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Development and feasibility of a conceptual model for planning individualised physical exercise training (IPET) for older adults: a cross-sectional study

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ABSTRACT

Objective Older adults constitute a heterogeneous group, and the focus of the individual physical exercise is often subject to the reasoning and experience of health professionals or exercise physiologists who prescribe them. Thus, this is the first effort to explicitly conceptualise the planning of individualised physical exercise training (IPET) for older adults in an outpatient setting and investigate individual exercise preferences.

Design The concept of IPET was developed by researchers, exercise physiologists and health professionals from a real-life outpatient setting using an iterative approach. Health indicators assessing aerobic capacity, strength, balance and musculoskeletal pain/discomfort sites form the basis of physical exercise recommendations. A cross-sectional study was conducted to assess the basis of implementing IPET.

Setting Outpatient setting.

Participants We included 115 older adults (70 females) from an outpatient setting with a median age of 74 years.

Outcome measures Health indicators assessing aerobic capacity, strength, balance and musculoskeletal pain/discomfort sites were collected and informed the concept of IPET that structures exercise programmes based on the individual citizen's needs and physical exercise preferences. Exceeding a health indicator cut-point results in exercise content mitigating the risk associated with the health indicator.

Results We included 115 older adults (70 females) from an outpatient setting median age of 74 years. Approximately two-thirds of participants exceeded at least one health indicator cut-point for aerobic training. One-third of the participants exceeded the cut-point for upper extremity strength, and almost all participants >99% exceeded the cut-point for lower extremity strength. Approximately two-thirds of the participants exceeded the cut-point for functional/balance training. The most prevalent site of musculoskeletal pain was the lower extremities. Eight of 20 training combinations were used, clustering the 115 participants primarily in three main training combinations.

Discussion This study shows that older adults vary in physical functioning, indicating that exercise preferences and rehabilitation needs are individual.

Trial registration number NCT04862481.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ A novel concept for transparently structuring individualised physical exercise training (IPET) for older adults in outpatient settings was developed through an iterative process that entailed scientific literature searches, professional discussion and practical testing.
⇒ The development of IPET is conducted in a real-life clinical setting, involving health professionals and older adults commencing physical rehabilitation.
⇒ The investigation of the IPET concept's acceptability, adherence, compliance and effectiveness in a high-quality randomised clinical trial conducted in a real-life setting has yet to be conducted.

INTRODUCTION

Older adults who commence physical rehabilitation in an outpatient setting vary greatly in physical function and, consequently, constitute a group with immense potential for improvement and increased quality of life. An effective physical exercise training programme that can be personalised to meet individual needs may realise this potential significantly.

Physical exercise training is an important disease management strategy in several chronic conditions.[1] Therefore, physical exercise training is imperative to increase physical functioning and well-being, especially in older adults, as their physical reserve capacity is lower than in younger individuals.

Admission to hospitals, followed by bed rest and a significant decrease in physical activity levels, may lead to losing muscle strength, muscle power and aerobic capacity.[1] To counteract such adverse effects, discharge of older adults from the hospital is often followed by physical rehabilitation in outpatient settings. In Denmark, older adults receive rehabilitation in a municipality-based rehabilitation centre, aiming to achieve the same or the best possible functionality compared with prehospitalisation.[2]

Importantly, an exploratory latent class analysis demonstrated different multimorbidity patterns with differences in physical functioning in older Danish adults with medical conditions one year after acute admission to the hospital.[3 4] The different disease patterns results in large heterogeneity across the population in both which body parts are affect and level of severity of symptoms for the individual. This heterogeneity advocates for differentiated and tailored physical rehabilitation strategies that are necessary for older adults to best target the rehabilitation. However, physical rehabilitation in municipality-based rehabilitation centres usually focuses solely on the primary reason for referral, which leaves the health professionals challenged in targeting all other relevant components. Most often the health professional then relies on practical experience, that however, does not allow transparency and consistency. Consequently, a conceptual model that allows a transparent and structured approach for exercise planning to match the individual to effectively improve their health status is warranted.

Sjøgaard *et al* introduced the first version of intelligent physical exercise training. The authors defined a conceptual model that tailors exercise training to promote a specific health effect in the working-age population by using predefined health indicators to identify the exercise elements needed for the individuals health problem.[5] The first version had specific resistance training tailored to the neck/shoulder area, specifically designed for a sedentary work profile. The concept of using health indicators and work profiles to tailor exercise programmes was further developed, including specific resistance training for all body regions and three work profiles.[6] The concept is grounded on the core idea of prescribing exercise based on the individual's physical capacity, health status, musculoskeletal pain/discomfort and occupational exposure and has proven effective in working-age populations.[7] This study investigated if the concept of prescribing exercise based on health indicators may also be feasible and effective when systematically prescribing exercise to older adults referred to physical rehabilitation if adapted to the target group. Even though others have developed models to plan multicomponent exercises in frail and prefrail older adults, such as the VIVIFRAIL programme, a conceptual model for individualised exercise in older adults commencing physical rehabilitation in an outpatient setting does not exist.[8]

The paper's objective was twofold: (1) to present a conceptual model for planning individualised physical exercise training (IPET) for older adults undergoing municipality-based rehabilitation and (2) to investigate the allocation of older adults into training categories in a municipality-based rehabilitation sample.

METHODS

In the methods section, the methodological approach for the conceptual development of the IPET model is described. The 'consensus on exercise reporting template' and 'Template for Intervention Description and Replication' were used to describe the IPET concept (see table 1).[9] Hereafter, a short description of the cross-sectional study performed to investigate the basis of implementing IPET is given.

Conceptual development of the IPET model

Exercise physiologists and health professionals developed the concept of IPET for older adults from real-life settings in an iterative process consisting of theoretical and practical discussions among relevant stakeholders, reviewing literature and practical testing to increase the applicability and usage in clinical practice (figure 1).

An iterative approach was used to investigate available recommendations from scientific literature and clinical guidelines for training components for older adults for some of the most common disorders and comorbidities in the more ageing population undergoing rehabilitation. Initially, literature searches examined reliability, validity, responsiveness and normative values for the older population for the health indicators incorporated in the original, intelligent physical exercise training model (ie, blood pressure (BP), muscular strength). Ongoing literature searches using the electronic databases; PubMed, Cochrane Library, and Scopus and websites of the WHO and the Danish Health Authorities were performed in January 2019 and involved the combining of the following concepts: "target group", "training category" and the "specific health indicator". Subsequently, reference lists of relevant articles, in-hand articles and relevant studies were scrutinised for information.

Hereafter, health professionals from the rehabilitation centres, exercise physiologists and researchers discussed the identified literature and current practice to develop the IPET model for the older population seen in rehabilitation. In addition, health data (ie, the reason for referral to the physical rehabilitation and test results from clinical tests) collected in outpatient settings to document practice was included to inform this process to target the older population better. Also, older adults were involved in testing the developed conceptual physical exercise model in clinical practice. This iterative process of systematically identifying literature on exercise recommendations and information on health indicators conceptual approach facilitated discussions on how such health information may be used more consistently and transparently in clinical decision-making regarding exercises and training modalities to prioritise in older adults. As a result of this process, the conceptual model for

Table 1 Description of the IPET concept following the CERT guideline[9]

Item category	IPET for older adults	Adaptations/modifications
Setting	The health sector, elderly care IPET based on health issues resulting in referral to community physical rehabilitation, musculoskeletal health and physical performance. Individual or group sessions, alternating between supervised and self-administered sessions. Intensive instruction period.	An initial intensive instruction period is recommended, to assure the exercises are performed correctly, with the prescribed intensities and doses.
Provider	Health professionals working in clinical practice or anyone facilitating physical exercise training for older adults	Since older adults most often suffer from more comorbidities influencing overall health, it is recommended that health professionals implement exercise interventions in the beginning, to monitor occasions of any adverse events.
Tailoring	Aerobic training is allocated if surpassing a cut-point for self-paced walking distance, body composition or/and blood pressure. Resistance training is allocated if surpassing a cut-point for hand grip strength and knee extension strength or reporting a site of musculoskeletal pain. Functional/balance training is allocated if surpassing a cut-point for tandem test and/or fall history within the past year.	The choices of cut-points to plan physical exercise training are adapted to the older target group, based on scientific literature and discussions with health professionals and exercise physiologists. Fewer training categories are presented in comparison to the working-age population since exercises are only prescribed for the primary site of musculoskeletal pain.
Sets, repetitions, intensity, duration, frequency	Aerobic training: 10–30 min at 60%–80% of HRR, corresponding to 13–14 on BORG's rate of perceived exertion-scale Resistance training: 2–4 sets per muscle group/session, with increasing intensity (8–15 RM) Balance exercises: 10–30 min. Frequency is three times/week	Training dosage is adjusted to accommodate exercise recommendations to the older target group.
Progression	Varied (linear, undulating) periodisation	N/A
Exercise description	See online supplemental file 1, which provides description and illustrations for proposed exercises within each specific training category.	N/A
Equipment	Treadmills, stationary bikes and rowing for aerobic activities, body weight and elastic bands for resistance training, bodyweight for balance exercises	Body weight and elastic bands are preferred for resistance training to enable that self-administered sessions can be conducted at home.
Motivational strategies	Individually prescribed exercises, supervision from health professionals, intensive initial instruction period, registration of self-administered resistance exercises with the use of a sports sensor chip.	Self-administered training is difficult to conduct for older adults with comorbidities. It might, therefore, be necessary to implement technologies that can monitor the self-administered training sessions to provide feedback on, for example, intensity.

Summarised description of the IPET concept and modifications made from the 'intelligent physical exercise training' conceptual model.[5]
CERT, consensus on exercise reporting template; HRR, heart rate reserve; IPET, Individualised Physical Exercise Training; N/A, not applicable; RM, repetition maximum.

intelligent physical exercise training by Sjøgaard *et al* was adapted to the population and the setting by adjusting health assessments and defining appropriate cut-points. Finally, the tailored exercises were tested in practice.[5]

The IPET concept

The IPET concept for older adults addresses physical impairments. It targets exercises to improve specific health indicators and reduce musculoskeletal pain or discomfort. In the older population, an initial health check that assesses aerobic capacity, strength, balance and sites of pain was used to tailor specific exercises to the individual's need (figure 2). That is, if the older adult exceeds a cut-point for a health indicator, that is, low muscle strength in the lower extremities an appropriate type of training (resistance training) is implemented in their programme to address this.[5] Some precautions may be necessary to adjust the exercises. If the any following symptoms are present; shortness of breath at rest with

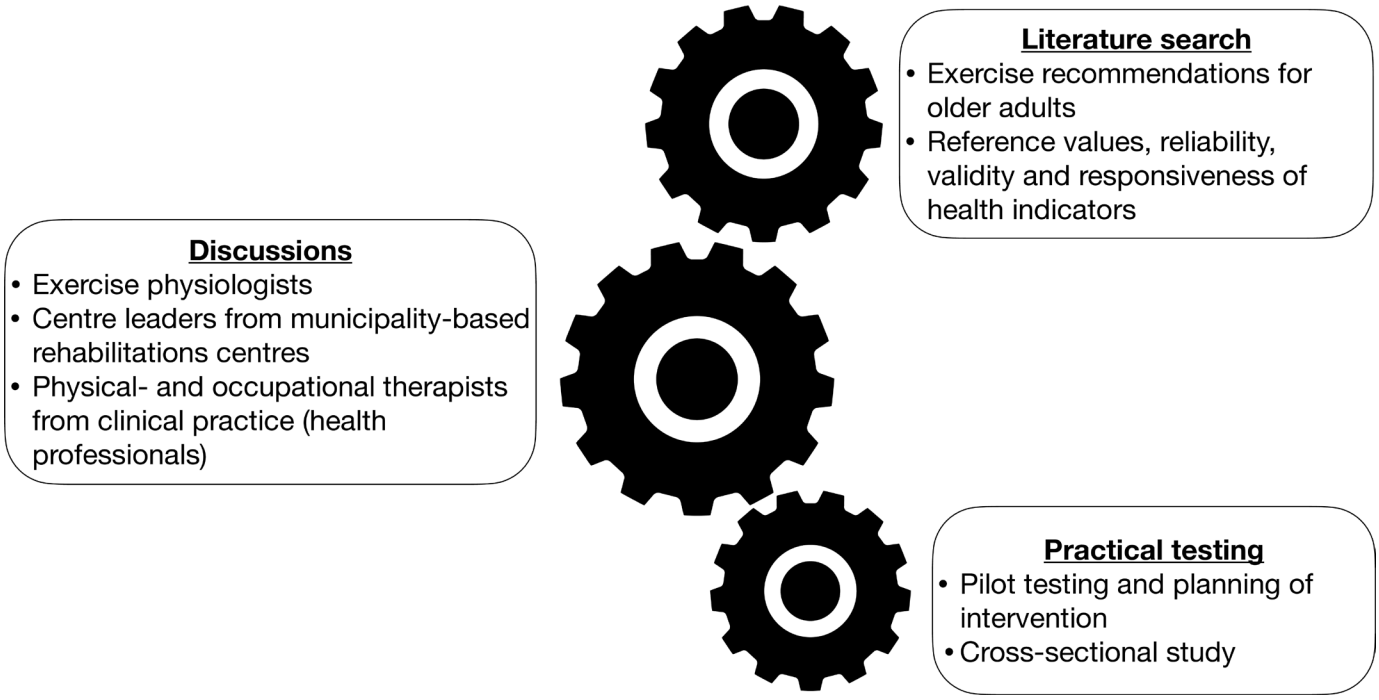

Figure 1 Procedure for developing the conceptual model.

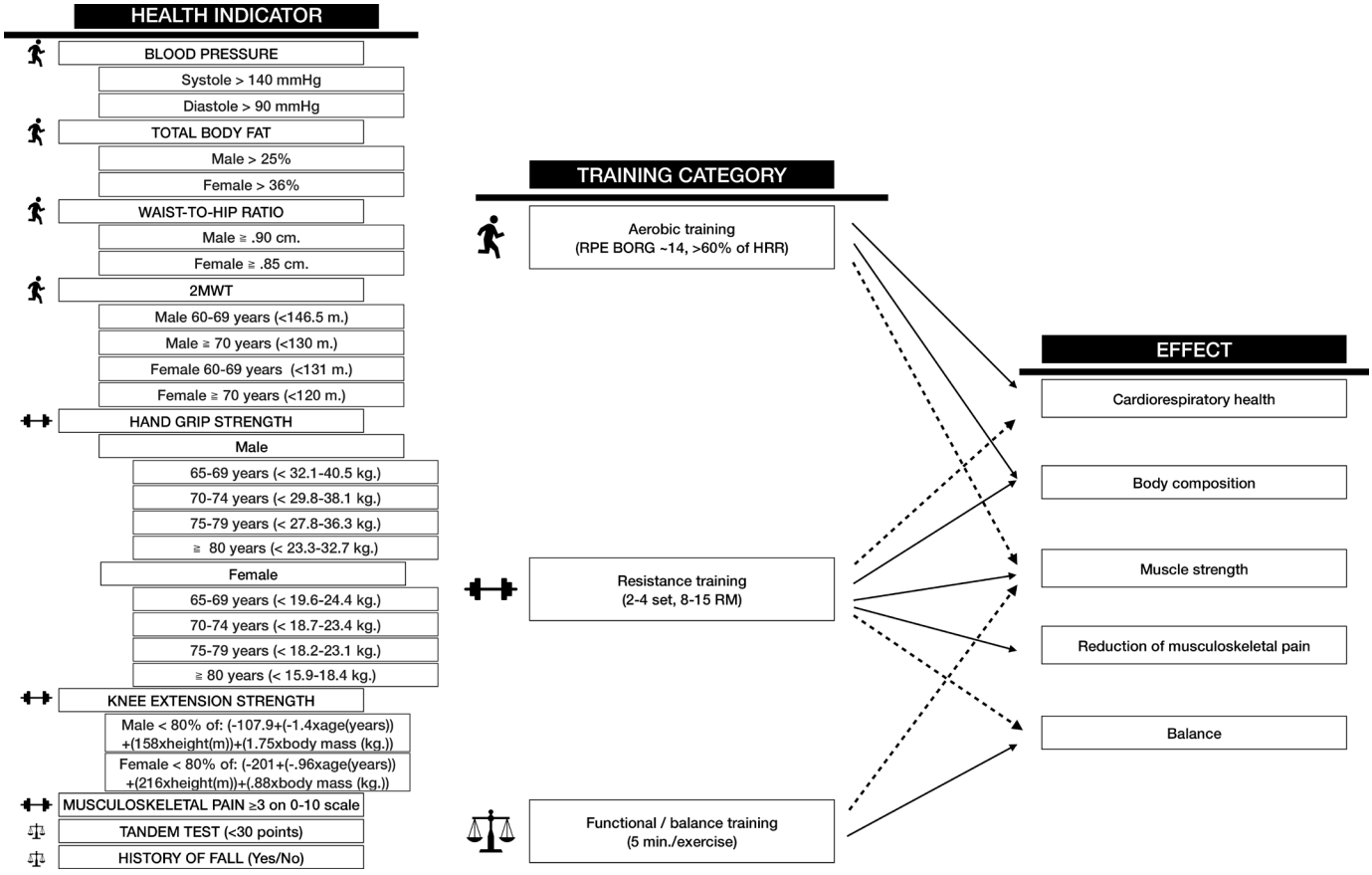

Figure 2 The relationship between the cut-points of each health indicator, the specific training category, and its direct (solid arrows) and indirect (dashed arrows) expected effects on health. 🏃 indicative for aerobic training, 🏋 indicative for resistance training, ⚖ indicative for functional/balance training. 2MWT, 2 min walk test; BORG, BORG's Rating of Perceived Exertion Scale; HRR, heart rate reserve; RM, repetition maximum.

or without heaviness in the chest, BP >180/110 mm Hg, fever, swelling or redness in any joint with no history of injury, changes in vision (blurriness or loss of sight), sudden weakness or neurological symptoms, medical attention should be given priorly.

Training categories

Aerobic and resistance training is the most beneficial physical exercise stimulator for improving physical capacity and function in older adults with common chronic health conditions.[1] American College of Sports Medicine highlights that combined training improves physical function more than any single-component exercise.[10] Further, physical exercise training is often used to treat musculoskeletal pain and discomfort.[11 12] Functional and balance exercises can be used to reduce the rate of fall-related injuries.[13] Consequently, the three main training categories prioritised in older adults are aerobic, resistance and functional/balance training.

The training programmes derived from the proposed IPET model have a duration of 40 min. Before engaging in the IPET programme, a 10 min warm-up is recommended. Several health indicators can indicate recommending the same training category, however, the time allocated to each training category is independent of the number of health indicators surpassing a cut-point. If surpassing at least one cut-point for a training category, the specific training category was allocated to the training programme. In addition, as rehabilitation typically focuses on a primary reason for referral, the IPET approach for older adults only targets the primary site of pain or discomfort.

The exercises (see online supplemental file 1) are chosen to be conducted in outpatient settings or at home. In general, the progression and regression of exercises must fit the individual's needs, capacity and preferences.

Aerobic training comprises one category which holds six different aerobic exercises, including walking/running, cycling, stepping, walking lunges, jumping jacks or ski jumps. Exercises are performed in blocks of a minimum of 10 min. We suggest using perceived exertion scales to monitor the intensity of the exercise, as many older adults use medications that single-handedly or combined with other medicaments can affect heart rhythm. Exercising with intensities of ~14 on the Borg Rate of Perceived Exertion Scale (BORG 6–20) (~6 MET activity) corresponding to moderate to vigorous activities for individuals with VO2-max levels below ~30 mL O_2/min/kg can be used.[14]

Resistance training is prescribed based on strength measures and musculoskeletal pain/discomfort. Three main categories are present: (1) compound exercises for the upper extremities, (2) compound exercises for the lower extremities and (3) total body exercises. Each exercise is allotted in blocks of a minimum of five min and listed in a prioritised order. Resistance training exercises based on the primary area of musculoskeletal pain/discomfort consist of six categories (ankle/knee, hip, lower back, neck, shoulder/upper back and elbow/hands), each with six exercises to choose from (see online supplemental file 1). Varied (linear or undulating) periodisation can be used. We propose volume and intensities of 2–4 sets at 8–15 RM, with ~60 s rest between sets (table 1). Resistance training exercises are performed using resistance bands. To fit exercises to the older individual, the following variables can be regulated, tension and colour of the elastic band, the tempo of the movement, supporting surface and starting position (sit vs stand) to compensate for lack of strength and/or balance range-of motion.

Functional/balance training comprises one category with six balance exercises listed in a prioritised order. The choice of exercises is inspired by the Otago exercise protocol and Thai-Chi movements.[15] Exercises based on these concepts are already widely used, and prioritising and implementing them systematically seem reasonable. Each exercise is allotted in blocks of a minimum of five min, and particular focus should be on the quality of movement.

The health indicators

The specific cut-points for the included health indicators are listed in figure 2. These are gender, age, height and/or weight specific as informed by literature and expert discussion as described.

Health indicators for aerobic training

Health indicators for aerobic training consist of BP measurements, total body fat (TBF), waist-to-hip ratio (WHR) and the 2 min walk test (2MWT).

Hypertension is associated with comorbidities such as atherosclerosis, apoplexy and metabolic conditions, and studies have demonstrated the beneficial effect of lowering BP using exercise. Some studies suggest that the largest decreases in BP can be obtained in the hypertensive population when performing aerobic training with moderate to high intensities.[1 16] The systolic and diastolic BP cut-points are based on the general population hypertension threshold.[17]

Being overweight is a risk factor for cardiovascular and metabolic disorders, when resulting in obesity, being overweight can also aggravate and worsen underlying health conditions.[18] TBF has been suggested as a simple alternative measure of adiposity and predictor of cardiovascular health and functional limitations.[19 20] An umbrella review by Bellicha *et al* concludes that if the energy expenditure is matched, no differences exist between aerobic and high-interval training for fat loss.[21] The cut-points for TBF are gender-specific and age-specific.[22]

WHR is closely related to disease risk and mortality.[23] In a cross-sectional study by Price *et al*, the authors investigated the association of body mass index (BMI), waist circumference and WHR with mortality and cause-specific mortality in 14 833 older adults aged ≥75.[24] The study concluded that increased mortality risk is more clearly indicated for relative abdominal obesity as measured by

high WHR compared with BMI. Training interventions targeting a reduction in TBF will undoubtedly also affect visceral fat.[25] The cut-points for WHR are gender-specific and based on the recommendations presented in the expert consultation report from WHO.[23]

The 2MWT indicates walking ability, which is strongly related to functional performance and exercise capacity.[26] Exercise, including aerobic training, has moderate to large effects in increasing the total distance walked and gait velocity.[27] The cut-points for the 2MWT are gender-specific and age-specific and based on the consolidated data presented in the review by Bohannon.[28] The cut-point for the 2MWT is set to be 80% of the reference value.[28]

Health indicators for resistance training

Health indicators for resistance training consist of handgrip strength, maximal voluntary isometric knee extension contraction and reporting of musculoskeletal pain.

Handgrip strength is a helpful clinical tool and an excellent proxy measure for overall strength in the upper extremities in older adults.[29] A longitudinal German study of 11.790 men and women aged 17–90 years reported that handgrip strength is significantly associated with increased mortality risk.[30] Further, studies have reported that handgrip strength can be a responsive measure following training.[31] The cut-point for a weak handgrip strength is stratified for gender, age and height based on data from the study by Steiber *et al*.[30]

Knee extension strength is a proxy measure for lower extremity strength. Studies have demonstrated a strong association between maximal voluntary isometric contraction of the knee extensors and physical and psychological health characteristics.[32 33] The cut-point for knee extension strength is based on the study by Harbo *et al* and is gender, age, height and body mass specific.[34 35]

If cut-points for both strength measures are lower than 80% of the mean reference value depending on gender, age and height,[30 35] then total body resistance training is allocated to the programme.

Self-reported musculoskeletal pain/discomfort is highly prevalent among older adults and is associated with kinesiophobia, among other factors, potentially resulting in more pain/discomfort.[36 37] Musculoskeletal pain and discomfort have also been identified as one of the most common barriers to physical activity in older adults. This is important to consider when managing reduced physical function.[38] Resistance training is a proven effective therapeutic modality often used to manage chronic musculoskeletal pain/discomfort.[12] While older adults may fear that resistance training will increase their pain, a recent meta-analysis has shown that there is no scientific basis for fearing pain during exercises concerning the outcome measures of pain and potential function and disability.[11] Resistance training for a specific body region is based on the 3-month average pain intensity score of the most painful body part with a cut-point ≥3 on a 10-point numeric scale.

Health indicators for functional/balance training

Health indicators for balance training and risk of falling are based on the Tandem balance test and history of falls within the last year.

The Tandem balance test can indicate poor balance and risk of falling.[39 40] The cut-point for the tandem test is based on completing all test stages while maintaining balance within the supporting surface.[39 40]

A history of falls, defined as 'inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects', within the last years may indicate poor balance. One study reported that 25% of their participants had recurrent falls within 365 days of hospital discharge, and roughly 50% of the recurrent falls happened within the first 90 days.[41] Individualised exercise programmes have previously been shown to reduce the number of falls.[42] Collecting the history of falls within the last year might serve as an important indicator of balance training to reduce the number of falls.

Implementation of the IPET concept in rehabilitation practice

Study population

A cross-sectional study was conducted from January to September 2021 to investigate the physical functioning and health profile of older adults in municipality-based rehabilitation (outpatient setting) and to identify frequencies of training categories allocated according to the conceptual IPET model (ClinicalTrials.gov, reg. ID: NCT04862481).

Eligibility criteria were age 65 years or older and no presence of any of the following exclusion criteria: inability to speak or read Danish, in active cancer treatment, upper or lower limb amputations, hypertension >180/110 mmHg, referred to rehabilitation primarily due to gynaecological or neurological conditions (apoplexies) or surgeries where movement restrictions prohibit participating in most of the measurements or discouragement from a general practitioner.

Assessment of health indicators

The clinical assessments of health indicators presented in this paper followed the same testing procedures described previously in our protocol paper.[43]

Resting BP (OMRON HBP 1100, Kyoto, Japan), height, waist and hip circumference, and body composition (Tanita 9MC-780U Multi Frequency Segmental Body Composition Analyzer, Tokyo, Japan) were assessed.[43] Further, before testing function and strength, the participants performed a warm-up for 10 min on an ergometer bike. The 2MWT was conducted in a 15.2 m course, registering walked distance in metres while simultaneously recording perceived exertion (BORG 6-20) and heart rate (Apple Watch, Series V.5, 44 mm, California, USA) before and after the test.[28] Handgrip strength was assessed in both arms using a hydraulic hand dynamometer (SAEHAN, Masan, South Korea), with the shoulder in a neutral position and the elbow in a 90° position. The

maximum value of either hand was used as the measure of an individual's strength of the forearm and hand muscles, as previously described by Steiber.[30] The maximal voluntary isometric contraction for the left quadriceps was measured in a seated sitting position with the knee and hip at a 90° angle, using a strain gauge (SDU, Odense, Denmark) applied just above the malleolus. The lever arm was measured from the lateral epicondyle of the knee to the midpoint of the strain gauge.[44] The Tandem test was conducted in a quiet environment, and 10 points were given for stance in each position.[43] Area of musculoskeletal pain and discomfort within the last three months was self-reported using a body-chart diagram and a numeric rating scale from 0 to 10, 10 being the worst possible pain. Falls within the last year were defined as 'an event that results in a person coming to rest inadvertently on the ground, floor or other lower level'.[45] According to the Consolidated Standards of Reporting Trials (CONSORT) extension for pilot and feasibility studies, feasibility studies should inform if and how future studies or interventions should be performed. Consequently, this study assesses the feasibility of the assessment of the health indicators within the population by reviewing if the health indicators can be assessed safely and applied within the majority of the population.[46]

Statistical analysis

Data were tested for Gaussian distribution using visual inspection and Shapiro-Wilk test, and data are summarised and presented as medians with IQRs. Categorical variables are summarised using counts and percentages. Probability values of $p<0.05$ (two tailed) were considered statistically significant. All statistical analyses were conducted using Stata BE V.17.

RESULTS

We included 115 participants referred to rehabilitation in January–September 2021 with a median age of 74 years, IQR (71–78 years) for women and 73.5 IQR (70–80 years) for men. The median weight was 69.3 kg, IQR (58.4–77.9 kg) for women and 83.2 kg, IQR (70.3–92.5 kg) for men. Further, characteristics of the included participants for health indicators related to planning IPET are listed in table 2, with percentages on how many exceeded the selected cut-points.

The primary musculoskeletal pain and discomfort site was in the lower extremities for 41 (36.7%) of the participants. Further, 36 (32.1%) participants reported musculoskeletal pain and discomfort in the upper extremity and 29 (25.9%) in the spinal region. Only two (1.8%) participants reported the abdomen as the most intense site of pain or discomfort, and two (1.8%) participants could not decide what the most prevalent site of pain or discomfort was and reported the same pain/discomfort levels in the lower spine, hips and knees. Only two (1.8%) participants did not report any musculoskeletal pain or discomfort. Three participants did not hand in the self-reported questionnaire and could not be reached after the trial.

Allocation of training categories

Given the previously mentioned cut-points, participants were allocated to eight out of the 20 practically relevant training combinations based on their test results (table 3). Approximately, ~88% of the participants were allocated primarily into one of three following training combinations:

1. Aerobic training combined with three resistance training exercises for one body area with musculoskeletal pain/discomfort and three for the upper or lower extremities.

Table 2 Health indicator characteristics of participants

	Male (n=45)	Female (n=70)	Total (n=115)	No. who exceeded cut-points (%, n)
Systolic blood pressure (mm Hg)	139 (128–149)	145 (133–156)	143 (130–153)	56 (64)
Diastolic blood pressure (mm Hg)	79 (73–84)	78 (74–84)	78 (73–84)	12 (14)
Waist-to-hip ratio	1.0 (0.96–1.0)	0.90 (0.84–0.95)	0.94 (0.87–1.0)	67 (77)
Total body fat (%)	27.6 (22.9–29.8)	34.3 (28.5–40)	30.3 (25.8–37.2)	51 (59)
2 min walk test (metres)	132 (105–165)	126 (91–152)	130 (102–160)	44 (51)
Handgrip strength right hand (kg)	37 (29–45)	22 (14–27)	25 (19–34)	29 (33)
Handgrip strength left hand (kg)	37 (25–44)	21 (15–26)	24 (18–34)	
Peak torque in knee extension (Nm)	98 (73–129)	67 (53–82)	75 (58–100)	99 (112)
Tandem test (sec)	30 (28–30)	30 (24–30)	30 (24–30)	37 (42)
History of fall the past year (n, %)	No 21 (47%) Yes 24 (53%)	No 35 (50%) Yes 35 (50%)	No 56 (49%) Yes 59 (51%)	62 (59)

Physical characteristics of participants. Variables are presented as medians with IQR.

Table 3 All practically relevant combinations of the training categories

	Warm-up (RPE 12–13)	Aerobic training (RPE~14)	Resistance training (2–4 set, 8–15 RM) (5 min/exercise)			Balance training (5 min/exercise)	Individuals allocated to intervention
Combination	WUP	AER	RT1	RT2	TRT	BTR	Individuals (n)
General	10	20			20		
AER	10	30			10		
RT1	10		30		10		
TRT	10	10			30		
BTR	10				10	30	
AER+RT1	10	20	20				
AER+TRT	10	20			20		
AER+BTR	10	20				20	
RT1+RT2	10		20	20			2
RT1+TRT	10		20		20		
RT1+BTR	10		20			20	1
TRT+BTR	10				20	20	
AER+RT1+RT2	10	10	15	15			34
AER+RT1+TRT	10	10	15		15		6
AER+RT1+BTR	10	15	15			10	1
AER+TRT+BT	10	15			15	10	
RT1+RT2+BTR	10		15	15		10	
RT1+TRT+BTR	10		15		15	10	3
AER+RT1+RT2+BTR	10	10	10	10		10	32
AER+RT1+TRT+BTR	10	10	10		10	10	31

All practically relevant combinations of the training categories and the time (minutes) allotted to each training category for each combination. Resistance training is prescribed for the primary site of musculoskeletal pain/discomfort, and when cut-points for both lower and upper extremity strength are surpassed these resistance training exercises are collapsed to total body resistance training. Thus, the following combinations were omitted from the table; RT1+RT2+TRT; AER+RT1+RT2+TRT; RT1+RT2+TRT+ BRT; AER+RT1+RT2+TRT+BRT. The last column shows the number of participants allocated to the specific combination of exercises.
AER, aerobic training; BTR, balance training; RM, repetition maximum; RPE, rate of perceived exertion; RT1, resistance training (first focus area); TRT, total body resistance training; WUP, warm-up.

2. Aerobic training combined with two resistance training exercises for one body area with musculoskeletal pain/discomfort, two for either the upper or lower extremities and two balance exercises.
3. Aerobic training combined with two resistance training exercises for one body area with musculoskeletal pain/discomfort, two for total body and two for balance.

Feasibility of the assessment of health indicators

The participants tolerated the assessment well for the presented health indicators in this model, with few participants not completing all measures for handgrip strength and knee extension strength. Thus, 96% of participants completed the handgrip assessment bilaterally, and 98% completed the left quadriceps's maximal voluntary isometric contraction test. All participants completed the 2MWT, with 16% using walkers or canes during the assessment. Only 2% of the participants could not complete the 2MWT without breaks due to dyspnoea. Assessment of health indicators was completed within 90–120 min.

DISCUSSION

This paper presents a novel approach for tailoring individual physical rehabilitation to the older population and assesses the approach's feasibility and the diversity of training programmes possible in an outpatient rehabilitation setting.

American College of Sports Medicine recommends combining training for older adults, comprising aerobic, resistance, flexibility and balance training to promote health and well-being.[10] However, being impaired due to, for example, musculoskeletal pain or discomfort hinders older adults from meeting these recommendations.[47] Results from this study show that exercise preferences are individual, challenging a generic approach. Thus, this is the first effort to explicitly conceptualise the planning of physical exercise training for older adults in an outpatient setting, assessing aerobic capacity, strength, balance and pain sites. The conceptual IPET approach presented in this paper is suitable for older adults in various outpatient

settings where functional limitations persist with or without musculoskeletal pain/discomfort.

The assessment of health indicators was highly feasible and did not result in any adverse events. Most of the older adults tolerated the physical testing and self-reported assessment well. Only a few could not complete the knee extension and handgrip strength assessment. Roughly ~40% of the practically relevant training combinations were used, with ~88% of the older adults allocated primarily to three training combinations.

The IPET approach presented in this paper was developed from the 'intelligent physical exercise training' programme previously applied to working populations. IPET for older adults used fewer training combinations compared with the working-age population.[5] While the IPET approach presented in this paper can adapt to a large variety of physical profiles, most older adults in this study have related needs for physical exercise training. This accentuates that all varieties of training combinations presented in table 3 are unnecessary. However, the listed exclusion criteria may influence and homogenise the older adults in this study more than expected.

A main difference between the algorithms described in the working-age population and this study is that the working-age population is prescribed exercise for the two most painful sites of musculoskeletal pain/discomfort. It was reasoned relevant if only the primary site of pain was addressed in the older adults, as it allowed for more than one exercise for a specific body part. Even though older adults experience multiple sites of musculoskeletal pain and discomfort, a primary site of pain/discomfort is often the reason for seeking physical rehabilitation.

Nevertheless, prescribing physical exercise training based on individual needs and intended outcome is highly appropriate, as stated in a recent expert consensus guideline recommending exercise for older adults.[48] The training categories recommended are similar for most older adults, however, the body area to be addressed varies. In this study, almost all older adults (~99%) had reduced muscle strength in the lower extremities. However, some older adults (~29%) also showed reduced strength in the upper extremities, implying that focusing only on lower-body resistance training would be insufficient for almost a third of the population.

Only six older adults did not exceed cut-points for health indicators recommending aerobic exercises. All were allocated to resistance training due to reduced strength in extremities or musculoskeletal pain/discomfort. This aligns with existing literature, agreeing that aerobic and resistance training are the essential training categories recommended for older adults.[10]

Strengths and limitations

The primary strength of this study was the involvement of exercise physiologists and health professionals in developing and adapting the conceptual model. The involvement of stakeholders when developing interventions increases the intervention's probability of success.[49] Similarly, the choice of health indicators was balanced between the measures' ability to reflect the specific concept it intends and the health professional's knowledge and usage in clinical practice. It is a strength as the choice of health indicators was based on current literature, and a consensus was reached through discussion with healthcare professionals. Similarly, it is a methodological strength that the health indicators are objectively assessed and follow a literature-informed cut-point. The choice of clinical test to reflect the health indicator was based on feasibility within the applied municipality setting, which may not always be possible in other locations. Substituting clinical tests may be relevant in different contexts. In such cases, the clinical tests' validity and reproducibility are important. Involving more extensive and precise measures was considered. However, health professionals generally believe it loses value when applied in real-life settings if health indicators are unfamiliar or too advanced.

The cut-points for health indicators within this study were based on age and gender when possible; however, several other variables could be considered. In general, the presented conceptual model is vulnerable regarding appropriate cut-points, which can be influenced by several variables, hereunder ethnicity, geographical location, anthropometry, tools of measurement, etc, which can be relevant to include in other contexts.

Older adults often suffer from many underlying chronic health conditions, contributing to adverse health outcomes.[1] Adjusting the intensity of the prescribed exercises related to the specific underlying health condition could be relevant for further persecution to develop the presented concept. Nevertheless, for most health conditions, the effectiveness of multicomponent training is evident, and recommended training categories are recurrent between comorbidities.[1 48]

Planning exercise programmes using the IPET approach can be fitted individually and applied in a broad context. Still, older adults referred to outpatient settings may have been prescribed strict regimes by their surgeon or general practitioner that the health professionals must comply with. In these cases, a pragmatic approach in prescribing physical exercise to older adults is recommended to ensure sustainability and safety. If exercises suggested by the IPET concept are deemed unsuitable by health professionals, other care should be prioritised.

Future steps

The next step is to investigate and report the IPET concept's acceptability, adherence, compliance and effectiveness in a high-quality randomised clinical trial conducted in a real-life setting. If proven effective, the concept of IPET could be a systematic approach offering older adults tailored physical exercise training regardless of the experience and reasoning of the health professional and setting. This and future studies regarding IPET are assignable in various outpatient settings.

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Patient consent for publication Consent obtained directly from patient(s).

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