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Derleme Makalesi– Review Paper

INVESTIGATION OF EFFECTIVENESS OF HIGH-INTENSITY FUNCTIONAL EXERCISE ON OLDER ADULTS: A SYSTEMATIC REVIEW

YAŞLI BİREYLERDE YÜKSEK YOĞUNLUKLU FONKSİYONEL EGZERSİZİN ETKİNLİĞİNİN ARAŞTIRILMASI: SİSTEMATİK DERLEME

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Özet

Bu sistematik derlemenin amacı, Yüksek Yoğunluklu Fonksiyonel Egzersizin (YYFE) 65 yaş ve üzeri yaşlı bireylerde fizyolojik ve psikolojik işlevler üzerindeki etkinliğini araştırmaktır. Bu sistematik derleme, PEDro ölçeğine göre tasarlanmıştır. Sistematik arama için PubMed, Web of Science ve Scopus veritabanları kullanıldı. Toplam 1340 çalışma tespit edildi. Bu çalışmaların tam metinleri çalışmaya dahil etme ve hariç tutma kriterleri açısından değerlendiril ve son olarak 9 çalışma kriterleri karşılayarak derlemeye dahil edilmiştir. Fiziksel fonksiyonlar ve psikososyal fonksiyonlar anket ve testlerle değerlendirildi. Dahil edilen çalışmaların sonuçlarına göre YYFE, değerlendirilen parametreler açısından etkili olmuştur. Bu sistematik derlemenin bir sonucu olarak, YYFE fiziksel fonksiyonlar ve hemodinamik tepkiler üzerinde etkilidir, ancak psikososyal fonksiyonlar üzerindeki etkisi tartışmalıdır, ancak olumsuz etkiler bildirilmemiştir.

Anahtar Kelimeler: Yaşlı, Yüksek Yoğunluklu Fonksiyonel Egzersiz, Egzersiz Terapisi, Rehabilitasyon, Sistematik Derleme

Abstract

The aim of this systematic review was to investigate the effectiveness of High-Intensity Functional Exercise (HIFE) on physiologic and psychological functions in older adults aged ≥65 years. This systematic review was designed according to the PEDro scale. PubMed, Web of Science and Scopus databases were used for the systematic searching. Total 1340 studies were identified. The full texts of these studies were examined in respect of the study inclusion and exclusion criteria, and finally 9 studies met the criteria and were included for evaluation. Physical functions and psychosocial functions were evaluated via questionnaires and tests. According to results of the included studies HIFE was effective in respect of the evaluated parameters. As a result of this systematic review HIFE is effective on physical functions and hemodynamic responses but the effect on psychosocial functions are controversially, at the same time there were no reports of negative effects.

Keywords: Aged, High-Intensity Functional Exercise, Exercise Therapy, Rehabilitation, Systematic Review

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1. INTRODUCTION

The older adults is increasing rapidly in almost all countries worldwide (WHO, 2020). The World Health Organization (WHO) reported that the rate of the global population aged over 60 years was 12% in 2015 and is estimated to be 22% by 2050 (Ageing and Health, 2020). Previously, older adults has been defined as aged ≥65 years, but today with increasing average lifespan now definitions have started to be used of "young old" for the 65-74 years age group, and "middle-old and oldest-old" for those aged >75 years (Orimo et al., 2006, pp. 149-158). As a result of the physiological changes of ageing, restrictions in functions and general quality of life (QoL) increase with advancing age (Galloza et al., 2017, pp. 659-669).

In a study that evaluated the physiological effects of a sedentary life in the older adults, it was reported that the most inactive group was older adults with sat for mean 8.5-9.6 hours per day (Wullems et al., 2016, pp. 547-565). According to a report published by the American Centre for Disease Control (CDC), the rate of older adults who reached the recommended strength training targets was 12% of the young-old and 10% of the oldest old (CDC 2001, pp. 25-28). In another study that compared aerobic exercise with strength exercises in 382 females aged ≥65 years, only 18% complied with the predicted program (Picorelli et al., 2014, pp. 323-331). Therefore, it is extremely important to take precautions against an increasing sedentary lifestyle together with ageing.

Although there is no generally accepted definition, High-Intensity Functional Exercise (HIFE) generally refers to relatively short interval exercise sessions, which are performed with maximum effort or at an intensity close to the intensity provided by the highest oxygen intake, ie, peak oxygen intake (Gibala et al., 2008, pp. 58-63). Strengthening exercises are very important for the older adults because of the beneficial effects on muscle loss, osteoporosis and functional losses that occur with ageing (Nelson et al., 2007, pp. 1435-1445). Previous studies have shown that resistance exercises can significantly improve the strength and functional capacity of the older adults requiring assistance and even those in nursing homes (Nelson et al., 2007, pp. 1435-1445, Fragala et al., 2019, pp. 2019-2052).

The effect of HIFE is not only on muscle strength and functionality. It has been shown in literature that HIFE could have beneficial effects in the fat oxidation changes, many different diseases such as Parkinson's disease, chronic obstructive pulmonary disease (COPD), hypertension (HT), cardiovascular diseases (CVD), and various metabolic conditions such as diabetes mellitus (DM) (Gibala et al., 2008, pp. 58-63, Boselt et al., 2017, pp. 301-310, Astorino et al. 2018, 51-63, Schenkman et al., 2018, pp. 219-226, Boutcher and Boutcher 2017, pp 157-164, Wewegw et al., 2018, pp. 21, Little et al., 2011, pp. 1554-1560).

Due to the increasing ageing population worldwide, non-infectious chronic diseases have become a serious public health problem. The functional impairments caused by chronic diseases lead to an impaired quality of life and increased mortality risk (Filho et al. 2013, pp.

1-12). For all the reasons mentioned above, exercise is of undeniable importance in improving functional, cognitive and health parameters in older adults. The hypothesis of this study was that "HIFE has positive effects on physical functions and psychosocial functions in older adults". Therefore, the aim of this systematic review was to compare and discuss clinical studies that have investigated the efficacy of HIFE in individuals aged ≥65 years.

2. METHODS

This systematic review was designed according to the Physiotherapy Evidence Database scale (PEDro) (Moseley et al., 2002, pp. 43-49). The literature searching for this study was performed by 3 researchers. PubMed, Web of Science (WOS) and Scopus databases were used and only studies published in English were included in the search (Pubmed, 2020, Wos 2020, Scopus 2020).

The search terms used in the literature search were, "aged" OR "older adults" OR "older people" OR "older women" OR "older men" OR "elderly" OR "elder adults" OR "elder people" OR "elder men" OR "elder women" OR "seniors" OR "older" OR "geriatric" and "high-intensity exercise" OR "high-intensity interval training" OR "high-intensity training".

The databases were scanned between 01st April 2019 and 31st May 2019. The results were evaluated in respect of duplication, and any repeated studies were removed (Figure 1). The titles and abstracts of a total of 563 articles reached as a result of the database scan were evaluated by 3 researchers (HG, BT, FT) in respect of the criteria for inclusion in and exclusion from the systematic review. The references of all the articles evaluated were also reviewed in respect of additional literature information. For articles where the title and abstract were insufficient for evaluation, the whole article was read. In the case of disagreement between the 3 researchers, a 2 to 1 majority decision was taken.

2.1. Inclusion and Exclusion Criteria

Inclusion Criteria:

- Studies evaluating the effects of HIFE on older adults,
- Randomized controlled studies,
- Studies published in English,
- Studies in the last decade
- Studies with participants aged ≥65 years.

Exclusion criteria:

- Studies not meeting the inclusion criteria,
- Animal studies.

2.2. Data Extraction

After selection of the studies, a data extraction form standardized according to the PEDro Scale criteria was used for each study:

- Bibliographic data (authors, journal, year of publication),
- Study aim,
- Characteristics of the study population (age, gender, etc.).
- Aim of the intervention (for both intervention and control groups),
- Follow-up period and times of evaluation,
- Study outcomes and parameters evaluated,
- Study results.

Evaluation of the studies was made using the PEDro Scale, which is a checklist comprising 11 "yes/no" questions formed to evaluate the studies in respect of bias, blindness and adequacy of follow up.

The first question is not scored, and the other 10 questions are scored as 1 point for a response of "yes" and 0 points for a response of "no". Based on the classification shown below, the methodological quality of the study is reflected as follows:

- 9–10 PEDro points = excellent,
- 6-8 points = good,
- 4-5 points = acceptable
- <4 points = poor (Moseley et al., 2002, pp. 43-49).

The PEDro scale was applied by the 3 researchers, and consensus method was used to resolve any differences in the scoring of the studies.

2.3. Study Selection

The date and language restrictions were applied as the search strategy and as a result of the first electronic scan of 3 different databases, a total of 1340 studies were identified. After removal of duplications, 563 studies remained, then after screening of the titles and abstracts of the studies, this number fell to 143. The full texts of these studies were examined in respect of the study inclusion and exclusion criteria, and finally 9 studies met the criteria and were included for evaluation (Figure 1) (Carlsson et al., 2011, pp. 554-560, Cahn et al., 2017, pp. 78-88, Lindelöf et al., 2013, 369-376, Littbrand et al., 2011, pp. 1274-1282, Raymond et al. 2017, pp. 208-214, Sayers et al. 2016, pp. 2327-2336, Schmidt et al. 2014, pp. 86-97, Toots et al. 2017, pp. 323-332, Sondell et al., 2018, pp. 1-18).

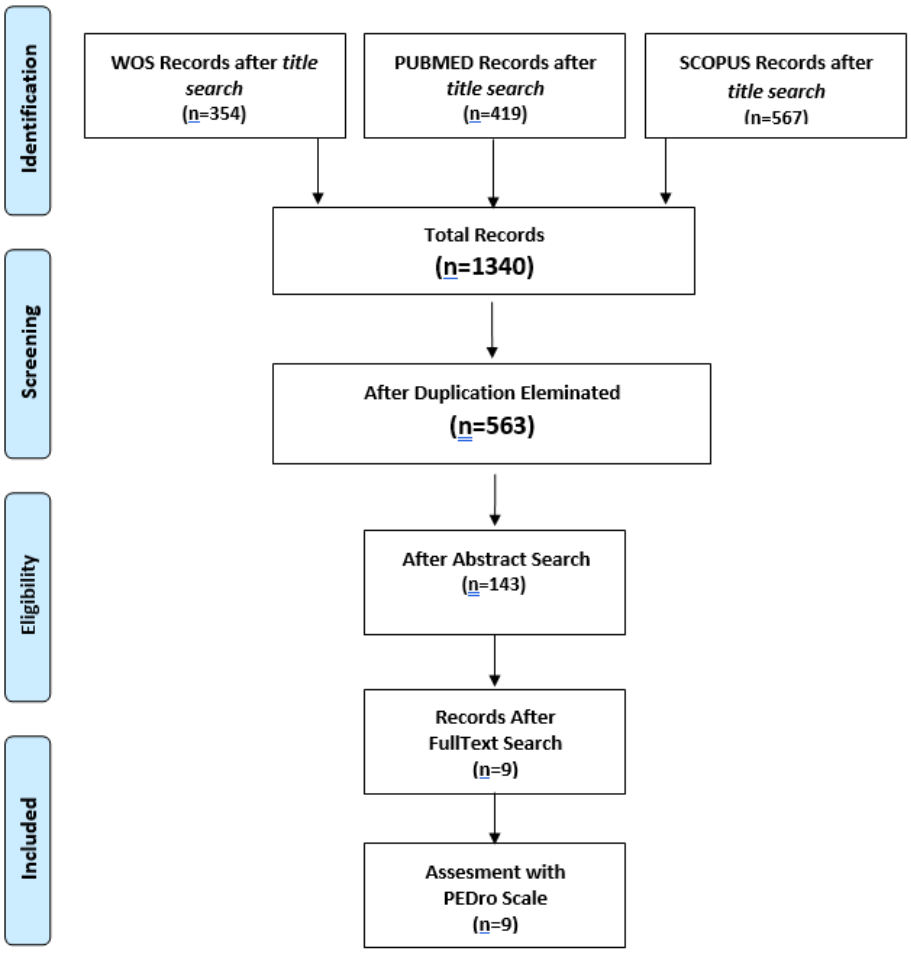

Figure 1. Flow Chart

2.4. Quality Evaluation

The quality of the methodology of the studies was evaluated with PEDro Scale (Moseley et al., 2002, pp. 43-49). The highest points obtained by the studies included in this systematic review were the maximum of 10 points from 10 (Lindelöf et al., 2013, pp. 369-376) and the minimum points obtained were 7 from 10 (Cahn et al., 2017, pp. 78-88, Lindelöf et al., 2013, 369-376, Schmidt et al. 2014, pp. 86-97, Toots et al. 2017, pp. 323-332, Sondell et al., 2018, pp. 1-18). The methodological quality of all the studies was mean 8 points from 10 on the PEDro scale. The methodological quality points of all the studies are shown in Table 1.

3. RESULTS

3.1. Participants

The total number of participants in the studies examined in this review was 1613. All the participants were aged >65 years.

3.2. Interventions

The HIFE programs included exercises such as balance exercises, football training and strengthening exercises (leg press, pull-down, back extension, etc.). For these applications to be HIFE, Carlsson et al., Lindelöf et al., Raymond et al. and Littbrand et al. included strengthening training with a load that the subjects could perform with 8-12 maximum repetitions (Carlsson et al., 2011, pp. 554-560, Lindelöf et al., 2013, 369-376, Littbrand et al., 2011, pp. 1274-1282, Raymond et al. 2017, pp. 208-214). Interventions in the other studies were observed to be consistent with HIFE. Therefore, the exercises included in the studies in this systematic review will be referred to as HIFE in this study (Table 2).

3.3. Comparative Interventions

The comparative interventions were traditional exercises (home exercises, stretching and strengthening exercises, group exercises) or medical treatment, or no intervention.

4. DISCUSSION

The aim of this systematic review was to examine the efficacy of HIFE in older adults. The effectiveness of HIFE on the physical and psychosocial functions was examined in the included studies and the results showed that HIFE had a positive effect on physical and psychosocial functions and caused no side-effects. Previous studies have reported that HIFE is effective on muscles and neural structures. However, it must not be forgotten that it is a risky application for older adults. Therefore, for the older adults to be included in training it is necessary to take comorbid problems into consideration, such as hypertension, diabetes, kidney failure and heart failure. To be able to eliminate the risks, inclusion, exclusion and termination criteria of the older adults must be formed carefully. Particularly, for the termination criteria parameters such as exercise tolerance, physiological response to exercise and clinical findings must be evaluated. In other words, primary and secondary termination criteria should be defined in detail and there must be careful follow up throughout the whole training period.

Table 1. Scoring of the methodological quality of included studies using PEDro Scale

Studies	Eligibility criteria 1	Random Allocation 2	Concealed allocation 3	Baseline comparability 4	Blinding Subject 5	Blinding therapist 6	Blinding assessor 7	Outcome data > 85% 8	Intention to treat 9	Between Group results 10	Point measure / measures of variability 11	PEDro Score
Carlsson et al., 2011	YES	YES	NO	YES	NO	YES	YES	YES	YES	YES	YES	8
Chan et al., 2017	YES	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	7
Sayers et al., 2016	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	9
Sondell et al., 2018	YES	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	7
Raymond et al., 2017	YES	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	8
Lindelöf et al., 2013	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	10
Toots et al., 2017	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	YES	7
Schmidt et al., 2014	YES	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	7
Littbrand et al., 2011	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	9

Table 2. Overview of included studies

Study	Aim	Population	Intervention/Comparison	Follow-up	Outcomes	Results
Carlsson et al. 2011	Comparison of HIFE and protein intake	N= 177 **Group 1:** HIFE group (n = 83) **Group 2:** Control Group (n = 94) Both groups were separated into subgroups of protein and placebo.	A total of 29 sessions each lasting approximately 45 min were held five times every two weeks for three months. **Group 1:** HIFE + protein intake or placebo drinks **Group 2:** Seated watching films, singing, reading, and conversation + protein intake and placebo drinks	Pre-intervention and at 3rd and 6th months	Body weight (BW), Intracellular water (ICW)	3rd month p>0.05 6th month BW p=0.021 ICW p=0.039 A significant increase was seen in favor of the HIFE group.
Chan et al. 2017	Comparison of HIFE and low-intensity exercise	N=289 **Group 1:** n=143- HIFE **Group 2:** n=146 – low-intensity exercise	**Group 1:** A total of 48 sessions were applied twice a week for 6 months **Group 2:** After one session of training, low-intensity exercises were followed up with a home program	At baseline, then at 3, 6 and 12 months of follow up	Weight Loss Exhaustion Energy expenditure of walking Low level activity Walking Speed Hand Grip Fat Free Mass Index Timed Up and Go Test One-leg-stand time	Energy expenditure of walking 6th month p<0.001, 12th month p=0.032 5 m Walking Test 6th month p<0.001, 12th month p=0.033 Dominant Hand Grip Strength 6th month p<0.001 Timed Up and Go Test 3rd month p=0.010, 6th month p<0.001, 12th month p=0.003 One-leg-stand time 6th month p<0.001, 12th month p=0.001 HIFE was determined to be more effective. No difference was determined in the other parameters.
Sayers et al. 2016	The effect of strength training applied at different high speed	N=42 **Group 1:** high-intensity strength training (n=28): 2 subgroups of fast (n=14) and slow (n=14) strength training **Group 2** Control Group (n=14)	**Group1:** Fast and slow strength training applied 3 times a week for 12 weeks. Subjects were instructed to perform exercise with an isokinetic device at 1 max and 3-12 repetitions at 40% as far as possible. **Group2:** No exercises were performed by the control group	Pre- and post-intervention	Habitual and maximal gait speed (GS) Timed Up and Go Test Short Physical Performance Battery (SPPB).	A difference was determined between Group 1 and Group 2 only in SPPB (p=0.01) Maximal GS (p=0.07), Timed Up and Go (p=0.03), SPPB (p=0.03) A significant difference was determined in favor of fast strength training
Sondell et al. 2018	Comparison of the effect on motivation of older adults with dementia of participation in social group activities and HIFE	N=186 **Group 1:** High-Intensity Functional Exercise (n=93) **Group 2:** Seated social group activity (n=93)	**Group 1:** In groups for 45 minutes, five times per two-week period, for 4 months (40 sessions in total). High-intensity strength training and balance training was determined on the status of the participants by 2 physiotherapists. **Group 2:** Participation in social activities such as handicrafts, gardening and leisure time activities	Pre- and post-intervention	The motivation of the exercise group during activity sessions was compared with that of the social activity group. The motivation of the exercise and social activity groups to participate in activities	Motivation to participate in HIFE and social activities was determined as generally high (p<0.001). Generally, no difference was found between the groups in motivation during the activity sessions. However, the motivation of the exercise group during the sessions increased over time, whereas the motivation of the social activity group decreased.

Lindelöf et al. 2013	Comparison of the effect of HIFE and social activities.	N: 48 **Group 1:** High-Intensity Functional Exercise (n=20) **Group 2:** Social activities (n=28)	A total of 29 sessions each lasting approximately 45 min held five times every two weeks for three months. **Group 1:** Group exercise sessions for lower-limb strength, balance, and gait ability. **Group 2:** Seated watching films, singing, reading, and conversation	Pre- and post-training	Changes perceived as associated with the activities were evaluated with 13 questions prepared by the researchers. (For example: Has your leg strength increased? Do you socialize more with others?	The results showed that HIFE had a positive effect ($p<0.001$). The subjects reported only that they had become tired ($p=0.027$)
Toots et al. 2017	Comparison of the effects of HIFE on cognitive functions	N= 186 **Group 1:** High-Intensity Functional Exercise (n= 93) **Group 2:** Social activities (n= 93)	**Group 1:** A total of 40 sessions each lasting 45 mins were applied as 5 sessions every 2 weeks for 4 months. The HIFE program included 39 functional exercises aimed to improve lower extremity strength, balance and mobility. **Group 2:** Participation in social activities of conversation, singing, listening to music and reading, and art appreciation.	Baseline, 4, and 7 months	MMSE Alzheimer's Disease Assessment Scale-Cognitive Subscale (ADAS-Cog), Verbal fluency, Nutrition, Vision, Self-reported health, Geriatric Depression Scale	No difference was observed between the data of the two groups ($p>0.05$).
Schmidt et al. 2014	Evaluation of the cardiovascular effects of football training and strength training in older adults untrained males	N= 26 **Group 1:** Football training (n= 9) **Group 2:** Strength training (n=9) **Group 3:** Control Group (n=8)	The program was applied for 1 year: for the first 4 months, 1 hour twice a week, and for the subsequent 8 months, 1 hour 3 times a week. **Group 1:** Football training on natural grass. **Group 2:** Strength training of leg press, knee extension in a sitting position, hamstring curl in the prone position, pull-down, lateral dumbbell raises or similar. Strength training sets were applied with 16-20 maximum repetitions (MR), 12 MR, 10MR and 8 MR in the first, second, third and last 9 months, respectively. **Group 3:** No participation in any activity	Baseline, 4 and 12 months	Maximum oxygen uptake Blood Lipids Echocardiography Peripheral vascular function	Following football training, significant effects were seen at 4-12 months (LVIDD, LVEDV, LV mass index, left ventricle systolic function, right ventricle systolic function) in cardiac structure Resting heart rate decreased and VO2max improved ($p<0.05$) Improvements were only seen in systolic functions in football training group ($p<0.05$) Football training was seen to provide better cardiovascular effects in healthy older males
Raymond et al. 2017	Comparisons of the effect of HIFE and individualized physiotherapy on hospitalized older adults.	N= 468 **Group 1:** HIFE (n= 236) **Group 2:** Control Group (n= 232)	**Group 1:** In sessions lasting 45-60mins, HIFE was applied 3 times a week, and individualized physiotherapy, twice a week. Each exercise was performed as 2 sets of 8-12MR. The exercises comprised lower extremity progressive resistance strength training exercises and balance exercises for postural stability. **Group 2:** 5 sessions a week of individualized physiotherapy was applied. The therapy included gait training, aerobic, balance and strength exercises, range of movement, transfers and stairs practice.	Baseline and 48 hours before discharge	Elderly Mobility Scale Berg Balance Test Gait Speed Timed Up and Go Test Functional Reach Test	On discharge, BBT $p=0.04$ A significant increase was observed in favor of HIFE. No difference was seen between the groups in the other parameters.
Littbrand et al. 2011	Examination of the effect of HIFE	N=191 **Group 1:** HIFE (n=91) **Group 2:** Social Activities (n=100)	**Group 1:** HIFE included 41 exercises; lower extremity strength, balance, functional weight raising. The strengthening exercises were performed with 8-12 MR and when the participant could do more than 12, the weight was increased. Balance exercises were performed to provide postural stability. A total of 29 sessions, each lasting 45 mins were applied 5 times in a 2-week period for 3 months. **Group 2:** A program was applied of seated social activities (watching films, reading, singing, conversation).	At baseline, 3, and 6 months	Berg Balance Scale Mini nutritional assessment (MNA), MMSE Geriatric Depression Scale Vision Hearing	An increase was determined in the Berg Balance Scale Score. HIFE was not determined to have a negative effect on malnutrition, depression, dementia syndromes or severe physical disorders.

In the general our observation of the studies examined, subjects were excluded from the studies when it was thought that they could be mentally and physically affected by the questionnaires and tests. It is of course normal for older adults to have several comorbid problems. Therefore, in some studies comorbid problems have been defined but have not been used as exclusion criteria. For example, in the studies by Carlsson et al., Lindelöf et al., Littbrand et al. and Toots et al., the subjects included in the training were those with a good mental state, who could perform daily living activities independently and stand up from an armchair without support (Carlsson et al., 2011, pp. 554-560, Lindelöf et al., 2013, 369-376, Littbrand et al., 2011, pp. 1274-1282, Sayers et al. 2016, pp. 2327-2336). In the study by Raymond et al., despite the determination of several comorbidities in the older adults, subjects were included with a good mental state and good physical status such as the ability to transfer weight and sufficient exercise tolerance (Raymond et al. 2017, pp. 208-214). However, to avoid the exercise forming any risk, Carlsson et al. did not include those with a pacemaker or metal implants anywhere in the body (Carlsson et al., 2011, pp. 554-560).

Schmidt et al. excluded subjects with symptoms of cardiovascular disease, a history of cancer, type 2 diabetes mellitus, hypertension, or severe hyperlipidemia, those with musculoskeletal complaints, neuropathy, and those who smoked (Schmidt et al. 2014, pp. 86-97). In the study by Sayers et al., despite the inclusion of ambulatory, with or without assistance, older adults, subjects were excluded if they had a history of heart disease, neurological disease, pulmonary disease requiring oxygen support, a history of hip fracture or lower extremity joint replacement surgery in the last 6 months, or had uncontrollable hypertension (Sayers et al. 2016, pp. 2327-2336).

To determine the effect of HIFE on physical functions, gait and balance parameters have been evaluated in studies. Questionnaires and tests such as the Walking Speed Test, Timed Up and Go Test, Short Physical Performance Battery, Energy expenditure of walking, Gait Speed, Elderly Mobility Scale, Berg Balance Test, Functional Reach Test and Barthel Index have been selected for these data, and grip strength has also been examined.

Balance is the postural adaptation at rest and during an activity to be able to keep the center of gravity over the supporting surface (Means et al. 2005, pp. 238-50). The balance is necessary for achievement of daily living activities and optimal functions and to gain independence (Blum et al., 2008, 559-566). Afferent (visual, vestibular, proprioceptive systems) and efferent (muscle strength and joint flexibility) mechanisms providing balance are negatively affected by ageing. It has been reported that 13% of individuals aged 65-69 years and 46%of those aged ≥85 years in the population have impaired balance (Felsenthal et al., 2001, 561-577).

Impaired balance causes fall in the older adults. Hospitalization caused by trauma of the older adults have been reported to be associated with a fall in 68% of subjects and this rate has been determined to reach 86% in those aged ≥85 years (Covington et al., 1993, pp. 847-52). Falls encountered at such a high frequency are the reason for 27% of deaths in healthy individuals aged 70-79 years (Müjdeci et al. 2010, pp. 148-54). Doğru et al. reported that the older people prefer to use an assistive device when walking to prevent falls (Dogru et al.,

2016, 3267-3271). Therefore, in studies to prevent falls that may cause very high morbidity and mortality rates in the older adults, researchers have focused on balance and gait (Tyson et al., 2006, pp. 30-38). Activities which can develop balance and gait have been added to the content of HIFE training programs. The training includes exercises such as balance exercises, football training, and strength training (leg press, pull-down, back extension, etc.). For these applications to be HIFE, Carlsson et al., Lindelöf et al., Raymond et al. and Littbrand et al. included strengthening training with a load that the cases could perform with 8-12 maximum repetitions (Carlsson et al., 2011, pp. 554-560, Lindelöf et al., 2013, 369-376, Littbrand et al., 2011, pp. 1274-1282, Raymond et al. 2017).

In the study by Chan et al., geriatric subjects were followed up for one year (Cahn et al., 2017, pp. 78-88). At the end of the study, it was reported that energy expended when walking had reduced, and gait speed had increased. There were also reported to be increases in the data of grip strength, the Timed Up and Go Test, and the one-leg stand time. Thus, it was concluded that HIFE was effective in balance and gait activities. Similar results were reported in the study by Sayers et al (Sayers et al. 2016, pp. 2327-2336). With the implementation of HIFE, significant improvements were obtained in the gait speed, Timed Up and Go Test, and short physical performance battery, and it was reported that rapidly applied HIFE was effective (Sayers et al. 2016, pp. 2327-2336). Littbrand et al. evaluated the balance of older adults using the Berg Balance Scale and showed long-term effects on balance (Littbrand et al., 2011, pp. 1274-1282). In another study, the efficacy of HIFE was evaluated with the Elderly Mobility Scale, the Berg Balance Test, gait speed and functional reach tests. The results of that study showed that HIFE had a positive effect on the Berg Balance Test results, but the other parameters were not affected (Raymond et al. 2017, pp. 208-214). Those results suggest that there was an effect of the inclusion of patients in a HIFE training program only for the period that they were in hospital and therefore the training period was short. When the training periods of other studies are examined, it is noticeable that there are longer training periods, such as 3, 4, and 6 months and 1 year.

Unlike other studies, Carlsson et al. examined the effect of HIFE on body weight and intracellular water and Schmidt et al. evaluated hemodynamic responses (Carlsson et al., 2011, pp. 554-560, Schmidt et al. 2014, pp. 86-97). For these parameters, maximum oxygen uptake, blood lipids, electrocardiography and peripheral vascular function tests were used. These studies reported that HIFE was effective in respect of the parameters evaluated.

In the studies examined in this systematic review, in addition to physical functions, the effect of HIFE on cognitive functions and psychosocial functions was investigated. For example, Lindelöf et al. examined the perception of fatigue and the feeling of confidence (Lindelöf et al., 2013, 369-376). Sondell et al. evaluated the effect on motivation (Sondell et al., 2018, pp. 1-18). Littbrand et al. evaluated mental status and depression and Toots et al. investigated the effects of HIFE on cognitive functions (Littbrand et al., 2011, pp. 1274-1282, Toots et al. 2017, pp. 323-332). For evaluation of these functions, the MMSE, Geriatric

Depression Scale, and the Alzheimer's Disease Assessment Scale-Cognitive subscale (ADES-Cog) were used, Verbal Fluency was evaluated, and the subjects were questioned about how they perceived their health status.

When the effect of HIFE on psychosocial functions is examined, some studies have reported no effect, some have reported positive effects, and others have reported no negative effects (Lindelöf et al., 2013, 369-376, Littbrand et al., 2011, pp. 1274-1282, Toots et al. 2017, pp. 323-332). Although it was shown in several studies that exercise had a positive effect on psychosocial functions, it did not seem possible to make a definitive judgement in this systematic review. In addition to the physical and psychosocial integrity of health, impairments are seen in physical and psychosocial functions in the ageing process. Researchers have difficulty in deciding which exercise program should be selected for older adults in this period, with problems such as which is the most beneficial exercise method and what frequency and for how long it should be applied. However, the studies examined in this review did not report any negative effects of HIFE.

A total of 9 studies met the inclusion and exclusion criteria for evaluation in this review. The results related to the efficacy of HIFE in these 9 studies have been discussed, and it was generally seen that one of the limitations of the studies was that termination criteria were not clearly defined. As the study participants were sedentary geriatrics, it is likely that several problems were encountered such as joint pain, soft tissue injury and dizziness as a result of these high intensity exercises. Another limitation was that there are several parameters in the context of psychosocial functions but the parameters in the studies in this review were noticeably insufficient. Therefore, future studies of HIFE applied to geriatric individuals should include exercise tolerance, pain and joint injuries within the termination criteria. Studies should also be planned which would comprehensively evaluate psychosocial functions.

As a result of this systematic review, it can be concluded that HIFE is effective on physical functions and hemodynamic responses. The studies related to the effect on psychosocial functions are controversially, although there were no reports of negative effects.

In conclusion, HIFE is an appropriate exercise method which can be used for the improvement of physical functions and psychosocial function in older adults. In future studies it is very important that detailed evaluating of the appropriacy of the HIFE programs for older adults by multi-disciplinary team. Evaluations should be included inclusion and exclusion criteria, primary and secondary termination criteria, motivation and comorbidity levels. In addition, it is thought that it would be beneficial to provide the participants with detailed training about HIFE and teaching the self-monitoring methods.

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