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Background and Purpose. The objective of this review was to construct an updated evidence-based clinical practice guideline on the use of physical activity and diet for the management of osteoarthritis (OA) in adults (>18 years of age) who are obese or overweight (body mass index ≥25 kg/m^2).

Data Sources. Articles were extracted from the following databases: MEDLINE, EMBASE (Current Contents), SPORTDiscus, SUM, Scopus, CINAHL, AMED, BIOMED, PubMed, ERIC, the Cochrane Controlled Trials, and PEDro.

Study Selection. The Ottawa Panel and research assistance team strictly applied the inclusion and exclusion criteria from previous Ottawa Panel publications.

Data Extraction. An *a priori* literature search was conducted for articles related to obesity and OA of the lower extremities that were published from January 1, 1966, to November 30, 2010. Inclusion criteria and the methods to grade the recommendations were created by the Ottawa Panel.

Data Synthesis. Recommendations were graded based on the strength of evidence (A, B, C, C+, D, D+, or D−) as well as experimental design (I for randomized controlled trials and II for nonrandomized studies). In agreement with previous Ottawa Panel methods, Cochrane Collaboration methods were utilized for statistical analysis. Clinical significance was established by an improvement of ≥15% in the experimental group compared with the control group. There were a total of 79 recommendations from 9 articles. From these recommendations, there were 36 positive recommendations: 21 grade A and 15 grade C+. There were no grade B recommendations, and all recommendations were of clinical benefit.

Limitations. Further research is needed, as more than half of the trials were of low methodological quality.

Conclusions. This review suggests that physical activity and diet programs are beneficial, specifically for pain relief (9 grade A recommendations) and improved functional status (6 grade A and 7 grade C+ recommendations), for adults with OA who are obese or overweight. The Ottawa Panel was able to demonstrate that when comparing physical activity alone, diet alone, physical activity combined with diet, and control groups, the intervention including physical activity and diet produced the most beneficial results.

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[Ottawa Panel Evidence-Based Clinical Practice Guidelines for the Management of Osteoarthritis in Adults Who Are Obese or Overweight. *Phys Ther.* 2011;91:843–861.]

Osteoarthritis (OA) is a degenerative joint disease that directly affects more than 27 million Americans[1] and is a primary cause of long-term disability.[2] In turn, disability is known to lead to physical inactivity and muscle weakness, which further affect joint health, biomechanics, functional status, and quality of life (QoL), all the while leading to obesity.[3] Recognized both as an important risk factor for structural joint damage, especially in weight-bearing joints,[4,5] and as a global public health problem,[6] obesity frequently is present among physically inactive people with OA. It increases the risk of development and progression of lower-limb OA[7] and increases the risk of knee OA by 4 times compared with people with a body mass index (BMI) of <30 kg/m^2.[8] In addition, obesity has been shown to affect the joint mechanics[9] and cause inflammation among individuals with OA of the knee—an increased body mass can increase the mechanical stress on joints, causing disarrangements or abnormalities and a response in inflammatory mediators, resulting in increased pain.[10] An increase in fat surrounding the quadriceps muscles also may increase disability due to a decrease in lower-extremity performance.[11]

Regular physical activity is very important for maintaining muscle strength (force-generating capacity), joint structure, joint functioning, and bone health.[4] Weight-bearing physical activity has been shown to improve muscle strength and self-reported measures of pain and physical function among individuals with knee OA,[12] improve injury prevention,[13,14] improve balance control,[15] and improve proprioception.[16]

Fortunately, obesity, physical inactivity, and muscle weakness are modifiable risk factors of OA.[17] Physical activity, including walking, often is recommended for people with OA, people with obesity, and people with a combination of both conditions.[5,18–21] Although there is increasing evidence that suggests physical activity is associated with numerous physical, functional, and QoL benefits, 27.8% of people with OA engage in physical activity on a regular basis compared with 31.0% of those without arthritis.[22] The scientific literature, including a recent meta-analysis, suggests that physical activity with or without diet has therapeutic effects on pain, range of motion, muscle strength, and functional status.[21,23–28] Recent guidelines suggest physical activity or diet for adults with OA,[10,11] although these guidelines were not focused on a target population of adults who were obese or overweight.

As summarized in previous Ottawa Panel scientific articles, "Evidence-based clinical practice guidelines (EBCPGs) are precise statements on recommended interventions that are based on scientific literature and include a graded strength of evidence."[29] This EBCPG aims to use the Ottawa Panel's familiarity with EBCPGs[29–33] to contribute to the field of OA management by: (1) focusing on specific characteristics and needs of individuals with OA who are obese or overweight and (2) giving practitioners (family physicians, kinesiologists, dietitians, physical therapists, physiatrists, rheumatologists, and others) concise and up-to-

Table 1.
Combined Grading Recommendations[a]

Grade	Clinical Importance	Statistical Significance	Study Design
Grade A* (strongly recommended**)	≥15%	$P<.05$	RCT (single or meta-analysis)
Grade B*	≥15%	$P<.05$	CCT or observational (single or meta-analysis)
Grade C+* (use suggested**)	≥15%	Not significant	RCT/CCT or observational (single or meta-analysis)
Grade C* (neutral**)	<15%	Not significant	Any study design
Grade D* (neutral**)	<15% (favors control)	Not significant	Any study design
Grade D+* (use not suggested**)	<15% (favors control)	Not significant	RCT/CCT or observational (single or meta-analysis)
Grade D−* (strongly not recommended**)	≥15% (favors control)	$P<.05$ (favors control)	Well-designed RCT with >100 participants (if <100 participants, becomes a grade D recommendation)

[a] Combined grading recommendations according to the Ottawa Panel[29,33] for alphabetical grading system (indicated by asterisk) and to the Cochrane Collaboration (www.cochrane.org) for international nominal grading system (indicated by double asterisk). RCT=randomized controlled trial, CCT=clinical controlled trial.

date knowledge on physical interventions, especially physical activity with and without diet.

Method

This project used the same methods[26] as those of a previous study conducted by the Ottawa Panel on therapeutic exercise for patients with OA.[21] Methodological quality was graded using the Jadad scale,[34] a 5-point measure that gives 2 points for reliability and validity (ie, whether the study was double-blinded and whether the double-blinded method was appropriate), 2 points for randomization (ie, whether the study involved randomization and whether the randomization method was appropriate), and 1 point for explanation of participant withdrawals and dropouts.

In conjunction with the methods of previous Ottawa Panel publications,[29,33] the construction of EBCPGs was developed using the Appraisal of Guidelines Research and Evaluation (AGREE) criteria (www.agreecollaboration.org). The Ottawa Panel individual recommendations were graded as A, B, C, C+, D, D+, or D− based on the strength of evidence (Tab. 1). An alphabetical grading system was presented according to the Ottawa Panel methods,[29] marked with an asterisk in Table 1, and an additional alphabetical system recently adopted by the Cochrane Collaboration (www.cochrane.org) has the corresponding levels in parenthesis.

Literature Search

A library scientist conducted an extensive *a priori* literature search for articles related to obesity and OA of the knee in June 2009. Applying Cochrane Collaboration search techniques, the search included articles published from January 1, 1966, to November 31, 2010, and were extracted from the following databases: MEDLINE, EMBASE (Current Contents), SPORTDiscus, SUM, Scopus, CINAHL, AMED, BIOMED, PubMed, ERIC, the Cochrane Controlled Trials, and PEDro. A hand search of the reference lists of potential case-control studies (CCSs) also was performed.

Study Inclusion and Exclusion Criteria

The Ottawa Panel and research assistance team strictly applied the inclusion and exclusion criteria (Tab. 2) so that every included article met the specific intervention, study design, participant, and outcome criteria. These precise selection methods are described in previous Ottawa Panel publications.[29,33] These inclusion and exclusion criteria were approved through Ottawa Panel consensus.

Interventions

Studies that applied physical activity, diet, or both for the management of OA in adults who were obese or overweight were included. Studies were not included if interventions included surgery, injections to the lower extremities, medication for weight loss, medication for management of OA symptoms, acupuncture, or multidisciplinary and function restoration programs (Tab. 2).

Study Designs

Studies that were randomized controlled trials (RCTs), controlled clinical trials (CCTs), cohort studies, and head-to-head studies (eg, diet versus

Table 2.
Inclusion and Exclusion Criteria[a]

Inclusion	Exclusion
Interventions • Eligible control groups: placebo, untreated, routine conventional therapy, active physical therapy treatments, educational pamphlets (lifestyle modification) • Eligible interventions: physical activity (aerobic or strengthening, stretching), dietary modifications, behavioral support, electrotherapy	**Interventions** • Surgery or injections to lower-extremity joints • Medication for weight loss • Medication changes for management of OA symptoms • Multidisciplinary, functional restoration programs
Study Designs • Randomized controlled trials • Clinical controlled trials • Head-to-head comparison of physical activity and diet studies	**Study Designs** • Case series/case reports • Cohort studies • Case-control studies • Reviews and guidelines • Data without a mean and SD • Sample size of <5 participants per treatment group • Studies with >25% dropout rate
Participants • Outpatients or inpatients • Diagnosis of OA (lower extremity) • Age groups >18 y • Mixed population (only if OA and RA) • BMI ≥25.0 kg/m^2 for overweight and ≥30.0 kg/m^2 for obesity	**Participants** • Oncologic conditions • Pulmonary conditions • Neurologic conditions • Cardiac conditions • Dermatologic conditions • Pediatric conditions (juvenile arthritis) • Psychiatric conditions • No known pathology or impairments • Multiple conditions
Outcomes • Balance status • Body composition, girth, weight, BMI • Cardiopulmonary functions • Disease activity, progression • EMG activity • Functional status • Joint imaging • Mobility, flexibility, range of motion • Muscle force, endurance, power • Pain relief • Patient adherence • Patient satisfaction • Psychological well-being • Quality of life • Self-efficacy • Weight loss	**Outcomes** • Biochemical measures • Serum markers

[a] OA=osteoarthritis, RA=rheumatoid arthritis, SD=standard deviation, BMI=body mass index, EMG=electromyographic.

physical activity, as opposed to diet versus control) were included. Additionally, only articles published in English or French were included in order to diminish time and translation costs. Studies were excluded if they were uncontrolled cohort studies, case studies, reviews, or guidelines; were conducted with no comparison group; provided data without means and standard deviations; reported a ≥20% dropout rate; or had a sample of fewer than 5 patients per group (Tab. 2).

Participants

Studies must have had adult participants (>18 years of age) who were identified as overweight (BMI ≥25 kg/m^2) or obese (BMI ≥30 kg/m^2) and were affected by OA in the lower extremities.[6] Studies were excluded if participants had cancer or other oncologic conditions, pulmonary conditions, cardiac conditions, dermatological conditions, neurological conditions, other rheumatologic or musculoskeletal conditions, pediatric conditions (eg, juvenile arthritis), or psychiatric conditions (Tab. 2).

Outcomes

Several types of outcomes were of relevance for this article (Tab. 2). Note that researchers might have used different instruments to measure the same outcome (eg, one researcher might use the Lequesne Index to measure the concept of functional status, whereas another researcher might use the Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC]). Outcomes of primary interest were functional status (Lequesne Index, WOMAC), physical function (Medical Outcomes Study 36-Item Short-Form Health Survey questionnaire [SF-36] physical function score), self-efficacy (stair climbing test), pain scale (visual analog scale [VAS] score), endurance (Six-Minute Walk Test), stiffness (WOMAC stiffness score), strength (hamstring and quadriceps muscle strength), torque (concentric knee extension), body composition (waist circumference, body weight, BMI, lean body mass, and body fat mass), mental health (SF-36 mental health score), psychological well-being (physical function and body satisfaction measure), and mobility (walking speed) (Appendix). Articles were excluded if outcome measures were biomechanical measures, biochemical measures, or serum markers (Tab. 2).

Study Selection

Following the literature search, 2 reviewers from the research assistance team were trained by the Ottawa Panel to systematically classify the articles into inclusion and exclusion groups using the criteria

constructed by the Ottawa Panel (Tab. 2). Separately, the 2 reviewers read each article and compiled lists of articles to be included or excluded. When disagreement emerged, the primary investigator of the Ottawa Panel was consulted, and a consensus was reached on the ultimate placement of the article.

Data Extraction and Methodological Quality Assessment

The 2 reviewers from the research assistance team independently extracted data from the articles retrieved from the literature search with the use of data extraction forms. Information of interest included study design, intervention, treatment groups, method, results, and quality scoring information. The quality scoring information was used to assess the articles according to the Jadad scale.

Data Analysis

To analyze the data, the Ottawa Panel applied a Cochrane Collaboration statistical analysis similar to that of past Ottawa Panel publications.[29,33] The weighed mean difference (WMD), the absolute benefit, and the percentage of relative change between intervention and control groups were calculated using continuous data. Relative risks were utilized to analyze dichotomous data (ie, data that can easily be separated into 2 or more categories). Calculations were made with the Review Manager (RevMan) computer software program.*

Results

Literature Search

From the November 2010 search, the library scientist found 114 articles on the management of OA in adults who were obese or overweight. Of these articles, 63 were identified as potentially relevant.

The Ottawa Panel and the research assistance team ultimately agreed, according to the inclusion and exclusion criteria (Tab. 2), on the selection of 10 articles that were CCSs[35–44] (see Appendix and eAppendix, available at ptjournal.apta.org). Initial disagreements on CCS selection were resolved through Ottawa Panel consensus.

Fifty-three studies were excluded for various reasons. Studies were excluded if they showed no intervention,[45–62] if they were not clinical trials,[4,9,63–74] if they possessed irrelevant outcome measures,[75–78] if they were CCSs,[79] if they were cohort analytic studies,[80] if they contained gastroplasty interventions,[81] if they did not have any controls,[82] if there were no data past baseline,[83] if the dropout rate was ≥20%,[84] if they were literature reviews,[27,85] if they were case series,[86] if there was no description of weight loss,[87] if the study population did not have OA,[88–90] if there were no comparison groups,[91] if there were no group results,[92] or if they were concurrent studies involving nonsteroidal anti-inflammatory drugs or medicinal weight loss interventions.[93,94]

Methodological Quality

The Jadad scale identified 5 articles[35,37,38,44,50] as being of high methodological quality (≥3) and the remaining 5 trials as being of low methodological quality,[36,39,40,42,43] due mainly to the double-blindness criterion. Although they achieved a low score, these studies had good methods and were included in our database. The methodological quality level, however, was mentioned with each recommendation (Appendix) and detailed in the eAppendix. The Ottawa Panel agreed that it is difficult to implement a double-blindness criterion for interventions that include aerobic physical activity (ie, no matter the alternative proposed, the patients will know whether they participated in an aerobic physical activity program). More weight was given to whether the study method involved randomization, rather than double blinding (see Appendix and eAppendix for a summary of the trials).

Effectiveness of Physical Activity or Diet for OA and Obesity

Due to publication restrictions, only the CCSs[35,37,38,50] with a methodological quality of ≥3 according to the Jadad scale[34] will be presented in the following section. For the same reason, only 2 figures among 50 were selected (see Appendix and the eAppendix for an overview of the results of all the included CCSs).

In regard to low-energy diet versus conventional high-protein diet (control), an RCT by Christensen et al[35] (N=96) (Tab. 3, Fig. 1; also see Appendix and eAppendix) showed clinically important benefits with statistical significance for improved functional status (WOMAC total score) at end of treatment (8 weeks) (relative difference=−24%) and for improved physical function (WOMAC function score) at end of treatment (relative difference=−26%) (results not shown). Clinical significance without statistical significance was found for improved pain relief (WOMAC pain score) at end of treatment (relative difference=−15%) and for reduced stiffness (WOMAC stiffness score) at end of treatment (relative difference=−17%) (results not shown).

For the intervention of exercise and diet versus healthy lifestyle (control), an RCT by Focht et al[41] (N=252) (see Appendix and eAppendix) exhibited clinically important benefits without statistical significance for improved self-efficacy on stairs (stair climbing) at end of treat-

* Copenhagen, Denmark: The Nordic Cochrane Centre, The Cochrane Collaboration (www.Cochrane.org).

Table 3.
Results for the Relative Difference for Low-Energy Diet Versus Conventional High-Protein Diet[a]

Study	Treatment Group	Outcome	No. of Participants	Baseline Mean	End-of-Study Mean	Absolute Benefit	Relative Difference in Change From Baseline	WMD/95% CI
Christensen et al[35] (2005)	Low-energy diet	Lean body mass (kilograms) Higher is better End of treatment (8 wk)	40	50.6	47.6	−1.80	−4%	WMD: 1.80 CI low: 0.69 CI high: 2.91
	Conventional high-protein diet		40	51.1	49.9			

[a] WMD=weighted mean difference, CI=confidence interval.

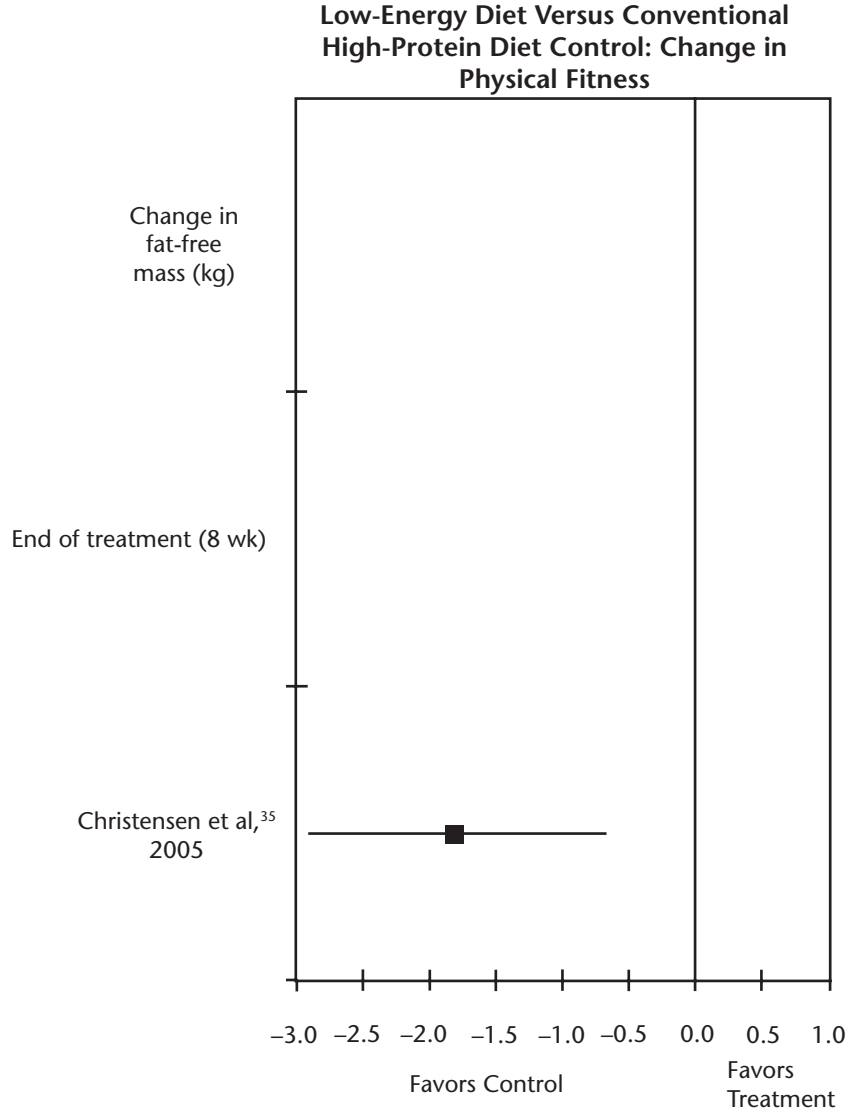

Figure 1.
Low-energy diet versus conventional high-protein diet (control): change in physical fitness.

ment (18 months) (relative difference=17%). Moreover, it showed clinically important benefits with statistical significance for improved self-efficacy in walking (Six-Minute Walk Test) at end of treatment (relative difference=20%) (Tab. 4, Fig. 2).

A study by Messier et al[37] (N=252), which measured the effects of exercise and diet versus healthy lifestyle (control) (see Appendix and eAppendix), showed clinically important benefits with statistical significance for improved endurance (Six-Minute Walk Test) at end of treatment (6-month assessment) (relative difference=17%) and at end of treatment (18-month assessment) (relative difference=16%) (results not shown). Clinically important benefits without statistical significance were demonstrated for improved mobility (stair climbing) at end of treatment (6-month assessment) (relative difference=25%) and end of treatment (18-month assessment) (relative difference=23%) (results not shown).

Interestingly, the CCSs with higher methodological quality[35,37,38,41] also obtained positive results (grades A and C+) for several clinical outcomes when there were comparisons between exercise only and the control intervention and between

Table 4.
Results for the Relative Difference for Exercise and Diet Versus Healthy Lifestyle (Control)[a]

Study	Treatment Group	Outcome	No. of Participants	Baseline Mean	End-of-Study Mean	Absolute Benefit	Relative Difference in Change From Baseline	WMD/95% CI
Focht et al[41] (2005)	Exercise and diet	Self-efficacy (stair climbing) Higher is better End of treatment (18 mo)	58	63.84	77.25	11.37	17%	WMD: −4.97 CI low: −13.98 CI high: 4.04
	Healthy lifestyle		67	70.24	72.28			
Focht et al[41] (2005)	Exercise and diet	Self-efficacy (Six-Minute Walk Test) Higher is better End of treatment (18 mo)	58	66.44	84.95	13.49	20%	WMD: −12.05 CI low: −21.97 CI high: −2.13
	Healthy lifestyle		67	67.88	72.9			
Messier et al[37] (2004)	Exercise and diet	WOMAC pain score Lower is better End of treatment (6 mo)	63	7.27	5.47	−0.74	−10%	WMD: −0.72 CI low: −2.01 CI high: 0.57
	Healthy lifestyle		70	7.25	6.19			
Messier et al[37] (2004)	Exercise and diet	WOMAC pain score Lower is better End of treatment (18 mo)	58	7.27	5.07	−0.97	−13%	WMD: −0.95 CI low: −2.22 CI high: 0.32
	Healthy lifestyle		67	7.25	6.02			

[a] WMD=weighted mean difference, CI=confidence interval, WOMAC=Western Ontario and McMaster Universities Osteoarthritis Index.

diet only and the control intervention. The results showed a larger number of grades A and C+ when exercise and diet were combined compared with the control intervention (Appendix). It should be noted that Rejeski et al,[38] in an RCT with similar comparative groups,[35,37,41] showed positive recommendations for psychological well-being and QOL. There were no grade B recommendations.

A grade A recommendation (Tab. 1), according to the Ottawa Panel grading system, was obtained in those RCTs that were found to be both clinically and statistically significant. The following outcomes received a grade A recommendation: psychological well-being,[38] functional status,[35,36,40] strength,[36,43] torque,[43] mobility,[38,40,42] walking endurance,[39] self-efficacy during stair climbing,[41] self-efficacy in walking,[41] pain relief,[36,40,42] and body composition.[36,40]

A grade C+ recommendation (Tab. 1) was given by the Ottawa Panel for an RCT or CCT with clinical but not statistical significance. Grade C+ recommendations were found for psychological well-being,[38] body composition,[35,36,43] functional status,[35] pain relief,[35,40] transfer pain frequency,[39] transfer pain intensity,[39] stiffness relief,[35] self-efficacy during stair climbing,[41] self-efficacy in walking,[41] mobility,[37] and torque.[45]

A grade C recommendation (Tab. 1) was granted by the Ottawa Panel when neither clinical significance nor statistical significance was found. These outcomes included mental status,[38] functional status,[35,36,38,39] psychological well-being,[38] body composition,[35,36,43] walking endurance,[36,37,39,40] mobility,[37,39,42] self-efficacy on stairs,[41] self-efficacy in walking,[41] pain relief,[37,42] ambulation pain frequency,[39] transfer pain intensity,[39] transfer pain frequency,[39] strength,[36] and torque.[43]

A grade D recommendation (Tab. 1) was given for outcomes that demonstrated clinical importance favoring the control group of less than 15%. Ottawa Panel grade D recommendations were given for: pain relief,[37,39] functional status,[39] stiffness,[40] body composition,[35,36,40] strength,[36] and mental status.[38]

A grade D+ recommendation (Tab. 1) was given to outcomes demonstrating clinical importance favoring control of ≥15% for the control

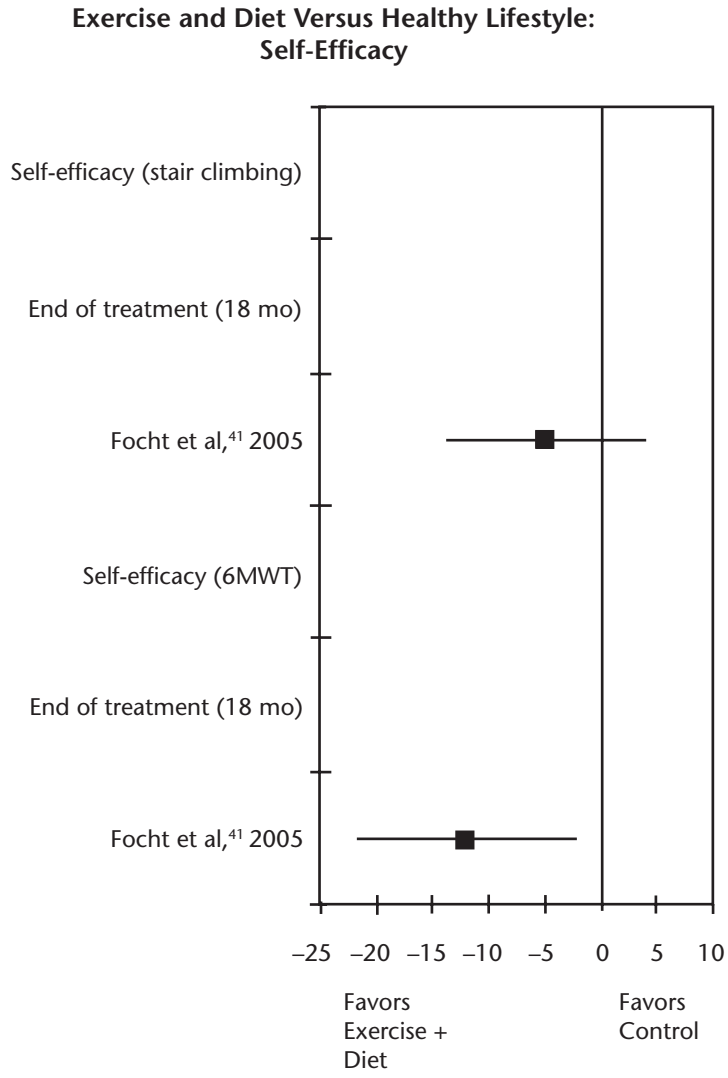

Figure 2.
Exercise and diet versus healthy lifestyle (control): self-efficacy. 6MWT=Six-Minute Walk Test.

group. Only one outcome, pain relief,[39] received a D+ grade.

Lastly, grade D− recommendations (Tab. 1) were given for outcomes that showed both clinical and statistical significance favoring the control group. According to the Ottawa Panel grading system, psychological well-being[38] received a D− grade.

Discussion

The Ottawa Panel was able to demonstrate that, when comparing physical activity alone, diet alone, physical activity combined with diet, and control interventions, the intervention including physical activity and diet produced the most beneficial results (a total of 86 positive recommendations: 22 grade A and 23 grade C+), specifically in clinical outcomes such as pain relief, strength, functional status, and QoL.

However, the Ottawa Panel recommendations regarding weight loss (<5%) and body composition changes in study participants with OA who were obese or overweight were not as convincing. Although 5% weight loss combined with physical activity provided improvement in clinical outcomes, the weight loss was not sufficient to slow the disease progression.[37]

Christensen et al[35] showed that a low-energy diet was more effective in improving functional status and physical function than a conventional high-protein diet, and a strong negative correlation was shown between increases in physical function and decreases in percentage of body fat among an elderly population. Focht et al[41] showed that physical activity and diet can improve self-efficacy in walking, strength, pain relief, and functional status. The intervention period was a sufficient length (18 months), and the study had a sufficient sample size (N=316). Messier et al[37] used a physical activity and diet intervention for a sufficient length of time (6 and 18 months) with a large and adequate sample size (N=316). The results of this study showed that the combination of physical activity and diet improved mobility, pain relief, and endurance. The results also showed that intensive weight loss improved functional status, pain relief, mobility, endurance, and torque. Rejeski et al[38] had adequate diet and physical activity intervention periods (6 and 18 months) with a large sample size (N=316). This study was unique, as it assessed QoL as an outcome measure using the SF-36. The results of this study were interesting, as they favored the control group.

Lim et al[44] demonstrated several differences with various exercise modes among individuals with OA. Aquatic exercise including endurance, strength, and aerobic training was shown to be more effective in reducing pain compared with a home-based exercise program consisting of strengthening exercises.[44] Land-based exercise performed in

a gym that included strength, aerobic, stretching, and range-of-motion training was shown to be more effective in reducing pain compared with a home-based exercise program consisting of strengthening exercises (Appendix).[44]

The significant pain relief despite nonsubstantial weight loss among study participants with OA who were obese or overweight can be attributed to the beneficial effects of exercise on the musculoskeletal system.[36–38] The significant improvements in functional outcomes, despite a relatively low percentage of weight loss, among study participants with OA who were obese or overweight may be attributed to the beneficial effects of exercise on the cardiovascular and neuromuscular systems. Regular physical activity induced improvements in endurance, strength, and balance, which resulted in improved abilities to perform activities of daily living and improved participation in leisure activities.

The significant improvements in QoL among study participants with OA who were obese or overweight may be a reflection of mental health and social benefits associated with the participation in physical activities. Physical activity promotes psychological well-being by reducing feelings of fatigue, depression, and anxiety and improving self-esteem, confidence, concentration, and mental awareness. The social benefits of participation in physical activity include a reduction in the sense of isolation and loneliness, improved social networks and social capital, and increased community connectedness and cohesion.

The recent conceptual framework underlying the Intensive Diet and Exercise for Arthritis (IDEA) study protocol[17] proposed that weight loss, which would reduce joint load and inflammation, may improve mobility, body composition, and strength and result in reduced pain and an enhanced functional outcome and QoL in individuals with OA who are obese. A multidisciplinary team is recommended to investigate the complex health complications related to obesity.[95] Weight loss can be facilitated by dietitians, and physical therapists play a key role in enrolling individuals who are obese or overweight in lower-extremity muscle strengthening and balance exercise programs[74,96–98] after significant weight loss[9] in order to maintain and develop lean muscle mass,[91] to improve the biomechanics and stability of the knee, and to indirectly slow down the progression of knee OA.[99–101] These biomechanical improvements can potentially reduce pain and enhance functional status in individuals with OA who are obese.

Behavioral strategies such as patient education, health counseling, realistic and achievable goal setting, telephone contacts, 7-day physical activity and dietary logs, social/peer support, self-management, self-efficacy, and positive feedback, either alone or in numerous combinations, have been studied in populations without OA and should be explored in depth in individuals with OA who are obese or overweight.[102,103] However, relapse after weight loss in individuals with no specific disability is rampant even with behavioral interventions.[104] This may be an additional challenge, especially in older individuals who are disabled.

Although the Ottawa Panel members cannot strongly support the positive recommendations that emerged from the CCSs with lower methodological quality,[36,39,40,42,43] these CCSs provide good research hypotheses that can be further explored for future RCTs related to: (1) intensive diet[40,42] (2) combined pain therapy,[43] (3) longer follow-up,[36,37] and (4) more-quantitative outcomes to measure weight loss[36] (Appendix).

Limitations

Although the Ottawa Panel guidelines were developed using rigorous quantitative methods,[36] a potential publication bias may have occurred because only those articles written in English and French were included. This selection process inevitably misrepresents the amount of research that has been conducted on OA and obesity globally. Additionally, the Ottawa Panel is made up of clinical experts from North America as opposed to being more internationally focused with clinical practitioners and researchers outside of North America, such as those people who make up the Osteoarthritis Research Society International (OARSI) Panel. The current Ottawa Panel recommendations demonstrated herein differ from the 2008 recommendations produced by the OARSI[18] in that the Ottawa Panel examined the efficacy of physical activity and diet programs in the management of OA in adults who were obese or overweight and did not include surgical or pharmacological interventions.

Of the included studies, 2 showed limitations: the study by Christensen el al[35] had a small study sample (N=71) and a short intervention length (8 weeks), and the study by Miller et al[40] focused solely on the outcomes of an intensive weight loss intervention. The intervention duration was sufficient (6 months); however, the study sample size was quite small (N=87). The D grades (ie, clinical importance is <15% and favors control) in functional status and pain relief are somewhat misleading. A total of 3 D grades were given in head-to-head studies (eg, diet versus physical activity) in which physical

activity alone was favored over a combination of diet and physical activity.[17,36]

The methodological quality (ie, the type and duration) of diet or physical activity programs must be taken into consideration (Appendix). It is not certain why the physical activity groups fared better for these outcomes compared with the combined diet and physical activity groups. We hypothesize that: (1) physical activity improved functional measures, (2) diet improved self-report measures, and (3) diet and physical activity improved both functional and self-report measures.

Although radiographic evidence is primarily used for the diagnosis of OA, there may be difficulties with the diagnosis if there is a lack of either physical or laboratory findings, causing an inconsistency between symptoms and the results of the radiographic examinations.[105] In these situations, classic clinical criteria for knee OA and grading scales are used to support and clarify the diagnosis.[105]

The Jadad scale was selected over other quality measure alternatives, such as the PEDro scale, to remain consistent with Cochrane Collaboration methods. Olivo et al[106] found that the Jadad scale exhibits the best psychometric quality for assessing the methodological quality of CCTs, even though single- and double-blind studies are difficult to conduct[107] in OA and obesity research. However, sound methodological research in this area is both necessary and important. To the knowledge of the Ottawa Panel, there is no conclusive evidence on the most appropriate methodological scale to apply for OA and obesity research. The use of BMI, waist circumference, and body weight as valid indicators of successful weight loss in individuals with OA is debatable because these measurements do not discriminate between lean and fat body mass.[108] Body composition measurements are more valid.[29]

Further research should examine other alternative therapies for weight reduction that were not included in this review. Toda[109] found some physical benefits of mazindol diet pills for weight reduction in an elderly population (ie, 45–69 years of age) in Japan. Such results prompt further discussion on the use of diet pills and whether their regular usage would be beneficial or practical (eg, cost) for specific populations of people with knee OA (ie, elderly people, people who are obese or overweight). Although both strengthening and aerobic exercises are effective for OA,[110,111] another interesting topic that warrants further research and that would help address more-specific activity prescription is the differences in aerobic versus resistance training activity.

Three groups of studies—Messier et al[37] (2004) and Rejeski et al[38] (2002); Messier et al[39] (2000), Miller et al[40] (2006), and Messier et al[17] (2009); and Focht et al[41] (2005), Wang et al[43] (2007), Focht et al[50] (2002), and Focht et al[51] (2004)— come from the same laboratory, which may misrepresent the depth of available research and may bias the conclusions that can be derived from a limited database. Adults with OA who are obese or overweight are a challenging population to study because it is not known exactly how many of the physical impairments are due to weight problems versus the joint condition.[35] Because individuals with OA generally are older, they also have many associated medical conditions. There also is evidence from a relatively large randomized subject pool (N=316) that participants with comparatively less pain at baseline demonstrated more benefits at follow-up.[41] More research is needed on how programs for managing OA for individuals with obesity can be optimally adjusted to maximize benefits for various levels of knee OA disability.

Implications for Practice

The Ottawa Panel found important evidence to support the use of diet or physical activity programs for the overall management of OA of the knee. Results of positive recommendations (grades A and C+) from included studies with high methodological quality (Jadad scale score 3)[20,37,38,41,44] indicate that diet or physical activity programs were promising for short-term (6-month) pain relief (2 grade A recommendations, 6 grade C+ recommendations); for long-term follow-up (18-month) pain relief (3 grade C+ recommendations); and for the improvement of torque (2 grade C+ recommendations), functional status (2 grade A recommendations, 2 grade C+ recommendations), self-efficacy (2 grade A recommendations, 2 grade C+ recommendations), endurance (2 grade A recommendations), mobility (1 grade A recommendation, 3 grade C+ recommendations), and psychological well-being (2 grade A recommendations, 1 grade C+ recommendation). Groups that received both physical activity and diet produced the best results compared with physical activity–only groups, diet-only groups, and control groups.

The Ottawa Panel recommends reducing weight prior to the implementation of weight-bearing exercise to maintain joint integrity and to avoid joint disease and dysfunction. The Ottawa Panel also recommends the inclusion of diet or physical activity programs in the management of OA among individuals who are obese or overweight. Because physical therapists are not experts in diet, it is suggested that they work with an interdisciplinary

team including dietitians. Additional research is needed on the specific components of the interventions that produced clinical benefits for the older adult populations so that treatment can become more standardized and easier to prescribe by practitioners and clinicians. Lastly, more knowledge is needed on how OA management programs can be better tailored to increase long-term adherence, especially among people with OA who are obese or overweight.

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Appendix.

Ottawa Panel Recommendations[a]

1. **Physical activity (aerobic training and strength training) versus control, level I (1 RCT, N=56, low quality).[36] Grade A** for pain relief (VAS score), functional status (WOMAC score), and strength (quadriceps and hamstring muscle strength) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C+** for body composition (waist circumference) at end of treatment (8 weeks) (clinically important benefit demonstrated without statistical significance). **Grade C** for functional status (Lequesne Index), walking endurance (6MWT), and body composition (body weight, BMI [kg/m^2], and lean body mass [kg]) at end of treatment (8 weeks) (no benefit demonstrated). **Grade D** for body composition (lean body mass [%]) at end of treatment (8 weeks) (no benefit demonstrated but favoring control).

2. **Physical activity (aerobic training and strength training) and diet (caloric restriction of 25%–30%, 1,500–3,000 cal/d) versus control, level I (1 RCT, N=56, low quality).[36] Grade A** for pain relief (VAS score), functional status (WOMAC score, Lequesne Index), body composition (waist circumference), and strength (quadriceps and hamstring muscle strength) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C** for body composition (lean body mass, fat body mass, body weight [kg], and BMI [kg/m^2]) and walking endurance (6MWT) at end of treatment (8 weeks) (no benefit demonstrated).

3. **Diet (caloric restriction of 25%–30%, 1,500–3,000 cal/d) versus control, level I (1 RCT, N=56, low quality).[36] Grade A** for pain relief (VAS score) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C** for functional status (WOMAC score, Lequesne Index), walking endurance (6MWT), body composition (body weight, BMI [kg/m^2], waist circumference, fat body mass, and lean body mass), and strength (quadriceps muscle strength) at end of treatment (8 weeks) (no benefit demonstrated). **Grade D** for strength (hamstring muscle strength) at end of treatment (8 weeks) (no benefit demonstrated but favoring control).

4. **Physical activity (aerobic training and strength training) versus diet (caloric restriction of 25%–30%, 1,500–3,000 cal/d), level I (1 RCT, N=56, low quality).[36] Grade C+** for improved strength (quadriceps and hamstring muscle strength) at end of treatment (8 weeks) (clinically important benefit demonstrated without statistical significance). **Grade C** for pain relief (VAS score), functional status (WOMAC score, Lequesne Index), walking endurance (6MWT), and body composition (body weight, BMI [kg/m^2], lean body mass, waist circumference, and fat body mass) at end of treatment (8 weeks) (no benefit demonstrated).

5. **Physical activity (aerobic training and strength training) versus physical activity (aerobic training and strength training) and diet (caloric restriction of 25%–30%, 1,500–3,000 cal/d), level I (1 RCT, N=56, low quality).[36] Grade A** for functional status favoring diet and physical activity (Lequesne Index) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C+** for pain relief favoring diet and physical activity (VAS score) at end of treatment (8 weeks) (clinically important benefit demonstrated without statistical significance). **Grade C** for functional status (WOMAC score), walking endurance (6MWT), body composition (body weight, BMI [kg/m^2], waist circumference, lean body mass, fat body mass), and strength (quadriceps and hamstring muscle strength) at end of treatment (8 weeks) (no benefit demonstrated).

6. **Diet (caloric restriction of 25%–30%, 1,500–3,000 cal/d) versus physical activity (aerobic training and strength training) and diet (caloric restriction of 25%–30%, 1,500–3,000 cal/d), level I (1 RCT, N=56, low quality).[36] Grade A** for pain relief favoring diet and physical activity (VAS score), functional status favoring diet and physical activity (WOMAC score), and functional status favoring diet and physical activity (Lequesne Index) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C+** for strength favoring diet and strength (quadriceps and hamstring muscle strength) at end of treatment (8 weeks) (clinically important benefit demonstrated without statistical significance). **Grade C** for walking endurance (6MWT) and body composition (body weight, BMI [kg/m^2], waist circumference, lean body mass, and fat body mass) at end of treatment (8 weeks) (no benefit demonstrated).

7. **Intensive physical activity (aerobic training, strength training) and intensive diet (deficit of 1,000 kcal/d, 20% protein, 25% fat, 55% carbohydrate diet) versus control, level I, (2 RCTs, N=174, low quality).[40,43] Grade A** for functional status (WOMAC sum score),[40] pain relief (WOMAC pain score),[40] physical function (WOMAC function score),[40] mobility (stair climbing time),[40] and torque (concentric knee extensors) at end of treatment (6 months)[43] (clinically important benefit demonstrated). **Grade C+** for force (concentric knee extension)[43] and torque (eccentric knee extension/lean mass)[43] at end of treatment (6 months) (clinically important benefit demonstrated without statistical significance). **Grade C** for walking endurance (6MWT),[40] force (eccentric knee extension),[43] and body composition (body weight, BMI [kg/m^2], waist circumference, and fat body mass)[40] at end of treatment (6 months) (no benefit demonstrated). **Grade D** for stiffness (WOMAC stiffness score)[40] and body composition (lean body mass)[40] at end of treatment (6 months) (no benefit demonstrated, but results favored the control group).

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8. **Diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) versus control, level I (1 RCT, N=316, low quality).[38] Grade C** for quality of life (SF-36 mental health and physical function scores) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated). **Grade D−** for psychological well-being (physical function and body satisfaction measure) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit favoring control demonstrated with statistical significance).

9. **Physical activity (aerobic [50%–75% HRR] and resistance training) versus diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) and physical activity (aerobic [50%–75% HRR] and resistance training), level I (1 RCT, N=316, low quality).[38] Grade A** for psychological well-being (physical function and body satisfaction measure) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit demonstrated favoring physical activity). **Grade C** for quality of life (SF-36 mental health and physical function scores) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated).

10. **Diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) and physical activity (aerobic [50%–75% HRR] and resistance training) versus control, level 1 (1 RCT, N=316, low quality).[38] Grade C** for quality of life (SF-36 physical function score) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated). **Grade D** for quality of life (SF-36 mental health score) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated, but results favored the control group). **Grade D−** for psychological well-being (physical function and body satisfaction measure) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit favoring control demonstrated with statistical significance).

11. **Diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) versus physical activity (aerobic [50%–75% HRR] and resistance training), level I (1 RCT, N=316, low quality).[38] Grade C+** for psychological well-being (body satisfaction measure–physical function) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit demonstrated without statistical significance favoring diet only). **Grade C+** for psychological well-being (body satisfaction measure–appearance) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit demonstrated without statistical significance favoring physical activity). **Grade C** for quality of life (SF-36 mental health and physical function scores) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated).

12. **Diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) versus diet (aerobic [50%–75% HRR] and resistance training) and physical activity (aerobic [50%–75% HRR] and resistance training), level I (1 RCT, N=316, low quality).[38] Grade A** for improved psychological well-being (body satisfaction measure–physical function) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit demonstrated favoring diet). **Grade C** for psychological well-being (body satisfaction measure–appearance) and quality of life (SF-36 physical function score) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated).

13. **Physical activity (aerobic [50%–75% HRR] and resistance training) versus diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) and physical activity (aerobic [50%–75% HRR] and resistance training), level I (1 RCT, N=316, low quality).[38] Grade A** for psychological well-being (physical function and body satisfaction measure) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit demonstrated favoring physical activity). **Grade C** for mental status (SF-36 mental health and physical function scores) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated).

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14. **Diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) and physical activity (aerobic [50%–75% HRR] and resistance training) versus control, level I (1 RCT, N=316, low quality).[38] Grade C** for quality of life (SF-36 physical function score) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated). **Grade D** for quality of life (SF-36 mental health score) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated but favoring control). **Grade D−** for psychological well-being (physical function and body satisfaction measure–appearance) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit favoring control demonstrated with statistical significance).

15. **Diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) versus physical activity (aerobic [50%–75% HRR] and resistance training), level I (1 RCT, N=316, low quality).[38] Grade C+** for psychological well-being (body satisfaction measure–physical function) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit demonstrated without statistical significance favoring diet). **Grade C+** for psychological well-being (body satisfaction measure–appearance) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit demonstrated without statistical significance favoring physical activity). **Grade C** for quality of life (SF-36 mental health and physical function scores) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated).

16. **Diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) versus diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) and physical activity (aerobic [50%–75% HRR] and resistance training), level I (1 RCT, N=316, low quality).[38] Grade A** for psychological well-being (body satisfaction measure–physical function) at average between the 6-month follow-up and the 18-month assessment at end of treatment (clinically important benefit demonstrated favoring diet). **Grade C** for psychological well-being (body satisfaction measure–appearance) and quality of life (SF-36 mental health and physical function scores) at average between the 6-month follow-up and the 18-month assessment at end of treatment (no benefit demonstrated).

17. **Low energy diet versus conventional high protein diet (control), level I (1 RCT, N=96, high quality).[35] Grade A** for functional status (WOMAC total score) and physical function (WOMAC function score) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C+** for pain relief (WOMAC pain score) and stiffness (WOMAC stiffness score) at end of treatment (8 weeks) (clinically important benefit demonstrated without statistical significance). **Grade C** for body composition (body weight [kg], fat body mass [kg], fat body mass [%]) and functional status (Lequesne index score [0–26]) at end of treatment (8 weeks) (no benefit demonstrated). **Grade D** for body composition (lean body mass [kg]) at end of treatment (8 weeks) (no benefit demonstrated but favoring control).

18. **Physical activity (strength training and aerobic training) and diet (patient education and cognitive-behavioral modification strategies) versus physical activity (strength training and aerobic training), level I (3 RCTs, N=656)[37,39,41] (1 RCT[37] is high quality, 2 RCTs[39,41] are low quality). Grade C+** for pain relief (transfer pain frequency and transfer pain intensity)[39] at end of treatment (3 months), pain relief (WOMAC pain score)[37] at end of treatment (6 and 18 months), and self-efficacy on stairs (stair climb)[41] at end of treatment (18 months) (clinically important benefit demonstrated without statistical significance favoring physical activity and diet). **Grade C** for pain relief (ambulation pain frequency)[39] at end of treatment (3 months and 6 months), pain relief (transfer pain intensity and transfer pain frequency)[39] at end of treatment (6 months), walking endurance (6MWT)[37,39] at end of treatment (3 months,[39] 6 months,[37,39] and 18 months[37]), mobility (stair climbing)[37,39] at end of treatment (3 months,[39] 6 months,[37,39] and 18 months[37]), functional status (transfer self-reported function) at end of treatment (3 months),[39] functional status (ambulation self-reported function, transfer self-reported function, summary self-reported function) at end of treatment (6 months)[39] and self-efficacy in walking (6MWT) at end of treatment (18 months)[41] (no benefit demonstrated). **Grade D** for pain relief (ambulation pain intensity)[39] and functional status (ambulation self-reported function, summary self-reported function) at end of treatment (3 months)[39] (no benefit demonstrated, but results favored physical activity). **Grade D+** for pain relief (ambulation pain intensity) at end of treatment (6 months)[39] (clinically important benefit demonstrated favoring physical activity without statistical significance).

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19. **Physical activity (strength training and aerobic training) and diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) versus control, level I (2 RCTs, N=632)[37,41] (1 RCT[37] is high quality, 1 RCT[41] is low quality). Grade A** for walking endurance (6MWT)[37] at end of treatment (6 months and 18 months) and self-efficacy (stair climbing and 6MWT)[41] at end of treatment (18 months) (clinically important benefit demonstrated). **Grade C+** for mobility (stair climbing)[37] at end of treatment (6 months and 18 months) (clinically important benefit demonstrated without statistical significance). **Grade C** for pain relief (WOMAC pain score)[37] at end of treatment (6 months and 18 months) (no benefit demonstrated).

20. **Physical activity (strength training and aerobic training) and diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) versus diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%), level I (2 RCTs, N=632)[37,41] (1 RCT[37] is high quality, 1 RCT[41] is low quality). Grade A** for self-efficacy in walking (6MWT)[41] at end of treatment (18 months) (clinically important benefit demonstrated favoring physical activity and diet). **Grade C+** for mobility (stair climbing)[37] at end of treatment (6 months), pain relief (WOMAC pain score)[37] at end of treatment (18 months), and self-efficacy (stair climbing)[41] at end of treatment (18 months) (clinically important benefit demonstrated without statistical significance favoring physical activity and diet). **Grade C** for walking endurance (6MWT)[37] at end of treatment (6 months and 18 months), mobility (stair climbing)[37] at end of treatment (18 months), and pain relief (WOMAC pain score)[37] at end of treatment (6 months) (no benefit demonstrated).

21. **Physical activity (strength training and aerobic training) versus control, level I (2 RCTs, N=632)[37,41] (1 RCT[37] is high quality, 1 RCT[41] is low quality). Grade C+** for mobility (stair climbing)[37] at end of treatment (6 months) (clinically important benefit demonstrated without statistical significance). **Grade C** for walking endurance (6MWT)[37] at end of treatment (6 months and 18 months), mobility (stair climbing)[37] at end of treatment (18 months), pain relief (WOMAC pain score)[37] at end of treatment (6 months and 18 months), and self-efficacy (stair climbing,[41] 6MWT[41]) at end of treatment (18 months) (no benefit demonstrated).

22. **Physical activity (strength training and aerobic training) versus diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%), level I (2 RCTs, N=632)[37,41] (1 RCT[37] is high quality, 1 RCT[41] is low quality). Grade A** for mobility (stair climbing)[37] at end of treatment (6 months) (clinically important benefit demonstrated favoring physical activity). **Grade C+** for pain relief (WOMAC pain score)[37] at end of treatment (6 months) (clinically important benefit demonstrated without statistical significance favoring diet). **Grade C** for walking endurance (6MWT)[37] at end of treatment (6 months and 18 months), mobility (stair climbing)[37] at end of treatment (18 months), pain relief (WOMAC pain score)[37] at end of treatment (18 months), and self-efficacy (stair climbing[41] and 6MWT[41]) at end of treatment (18 months) (no benefit demonstrated).

23. **Diet (behavior modification, lower caloric intake based on group dynamics literature and social-cognitive theory, average weight loss of 5%) versus control, level I (2 RCTs, N=632)[37,41] (1 RCT[37] is high quality, 1 RCT[41] is low quality). Grade C** for walking endurance (6MWT)[37] at end of treatment (6 months and 18 months), mobility (stair climbing)[37] at end of treatment (6 months and 18 months), pain relief (WOMAC pain score)[37] at end of treatment (6 months), and self-efficacy (stair climbing,[41] 6MWT[41]) at end of treatment (18 months) (no benefit demonstrated). **Grade D** for pain relief (WOMAC pain score)[37] at end of treatment (18 months) (no benefit demonstrated, but results favored the control group).

24. **Diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture and electrotherapy versus diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture for patients with stage 2 OA, level I (1 RCT, N=126, low quality).[42] Grade A** for pain relief (VAS pain) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C** for mobility (walking speed) at end of treatment (8 weeks) (no benefit demonstrated).

25. **Diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture and electrotherapy versus electrotherapy for patients with stage 2 OA, level I (1 RCT, N=126, low quality).[42] Grade A** for pain relief (VAS pain) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C** for mobility (walking speed) at end of treatment (8 weeks) (no benefit demonstrated).

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26. **Diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture versus electrotherapy for patients with stage 2 OA, level I (1 RCT, N=126, low quality).[42] Grade C** for pain relief (VAS pain) and mobility (walking speed) at end of treatment (8 weeks) (no benefit demonstrated).

27. **Diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture and electrotherapy versus diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture for patients with stage 3 OA, level I (1 RCT, N=126, low quality).[42] Grade A** for pain relief (VAS pain) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C** for mobility (walking speed) at end of treatment (8 weeks) (no benefit demonstrated).

28. **Diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture versus electrotherapy for patients with stage 3 OA, level I (1 RCT, N=126, low quality).[42] Grade A** for pain relief (VAS pain) and mobility (walking speed) at end of treatment (8 weeks) (clinically important benefit demonstrated).

29. **Diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture versus electrotherapy for patients with stage 3 OA, level I (1 RCT, N=126, low quality).[42] Grade A** for mobility (walking speed) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C** for pain relief (VAS pain) at end of treatment (8 weeks) (no benefit demonstrated).

30. **Diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture and electrotherapy versus diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture for patients with stage 4 OA, level I (1 RCT, N=126, low quality).[42] Grade A for** pain relief (VAS pain) at end of treatment (8 weeks) (clinically important benefit demonstrated). **Grade C** for mobility (walking speed) at end of treatment (8 weeks) (no benefit demonstrated).

31. **Diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture and electrotherapy versus electrotherapy for patients with stage 4 OA, level I (1 RCT, N=126, low quality).[42] Grade A** for pain relief (VAS pain) at end of treatment (8 weeks) (important benefit demonstrated). **Grade C** for mobility (walking speed) at end of treatment (8 weeks) (no benefit demonstrated).

32. **Diet (15%–20% protein, 25% fat, 55%–60% carbohydrate diet with 6 food unit groups and less caloric intake [300–500 kcal]), physical activity (aerobic exercise), and acupuncture versus electrotherapy for patients with stage 4 OA, level I (1 RCT, N=126, low quality).[42] Grade C** for pain (VAS pain) and mobility (walking speed) at end of treatment (8 weeks) (no benefit demonstrated).

33. **Aquatic exercise (40-min exercise in water gym per session, 3 times a week, consisting of endurance, strength, and aerobic training) versus home-based exercise (control group received strengthening exercise and behavioral education), level I (1 RCT, N=75, high quality).[44] Grade A** for pain relief (BPI pain) at end of treatment (8 weeks) (important benefit demonstrated). **Grade C+** for pain relief (BPI pain interference) and physical function (WOMAC score) at end of treatment (8 weeks) (important benefit demonstrated without statistical significance). **Grade C** for physical fitness (body weight, BMI, lean body mass, body fat mass, and body fat proportion), global function (SF-36 mental component summary and physical component summary) at end of treatment (8 weeks) (no benefit demonstrated). **Grade D** for torque (peak torque for knee extension and knee flexion) and physical fitness (waist circumference) at end of treatment (8 weeks) (no benefit demonstrated but favoring control).

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34. **Land-based exercise (40-min exercise per session, 3 times a week, consisting of strength, aerobic, stretching, and range-of-motion training) versus home-based exercise (control group received strengthening exercise and behavioral education), level I (1 RCT, N=75, high quality).[44] Grade A** for pain relief (BPI pain) at end of treatment (8 weeks) (important benefit demonstrated). **Grade C+** for pain relief (BPI pain interference), physical function (WOMAC score), and torque (peak torque knee flexion) at end of treatment (8 weeks) (important benefit demonstrated without statistical significance). **Grade C** for physical fitness (body weight, BMI, lean body mass, body fat mass, and body fat proportion), global function (SF-36 mental component summary and physical component summary) at end of treatment (8 weeks) (no benefit demonstrated). **Grade D** for torque (peak torque for knee extension) and physical fitness (waist circumference) at end of treatment (8 weeks) (no benefit demonstrated but favouring control).

35. **Land-based exercise (40-min exercise per session, 3 times a week, consisting of strength, aerobic, stretching, and range-of-motion training) versus aquatic exercise (40-min exercise in water gym per session, 3 times a week, consisting of endurance, strength, and aerobic training), level I (1 RCT, N=75, high quality).[44] Grade C+** for pain relief (BPI pain) and torque (peak torque for knee flexion) at end of treatment (8 weeks) (important benefit demonstrated without statistical significance). **Grade C** for torque (peak torque knee extension), physical fitness (lean body mass), and global function (SF-36 physical component summary).

[a] RCT=randomized controlled trial, VAS=visual analog scale, WOMAC=Western Ontario and McMaster Universities Osteoarthritis Index, 6MWT=Six-Minute Walk Test, BMI=body mass index, SF-36=Medical Outcomes Study 36-Item Short-Form Health Survey questionnaire, HRR=heart rate reserve, OA=osteoarthritis, BPI=brief pain inventory.

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