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The effects of Nordic Walking on health in adults: A systematic review

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Abstract
Objective: Nordic walking is a physical activity gaining more and more interest among adults. The aim of the study was to conduct a systematic review to determine the effects of Nordic walking on the physical and mental health of adults
Method: We identified Nordic walking related randomized controlled trials (RCTs) in the electronic databases PubMed, EBSCO and CNKI, however 19 from 47 studies were selected for evaluation and systematic review based on relevant data.
Results: Most of the study subjects were in the middle-aged and elderly clinical population, and three studies included non-clinical populations. The intervention was conducted most often three times a week for 8 weeks or more. The main effects of Nordic Walking were physical and psychological benefit, in particular the improvement of circulatory and respiratory and quality of life. All studies reported at least one beneficial effect of Nordic walking compared to the control group.
Conclusion: Nordic walking has some beneficial effects on the physical and mental health of adults with or without clinical symptoms.

Keywords: Nordic Walking, adults, health

1. Introduction

Regardless of age and health status, appropriate physical activity can improve the physical and mental health of adults [1]. However, at present, many adults are still physically inactive. They justify their absence from classes due to lack of time, poor health or limited finances. Encouraging adults to increase their physical activity by promoting simple and inexpensive exercise (e.g., walking) is an essential component of health policy [2].

Walking is recognized worldwide as the most common form of physical activity. Walking is effective self-regulating and the joints are less impacted, so the risk of injury on foot is relatively low. For people who want to increase physical activity, including the elderly and people with chronic diseases, walking is often the first choice. Nordic Walking (NW) is an outdoor, non-competitive form of exercise that originated in Fin-land as a summer conditioning sport developed for cross-country skiers. It is a type of pole-holding walking that is used to combat weight-bearing movements of the lower extremities and has low-impact, medium-intensity characteristics similar to walking [3]. Since the creation of walking with a cane in the 1980s and 1990s, walking with a cane has become increasingly popular in Europe and is also widely valued in other Western countries [4]. The main technical features of Nordic Walking are increased stride length, increased range of motion of the hip joint, and gripping technique. The main features of Nordic Walking techniques are that they allow trainers to have a more normal gait, higher arm position, and more sustained grips [5].

Nordic Walking also has the following benefits compared to regular walking: Nordic Walking increases oxygen uptake, exercise heart rate, and calorie expenditure without significantly increasing self-exertion [6]. Nordic Walking improves the muscle vitality of the upper limbs of athletes [7]; Nordic Walking also reduces the impact on the knee joint vertically [8]. Overweight people, the elderly, Parkinson's disease, or people with chronic diseases such as heart disease have low levels of physical activity, and in recent years there have been many reports of the use of Nordic Walking for fitness and rehabilitation in these groups, and many countries have provided public welfare Nordic Walking exercises in communities or government organizations [9]. The health benefits of Nordic Walking encompass multiple aspects of adults [10,11]. The purpose of the study was to conduct a systematic review to determine the effects of Nordic walking on the physical and mental health of adults.

2. Research methods

2.1 Literature search

With computer search as the mainstay and manual search as a supplement, the bibliographic databases of PubMed, EBSCO and CNKI were retrieved from the search time was until June 2022. Literature search does not limit the type of publication, including journal literature, conference papers, dissertations, etc. The search is carried out in a combination of subject words and free words, and the search language is Chinese or English, and the corresponding search formula is formulated according to the characteristics of each database. Secondary searches were conducted for references to included literature and related reviews.

The English search terms and search methods are as follows (taking Embase as an example): “Nordic Walking” or “Nordic Pole Walking” or “Pole Striding” or “Pole Walking”; “fitness” or “exercise” or “physical activity” or “rehabilitation” and Chinese terms and search strategies are as follows: “Nordic Walking” or “Walking with a Cane”

2.2 Inclusion criteria and selection process for relevant literature

This study was a systematic review of Nordic Walking, and the searched articles were categorized and included in this study. (1) Study design: randomized controlled trial (RCT) or controlled trial (CT) as the study object; (2) Population: adults over 18 years of age; (3) Intervention: The experiment takes Nordic Walking as the main training content; (4) Control group: non-Nordic Walking exercise program, non-motor intervention and other means; (5) Results: Subjective or objective measurement indicators of physical health or disease rehabilitation and mental health. The study is based on full-text articles on academic research written in English or Chinese. Determine the title and abstract of the article by searching, excluding irrelevant provisions, and then independently review the full text of the rest to ensure compliance with the inclusion criteria.

2.3 Data Extraction

According to the needs of the systematic review, the following data of the selected articles were extracted for analysis: (1) study design; Population groups and numbers; Age and gender; Eligibility criteria; Methods of inclusion and selection of study participants; (2) Details of Nordic Walking interventions and control strategies; The basic situation of the study object; Measurement results; And the impact of Nordic Walking on these results. According to the type of paper selected, the papers are divided into four categories for analysis: (1) The effect of Nordic Walking on the rehabilitation of the skeletal musculoskeletal system is studied; (2) Study on the effect of Nordic Walking on disease rehabilitation (3) Study on the effect of Nordic Walking on the health of middle-aged and elderly people (4) Study on the effect of Nordic Walking on depression.

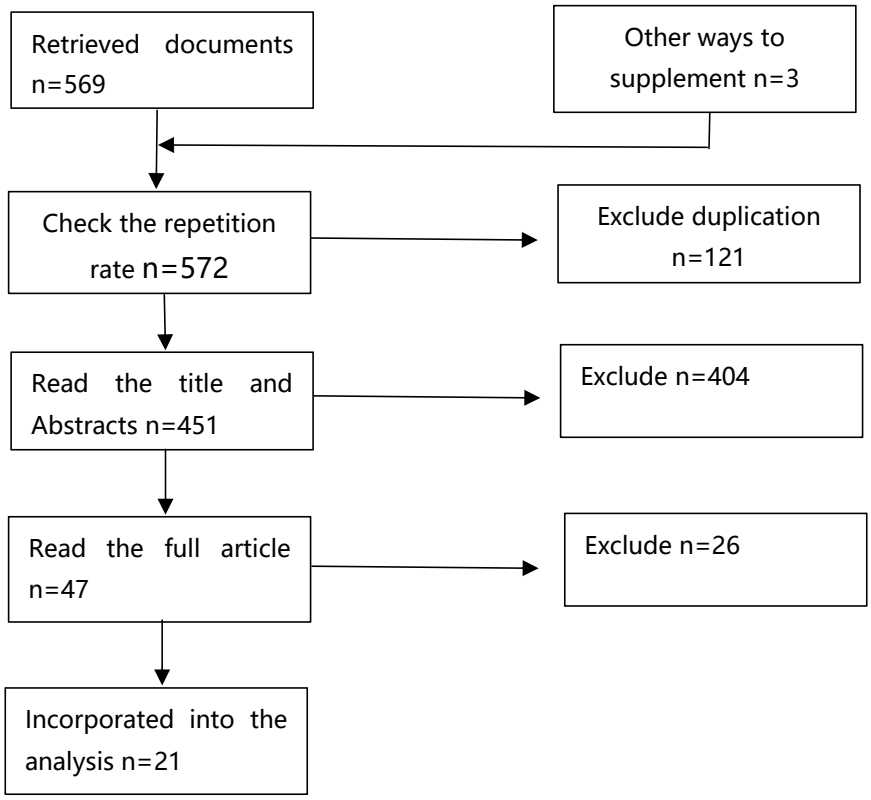
3. Results

The search process is shown in Figure 1. A total of 569 articles were searched, 3 were supplemented by other means, a preliminary review of 572 article abstracts was conducted, and 121 articles were excluded by double checking; Exclude 404 articles by reading the title and abstract; Through academic papers, full texts and RCT screening, the full text of 47 articles was independently examined, and 26 were excluded. A total of 21 articles were therefore included in the criteria.

Key findings: A total of 21 papers from 19 studies met the inclusion criteria. 12 papers from 10 studies discussed the

issue of Nordic Walking on disease rehabilitation, and 8 studies dedicated to Nordic Walking as a form of fitness, describing the health effects of Nordic Walking; One study focused on the effects of Nordic Walking on mental health for depression.

Figure 1: Literature search results



3.1. Quality Assessment

Study selection was based on randomized controlled trial (RCT) or controlled trial (CT) articles. The 19 included studies all reported on baseline participants, were parallel and comparable, with references to "randomized" or "randomized controlled trials" in the literature, and 13 describing specific randomized methods, such as randomized number tables and computer randomization; 6 items are assigned to hide. All subjects signed an informed consent form. Quality evaluation is carried out according to the PEDro scale. Of the 21 articles, 12 were of high quality and 9 were of medium quality.

3.2. Study population

The characteristics of the study participants are as follows: (1) Participants: Systematic review study participants were mainly middle-aged and elderly men and women from the clinical population (i.e., the diagnosed disease). The study population included type 2 diabetes mellitus [30, 17], peripheral arterial disease [23, 27], Musculoskeletal Conditions [12,15,25,28, 29], Chronic Obstructive Pulmonary Disease (COPD) [26], Parkinson's disease [13], depression [24], and groups of chronic diseases in the elderly [14,19,20,22]. There were four non-clinical population studies, all of middle-aged and older women [18, 21, 31,32]. (2) Sample sizes ranged from 23 to 166 people, and most studies included about 30-60 participants. The average age of participants in each study was between 45 and 74 years old. (3) Five of these studies targeted only female participants [18,21,28,31,32].

3.3. Design and implementation of training programs

Details of the Nordic Walking training program are shown in Table 1. Most Nordic Walking projects have a duration of 8 weeks or more (average 13.1 weeks, ranging from 6-24 weeks). The Exception to the Nordic Walk project in the Girold study was a 4-week period [23]. The training frequency for these programs is 1-5 times a week, and the Nordic Walking training time is 30-90 minutes. Most programs require participants to undergo moderate-intensity training, which is achieved through subjective and objective measurements, including fatigue grading, heart rate, heart rate rating, and acceleration methods.

Intensity monitoring during training varies in the four research projects of Skeletal and Musculoskeletal Rehabilitation, Middle-Aged and Elderly Health, Disease Rehabilitation, and Mental Health, some studies were monitored using the Brog scale, and the intensity range was generally controlled between 11-14[12,15,17,18,19,20,22,23,25,26,28] of which Takeshima's study required subjects to reach the range of 15-17 intensities at some time [14]. The study by Cokorilo

published in a 2022 paper, used heart rate to monitor the intensity of Nordic Walking [32]. Among them, disease rehabilitation generally requires the use of 40%-60% of the maximum heart rate of low and medium intensity training, and some use the gradual increase in intensity for training, and the large intensity is 75-80% of the maximum heart rate; Someone reported that their participants exercised at different but unspecified intensities, monitoring intensity in a consciously fatigued manner [13,2429,30,31].

Table 1: Detailed diagram of each experimental training plan

author	year	Plan (week)	frequency (times)	Time (minute)	strength
T. Bieler, etc.	2016	16	3	60	Borg Scale 1970,Expected training intensity 12–14,
E. P. Monteiro, etc.	2016	6	2	35-50	Participants walk at a minimum speed of 0.5 km/h, increasing by 0.5 km/h every 30 seconds until they are informed of the comfortable walking speed. If the volunteers tell them to walk faster than usual, gradually decrease the speed by 0.5 km/h until the volunteers mark the SSW again.
N. Takeshima, etc.	2013	12	3	50-70	The degree of exertion was assessed using the Borg 6-20 RPE scale (Borg, 1982). Subjects were asked to start resistance at intensity of 11 to 13 and then gradually increase it to strength of 15 to 17.
T. Bieler, etc.	2017	12	3	60	Borg Scale 1970,Expected training intensity 12–14,
N. Wasenius, etc.	2014	12	3	60	The NWR team conducted progressive endurance training with 50-60% heart rate reserve (HRR) in weeks 1-4,progressive endurance training with 60-70% heart rate reserve (HRR) in week 5-8, and progressive endurance training with 70-80% heart rate reserve (HRR) in weeks 9-12.
N. Wasenius, etc.	2014	12	3	60	After 4 weeks of training, the heart rate target range gradually increases (weeks 1-4: 50-60%, 5-8 weeks: 60-70%, weeks 9-12: 70-80% heart rate reserve)
P. Kocur, etc.	2017	12	3	60	Intensity is no higher than 70% of heart rate reserve (HRR) or less than 40%
T. Parkatti, etc.	2012	9	2	60	The intensity target is 60% of the maximum heart rate predicted by age.
V. Muollo, etc.	2019	24	3	60-90	Exercise intensity is specified by using heart rate reserve (HRR), i.e. from 40-59% HRR to 60-84% HRR.
Atle h. saEtErbaKKEn , etc.	2017	10	2	30	The intensity of the first five minutes gradually increases to 12 rpE (mild) and then to 12-14 rpE (mild to moderate) for the remaining 25 minutes.
N. A. Gomeñuka, etc.	2019	8	3	60	Heart rate band monitors strength, max70%
S. Girold, etc.	2017	4	3	60	Heart rate blood pressure monitoring intensity

F. Kruidijk, etc.	2019	24	2	60	Low-intensity exercise (walking and leisure exercise),
C. Spafford, etc.	2014	12	3	30	Heart rate band monitoring of medium to low intensity Maximum heart rate 75%
M.K. Breyer, etc.	2010	12	3	60	
E. G. Clins, etc.	2012	24	3	30	Patients began walking for 30 minutes, 20% of the training intensity is light intensity, 60% of the training intensity is medium intensity, 20% of the training intensity is high intensity.
K. Manerkorpi, etc.	2010	15	2	45-50	Borg scale: RPE <12 is thought to correspond to a maximum heart rate of <40%, while 12 to 13 (moderate) corresponds to a maximum heart rate of 40 to 60%, 14 to 16 (severe) corresponds to a maximum heart rate of 60 to 85%
J. Hartvigsen, etc.	2010	8	6—8	45	Predetermined intensity
T. Fritz, etc.	2011	16	5	60	Self-monitoring, appropriate strength.
Y. Nemoto, etc.	2021	12	3	50	Moderate intensity, self-monitoring.
N. Cokorilo, etc.	2022	12	3	35-45	Stage 1: 60–65%; Stage 2: 65–70%; Stage 3 75–80% maximum heart rate.

In most programs, instructors are physical therapists, sports or Nordic Walking instructors, or medical staff trained in Nordic Walking. Most studies reported on the use of Nordic Walking poles, with four studies using Nordic Walking techniques advocated by the International Nordic Walking Association. Six studies compared supervised and unsupervised Nordic Walking training. Training sites are generally selected outdoors, including parks, playgrounds, outdoor trails, and asphalt pavements; There are also options for training on indoor treadmills.

Most studies included Nordic Walking as an experimental group, with controlled experiments with ordinary walking or free walking; Three studies included a non-exercise control group. The following also examines exercise programs other than Nordic Walking compared to the control group: The studies by Bieler selected super-vised strength training (ST), supervised Nordic Walking (NW), and unsupervised home exercise (HBE) for experimental controls [12,15]; The study by Takeshima and oth-ers used the Nordic Walking group (NW), regular walking group (CW), resistance group (RES) and control group for study [14]. The study by Wasnius selected the Nordic Walking group, strength resistance training group and non-exercise control group for study [17]; The study by Atle H. saEtErbaKKEn and others selected Nordic Walking (NW) compared with specialized strength training (ST) versus non-training control group (Con) [21]; Jan Hartvigsen et al. in 2010 chose supervised and unsupervised Nor-dic Walking compared to daily exercise training [29]. Yuta Nemoto et al. also chose un-supervised Nordic Walking training in 2021 for a study of health interventions for the elderly [31].

3.4. Results of Nordic Walking on the rehabilitation of the skeletal musculoskeletal system

Kaisa Mannerkorpi et al. demonstrated in 2010 that moderate to high-intensity Nordic Walking (NW) training improves functional capacity and reduces activity re-striction levels in patients with fibromyalgia (FM) [28]. Jan Hartvigsen et al. 2010 studied the effects of Nordic Walking on lower back pain in 2010, and the results showed that supervised Nordic Walking training was more effective in terms of pain, disability, and patient-specific functions in patients with low back pain, helping patients reduce the number of painkillers and allow patients to seek less contemporaneous care for low back pain [29]. The above two studies reported the role of Nordic Walking in the reha-bilitation of the motor system. C. Spafford et al. found that a 12-week Nordic Walking training program based on a home-based 12-week Nordic Walking training program significantly improved walking distance for crippled patients [25]. T. Bieler et al. 2016 study showed that the improvement of sitting, climbing stairs and walking ability in patients with hip osteoarthritis (OA) in 4 months of Nordic Walking training was sig-nificantly better than other training methods; It also has certain advantages in im-proving physical activity and mental health [12,15].

3.5. Nordic Walking results for disease recovery

Subjects with normal glucose tolerance to Nordic Walking improved sleep quality and BMI after four months of Nordic Walking, with little or no musculoskeletal pain [30]. Niko Wasenius et al. conducted a study in 2014 on the effects of Nordic Walking (NW) and strength resistance training (RT) on type 2 diabetes, and the results showed that the amount of

high-intensity physical activity (structured exercise + unstructured lei-sure time physical activity) in the Nordic Walking group increased significantly com-pared with RT training after impaired sugar regulation in obese middle-aged men, but steps affected the total amount of activity per unit time, and NW exercise was a bene-ficial physical activity suitable for patients with type 2 diabetes [16,17].

Eileen G. Collins et al. compared the effects of 24 weeks of Nordic Walking and free walking on physical function in patients with peripheral arterial disease (PAD) in 2012, and the results showed that there was no difference in tissue oxygenation be-tween the Nordic Walking and free walking groups; Within the constant operating rate test group, the time required to achieve the minimum tissue oxygenation value is sig-nificantly longer; There was no difference between the two groups in terms of per-ceived walking distance measured by the Walking Distance subscale in the Physical Perception, Physical Function, or Walking Impairment Scale [27]. Sebastien Girold et al. studied the effects of Nordic Walking and free walking on recovery in patients with acute coronary syndrome (ACS) and peripheral arterial occlusive disease (PAOD) in 2017, and the study showed that the walking distance in the Nordic Walking group was significantly greater than that in the free walking group, the ACS group and the PAOD group improved significantly, but only in patients with PAUD [23]. Ma-rie-Kathrin Breyer et al. conducted a study in 2010 on Nordic Walking to improve daily physical activity in patients with CHRONIC obstructive pulmonary disease, which showed that after three months of training, the Nordic Walking group increased the ability to perform daily physical activity such as walking and standing time and walking intensity; There was a significant increase in 6MWD compared to the control group. In contrast, the control group maintained daily physical activity and 6MWD at all time points compared to baseline [26].

3.6. Study on the effects of Nordic Walking on the health of middle-aged and elderly people

Terttu Parkatti et al. conducted a study in 2012 on the effects of planned Nordic Walking (NW) on the functional ability of elderly sedentary people, and the results showed that after participating in Nordic Walking training, the trainees improved their balanced standing test by 15.3%, their arm curls improved by 19.7%, their 2-minute step test improved by 14.0%, their sitting posture and stretch test improved by 92.5%, their back stretch improved by 17.3%, and their up and down movement test improved by 10.0%. NW exercise has a significant effect on the functional capacity of sedentary elderly people [19]. Nobuo Takeshima et al. compared the effects of Nordic Walking NW with traditional walking CW and belt resistance training RES on the health of the el-derly in 2013, and the study showed that Nordic Walking training can improve the upper body strength of trainees; Better improvement of cardiorespiratory fitness in trainees; Nordic Walking training can provide better overall benefits for trainees [14]. Piotr Kocur et al. demonstrated in 2017 that the effects of Nordic Walking training on upper body muscle groups in middle-aged female office workers improved signifi-cantly [18]. Natalia Andrea Gomeñuka et al. conducted an eight-week Nordic Walking training session for 33 seniors in 2019, focusing on the impact of training on functional mobility, quality of life, and postural balance in the elderly, and the results showed that after eight weeks of Nordic Walking training, there were improvements in the areas of self-selected walking speed and motor rehabilitation index, static balance, dynamic stability, and psychological and social participation in quality of life, but the difference between NW and W was not significant [11]. Valentina Muollo et al. in 2019 assessed the effects of diet combined with long-term supervised NW and W training on body composition, aerobic capacity and strength in overweight adults. The results of the study showed that through 6 months of training, the BMI index of the NW group was significantly reduced, and the overall lipid (8%), android fat (14%) and leg fat (9%) of the NW group were also significantly reduced. VO2 peaks improved only in the NW group (8%) after 6 months of Nordic Walking training. The 6MWT of trainees increased, and the MVCBB (14%), MVCQF (17%), and AC (35%) of the NW group improved [20]. Yuta Nemoto et al. examined the effects of unsupervised NW training on cognition and physical function in older women in 2021, and the study showed that regular NW training can improve cognition in older women; It also improves physical activity, such as walking speed and stride length. A 2022 study by Nebojsa Cokorilo et al. explained that NW training improves physical function, especially cardiopulmonary function, in older women more than RW training; It also has a significant effect on improving the physical fitness of older women [32].

3.6. A study of the effects of Nordic Walking on depression

Frank Kruisdijk et al. studied the antidepressant and health effects of patients with major depressive disorder (MDD) in 2019 through running therapy or Nordic Walking, and the results showed that there was no significant additional reduction in depressive symptoms in the intervention group using intentional treatment and proto-col-by-protocol analysis using GLM (Intergroup Interaction Time). Depression in both groups of patients with HAM-D17 decreased by an average of 2-3 points. Compared with the control group, the suitability parameters for the sub-extreme bike test, BMI, and visceral fat (the last item in the PP analysis only) showed significant improvements [24].

4. Discussion

4.1 Nordic Walking discussion of skeletal musculoskeletal system rehabilitation

Nordic Walking has a significant effect on the rehabilitation of the motor system of middle-aged and elderly people, and can alleviate problems such as muscle pain and joint movement disorders. Experiments have shown that Nordic Walking has a good rehabilitation effect on fibromyalgia (FM), has benefits in improving functional capac-ity, and can be an effective exercise method for patients with fibromyalgia (FM) [23]. Supervised Nordic Walking training can improve chronic low back pain, but the ex-perimental results do not support the conclusions strongly enough [29]. European walking is superior to strength training and unsupervised home training for improving the physical and mental health of patients with hip arthritis, and Nordic Walking can improve joint mobility in patients with arthritis over a long period of

time [12,15]. Inter-mittent claudication patients can significantly improve their walking distance through systematic Nordic Walking training, and can be used as a reference and promotion in related diseases [25].

4.2 Nordic Walking discussion of disease recovery

Current research shows that adults with Parkinson's disease, obesity, low back pain, diabetes markers and fibromyalgia can also benefit from Nordic Walking, further reinforcing this evidence. In studies of the effects of Nordic Walking on cardiopulmo-nary function, all studies including endurance tests found that Nordic Walking had a more beneficial effect than in the control group. In some studies, Nordic Walking has been found to improve endurance in limited populations, such as adults with Parkin-son's disease, chronic obstructive pulmonary disease, claudication pain, and cardio-vascular disease. However, due to the uniqueness of each population and its clinical features, it is difficult to generalize the benefits of Nordic Walking for people other than those described above, so further research is needed when claiming the fitness benefits of Nordic Walking for people with other health conditions.

4.3 Discussion of the health effects of Nordic Walking on middle-aged and elderly people

In the randomized trials studied, the benefits of Nordic Walking for the health of the elderly were more prominent: different experiments reported that the benefits of Nordic Walking on improving heart function and flexibility in the elderly were more obvious; There are also comprehensive benefits in improving upper body strength, cardiovascular endurance and flexibility in older adults, with Nordic Walking rec-ommended to older adults as an effective exercise model. For sedentary older adults, Nordic Walking improves shoulder flexibility and reduces tenderness in the lower and middle trapezius, inferior, and latissimus dorsi muscles; The study further found that Nordic Walking has a good effect on the functional ability of the elderly. Nordic Walking can significantly reduce the BMI index and become the main tool in the fight against obesity and overweight in middle-aged and elderly people [20]. Older women can improve physical function and cognition through regular Nordic Walking training, as well as significant improvements in health index and maximum oxygen consump-tion. However, studies have shown little difference between Nordic Walking training and regular walking training in terms of primary outcomes (self-selected walking speed) and most secondary outcomes (including motor rehabilitation index, static balance, dynamic stability, and areas of psychological and social participation in qual-ity of life). This suggests that further research is needed on the effects of Nordic Walking on the health of older adults to support the conclusions.

4.4 Discussion of the effects of Nordic Walking on depression

Studies of the antidepressant and health effects of running therapy or Nordic Walking on patients with major depressive disorder (MDD) did not draw statistically significant conclusions [24]. The reason may be that the antidepressant effect of exercise interventions cannot be measured and is unlikely to be selective and relatively small in the MDD clinical population, because the amount of action is very small. It suggests that integrated lifestyle interventions may be more effective than a single additional exercise intervention. Further clinical studies are needed on the impact of Nordic Walking training on mental health.

4.5 Discussion Summary

The purpose of this review was to describe and critically assess the effects of Nordic Walking training on the physical and mental health of adults. 21 articles from 19 RCTs and CT Were found in an extensive literature search. All 21 articles were published in 2010, and 11 of them were published in 2016, indicating that the Nordic Walking research field is still in the development stage. While it is possible that some studies were missing from the literature search, the small number of studies included in this review are more likely to reflect the developmental nature of this area of study. Since Nordic Walking is more popular in Europe, and related research has been mostly in Europe, we mostly use the English literature as the main research object to obtain a more comprehensive research scope. In the analysed studies, the diversity of study populations, control groups, and outcome measurements made comparisons between studies difficult. Most studies were conducted under supervision. However, due to heterogeneity in training structure, walking techniques, and learning processes, it is difficult to draw conclusions about the role of supervision. There were also reports that unsupervised groups had better compliance than oversight groups.

Still, all studies have found at least one positive effect. The results of this system-atic review are consistent with the results of a systematic review conducted by Harjula, 2007; Morgulec Adamowicz et al., 2011. Nordic Walking, in particular, has a good ef-fect on improving cardiopulmonary function, functional status, and motor ability.

5. Conclusions and prospects

In summary, the available clinical evidence shows that Nordic Walking has a pos-itive effect on adults with and without clinical symptoms in improving their improved cardiorespiratory fitness, functional status, motor performance, mental health and quality of life, with different results in improving the quality of daily life, requiring more high-quality multicenter large-sample randomized controlled trials for valida-tion. In general, Nordic Walking is a relatively safe and effective exercise treatment with few adverse reactions, and can be used as an effective means of related diseases and the healthy rehabilitation of middle-aged and elderly people. In the future, the methodological quality of clinical trials should be further improved, and improve-ments should be made in terms of increasing the sample size, extending the follow-up time, standardizing the treatment plan, blinding the evaluators, and unifying the evaluation indicators, so as to provide evidence-based medical evidence and guidance for clinical promotion.

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