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Original Study

Impact of Tailored Multicomponent Exercise for Preventing Weakness and Falls on Nursing Home Residents' Functional Capacity

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A B S T R A C T

Objectives: We aimed to determine whether the benefits of long (24 weeks) and short (4 weeks) training programs persisted after short (6 weeks) and long (14 weeks) periods of inactivity in older adult nursing home residents with sarcopenia.
Design: Multicenter randomized trial.
Intervention: The Vivifrail tailored, multicomponent exercise program (http://vivifrail.com) was conducted to individually prescribe exercise for frail older adults, depending on their functional capacity. The training included 4 levels combining strength and power, balance, flexibility, and cardiovascular endurance exercises.
Setting and Participants: Twenty-four institutionalized older adults (87.1 $\pm$ 7.1 years, 58.3% women) diagnosed with sarcopenia were allocated into 2 groups: the Long Training-Short Detraining (LT-SD) group completed 24 weeks of supervised Vivifrail training followed by 6 weeks of detraining; the Short Training-Long Detraining (ST-LD) group completed 4 weeks of training and 14 weeks of detraining.
Measures: Changes in functional capacity and strength were evaluated at baseline, and after short and long training and detraining periods.
Results: Benefits after short and long exercise interventions persisted when compared with baseline. Vivifrail training was highly effective in the short term (4 weeks) in increasing functional and strength performance (effect size = 0.32-1.44, $P < .044$) with the exception of handgrip strength. Continued training during 24 weeks produced 10% to 20% additional improvements ($P < .036$). Frailty status was reversed in 36% of participants, with 59% achieving high self-autonomy. Detraining resulted in a 10% to 25% loss of strength and functional capacity even after 24 weeks of training (effects size = 0.24-0.92, $P < .039$).
Conclusions and Implications: Intermittent strategies such as 4 weeks of supervised exercise 3 times yearly with no more than 14 weeks of inactivity between exercise periods appears as an efficient solution to the global challenge of maintaining functional capacity and can even reverse frailty in vulnerable institutionalized older adults.

The global population is living longer than ever before and life span is expected to continue to increase over the next decades.[1] Although advances in medicine have helped to prevent and treat aging-related health complications, frailty syndrome continues to be prevalent among older adults, hampering their activities of daily living through loss of muscle mass and strength (sarcopenia and dynapenia), and

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ultimately leading to poor functional ability, fatigue, and falls.[2] Sarcopenia is also associated with increased frailty and mortality because of related severe health complications such as decreased immunity and wound healing, increased risk of infection, pressure ulcers, pneumonia, cognitive impairment, and sleep disorders.[3]

Dependence through frailty is a challenge to health systems as it requires long-term care and eventual institutionalization,[4] which is related to high health care costs.[5] In turn, institutionalized older adults are more likely to have comorbidities, sarcopenia, and adverse events like a fall, which increases the risk of hospitalization.[6] In this regard, the current COVID-19 pandemic is especially worrisome for people aged ≥70 years as it continues to compromise hospital resources.[7]

The implementation of tailored exercise programs among the institutionalized frail is arguably the best way to improve functional capacity, muscle mass, and health status.[8] Physical exercise produces important metabolic improvements by reducing muscle atrophy, inflammatory processes, and loss of bone density, while maintaining appropriate insulin sensitivity, mitochondrial activity, and physical abilities.[9] Specifically, multicomponent exercise programs have been proven to be the most effective plan to modify or reverse physical frailty in people aged ≥70 years.[10–12] This has been amply demonstrated in daily acute interventions of 1 week,[13] short-term programs of 4-8 weeks,[14] and long-term training over 12 weeks.[15]

Although older adults are likely to experience adverse events or hospitalization that temporarily disrupt any physical activity, prior studies have demonstrated that exercise-related improvements may persist after short-[14,16–19] and even long-term[18,20–22] exercise cessation. Exercise appears to have a protective effect against physical atrophy during periods of inactivity, which is especially important for frail and institutionalized adults. In this regard, the use of exercise programs to improve physical health, both on admission and discharge, would be likely to have a tremendously positive impact on the public health care system.[8,13,23] Nonetheless, the available information about the residual effects of exercise programs after short and long deconditioning periods among institutionalized older adults is limited.[14,24] In an attempt to improve physical and functional capacity, we recently developed the Vivifrail multicomponent tailored exercise program (www.vivifrail.com) to focus on providing training to older adults, and to design strategies to promote and prescribe such tailored physical exercise.[25–27]

Against this background, the present study aimed to determine whether the benefits of long (24-week) and short (4-week) training programs persist after short (6-week) and long (14-week) inactivity periods in older adults with sarcopenia living in nursing homes.

Methods

Study Design

This is a follow-up study to a previous study demonstrating the protective effect of supervised training after deconditioning periods in institutionalized older adults who were confined during the first wave of the COVID-19 pandemic in Spain.[14] In this preliminary study, we conducted 4 weeks of the Vivifrail exercise program followed by a period of training cessation in 2 groups of sarcopenic, frail adults aged ≥75 years from 2 nursing homes. Results revealed a uniform response to the training in both groups demonstrating the robustness of the Vivifrail prescription guidelines. Besides, the short-term health improvements persisted after weeks of inactivity, preventing severe functional decline and strength loss. The present analysis extends this previous study by further examining the benefits and persistency after different time periods as a part of an ongoing multicenter randomized control trial (NCT03827499).

Adults aged >75 years living in 2 nursing homes and diagnosed with sarcopenia volunteered to participate in the study. Participants were randomly assigned to 2 experimental groups (1 from each nursing home): the Long Training-Short Detraining (LT-SD) group completed 24 weeks of training followed by 6 weeks of detraining; the Short Training-Long Detraining (ST-LD) group completed 4 weeks of training and 14 weeks of detraining. All participants followed the tailored multicomponent exercise training program Vivifrail (www.vivifrail.com).[25–27] Functional capacity and strength were evaluated at baseline (T0), after the short and long training programs (T1) and after the short and long detraining periods (T2). This was a multidisciplinary intervention involving, among other health professionals, 2 strength and conditioning trainers, 3 sport scientists, 1 physiotherapist, 1 medical doctor, 2 nurses, and the nursing home managers. The study was conducted according to the Declaration of Helsinki and was approved by the Ethics Commission of the local university (ID: 2131/2018).

Participants and Eligibility Criteria

Twenty-four participants underwent a medical examination to identify cardiovascular or metabolic conditions that would exclude participation, met the inclusion criteria according to the HEAL study protocol,[28] were informed of the characteristics of the study, and provided signed consent. Sarcopenia was identified according to the Foundation for the National Institutes of Health diagnosis algorithm[29]: gait speed <0.8 m/s, handgrip strength <26 kg for men and <16 kg for women, and appendicular lean mass (aLM) adjusted by body mass index (BMI) < 0.789 in men and <0.512 in women. The required sample size was determined on the basis of clinically relevant changes on the Short Physical Performance Battery (SPPB) in older adults. According to previous research on subjects with similar characteristics,[30] a clinically relevant change was ~1.5 ± 1.0 point increments after 12 weeks of multicomponent training. Differences of 1.5 points in total SPBB with a standard deviation of 1.0, with a power of 85%, α-value of 0.05, and effect size (ES) of 0.6 can be estimated with 11 participants using G*Power Software version 3.1.9.7.[31]

Outcome Measures

Initial screening included the following: dual-energy X-ray absorptiometry body composition, including bone mineral density and aLM; Mini Nutritional Assessment (MNA)[32]; disability in basic activities assessed with the Barthel index[33] and instrumental activities assessed with the Lawton index[34]; fear of falling with the Falls Efficacy Scale International (FES-I)[35]; cognitive impairment with Folstein's Mini Mental State Examination (MMSE)[36]; and a rapid screen of sarcopenia with the SARC-F scale.[37] Functional capacity (main outcome) was measured using SPPB test scores (from 1 to 12 points), depending on performance in (1) gait speed over 6 m, (2) 5-sit-to-stand test, (3) balance test, and (4) timed up-and-go test. Isometric handgrip strength was evaluated with a digital dynamometer (TKK 5101, Grip-D; Takey, Tokyo, Japan) to assess absolute strength (kg) and relative strength to body mass (kg/kg). Sit-to-stand speed (ie, the fastest velocity attained standing up from a chair) was measured using a linear position transducer (Speed4Lifts 2.0, Madrid, Spain) attached to a stick to automatically collect the mean propulsive velocity.[38] Measures were collected twice with a 2- to 5-minute rest between tests and the best result was considered for the analyses.

Multicomponent Exercise Program

After the initial assessment, participants attended a familiarization week to become acquainted with their specific exercise routine. Participants completed the individualized Vivifrail multicomponent exercise program. The full guidelines and materials for professionals responsible for the prescription of the exercise program are freely available online (http://vivifrail.com/resources).[27] Briefly, Vivifrail has individual exercise prescription programs or "passports" for older

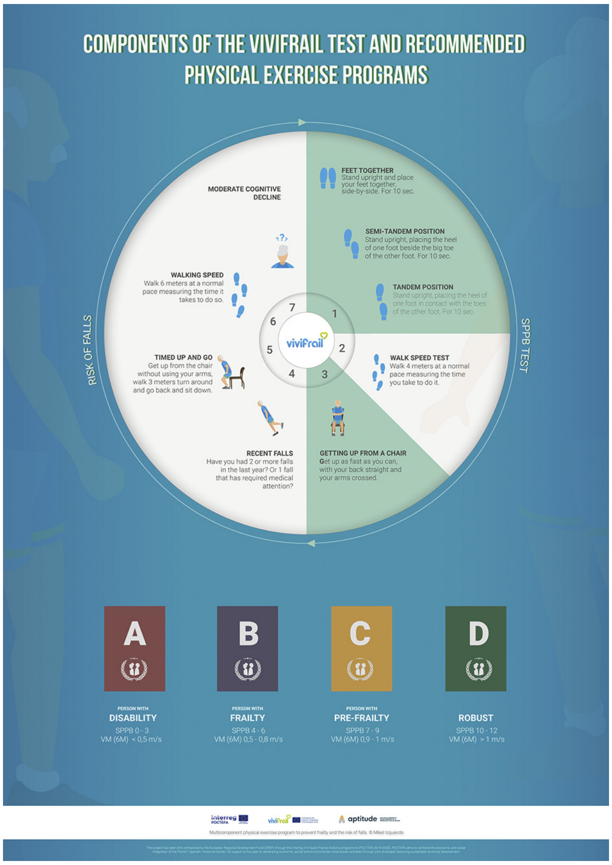

Fig. 1. Vivifrail preliminary screening tests and score-based recommended exercise programs depending on peoples' functional capacity level: serious limitation or disabled, A; moderate limitation or frail, B; slight limitation or prefrail, C; and robust, D. Initial assessment includes the Short Physical Battery Test (SPPB), walking speed (4-m and 6-m), and risk of falls. Participants with risk of falls should enrol in B+ or C+ programs. Available at Izquierdo.[27]

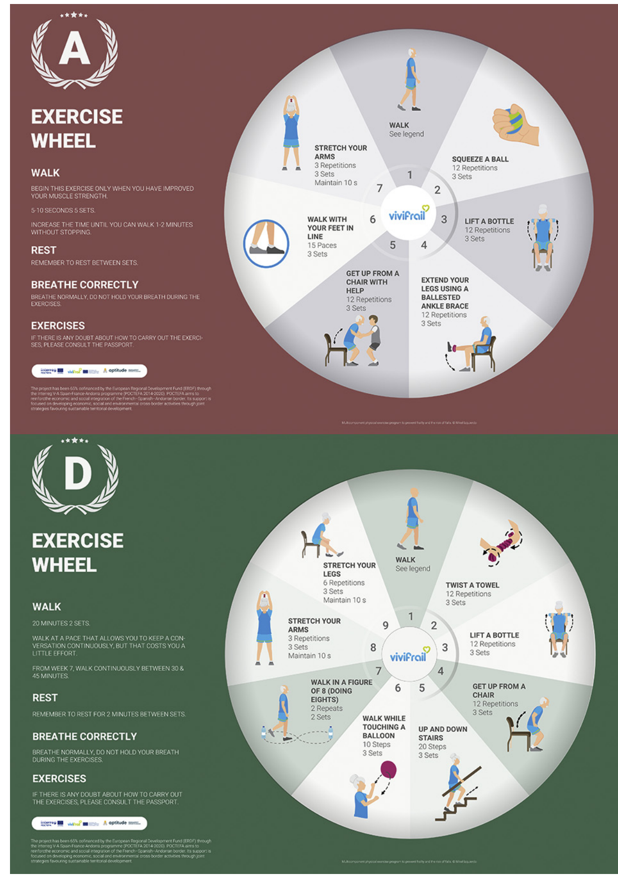

Fig. 2. An example of exercise wheel type A (frail) for an older person who can walk with difficulty or help and type D for a robust person (free download from http://vivifrail.com). Additionally, an App to perform the Vivifrail Test and to follow the exercise program corresponding to the degree of frailty and risk of falls is also available on Google Play or the App Store. Available at Izquierdo.[27]

adults depending on the person's functional capacity level [serious limitation or disability (A), moderate limitation or frail (B), slight limitation or prefrail (C), and robust (D)] as evaluated by the Short Physical Performance Battery (SPPB), a walking speed test and the risk of falling (Figure 1). The Vivifrail program is focused on individualized multicomponent exercise prescription according to the functional capacity of the older adults. Exercise regimes are organized in wheels (Figure 2) including resistance/power, balance, flexibility and cardiovascular endurance exercises, mainly involving lower-limb muscles (squats rising from a chair, leg press, and bilateral knee extension), upper body (seated bench press), and balance and gait re-training (eg, semi-tandem line walking, single leg standing, stepping practice, walking with small obstacles, proprioceptive exercises on unstable surfaces such as foam pads sequence, weight transfer from one leg to the other).

After the initial screening, participants enrolled into one of the individualized Vivifrail training programs according to their initial level. Those allocated in level A and those with fall risk (ie, timed up-and-go >20 s and/or cognitive impairment) completed a 5-day-a-week routine of multicomponent exercises, whereas the remainder combined strength, balance, and stretching exercises (3 days per week) with walking (2 days per week) (see more details in http://vivifrail.com). The initial load for resistance exercises was established according to the Vivifrail prescription guidelines through a progressive loading test, adjusting the load until the participant was able to perform ~30 repetitions with some effort. Initial load was set at 0.5 kg (dumbbells) and gradually increased in 0.5-kg increments for upper-body exercise; lower-body leg extensions started with free weight repetitions and gradually increased in 0.5-kg increments using ankle weights. Training sessions were directed by qualified strength and conditioning trainers (Degree in Sport Sciences) and supervised by the medical doctor, the physiotherapist, the nurses, and the care home managers.

Statistical Analyses

Descriptive statistics were used to summarize the characteristics of the sample by treatment group. Independence of groups at baseline was verified using the *t* test. Repeated measures *t* tests were conducted to determine the effects of the training program for each group. Analysis of covariance was conducted to determine whether the differences in health markers (strength and functional capacity outcomes) were different between the 2 groups in the training and detraining time periods after controlling for baseline scores. Differences between groups were presented using partial eta-squared to estimate the effect size (ESs), 95% confidence intervals (CIs), adjusted mean difference, percentage of change and *P* values. The significance level was set at $P < .05$. Calculations were performed with SPSS v24 (IBM Corp, Armonk, NY) and GraphPad Prism version 6.0 for Windows (GraphPad Software, Inc, La Jolla, CA).

Results

Two participants dropped out from the LT-SD group after 3 weeks because of a loss of interest. In total, 22 participants completed the full

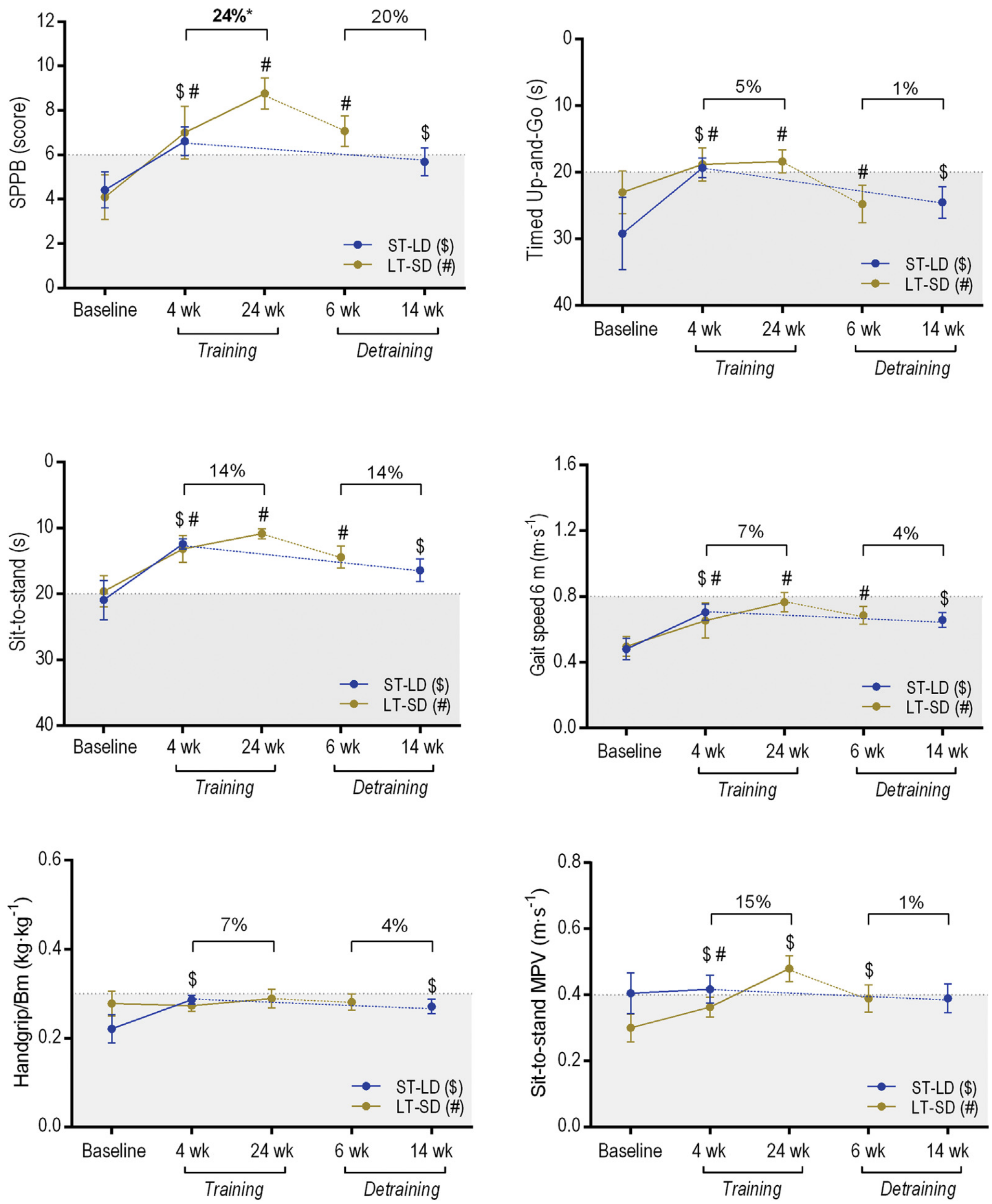

Fig. 3. Changes in physical functional capacity and strength along the different training and detraining periods in the 2 groups: LT-SD: long training (24-week), short detraining (6-week); and ST-LD: short training (4-week), long detraining (14-week). Data are means and 95% confidence intervals. Dotted line represents the cut-off points for frailty based on the literature.[7,11] *Significant between-group differences (ANCOVA $P < .05$). $^{\$\#}$Significant difference from baseline (paired t test $P < .05$). ANCOVA, analysis of covariance; Bm, body mass; MPV, mean propulsive velocity; SPPB, Short Physical Performance Battery.

intervention (91.6% compliance). Participants had similar baseline scores at the beginning of the intervention ($P > .05$) (Supplementary Table 1). No COVID-19 symptoms or positive cases for SARS-CoV-2 infection were detected during the confinement or during or after the evaluations. Attendance for training sessions during the 4-week short exercise intervention was 95% on average for both groups. Attendance during the 24-week long exercise intervention (LT-SD) was 75%.

Both groups positively responded to the 4-week multicomponent Vivifrail training program by significantly increasing their functional and strength parameters (ES from 0.32 to 1.44; $P < .05$), with the exception of handgrip strength in the LT-SD group (Supplementary Table 2, Figure 3). Additional training in the LT-SD group during the following 20 weeks produced significant increments in all variables (ES from 0.80 to 1.51) except for handgrip strength. Both LT-SD and ST-LD groups experienced a similar loss after detraining in SPPB and the timed up-and-go sit-to-stand tests (ES from 0.24 to 0.72). The LT-SD group showed a decrease in the sit-to-stand time and speed performance (ES = 0.92 and 0.76) and handgrip strength (ES = 0.23). Nevertheless, end-point values remained higher than baseline for all variables, being particularly high for the SPPB, gait speed, and sit-to-stand in both groups (ES from 0.41 to 1.15). Results from analysis of covariance (Supplementary Table 3) confirmed a similar response to training for the 4-week and 24-week interventions, with only the SPPB being significantly higher in the LT-SD group after 20 further weeks of training.

Frailty was reversed in 36% of participants, with 59% achieving high self-autonomy, that is, prefrail (C) and robust (D) conditions

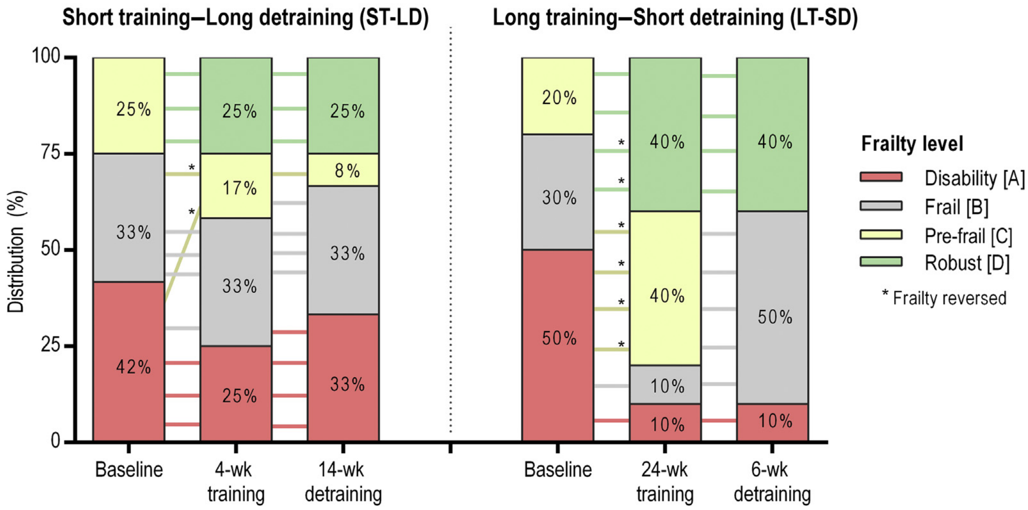

Fig. 4. Changes in the frailty level according to the Vivifrail classification. Lines are the evolution of each participant across the timepoints. *Frailty is considered reversed when upgrading from A or B to C or D levels.

(Figure 4). Furthermore, those who achieved a robust (D) level maintained this full autonomy even after the detraining period. By contrast, 83% of participants achieving prefrail status were unable to maintain their autonomy after detraining.

Discussion

The present study provides new information about the protective short- and long-term benefits of exercise after different periods of inactivity in older nursing home residents with sarcopenia. The main results of the study suggest that benefits after both short (4-week) and long (24-week) Vivifrail exercise programs persist and are maintained in older adults, resulting in better conditioning over baseline after 6-14 weeks of inactivity (home confinement). Nevertheless, 6 weeks of inactivity caused a loss in functional capacity even after 24 weeks of exercise training, which emphasizes the benefits of a regular routine.

Importantly, frailty was reversed in 36% of participants, with 59% achieving high self-autonomy after 24 weeks of supervised exercise intervention, and those who achieved a robust level maintained this full autonomy even after the detraining period.

Institutionalized older adults with sarcopenia benefited from the Vivifrail tailored exercise program both in the short (4 weeks) and the long (24 weeks) term. A similar decrease in functional fitness was observed after detraining periods of 6 and 14 weeks (10%-25%), but it remained elevated compared with baseline levels. This protective effect of physical exercise has been previously confirmed in community-dwelling older adults[18,21,22] and was recently suggested in an institutionalized population.[14] The change in functional capacity among institutionalized people after deconditioning for only 6 weeks is comparable to that observed after longer deconditioning periods in community-dwelling older adults.[18,20] This rapid loss in functional capacity among nursing home residents reaffirms the need for supervised exercise-based interventions in this population to protect from functional decline.[14] This is particularly critical among institutionalized older adults with dementia, who experience severe loss in physical functioning after inactivity periods.[24] Given the acute impact of physical inactivity among institutionalized people, it would be strongly advisable to introduce face-to-face, tailored multicomponent exercise programs into nursing homes and long-term care facilities as an essential daily activity.

According to our findings, intermittent strategies such as 4 weeks of supervised Vivifrail exercise, 3 times a year, with no more than 14 weeks of inactivity between the periods seems an efficient solution for the global challenge of maintaining functional capacity and may even reverse frailty in vulnerable institutionalized populations. This approach seems particularly appropriate when considering that older adults living in nursing homes are very likely to experience adverse events (falls or illness) that may interrupt their physical activity, which ultimately may lead to atrophy, and musculoskeletal and metabolic diseases.[9] Previous studies have demonstrated that functional impairment in community-dwelling older adults can be recovered with proper intermittent exercise programs.[16,39,40] Our findings support this and suggest that 4 weeks of supervised Vivifrail exercise interspersed by no more than 14 weeks of inactivity may be an effective, intermittent strategy to protect institutionalized older adults against physical disability and dependency.

Supervised Vivifrail training for 4 weeks resulted in noteworthy increases of up to 50% in strength and functional capacity, leading to 36% of participants reversing their initial frailty status and 59% achieving high self-autonomy. This short-term effectiveness is consistent with previous face-to-face training interventions among frail older adults[14,41] and is superior to home-based programs.[42] Likewise, a further 20 weeks of training resulted in 10%-20% additional enhancement over the 4-week program, being greater than similar long-term multicomponent, supervised interventions.[15,30,43] Of interest, this positive response to the Vivifrail training program was quite similar between 2 groups of sarcopenic, older adults from 2 different nursing homes.[14] The uniform improvement demonstrates the robustness of the Vivifrail prescription guidelines.[26] Furthermore, 4 weeks of regular tailored exercise training led to the acute recovery in basic self-help ability such as walking or standing up from a chair. Whereas previous interventions have shown an increase in functionality and walking speed in community-dwelling older people,[30,44] this is the first report to our knowledge of these improvements in institutionalized older adults. We believe this is particularly important given that older people living in care centers or nursing homes are likely to have reduced or no mobility, which elevates the risk of muscle waste due to immobilization, especially in the lower limbs.[45] Albeit speculative, our findings suggest that the acute recovery on autonomy would induce a physical and psychological stimulus that would motivate older adults to maintain an active lifestyle even during confinement periods.

Exercise interventions such as the Vivifrail program might show additional benefits in institutionalized older adults with nutritional (protein) supplementation.[46] This is especially relevant for people with sarcopenia who can experience severe muscle mass losses of ~20% after

7 days of immobilization.[47] However, controversies remain concerning the best practices for combined exercise and nutritional interventions. Protein intake with a focus on high leucine-containing foods is essential for maintenance of skeletal muscle mass in older adults.[47,48] Also, combined interventions of resistance training and creatine supplementation have led to increases in lean tissue mass of older adults.[49] That being said, one study found no extra improvements to resistance training in older adults with leucine-derived metabolites such as β-hydroxy-β-methylbutyrate.[50] Therefore, although combined treatments including supervised exercise programs in addition to nutritional supplementation likely constitute the best solution for conservation of functionality, muscle mass, and training adherence among vulnerable populations,[51] a better understanding is needed to determine the most effective individualized treatments.

The uniqueness and novelty of multicomponent Vivifrail, in comparison with other exercise programs, is that depending on the older person's functional capacity level (serious limitation, moderate limitation, and slight limitation as evaluated by the SPPB and a walking speed test) and the risk of falling (www.vivifrail.com), up to 6 different types of physical exercise programs can be downloaded, which can be implemented during unsupervised sessions (ie, Telemedicine).[26,27] Tailored interventions for increasing population physical activity levels should also consider behavioral aspects to ensure adherence and increase motivation for physical activity. Indeed, physicians and health care professionals should regularly ask the person how their exercise program is going.[52] Vivifrail app allows to standardize and monitoring the multicomponent exercise program in an agile and fast way in centers such as nursing homes. Additionally, it also makes it easier for a family member and/or caregiver to help and control the study participants. It allows to organize groups of participants in a comfortable and easy way and to better monitor them when checking that they are meeting the objectives. Finally, the greater benefits found could be related to the daily-frequency nature of the Vivifrail program, which can motivate many participants to complete each of the treatment cycles, and they can also see the evolution during the tests at the middle and end of the course to guide them.

Although the present study fills a gap in our knowledge, there remain some important challenges. Future studies must include (1) middle-term (8-12 weeks) training and exercise cessation group, (2) metabolic and morphologic adaptations (eg, hemodynamic profiles and changes in muscle cross-sectional area or aLM), and (3) 2 intermittent intervention groups of 4-week multicomponent training and 14-week detraining with and without protein supplementation.

Conclusions and Implications

Benefits in the short and long term after supervised, tailored multicomponent training (Vivifrail) persist in institutionalized older adults with sarcopenia. An intermittent intervention of at least 4 weeks, 3 times a year, with no more than 14 weeks of inactivity between periods is highly recommended in nursing homes as an essential activity to protect older adults from severe functional declines due to physical inactivity.

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Supplementary Table 1
Baseline characteristics of the study sample.

Variable	LT-SD	ST-LD	*P* Value
Age, y	84.0 (10.5)	87.2 (7.6)	.43
Body mass, kg	70.7 (12.3)	72.4 (11.4)	.74
BMI	29.4 (3.9)	28.8 (3.4)	.71
BMD, g/cm^2	1.12 (0.14)	1.07 (0.15)	.51
Fat, %	40.6 (4.9)	37.6 (8.3)	.30
Lean mass, kg	39.1 (6.9)	39.8 (7.5)	.83
aLM, kg	16.0 (4.0)	16.9 (3.4)	.58
aLM/BMI, kg	0.57 (0.15)	0.58 (0.11)	.85
MMSE score	22.7 (8.1)	25.9 (5.7)	.31
Barthel score	74 (22.2)	66.6 (29.3)	.51
Lawton score	2.9 (1.7)	2.0 (1.2)	.23
SARC-F score	3.9 (2.6)	4.5 (2.0)	.57
FES-I score	13.2 (5.4)	12.8 (2.9)	.85
Yessavage score	4.0 (2.3)	3.5 (3.5)	.70
SPPB score	4.1 (3.1)	4.4 (2.8)	.81
Handgrip, kg	20.1 (6.1)	16.3 (8.4)	.24
Timed up-and-go, s	23.0 (9.1)	29.2 (18.8)	.34
Gait speed 6 m, m/s	0.49 (0.16)	0.48 (0.21)	.86

aLM, appendicular lean mass; BMD, bone mineral density; BMI, body mass index; FES-I, Falls Efficacy Scale International; MMSE, Mini Mental State Evaluation; MNA, Mini Nutritional assessment; SARC-F, Simple Questionnaire to Rapidly Diagnose Sarcopenia; SPPB, Short Physical Performance Battery.
Data are means (standard deviations).

Supplementary Table 2
Changes in Functional Capacity and Strength in Response to the Training and Detraining Periods in the 2 Intervention Groups

Variable	Group	n	Training Effects						Detraining Effects					
			Baseline (T0) vs 4-wk Training (T1)			4-wk Training (T1) vs 24-wk Training (T2)			4-wk/24-wk Training (T1/T2) vs 14-wk/6-wk Detraining (T3)			Basline (T0) vs 14-wk/6-wk Detraining (T3)		
			Change (95% CI)	*P* Value	ES	Change (95% CI)	*P* Value	ES	Change (95% CI)	*P* Value	ES	Change (95% CI)	*P* Value	ES
SPPB score	LT-SD	10	2.9 (1.7, 4.1)	<.001*	0.83	4.5 (3.1, 5.9)	<.001*	1.40	−1.7 (−0.9, −2.5)	.001*	0.50	2.8 (1.4, 4.2)	.002*	0.84
	ST-LD	12	2.3 (0.8, 3.8)	.006*	0.71				−0.9 (−0.1, −1.7)	.034*	0.24	1.4 (0.1, 2.8)	.05*	0.41
Timed up-and-go, s	LT-SD	8	−4.2 (−2.9, −5.5)	<.001*	0.47	−6.3 (−0.5, −12.2)	.036*	0.80	4.8 (0.3, 9.3)	.039*	0.72	−1.4 (−5.1, 2.3)	.40	0.17
	ST-LD	11	−8.6 (−1.6, −15.6)	.021*	0.59				6.2 (0.9, 13.4)	.018*	0.41	−2.4 (−4.4, −8.8)	.42	0.13
Gait speed 6 m, m/s	LT-SD	8	0.16 (0.01, 0.31)	.044*	0.65	0.28 (0.12, 0.44)	.004*	1.24	−0.07 (−0.16, 0.03)	.13	0.27	0.16 (0.12, 0.29)	.001*	0.99
	ST-LD	11	0.21 (0.11, 0.32)	.001*	0.76				0.05 (−0.06, 0.15)	.34	−0.14	0.17 (0.04, 0.30)	.015*	0.60
Sit-to-stand, s	LT-SD	7	−6.8 (−4.1, −9.6)	.001*	1.11	−8.8 (−3.6, −14.1)	.006*	1.90	4.9 (0.6, 9.3)	.031*	0.92	−5.5 (−11.7, 0.6)	.041*	1.15
	ST-LD	7	−8.4 (−1.6, −15.2)	.023*	1.44				4.2 (2.2, 10.7)	.16	0.76	−4.2 (−0.3, −8.1)	.040*	0.55
Sit-to-stand MPV†, m/s	LT-SD	7	0.08 (0.03, 0.13)	.007*	1.22	0.15 (0.04, 0.26)	.014*	1.51	−0.09 (−0.05, −0.13)	.001*	0.76	0.06 (0.03, 0.14)	.15	0.64
	ST-LD	6	0.07 (0.02, 0.12)	.019*	0.48				−0.03 (−0.11, 0.05)	.44	0.18	0.04 (0.06, 0.15)	.34	0.28
Handgrip, kg	LT-SD	10	0.8 (1.7, 3.3)	.48	0.14	1.0 (0.6, 2.6)	.19	0.15	−1.5 (−0.1, −2.9)	.034*	0.23	−0.5 (−2.3, 1.3)	.54	0.08
	ST-LD	12	2.7 (1.4, 4.0)	.001*	0.32				−0.9 (−2.1, 0.2)	.10	0.11	1.8 (0.4, 3.1)	.014*	0.22
Handgrip/Bm, kg/kg	LT-SD	10	0.01 (−0.02, 0.05)	.48	0.15	0.02 (0.01, 0.05)	.17	0.22	<0.01 (−0.03, 0.04)	.87	0.03	0.02 (−0.03, 0.08)	.37	0.25
	ST-LD	12	0.04 (0.02, 0.05)	<.001*	0.33				−0.01 (−0.03, −0.01)	.13	0.10	0.03 (−0.01, 0.04)	.016*	0.23

Bm, body mass; CI, confidence interval; ES, effect size (Cohens *d*); SPPB, Short Physical Performance Battery.
LT-SD: long training (24-week), short detraining (60 week); ST-LD: short training (40 week), long detraining (14-week).
*Significant differences (paired *t* test $P < .05$).
†Mean propulsive velocity (MPV) measured with a linear transducer.

Supplementary Table 3

Results From Analysis of Covariance Testing the Changes in Health Markers Along the Time Periods and the Effects of the Training and Confinement Interventions

Variable	Group	n	Training (T1/T2)	Detraining (T3)	Adjusted Group Mean Difference[b]		Between-Group Differences (T1/T2)		Between-Group Differences (T3)	
			Adjusted Mean* (95% CI)	Adjusted Mean* (95% CI)	T1/T2 (95% CI)	T3 (95% CI)	*P* Value	ES	*P* Value	ES
SPPB score	LT-SD	10	8.7 (7.3, 10.2)	7.1 (5.6, 8.5)	2.1 (0.2, 4.1)	1.4 (−0.6, 3.4)	.035†	0.21	.15	0.11
	ST-LD	12	6.6 (5.3, 8.0)	5.7 (4.4, 7.0)						
Timed up-and-go, s	LT-SD	8	18.4 (14.7, 22.1)	24.8 (18.8, 30.7)	−1.0 (−5.9, 3.9)	−0.3 (−7.7, 8.2)	.68	0.01	.95	0.01
	ST-LD	11	19.4 (16.2, 22.5)	24.6 (19.5, 29.6)						
Gait speed 6 m, m/s	LT-SD	8	0.77 (0.64, 0.90)	0.69 (0.57, 0.80)	0.06 (−0.10, 0.22)	0.03 (−0.12, 0.18)	.43	0.04	.70	0.01
	ST-LD	11	0.71 (0.60, 0.81)	0.66 (0.56, 0.76)						
Sit-to-stand, s	LT-SD	7	10.9 (9.2, 12.6)	14.4 (10.7, 18.2)	−1.5 (−4.0, 0.9)	−2.0 (−7.3, 3.3)	.58	0.04	.43	0.06
	ST-LD	7	12.4 (10.7, 14.1)	16.4 (12.7, 20.2)						
Sit-to-stand MPV‡, m/s	LT-SD	7	0.42 (0.32, 0.51)	0.37 (0.27, 0.46)	0.07 (−0.10, 0.24)	0.01 (−0.16, 0.16)	.37	0.08	.99	0.01
	ST-LD	6	0.46 (0.36, 0.56)	0.37 (0.26, 0.47)						
Handgrip, kg	LT-SD	10	19.0 (17.6, 20.5)	17.8 (19.2, 19.3)	−1.8 (−3.8, 0.3)	−1.9 (−4.0, 0.16)	.08	0.15	.07	0.16
	ST-LD	12	20.8 (19.4, 22.1)	19.7 (18.3, 21.0)						
Handgrip/Bm, kg/kg	LT-SD	10	0.27 (0.25, 0.30)	0.28 (0.24, 0.32)	−0.01 (−0.05, 0.02)	0.01 (−0.04, 0.06)	.40	0.04	.67	0.01
	ST-LD	12	0.29 (0.26, 0.31)	0.27 (0.24, 0.30)						

Bm, body mass; CI, confidence interval; ES, effect size (partial eta squared); SPPB, Short Physical Performance Battery.

LT-SD: long training (24-week), short detraining (6-week); ST-LD: short training (4-week), long detraining (14-week).

*Adjusted for baseline scores.

†Significant effect ($P < .05$).

‡Mean propulsive velocity (MPV) measured with a linear transducer.