements in both physical and mental well-being, although the increase in physical well-being was not

statistically significant. Our implementation of the Full-Body in Bed Gym program aligns with the broader understanding that exercise is not only beneficial for physical health but also plays a significant role in enhancing emotional and mental well-being among the elderly. [37,38] An active lifestyle has been found to have a profound impact on psychological aspects such as mood, anxiety, and depression.[39–41] These changes are often attributed to the endorphin and monoamine hypotheses, suggesting that exercise triggers the release of these neurochemicals, thereby alleviating negative emotional states.[39] Moreover, exercise's influence on physiological factors such as body temperature regulation, cerebral blood circulation, and hypothalamic-pituitary-adrenal axis activity contributes to the emotional benefits, enhancing resilience to stressors.[39,42] Notably, the most substantial improvements are associated with aerobic exercises that engage large muscle groups. Such exercises, conducted at moderate to low intensities for 15 to 30 minutes per session, at a minimum frequency of three times a week over 10-week or longer programs, have demonstrated positive effects.[2,16,17,27,39,43] The home Full-Body in-Bed Gym program, involving a comprehensive regimen of 10 exercises that engage both upper and lower body muscles, and primarily consisting of rhythmic aerobic exercises, aligns perfectly with the type of exercise that promotes well-being and enhances the quality of life. Moreover, the program offers the potential for improved self-efficacy, a psychological mechanism that refers to the individual's belief in his ability to successfully accomplish a specific task or achieve a particular goal. As participants progress from initial repetitions to more advanced levels, their ability to accomplish these exercises could foster a sense of achievement and mastery, contributing to enhanced self-confidence and emotional well-being. In our study, we also recorded a significant reduction in pain levels after the intervention. Individuals experiencing chronic pain commonly suffer from deconditioning.[44,45] Consequently, our program could address muscular deconditioning not only through a direct effect on muscle structure but also by reducing perceived pain. Our patients expressed satisfaction with the protocol, and the six-month evaluation of compliance with the exercise protocol provided valuable insights into the long-term sustainability of this approach. An important number of subjects continued to adhere to the exercise regimen as initially prescribed, indicating that the Full-Body in-Bed Gym protocol is not only feasible but also sustainable over an extended period. However, 3 patients reported a reduction in exercise frequency to twice a week. While this may indicate a decreased commitment to the program, potential reasons behind this change should be considered. Factors such as individual health fluctuations, time constraints, or evolving preferences may have contributed to this adjustment.

Taken together, our findings suggest that the home Full-Body in-Bed Gym protocol could represent a viable approach to enhancing quality of life, alleviating pain, and mitigating sarcopenia risk factors in older adults. Moreover, the absence of reported adverse effects among the patients underscores the safety of this program, further solidifying its potential as a valuable tool in the home-based management of age-related muscle loss and its associated consequences. However, further research, including larger-scale and longer-term studies, is needed to confirm these initial results.

Indeed, our study presents some limitations. First, the modest sample size and the absence of a control group limit the generalizability of our findings. Additionally, the study's short duration and lack of long-term follow-up make it challenging to determine the sustainability of the observed benefits. Finally, our assessment of muscle loss was limited, primarily relying on the SARC-F questionnaire. Future studies should aim for a more comprehensive evaluation, encompassing both structural and functional aspects of muscle health.

In conclusion, incorporating physical activity into the daily lives of older adults not only serves to mitigate the effects of aging-related changes but also empowers them to maintain an active, engaged, and fulfilling life. Our study provides preliminary evidence that a short daily sequence of home Full-Body in-Bed Gym exercises could have a positive impact on pain perception, sarcopenia risk, and overall quality of life in sedentary elderly individuals. Moreover, the fact that a majority of patients in our study continued to engage in the exercise protocol at the six-month follow-up is an encouraging sign of the feasibility of such home-based in-bed interventions.

Nevertheless, while our findings are promising, further research with larger sample sizes, control groups, and longer follow-up periods is needed to confirm the potential benefits of this exercise approach and provide more comprehensive insights into its role in promoting healthy aging and delaying functional decline.

List of acronyms

T0 - the beginning of the intervention
T1 - after two months of training
BMI - body mass index
NRSp - Numeric Rating Scale
SARC-F - Sarc-F questionnaire
SF12 - The 12-Item Short Form Health Survey
SF-36 - The 36-Item Short Form Health Survey
MCS - Mental Component Summary
PCS - Physical Component Summary

Contributions of Authors

MCM and UC – development of the study design; MCM, AC, GR, AC, GC, CF, RJ, OL, EM, DYS, IS, CV and HV - data collection; MCM, UC and SM data interpretation; MCM, AC UC and SM – writing; BR, WG, UC and SM - supervision.

All authors read and approved the final edited manuscript.

Acknowledgments

Authors thank the elderly participants who took part in the study and followed the proposed exercise protocol.

Funding

The authors received no specific funding for this work.

Conflict of Interest

The authors declare no conflicts of interest.

Ethical Publication Statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

Corresponding Author

Maria Chiara Maccarone, Physical Medicine and Rehabilitation School, Department of Neuroscience, University of Padua, 35128 Padua, Italy
ORCID ID: 0000-0003-2793-1334
E-mail: mariachiara.maccarone@phd.unipd.it

E-mails and ORCID iD of co-authors
Allegra Caregnato: allegra.caregnato@studenti.unipd.it
ORCID iD: 0000-0001-8926-5301
Gianluca Regazzo: gianluca.regazzo@studenti.unipd.it
ORCID ID: 0009-0004-6277-4199
Alessandra Carriero: alessandra.carriero@studenti.unipd.it
ORCID iD: 0009-0008-2356-5457
Giacomo Casellato: giacomo.casellato@studenti.unipd.it
ORCID iD: 0009-0000-6788-6238
Claudia Finamoni: claudia.finamoni@studenti.unipd.it
ORCID iD: 0009-0005-3603-4725
Rossella Jirillo: rossella.jirillo@studenti.unipd.it
ORCID iD: 0009-0009-2495-1074
Olena Laskova: olena.laskova@studenti.unipd.it
ORCID iD: 0009-0006-2387-0190
Elena Marigo: elena.marigo.1@studenti.unipd.it
ORCID iD: 0000-0002-0263-0351
Daniela Yolanda Sánchez: danielayolanda.sanchez@studenti.unipd.it
ORCID iD: 0009-0008-9532-6746
Irene Seno: irene.seno@studenti.unipd.it
ORCID iD: 0009-0001-9142-6482
Chiara Venturin: chiara.venturin@studenti.unipd.it
ORCID iD: 0009-0003-7682-9421
Hillary Veronese: hillary.veronese@studenti.unipd.it
ORCID iD: 0009-0000-4818-0264
Barbara Ravara: barbara.ravara@unipd.it
ORCID iD: 0000-0002-0159-3245
Walter Giurati: walter.giurati@unipd.it
ORCID iD: 0000-0000-9991-3488
Ugo Carraro: ugo.carraro@unipd.it
ORCID iD: 0000-0002-0159-3245
Stefano Masiero: stef.masiero@unipd.it
ORCID iD: 0000-0002-0361-4898

References

1. Lauretani F, Russo CR, Bandinelli S, Bartali B, Cavazzini C, Di Iorio A, Corsi AM, Rantanen T, Guralnik JM, Ferrucci L. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol (1985). 2003 Nov;95(5):1851-60. doi: 10.1152/japplphysiol.00246.2003. PMID:14555665.
2. Angulo J, El Assar M, Álvarez-Bustos A, Rodríguez-Mañas L. Physical activity and exercise: Strategies to manage frailty. Redox Biol. 2020 Aug;35:101513. doi: 10.1016/j.redox.2020.101513. Epub 2020 Mar 20. PMID: 32234291; PMCID: PMC7284931.
3. Kojima G, Liljas AEM, Iliffe S. Frailty syndrome: implications and challenges for health care policy. Risk Manag Healthc Policy. 2019 Feb 14;12:23-30. doi: 10.2147/RMHP.S168750. PMID: 30858741; PMCID: PMC6385767.
4. Masiero S, Carraro U. (eds) Rehabilitation Medicine for Elderly Patients. Practical Issues in Geriatrics. Springer International Publishing AG, part of Springer Nature. doi: 10.1007/978-3-319-57406-6_40.
5. Papadopoulou SK. Sarcopenia: A Contemporary Health Problem among Older Adult Populations. Nutrients. 2020 May 1;12(5):1293. doi: 10.3390/nu12051293. PMID: 32370051; PMCID: PMC7282252..
6. Morley JE. Frailty and sarcopenia in elderly. Wien Klin Wochenschr. 2016 Dec;128(Suppl 7):439-445. doi: 10.1007/s00508-016-1087-5. Epub 2016 Sep 26. PMID: 27670855.
7. Ravara B, Giuriati W, Maccarone MC, Kern H, Masiero S, Carraro U. Optimized progression of Full-Body In-Bed Gym workout: an educational case report. Eur J Transl Myol. 2023 Jun 23;33(2):11525. doi: 10.4081/ejtm.2023.11525. PMID: 37358234; PMCID: PMC10388607.
8. Coletta EM, Murphy JB. The complications of immobility in the elderly stroke patient. J Am Board Fam Pract. 1992 Jul-Aug;5(4):389-97. PMID: 1496895.
9. Veronese N, Stefanac S, Koyanagi A, Al-Daghri NM, Sabico S, Cooper C, Rizzoli R, Reginster JY, Barbagallo M, Dominguez LJ, Smith L, Maggi S. Lower Limb Muscle Strength and Muscle Mass Are Associated With Incident Symptomatic Knee Osteoarthritis: A Longitudinal Cohort Study. Front Endocrinol (Lausanne). 2021 Dec 16;12:804560. doi: 10.3389/fendo.2021.804560. PMID: 34975772; PMCID: PMC8716541.
10. Buchmann N, Fielitz J, Spira D, König M, Norman K, Pawelec G, Goldeck D, Demuth I, Steinhagen-Thiessen E. Muscle Mass and Inflammation in Older Adults: Impact of the Metabolic Syndrome. Gerontology. 2022;68(9):989-998. doi:

10.1159/000520096. Epub 2022 Jan 31. PMID: 35100595; PMCID: PMC9501741.

11. Maccarone MC, Coraci D, Bernini A, Sarandria N, Valente MR, Frigo AC, Dionyssiotis Y, Masiero S. Sarcopenia prevalence and association with nutritional status in cohort of elderly patients affected by musculoskeletal concerns: a real-life analysis. Front Endocrinol (Lausanne). 2023 Jun 26;14:1194676. doi: 10.3389/fendo.2023.1194676. PMID: 37435492; PMCID: PMC10331423.
12. Maccarone MC, Masiero S, Papathanasiou J, Panayotov K, Kashilska Y, Prokopidis K, Papanastasiou C, Tyllianakis M, Dionyssiotis Y. Frailty Education: Promoting Geriatric Competencies Among Physical Medicine and Rehabilitation Residents. Am J Phys Med Rehabil. 2023 Oct 1;102(10):e137-e140. doi: 10.1097/PHM.0000000000002231. Epub 2023 Mar 4. PMID: 36882328.
13. Carraro U, Gava K, Baba A, Marcante A, Piccione F. To Contrast and Reverse Skeletal Muscle Atrophy by Full-Body In-Bed Gym, a Mandatory Lifestyle for Older Olds and Borderline Mobility-Impaired Persons. Adv Exp Med Biol. 2018;1088:549-560. doi: 10.1007/978-981-13-1435-3_25. PMID: 30390269.
14. Alizadeh Pahlavani H. Exercise Therapy for People With Sarcopenic Obesity: Myokines and Adipokines as Effective Actors. Front Endocrinol (Lausanne). 2022 Feb 17;13:811751. doi: 10.3389/fendo.2022.811751. PMID: 35250869; PMCID: PMC8892203.
15. Law TD, Clark LA, Clark BC. Resistance Exercise to Prevent and Manage Sarcopenia and Dynapenia. Annu Rev Gerontol Geriatr. 2016;36(1):205-228. doi: 10.1891/0198-8794.36.205. PMID: 27134329; PMCID: PMC4849483.
16. Dionyssiotis Y, Masiero S, Maccarone MC, Prokopidis K, Dzhafer N, Matzaroglou C, Tsekoura M, Panayotov K, Papathanasiou J. Frailty: future prospectives in rehabilitation medicine. Eur J Transl Myol. 2023 Jun 23;33(2):11347. doi: 10.4081/ejtm.2023.11347. PMID: 37358212; PMCID: PMC10388595.
17. Galloza J, Castillo B, Micheo W. Benefits of Exercise in the Older Population. Phys Med Rehabil Clin N Am. 2017 Nov;28(4):659-669. doi: 10.1016/j.pmr.2017.06.001. PMID: 29031333.
18. Mora JC, Valencia WM. Exercise and Older Adults. Clin Geriatr Med. 2018 Feb;34(1):145-162. doi: 10.1016/j.cger.2017.08.007. Epub 2017 Oct 10. PMID: 29129214.
19. Carraro U, Marcante A, Ravara B, Albertin G, Maccarone MC, Piccione F, Kern H, Masiero S. Skeletal muscle weakness in older adults home-restricted due to COVID-19 pandemic: a role for full-body in-bed gym and functional electrical stimulation. Aging Clin Exp Res. 2021 Jul;33(7):2053-2059. doi: 10.1007/s40520-021-01885-0. Epub 2021 May 28. PMID: 34047931; PMCID: PMC8160559.
20. Besnier F, Bérubé B, Malo J, Gagnon C, Grégoire CA, Juneau M, Simard F, L'Allier P, Nigam A, Iglésies-Grau J, Vincent T, Talamonti D, Dupuy EG, Mohammadi H, Gayda M, Bherer L. Cardiopulmonary Rehabilitation in Long-COVID-19 Patients with Persistent Breathlessness and Fatigue: The COVID-Rehab Study. Int J Environ Res Public Health. 2022 Mar 31;19(7):4133. doi: 10.3390/ijerph19074133. PMID: 35409815; PMCID: PMC8998214.
21. Ades PA, Keteyian SJ, Wright JS, Hamm LF, Lui K, Newlin K, Shepard DS, Thomas RJ. Increasing Cardiac Rehabilitation Participation From 20% to 70%: A Road Map From the Million Hearts Cardiac Rehabilitation Collaborative. Mayo Clin Proc. 2017 Feb;92(2):234-242. doi: 10.1016/j.mayocp.2016.10.014. Epub 2016 Nov 15. PMID: 27855953; PMCID: PMC5292280.
22. Vorona S, Sabatini U, Al-Maqbali S, Bertoni M, Dres M, Bissett B, Van Haren F, Martin AD, Urrea C, Brace D, Parotto M, Herridge MS, Adhikari NKJ, Fan E, Melo LT, Reid WD, Brochard LJ, Ferguson ND, Goligher EC. Inspiratory Muscle Rehabilitation in Critically Ill Adults. A Systematic Review and Meta-Analysis. Ann Am Thorac Soc. 2018 Jun;15(6):735-744. doi: 10.1513/AnnalsATS.201712-961OC. PMID: 29584447; PMCID: PMC6137679.
23. Sampogna F, Mastroeni S, Pallotta S, Fusari R, Uras C, Napolitano M, Abeni D. Use of the SF-12 questionnaire to assess physical and mental health status in patients with psoriasis. J Dermatol. 2019 Dec;46(12):1153-1159. doi: 10.1111/1346-8138.15074. Epub 2019 Oct 13. PMID: 31608501.
24. Perna S, Gasparri C, Ferraris C, Barrile GC, Cavioni A, Mansueto F, Patelli Z, Peroni G, Tartara A, Zese M, Rondanelli M. Validation of the Italian Version of the SARC-F Questionnaire to Assess Sarcopenia in Older Adults. Nutrients. 2022 Jun 18;14(12):2533. doi: 10.3390/nu14122533. PMID: 35745264; PMCID: PMC9228620.
25. Galli F, Chirico A, Mallia L, Girelli L, De Laurentiis M, Lucidi F, Giordano A, Botti G. Active lifestyles in older adults: an integrated predictive model of physical activity and exercise. Oncotarget. 2018 May 22;9(39):25402-25413. doi: 10.18632/oncotarget.25352. PMID: 29875997; PMCID: PMC5986634.
26. Cunningham C, O' Sullivan R, Caserotti P, Tully MA. Consequences of physical inactivity in older adults: A systematic review of reviews and meta-analyses. Scand J Med Sci Sports. 2020 May;30(5):816-827. doi: 10.1111/sms.13616. Epub 2020 Feb 4. PMID: 32020713.

27. Miller KJ, Areerob P, Hennessy D, Gonçalves-Bradley DC, Mesagno C, Grace F. Aerobic, resistance, and mind-body exercise are equivalent to mitigate symptoms of depression in older adults: A systematic review and network meta-analysis of randomised controlled trials. F1000Res. 2020 Nov 13;9:1325. doi: 10.12688/f1000research.27123.2. PMID: 34158928; PMCID: PMC8191520.
28. Cieza A, Causey K, Kamenov K, Hanson SW, Chatterji S, Vos T. Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2021 Dec 19;396(10267):2006-2017. doi: 10.1016/S0140-6736(20)32340-0. Epub 2020 Dec 1. Erratum in: Lancet. 2020 Dec 4;: PMID: 33275908; PMCID: PMC7811204.
29. Marzetti E, Calvani R, Tosato M, Cesari M, Di Bari M, Cherubini A, Collamati A, D'Angelo E, Pahor M, Bernabei R, Landi F; SPRINTT Consortium. Sarcopenia: an overview. Aging Clin Exp Res. 2017 Feb;29(1):11-17. doi: 10.1007/s40520-016-0704-5. Epub 2017 Feb 2. PMID: 28155183.
30. Franceschi C, Bonafè M, Valensin S, Olivieri F, De Luca M, Ottaviani E, De Benedictis G. Inflamm-aging. An evolutionary perspective on immunosenescence. Ann N Y Acad Sci. 2000 Jun;908:244-54. doi: 10.1111/j.1749-6632.2000.tb06651.x. PMID: 10911963.
31. Kortebein P. Rehabilitation for hospital-associated deconditioning. Am J Phys Med Rehabil. 2009 Jan;88(1):66-77. doi: 10.1097/PHM.0b013e3181838f70. PMID: 18688198.
32. Nishikawa H, Asai A, Fukunishi S, Nishiguchi S, Higuchi K. Metabolic Syndrome and Sarcopenia. Nutrients. 2021 Oct 7;13(10):3519. doi: 10.3390/nu13103519. PMID: 34684520; PMCID: PMC8541622.
33. Ojo AS, Balogun SA, Williams OT, Ojo OS. Pulmonary Fibrosis in COVID-19 Survivors: Predictive Factors and Risk Reduction Strategies. Pulm Med. 2020 Aug 10;2020:6175964. doi: 10.1155/2020/6175964. PMID: 32850151; PMCID: PMC7439160.
34. Branco M, Rêgo NN, Silva PH, Archanjo IE, Ribeiro MC, Trevisani VF. Bath thermal waters in the treatment of knee osteoarthritis: a randomized controlled clinical trial. Eur J Phys Rehabil Med. 2016 Aug;52(4):422-30. Epub 2016 Feb 19. PMID: 26899038.
35. Tognolo L, Maccarone MC, De Trane S, Scanu A, Masiero S, Fiore P. Therapeutic Exercise and Conservative Injection Treatment for Early Knee Osteoarthritis in Athletes: A Scoping Review. Medicina (Kaunas). 2022 Jan 3;58(1):69. doi: 10.3390/medicina58010069. PMID: 35056377; PMCID: PMC8778069.
36. Masiero S, Maccarone MC, Kostoglou-Athanassiou I, Dionyssiotis Y. Editorial: (Osteo)Sarcopenia & sarcopenic obesity. Front Endocrinol (Lausanne). 2023 Aug 24;14:1270350. doi: 10.3389/fendo.2023.1270350. PMID: 37693355; PMCID: PMC10484582.
37. Peluso MA, Guerra de Andrade LH. Physical activity and mental health: the association between exercise and mood. Clinics (Sao Paulo). 2005 Feb;60(1):61-70. doi: 10.1590/s1807-59322005000100012. Epub 2005 Mar 1. PMID: 15838583.
38. Maccarone MC, Scanu A, Coraci D, Masiero S. The Potential Role of Spa Therapy in Managing Frailty in Rheumatic Patients: A Scoping Review. Healthcare (Basel). 2023 Jun 30;11(13):1899. doi: 10.3390/healthcare11131899. PMID: 37444733; PMCID: PMC10340743.
39. Mikkelsen K, Stojanovska L, Polenakovic M, Bosevski M, Apostolopoulos V. Exercise and mental health. Maturitas. 2017 Dec;106:48-56. doi: 10.1016/j.maturitas.2017.09.003. Epub 2017 Sep 7. PMID: 29150166.
40. Catalan-Matamoros D, Gomez-Conesa A, Stubbs B, Vancampfort D. Exercise improves depressive symptoms in older adults: An umbrella review of systematic reviews and meta-analyses. Psychiatry Res. 2016 Oct 30;244:202-9. doi: 10.1016/j.psychres.2016.07.028. Epub 2016 Jul 22. PMID: 27494042.
41. Smith PJ, Merwin RM. The Role of Exercise in Management of Mental Health Disorders: An Integrative Review. Annu Rev Med. 2021 Jan 27;72:45-62. doi: 10.1146/annurev-med-060619-022943. Epub 2020 Nov 30. PMID: 33256493; PMCID: PMC8020774.
42. Hidalgo JL, Sotos JR; DEP-EXERCISE Group. Effectiveness of Physical Exercise in Older Adults With Mild to Moderate Depression. Ann Fam Med. 2021 Jul-Aug;19(4):302-309. doi: 10.1370/afm.2670. PMID: 34264835; PMCID: PMC8282290.
43. Gschwind YJ, Kressig RW, Lacroix A, Muehlbauer T, Pfenninger B, Granacher U. A best practice fall prevention exercise program to improve balance, strength / power, and psychosocial health in older adults: study protocol for a randomized controlled trial. BMC Geriatr [Internet]. 2013 Dec 9;13(1):105.
44. Verbunt JA, Seelen HA, Vlaeyen JW, Heijden GJ, Heuts PH, Pons K, et al. Disuse and deconditioning in chronic low back pain: concepts and hypotheses on contributing mechanisms. Eur J Pain [Internet]. 2003 Feb;7(1):9–21.
45. Panayotov K. Pain Treatment. In: Papathanasiou J, Panayotov K, editors. Essentials of Physical and Rehabilitation Medicine for undergraduate medical students 2nd ed. Ruse, BG: 2023. p. 229-240.

Disclaimer

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article or claim that may be made by its manufacturer is not guaranteed or endorsed by the publisher.

Submission: September 12, 2023
Revision received: September 25, 2023
Accepted for publication: September 25, 2023