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Yoga and Cardiac Rehabilitation (Yoga-CaRe) in post-acute coronary syndrome patients

Joga i rehabilitacja kardiologiczna (*Yoga-CaRe*) u osób po przebyciu ostrego epizodu wieńcowego

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Abstract

Cardiovascular diseases are a leading cause of death and disability in Asian Indians with huge psychological and economic impact as it affects population in thirty- and forty-year-olds, previously healthy adults and most productive social group. Successful transcatheter therapeutics has opened a new vista for its management; however, it cannot prevent its recurrence. Therefore, secondary prevention is cornerstone of management. Yoga-based Cardiac Rehabilitation (Yoga-CaRe) is a multifaceted approach targeting patient's physical, psychological, social and occupational status, preventing or delaying the progression of underlying disease and reducing the risk of recurrent rehospitalization and death as well as enabling the patients to live a comfortable and active life. Yoga is an ancient Indian system of philosophy; a mind-body discipline encompassing an array of philosophical precepts, mental attitudes and physical practice. Of seven major branches of yoga, *Hatha yoga*, which itself includes many different styles (e.g. Iyenger, Ashtanga, *etc.*), is probably the most commonly recognized, and incorporates elements of physical poses, breath control and meditation, and self-restraint (including that of diet, smoking, alcohol intake and sleep patterns). A Cochrane review reported a 27% reduction in total mortality and 19% reduction in total mortality and non-fatal cardiac events with cardiac rehabilitation (CR), comparing favorably to effective pharmacological treatments (e.g. antiplatelets, angiotensin-converting enzyme inhibitors, statins and beta-blockers). Yoga, therefore, could provide a useful frame work on which to develop an economical CR program, with additional advantages of being culturally appropriate to Indians and potentially be appealing to global population.

Key words: cardiovascular diseases, cardiac rehabilitation, *Hatha yoga*, transcatheter therapeutics, Yoga-CaRe

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Introduction

Cardiovascular diseases (CVD) are a leading cause of death and disability in the developed world, and are increasing rapidly in much of developing world with disproportionately higher risk among Asian Indians where coronary heart disease (CHD) mortality is over 1.5-fold higher compared to the general population [1, 2]. While primary intervention for CVD remains a priority in the long term, the vital need for effective secondary preventive interventions, aimed at improving both the duration and quality of life of those affected cannot be ignored. The psychological and economic aspect of CVD management are important, particularly in India where acute coronary syndrome increasingly occurs in thirty- and forty-year-olds, in previously healthy adults who experience considerable difficulty in accepting their new health status, with implications for enthusiasm and readiness to re-engage with the family and return to economically productive activity. Introduction of drug-eluting stents in percutaneous coronary intervention (PCI) and endovascular treatment (EVT) for vascular disease has considerably broadened the range of atherosclerotic lesions treatable by nonsurgical techniques achieving satisfactory early and late outcomes. However, successful transcatheter therapy of the affected vessel cannot itself prevent recurrence of atherosclerotic lesions. Therefore, secondary prevention is a cornerstone of management, including lifestyle modification (diet, exercise or quitting smoking) and medication. Cardiac rehabilitation (CR) is a multifaceted approach targeting patient's physical, psychological, social and occupational status, preventing or delaying the progression of underlying disease and reducing the risk of recurrent rehospitalization and death as well as helping them to live a comfortable and active life. This program also facilitates early ambulation of patient after myocardial infarction for prevention of deconditioning, which is contrary to the previous belief that such patient should take long term bed rest. The current indication for cardiac rehabilitation includes a history of ASCVD (Atherosclerotic CardioVascular Diseases: acute coronary syndrome, chronic stable angina, and post coronary artery bypass), chronic heart failure or atherosclerotic peripheral vascular disease.

This review focuses on exercise therapy for post-acute coronary syndrome.

Definition and indications of cardiac rehabilitation

CR is the process of restoring desirable levels of physical, social and psychological functioning after the onset of cardiovascular illness with aims to optimize patients functioning, enhance quality of life, and minimize the risk of recurrent cardiac events [3, 4]. Comprehensive CR programs are multi-component interventions, which include elements of exercise training, relaxation and stress management, secondary prevention, and pay attention to patient's psychological adjustment. They are generally delivered as a series of exercise-and-education sessions, provided on an outpatient basis over 4–8 weeks by large multidisciplinary teams (including nurse, psychologist, pharmacist, dieticians, counselors and physicians). Increasingly, home-based models of CR are becoming common, in which CR is self-supervised, and delivered through audio and reading material given to patients before discharge, with some subsequent support. Often a combination of both is used.

Systematic review of randomized control trials provides convincing evidence of effectiveness and safety or CR programs. A Cochrane review reported a 27% (odds ratio [OR]: 0.73; 95% confidence interval [CI]: 0.54 to 0.98) reduction in total mortality and 19% reduction (OR: 0.81; 95% CI: 0.65 to 1.01) in total mortality and non-fatal cardiac events with exercise-only CR, with slightly lower but comparable effects of comprehensive CR [5]. More recent meta-analyses suggest even stronger effect, with halving of mortality for any type of CR [6]. CR programs compare favorably to effective pharmacological treatments for secondary prevention of CVD (e.g. statins and beta-blockers). Among its component interventions, evidence suggest that exercise may have a stronger effect on mortality, while psychological interventions act more on quality of life measures; evidence on the other component of CR or the nature of exercise that produce the most benefit is limited [6].

Yoga practice — principle component of CR program

Yoga is an ancient Indian system of philosophy; a mind-body discipline encompassing an array of philosophical precepts, mental attitudes and physical practice [7]. Of seven major branches of yoga, *Hatha yoga* ,which itself includes many different styles (e.g. Iyenger, Ashtanga, *etc.*), is probably the most commonly recognized, and incorporates elements of physical poses, breath control and meditation, and self-restraint (including that of diet, smoking, alcohol intake and sleep patterns) [7]. As such, it encompasses most of the elements of a comprehensive CR program: improved physical fitness, stress reduction and life style (Figure 1). The philosophical aspects of yoga may be particularly beneficial in engendering healthy mental attitudes for engagement with society, potentially of great benefit following a life-threatening event that results in considerable introspection. The structure of yoga training program is also similar to CR (a series of exercise-and-education sessions), but requires considerably fewer resources (a yoga teacher). Yoga, therefore, could provide a useful framework on which to develop an economical CR program, with an additional advantages of being culturally appropriate to Indians and potentially be appealing to certain other

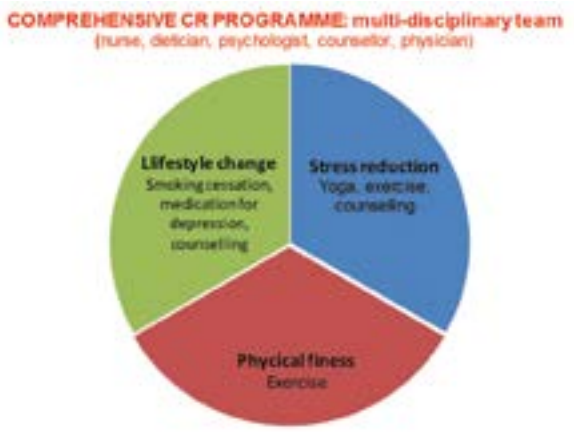


Figure 1. Yoga based comprehensive cardiac rehabilitation program

groups (e.g. women, elderly), who may prefer the gentler approaches inherent in yoga.

Mechanisms for cardiovascular health effects of *yoga*

Traditional therapeutic approaches, such as yoga, are often viewed with suspicion by the wider scientific community, in part as underlying mechanisms of action are poorly understood. A greater understanding of the pathways by which yoga exerts any potential beneficial effect on CVD risk would of value in providing a sound scientific basis on which to champion the inclusion of yoga into main stream clinical practice.

Previous systematic reviews [8–10] confirms the investigations of the health benefits of yoga and underlying mechanisms have often been limited by poor study design, small sample sizes, lack of a control group, inadequate statistical approach, uncertain masking of outcomes assessors to randomization and publication bias. Yoga beneficially influences blood pressure and heart rate responses to exercise, which are important and independent determinants of CVD risk. These are due to the effects of yoga on the sympathetic nervous system. It is thought that breathing exercise performed during yoga results in sustained improvement in baroreflex sensitivity and heart rate variability. In addition, effects on the rennin-angiotensin system, as evidenced by a reduction in plasma rennin activity may also help curtailing ventricular remodeling. It also appears to variously reduce fasting and glycated hemoglobin, insulin, total and LDL-cholesterol, triglyceride and weight, even in those without diabetes [11, 12]. Mechanisms are likely to include the greater physical activity and healthier diet associated with yoga, but may also include a beneficial effect on the hypothalamic-pituitary axis (HPA), as measured by lower levels of diurnal salivary cortisol, and increased urinary cortisol excretion [13]. Ectopic fat deposition is beneficially affected, with grater losses of central than peripheral fat [14].

Achieving a good exercise capacity is a key goal in cardiac rehabilitation, as this is a key determinant of current quality of life and future morbidity and mortality [3, 4]. Beneficial effects of yoga on functional capacity have been reported in healthy adults, albeit of lesser magnitude to those observed with aerobic exercise [14] in those with chronic heart failure, an improvement in maximal oxygen consumption and concurrent changes in levels of inflammatory markers of CRP and IL-6 were also identified [15]. Improvements have been reported in both diastolic function and ventricular structure [16], and in high risk subgroup of older individuals, in carotid IMT, with a marked (0.56 SD) change in IMT compared to usual care [9].

Cardiac rehabilitation

Exercise therapy for cardiac rehabilitation fits into main categories which are aerobic exercise and resistance training. Aerobic exercise is safe and can easily be modulated to maintain exercise intensity. Various types of aerobic exercise that involves the rhythmic movement of large muscle group are particularly recommended rather than playing sport. For example exercise on an ergometer or treadmill is one the best types of aerobic exercises for cardiac rehabilitation. Resistance training utilizes rubber tubes, free weights or training machines and is expected to improve muscle strength and endurance although indication, timing of introduction and intensity of such exercise should be determined carefully [17]. In a typical exercise program for cardiac rehabilitation, each session begins with warm up exercise and ends with cool down exercise and consists of aerobic exercises, resistance training and additional recreational exercises, as appropriate.

Studies have provided high quality evidence of various physical benefits of exercise, as listed in Table 1 [18]. These effects have been shown to be similar among different patient populations, including elderly patients and those with co morbidities [19]. However, there are great inter-individual variations in exercises tolerance, cardiac function and treatment targets. It is therefore important to individualize the exercises program for each patient based on the result of an exercise tolerance test.

A cardiac rehabilitation program can be divided into three phases, which are (1) the acute phase (2) the early/ /late recovery phase and (3) the maintenance phase. The acute phase (phase 1) is from the onset of a cardiac event until ambulation. The early recovery phase (early phase 2) is from ambulation until discharge from hospital, while the later recovery phase (late phase 2) extends from discharge until the patient resumes his normal activities. The maintenance phase (phase 3) commences with returning

Table 1. Effects of exercise therapy

Category	Effects	LOE
Exercise tolerance	Increases peak oxygen uptake	A
	Increases anaerobic threshold	A
Symptoms	Decreases the number of angina attacks by ↑ myocardial ischemic threshold	A
	Reduces severity of heart failure symptoms during exercise at a constant intensity	A
Respiration	Decreases tidal volume during exercise at a constant submaximal load	A
Cardiac function	Decreases heart rate during exercise at a constant submaximal load	A
	Decreases cardiac workload during exercise at a constant submaximal load	A
	Suppresses left ventricular remodeling	A
	Prevents deterioration of left ventricular systolic performance	A
	Improves left ventricular diastolic performance	A
	Improves myocardial metabolism	A
Coronary arteries	Prevents the progression of coronary stenosis	A
	Improves cardiac perfusion	B
	Improves endothelial dependent vasodilatory response of coronary arteries	B
Central circulation	Increases arterio-venous O_2 difference	B
Peripheral circulation	Reduces total peripheral vascular resistance at rest and during exercise	B
	Improves endothelial function of peripheral arteries	B
Coronary risk factors	Reduces systolic blood pressure	
	Increases HDL-cholesterol and decreases triglycerides	
	Reduces the prevalence of smoking	
Blood	Decreases platelet aggregability	B
	Decreases coagulability	B
Clinical outcome	Reduces coronary events	A
	Reduces hospitalization for exacerbation of heart failure symptoms	A (CAD)
	Prolongs survival (reduces all-cause death and cardiac death)	A (CAD)

A — multiple randomized control trials; B — single randomized control trial/non-randomized trials; LOE — level of evidence; CAD — coronary artery disease; HDL — high-density lipoprotein

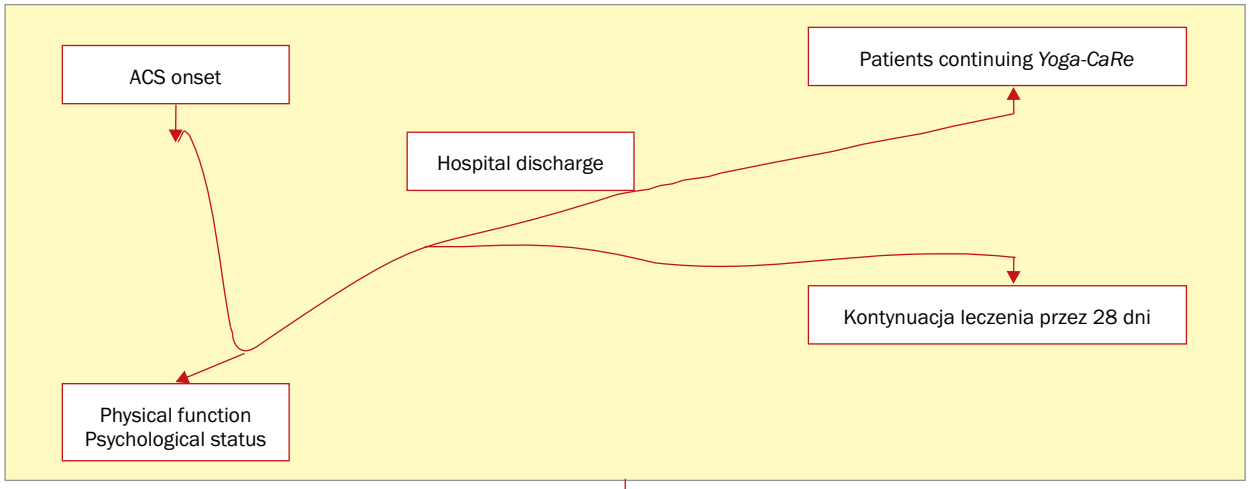
to normal activities and lasts throughout the patient's life-time (Table 2) [18]. It has been shown that who participate in both acute phase and recovery phase cardiac rehabilitation program achieve much more benefits from exercise than those who stop rehabilitation after the acute phase [20]. Patients require lifelong cardiac rehabilitation to receive sustained benefit, and they therefore should be given detailed instructions and offered a wide range of programs that are attractive enough to motivate them to continue rehabilitation.

Cardiac rehabilitation for post-acute coronary syndrome (ACS)

Acute coronary syndrome is a spectrum spanning from unstable angina, non-ST segment elevation myocardial infarction (NSTEMI) to ST segment elevation myocardial infarction (STEMI). Acute phase cardiac rehabilitation is given to patient in the early period after ACS (during index hospitalization), while recovery phase or maintenance phases cardiac rehabilitation is provided for patients who are recovering from ACS. Exercise therapy is expected to have various effects such as improving post-AMI heart failure and survival. It has been reported that AMI patient who participate in cardiac rehabilitation have a similar mean survival time to person without AMI [4] and that cardiac rehabilitation is at least as effective as PCI in reducing major adverse cardiac events in patient with stable CAD [21].

There is no definite time frame for the optimal timing for initiation of exercise after coronary stenting in view of the significant risk of coronary occlusion due to sub-acute stent thrombosis. However one study demonstrated a similar rate of acute adverse cardiovascular

Table 2. Phases of cardiac rehabilitation



Phases	Phase 1	Phase 2		Phase 3
Definition	Acute phase	Early recovery phase	Late recovery phase	Maintenance phase
Rehabilitation site	CCU	Gen. cardiac ward	Outpatient rehab. room	Community/home exercise facility
Aims	To return to normal daily activity	To return to normal social life	To return to normal social life and modify previous life style	To live a comfortable life and prevent recurrence
Main elements	Functional assessment Recovery planning Physical therapy in bed Sitting and standing Walk test (30–100 m)	Disease/functional assessment Neuro-psychological assessment Promoting the importance of rehab. Exercise tolerance test Exercise prescription Diet and drugs Counselling Instruction on healthy living Measures of handicaps Assisting the patients to recovery	Disease/functional assessment Neuro-psychological assessment Exercise tolerance test Exercise prescription Exercise therapy Diet and drugs Counselling Instruction on healthy living Group therapy Modification of coronary risk factors	Maintaining a better lifestyle Exercise prescription Exercise therapy Group therapy

events in 800 patients who performed early exercise training from the day after elective coronary stenting based on their tolerance assessed by cardiopulmonary exercise testing (CPX) compared with patient who did not exercise [22]. This suggests that patient in effective antiplatelet therapy can safely perform CPX and exercise up to the anaerobic threshold (AT) from the day after coronary stenting.

Acute phase (phase 1) cardiac rehabilitation program

At about 12 to 24 hours after the onset of AMI, hemodynamically stable patient with no heart failure symptoms, arrhythmias or post-MI angina should be released from complete bed rest and should gradually expand their activities. Resistance exercises of very low intensity in bed are beneficial for severely ill patient who are on assisted circulation or respiratory management.

Complication of AMI (e.g., arrhythmia, ventricular rupture, and papillary muscle dysfunction) are likely to occur during the first week so AMI patient should not perform exercise that has a Valsalva effect and cause marked hemodynamic change during this period. Changes of symptoms, hemodynamic parameters and the electrocardiogram should be assessed whenever the level of activity increased. Table 3 presents the criteria for exercise tolerance that should be met before increasing the level of activity [18]. Patient who are ambulatory in the coronary care unit and meet the criteria should be transferred to a general ward and undergo rehabilitation for the early recovery phase.

Table 3. Exercise tolerance criteria to be met for acute phase rehabilitation after acute coronary syndrome

1.	Absence of symptoms such as chest tightness, dyspnea, and palpitations
2.	Heart rate maintained at < 120 bpm and not increased by > 40 bpm
3.	Absence of life threatening or potentially life threatening arrhythmias
4.	Absence of ≥ 1-mm ischemic ST depression or marked ST elevation on ECG
5.	Absence of systolic blood pressure fluctuation ≥ 20 mm Hg, except when using toilet (the blood pressure criteria should be deleted at ≥ 2 weeks after the event)
6.	If one or more of these criteria is not met, measures such as additional medication should be taken and exercise tolerance test should be repeated at the same intensity on the next day

ECG — electrocardiography

Table 4. Contraindications to cardiopulmonary exercise testing

Absolute contraindication	1.	AMI within 2 days
	2.	Unstable angina not controlled by medications
	3.	Symptomatic severe aortic stenosis
	4.	Uncontrolled symptomatic heart failure
	5.	Acute pulmonary embolism or infarction
	6.	Acute aortic dissection
	7.	Mental disorders that prevents the patient from communicating with others
	8.	Acute pericarditis/myocarditis
Relative contraindication	1.	Left main trunk stenosis
	2.	Moderate heart valve stenosis
	3.	Electrolyte imbalance
	4.	Severe hypertension (SBP ≥ 200 mm Hg; DBP ≥ 110 mm Hg)
	5.	Tachy- or bradyarrhythmia
	6.	LVOT obstruction

AMI — acute myocardial infarction; LVOT — left ventricular outflow tract; SBP — systolic blood pressure; DBP — diastolic blood pressure

Table 5. Criteria for stopping an exercise tolerance test

1.	Symptoms	Limiting angina, dyspnea, syncope, dizziness, light headedness, or claudication
2.	Signs	Cyanosis, pallor, cold sweat, or motor ataxia
3.	Blood pressure	Little or no increase or a progressive decrease in systolic blood pressure or an abnormal increase in blood pressure ≥ 225 mm Hg
4.	ECG	Any obvious ischemic ST-T changes, any rhythm disorder, ventricular tachycardia, atrial fibrillation, R-on-T phenomenon, or second or third degree atrioventricular block

ECG — electrocardiography

Early recovery phase (early phase 2) cardiac rehabilitation program

During the early recover phase, rehabilitation should begin with risk assessment based on the patient's cardiac function and ability to tolerate exercise and whether or not the patient has residual ischemia and arrhythmia. Patient who are not at high risk should than undergo CPX to determine their exercise regimen. Conventionally the optimal exercise intensity for each patient is determined from the heart rate using Karvonen's formula. However, many patient with heart disease are taking beta-blockers, which interfere with estimation of the optimum exercise intensity by this method. Therefore CPX, which allows continuous analysis of gas exchange during ergometer exercise, should be performed whenever possible. However, CPX is contraindicated for patient with any of the conditions listed in Table 4. The test should be stopped if any of the criteria shown in Table 5 are met. The optimum exercise intensity mean that the patient's oxygen uptake is 60% of peak uptake (peak VO_2) or perceived exertion is rated as 12 or 13 on the Borg Scale. Exercise-related increase in sympathetic tone may result in the occurrence of arrhythmia, myocardial ischemia and thrombosis. The duration of each exercise session should

be initially set of about 10 minutes and gradually extended to about 30 minutes.

Late recovery phase (late phase 2) cardiac rehabilitation program

The mean duration of hospital stay for AMI or AP has become much shorter in recent years, resulting in patients being unable to receive sufficient cardiac rehabilitation during hospitalization. In turn, this has increased the importance of late recovery phase cardiac rehabilitation performed during outpatient visits. After discharge, each patient should be given an individualized program of regular exercise to promote a return to previous activities of daily living (ADL) and exercise capacity. The program should initially consist of two sessions of exercise (each lasting 10 minutes) per day, with the final target duration of each session being 30 to 60 minutes. Patients should exercise on at least 3 days per week, but preferably every day. The most marked recovery of exercise capacity occurs during the late recovery phase, so this phase of cardiac rehabilitation should aim to promote a return to work and/or other social activities.

All patients should undergo CPX at 1, 3 and 5–6 months during cardiac rehabilitation to evaluate the effectiveness and appropriateness of their exercise regimen. After confirming that a patient can safely follow the exercise program, it is important to promote confidence in exercising alone without supervision by an instructor.

Maintenance phase (phase 3) cardiac rehabilitation program

Patients receive maintenance phase cardiac rehabilitation after returning to normal daily activities and its primary aims are to improve the quality of life (QoL) and prolong survival by prevent recurrence of IHD, rather than to further enhance exercise capacity. It is ideal for each patient to continue physical training with confidence at home or at a community center.

Conclusions

Despite overwhelming evidence, CR programs continue to have limited uptake, in both developed and developing countries. The structure of yoga training program is also similar to CR (a series of exercise-and-education session), but requires considerably fewer resources. Cardiac rehabilitation has been shown to be a very important element of a comprehensive plan for the management and secondary prevention of cardiovascular disease. A comprehensive approach to rehabilitation based on interprofessional collaboration is considered to represent an ideal of multidisciplinary care. Secondary prevention of chronic disease is one of the most sustainable and cost-effective options.

Conflict of interest(s)

None.

Streszczenie

Choroby układu sercowo-naczyniowego są główną przyczyną zgonów i niepełnosprawności mieszkańców Indii, a ponadto mają ogromny wpływ psychologiczny i ekonomiczny, ponieważ często dotykają 30- i 40-latków, wcześniej niechorujących, którzy stanowią najbardziej produktywną grupę społeczną. Skuteczne techniki przezcewnikowe otworzyły nowe perspektywy w leczeniu tych chorób, jednak nie mogą zapobiec ich nawrotom. Z tego względu podstawowe znaczenie ma prewencja wtórna. Rehabilitacja kardiologiczna oparta na jodze (*Yoga-CaRe*) to wielopłaszczyznowe podejście oddziałujące na sferę fizyczną, psychiczną, społeczną i zawodową, którego celem jest zapobieganie lub spowalnianie progresji choroby podstawowej i obniżenie ryzyka ponownej hospitalizacji lub zgonu, a także poprawa komfortu życia i zachowanie pełnej aktywności. Joga to starożytny hinduski system filozoficzny, którego istotą jest dyscyplina ciała i umysłu i który obejmuje szereg reguł filozoficznych oraz ćwiczeń mentalnych i fizycznych. Spośród siedmiu głównych odmian jogi najbardziej znaną jest *Hatha yoga*, która również obejmuje wiele różnych rodzajów (tj. *Iyenger*, *Ashtanga etc.*) i łączy element ćwiczeń fizycznych, kontroli oddechu i medytacji z samoograniczeniami (dotyczącymi diety, palenia tytoniu, spożywania alkoholu i snu). W przeglądzie danych dostępnych w bazie *Cochrane* wykazano, że rehabilitacja kardiologiczna (CR) powoduje zmniejszenie o 27% śmiertelności całkowitej oraz o 19% śmiertelności całkowitej i zdarzeń sercowych niezakończonych zgonem, a więc pozwala uzyskać korzystniejsze efekty niż skuteczna farmakoterapia (tj. leki przeciwpłytkowe, inhibitory konwertazy angiotensyny, statyny i antagoniści receptorów beta-adrenergicznych). Joga może być użyteczna jako podstawa do opracowania ekonomicznego program CR, a jej dodatkowym atutem jest zgodność z kulturą Indii i popularność na całym świecie.

Słowa kluczowe: choroby układu sercowo-naczyniowego, rehabilitacja kardiologiczna, *Hatha yoga*, leczenie przezcewnikowe, *Yoga-CaRe*

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