A Global Review of Modified Cardiac Rehabilitation Programs and Outcomes of Stroke Survivors

Hana A S Abujarad[1,3], Siti Noraini Asmuri[1*], Mazatulfazura SF Salim[1], Thanalactchumy Chandrabose[1], Katijjahbe Md Ali [2], Sami S Elmahgoub[3]

[1] Department of Rehabilitation Medicine, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[2] Department of Medical Rehabilitation Services, Hospital Canselor Tuanku Muhriz, Universiti Kebangsaan Malaysia, 56000 Cheras, Kuala Lumpur, Malaysia
[3] Department of physiotherapy, Faculty of Medical Technology, University of Tripoli, Libya

***Corresponding author:**
Dr. Siti Noraini Asmuri, Senior Lecturer, PhD Rehabilitation (Occupational Therapy), Department of Rehabilitation Medicine, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, Email: ctnoraini@upm.edu.my, Phone:0060177917559 ,ORCID: https://orcid.org/0000-0001-6196-3909

Abstract
Stroke rehabilitation programs vary globally, leading to diverse outcomes and effectiveness across different regions. These programs are often tailored to address cardiovascular risk factors, which are a primary cause of mortality and hospital readmissions among stroke survivors. This review aims to identify and analyze the key risk factors addressed in modified cardiac rehabilitation programs worldwide, focusing on the similarities and differences in guidelines and intervention strategies across developed and developing countries. By examining empirical studies and international recommendations, the review provides insights into the effectiveness of these programs in managing cardiovascular health post-stroke and highlights the need for more standardized global approaches. Understanding these variations can inform improvements in rehabilitation practices and contribute to better outcomes for stroke survivors.
Keywords: Modified cardiac rehabilitation programs, stroke survivors, risk factors, global guidelines and studies

INTRODUCTION

Cardiac stroke remains one of the leading causes of death worldwide, primarily driven by the heightened risk of cardiovascular diseases [1]. In the last decade, global mortality from cardiovascular conditions reached a peak of 15.2 million [2], with recurring cardiovascular risks increasing by 11%, 26%, and 39% at one, five, and ten years, respectively [3]. Key factors contributing to these risks include smoking, alcohol consumption, poor diet, physical inactivity, depression, and stress [4]. Despite the severity of these risks, fewer than half of the world's countries have implemented comprehensive health programs aimed at managing them for stroke survivors [5]. These statistics highlight the critical need for global initiatives to

address cardiovascular risk factors through structured rehabilitation and preventative programs to improve the long-term health outcomes of stroke survivors.

Past studies have provided substantial evidence supporting cardiac rehabilitation as a safe and feasible option for stroke survivors [3]. The benefits of these programs extend to improving the quality of life for patients recovering from myocardial infarction, coronary artery bypass graft, heart failure, and coronary angioplasty [6]. Cardiac rehabilitation programs offer comprehensive, multidisciplinary interventions aimed at managing risk factors such as lifestyle changes, physical activity, and the reduction of adverse habits, ultimately helping to prevent comorbidities and reduce mortality rates [7]. In response, researchers advocate for the adoption of hybrid guidelines to overcome limitations in implementing aerobic exercises, which are essential for achieving significant health benefits. The integration of such guidelines has yielded positive outcomes for stroke patients, despite variations in how they are implemented across different health systems [8].

The primary advantages of cardiac rehabilitation programs for stroke survivors include improvements in physical function, such as enhanced cardiac endurance, functional strength, walking ability, and speed. Additionally, health indicators like quality of life, balance, strength, and the reduction of depression and harmful exercise habits also improve. One of the most significant benefits is the reduction in mortality rates among post-stroke patients, as these programs offer a structured approach to long-term recovery [9-10]. Attaining the goals outlined in these intervention programs is seen as vital for shaping the future of rehabilitation exercise plans.

Despite the numerous benefits, there remains no single, universally accepted cardiac rehabilitation program that delivers perfect outcomes for stroke survivors. Various world organizations and scholars have introduced a wide range of rehabilitation programs, but none

have proven to be entirely effective across all populations [6-9]. This review aims to examine the most effective modified rehabilitation programs implemented by health systems in both developed and developing countries. In addition, it will emphasize the common cardiovascular risk factors targeted by these programs, while also analyzing the contents, outcomes, and limitations of existing rehabilitation protocols.

By comparing the differences in program implementation and results across countries, this review will offer valuable insights into improving global standards for cardiac rehabilitation. Ultimately, it seeks to contribute to the development of more efficient rehabilitation strategies for stroke survivors, addressing the current gaps in program effectiveness and global implementation.

RISK FACTORS FOR STROKE

Past literature had reported two types of risk factors, namely modifiable and non-modifiable. The main modifiable and manageable risk factors are hypertension, dyslipidemia, cigarette smoking, physical inactivity, obesity, and diabetes mellitus. Figure 1 shows the main risk factors for cardiovascular diseases and stroke.

The American Heart Association (AHA) highlighted that these risk factors are closely linked with coronary heart disease and stroke, and are considered significant causes of recurrent strokes and higher mortality rates. The AHA further emphasizes on adjusting one's lifestyle and managing concurrent abnormal disorders. Subsequently, most intervention programs rely on lifestyle changes and modifying these risk factors [11-12]. Table 1 shows Cardiovascular risk factor variables and devices used to measure them.

Furthermore, these risk factors vary according to the educational and health awareness programs adopted by the health organizations of different countries. For example, the incidence of morbidity and mortality induced by stroke differ across continents, countries, and ethnicity

groups depending on the country with aging index, quality of healthcare services, and other sociodemographic characteristics [13-14].

Blood Pressure

Heart associations and societies define hypertension as systolic blood pressure exceeding 140 mmHg and/or diastolic blood pressure higher than 90 mmHg. Statistics by the AHA involving 13160 participants from cohort patients showed that the lifetime risk of hypertension varies according to racial and gender variations where the risk increased to 86.1%, 85.7%, 83.8%, and 69.3% for black males, black females, white males, and white females, respectively [13].

Diabetes Mellitus

Diabetes mellitus is defined as the abnormal value of fasting blood glucose, glucose tolerance test, HbA1c, and random glucose test exceeding 126 mg/dl, 200 mg/dl, 6.5%, and 200 mg/dl, respectively [15]. Statistics by the National Health and Nutrition Examination Survey (NHANES) showed that diabetes mellitus had increased the number of cases associated with stroke and ischemic heart diseases between 2013 to 2016 by 58% and 67%, respectively [16].

Dyslipidemia

The objective of dyslipidemia therapy is to achieve an LDL of less than 70 mg/dl for ischemic heart diseases and to minimize the recurrence of cardiac attacks and stroke [17]. Evidence suggests that abnormal elevation of lipoprotein can lead to an increase in mortality induced by cardiovascular diseases and stroke by 17% and 63%, LDL increases the chances of stroke by 27%, while HDL decreases cardiovascular diseases and stroke by 22% and 41%, respectively [13].

Smoking

A study involving 19,782 men and 215,00 women across several Asian countries reported a higher risk of coronary heart disease and stroke among smokers than non-smokers. The findings further revealed an increase in cardiovascular diseases and mortality among smokers by 32% and 109%, respectively. The descriptive analysis also showed higher coronary heart diseases and stroke among women than men by 207% vs 185% and 70% vs 24%, respectively [18].

Physical Inactivity

Physical activity evaluation (e.g., walking) refers to individuals who spend more than 150 minutes of moderate activity or 75 minutes of vigorous activity [19-20]. Existing evidence suggests that exercises minimize the incidence of cardiovascular diseases and stroke recurrence by 30% [21].

Obesity

Individuals with a body mass index of more than 25 kg/m^2 are considered overweight while those exceeding 30 kg/m^2 are considered obese [22-23]. Studies involving two million Asians revealed that obesity increases the risk of myocardial infarction, coronary heart diseases, and strokes among 76% of men vs 50% of women as well as 35% of men and 31% of women, respectively. Furthermore, men are more prone to have obesity-induced stroke than women [24-25]. It was also reported that weight reduction could reduce the risk of coronary heart disease by 23% for men and 33% for women, especially when their BMI is less than 23 kg/m^2 [11].

Diet

Dieticians highlight the importance of consuming high-quality foods.

Evidence suggests that consuming 180 grams of fish per day significantly reduced the risk of coronary heart disease by 37% than those who consume 23 grams of fish daily. Contrary to a high-quality diet, sodium intake increases the risk of cardiovascular risk, coronary heart disease, and stroke by 11%, 25%, and 12%, respectively [26].

MODIFIED CARDIAC REHABILITATION PROGRAMS FOR STROKE SURVIVORS AND GLOBAL COUNTRIES

Several studies investigated the impact of modified cardiac rehabilitation programs for stroke survivors on health indicators; however, there are obvious differences in the outcomes and materials of intervention programs. This section reviews a number of modified cardiac rehabilitation programs for stroke survivors conducted in different countries to ascertain the major similarities and differences across these programs.

United States

The American Heart Association (AHA) reported that rehabilitation services are an essential mechanism to support fast recovery from stroke and serve as secondary prevention for stroke recurrence. Rehabilitation services in the United States are broad and heterogeneous, and their provision of care varies across different intensities, duration, and types of intervention [7]. The AHA guidelines classify the types of rehabilitation services according to classes and levels, where the rehabilitation interventions depend on the strength [27-28], tone [29-30], sensorimotor of impairment [31-30], upper extremity function [29-30], balance [32-33] mobility of activity [34] as well as self-reporting impairment and technology adoption to monitor participation [35-36].

The adoption of cardiac rehabilitation programs in the United States had prompted significant improvements by more than 50% among 836,923 stroke survivors between 2002 to 2019, including 53% of lower mortality incidence, 12% of lower recurrent stroke, and 36% of lower hospitalization readmissions [37]. Other

modified cardiac rehabilitation programs for stroke survivors have expanded their rehabilitation services to include interventions like the cessation of smoking, performing physical activities, diet control, and weight loss. This has resulted in reduced mortality by at least a four-fold rate [38] along with significant enhancement in basic mobility, daily activity, and applied cognition as compared to the traditional rehabilitation programs [6-9-8].

United Kingdom

The United Kingdom guidelines for stroke survivors are adopted from the National Institute for Health and Care Excellence (NICE) and the Royal College of Physicians (RCP). These guidelines focus on the physical fitness and exercise approach as the main intervention for mortality prophylaxis and preventing comorbidities [39]. However, there is a lack of healthcare practitioners' delivery experience, particularly in adopting their experience with the intervention plans for stroke survivors [40]. The outcomes of ten studies in the United Kingdom showed no significant improvement in cardiovascular risks [41]. Thus, research scholars in the United Kingdom have updated their intervention programs by managing main risk factors like smoking, diet, exercise, blood pressure control, and BMI management [42].

Canada

A number of modified cardiac rehabilitation programs have been established for stroke survivors in Canada [43]. This negatively affected the management of stroke following consequences like mortality rate and management of risk factors [44]. Although these rehabilitation programs were invented by healthcare providers, it fails to include interventions for all risk factors of stroke and cardiovascular diseases, like adopting efficient exercises for stroke survivors [45-46]. To date, no studies have reported the beneficial outcomes of modified cardiac rehabilitation programs in

Canada; however, the Canadian Stroke Rehabilitation Practice Guidelines recommend exercise rehabilitation and direct clinical care for dysphagia, malnutrition, central pain, communications, and Life Roles [47].

Australia

Modified cardiac rehabilitation programs have long existed within the health system of Australia. However, stroke survivors' attendance to these programs has been limited between 2% to 30% and less than 6% of patients received referrals for rehabilitation services [48]. The Australian modified cardiac rehabilitation programs utilize the health-based services provided by local healthcare professionals like exercise physiologists, physiotherapists, dietitians, psychologists, pharmacists, and other health specialists [49]. The main objectives are to promote the management of cardiovascular risk [49], increase the levels of exercise and physical activity [50], manage blood pressure and BMI [49], improve life quality [51], and control anxiety and depression [49].

European Union Countries

European Union countries have adopted cardiac rehabilitation programs for stroke survivors with advanced approaches to control the risk factors like aging, diabetes, hypertension, obesity, hyperlipidemia, ischemic heart disease, valvular heart disease, smoking, and alcohol abuse to minimize the mortality rate and hospital readmissions [2]. In Belgium, the modified cardiac rehabilitation programs showed effective outcomes for 1,549 stroke survivors via improved walking capacity and quality of life as compared to the conventional programs [52]. Meanwhile, the modified rehabilitation programs for stroke survivors in Italy involved a multidisciplinary team in managing favorable outcomes like exercise performance, nutrition restrictions, smoking cessation, stress management, and social support. Studies on the efficacy of cardiac rehabilitation programs for stroke survivors in European Union countries

reported significant differences in visceral fat, waist circumference, and exercise capacity; however, no significant results existed in terms of blood pressure, lipid levels, and heart rate [53].

China

A number of studies have highlighted significant weaknesses in the implementation of modified cardiac rehabilitation programs for stroke survivors in China, which leads to no significant difference in the mortality (as primary) and favorable targets (as secondary) outcomes between the conventional and modified cardiac rehabilitation programs for stroke survivors [54]. It is believed that the local health authority emphasizes early rehabilitation to minimize mortality among stroke survivors [55]. On the other hand, the practice of modified cardiac rehabilitation programs for stroke survivors remains controversial due to the insufficiency of clinical evidence [54].

CONCLUSION

This paper advocates for the development of modified cardiac rehabilitation programs aimed at achieving optimal health indicators to improve health status, quality of life, and life expectancy for stroke survivors. A comprehensive review of the existing literature reveals that while many countries share similar approaches in implementing these programs, differences arise in the intervention materials and techniques used. Key guidelines across various nations emphasize multidisciplinary interventions targeting major risk factors such as blood pressure, obesity, and smoking, alongside physical exercises to enhance mobility and maintain physical capacity.

However, a notable difference in these guidelines is their varying success in reducing mortality rates, comorbidities, and hospital readmissions for stroke survivors. Some modified cardiac rehabilitation programs have been more successful in addressing these outcomes due to innovations in the design and execution of rehabilitation strategies. This underscores the need

for continuous refinement of rehabilitation programs, especially in regions where stroke recovery outcomes remain suboptimal, to ensure long-term health benefits for patients.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

AUTHOR CONTRIBUTION STATEMENT

• Conceptualization: Hana A S Abujarad, Siti Noraini Asmuri, & Mazatulfazura SF Salim.

• Project administration: Hana A S Abujarad, Siti Noraini Asmuri, & Mazatulfazura SF Salim.

• Visualization: Hana A S Abujarad, Siti Noraini Asmuri, & Mazatulfazura SF Salim.

• Writing - original draft: Hana A S Abujarad.

• Writing - review & editing: Hana A S Abujarad, Siti Noraini Asmuri, Mazatulfazura SF Salim, Katijjahbe Md Ali, Thanalactchumy Chandrabose, & Sami S Elmahgoub.

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Table legends

Table 1. Cardiovascular risk factor variables and measurement device

Risk factor	**Instrument**
Hypertension	
Blood pressure	Sphygmomanometer
Dyslipidemia	
Lipid profile (cholesterol, HDL, LDL, Triglyceride)	Biochemical analysis
Smoking	Self-Reported Status
Physical activity	International Physical Activity Questionnaire (IPAQ).
Health Related Quality of Life	Stroke Specific Quality of Life index.
Obesity	
Height, Weight, BMI	Weighing Scales & Meter Rule
Diabetes mellitus	
Fasting glucose level, Hemoglobin A1c	Biochemical analysis
Diet	Vegetable & Fruit servings/day

Figure legends

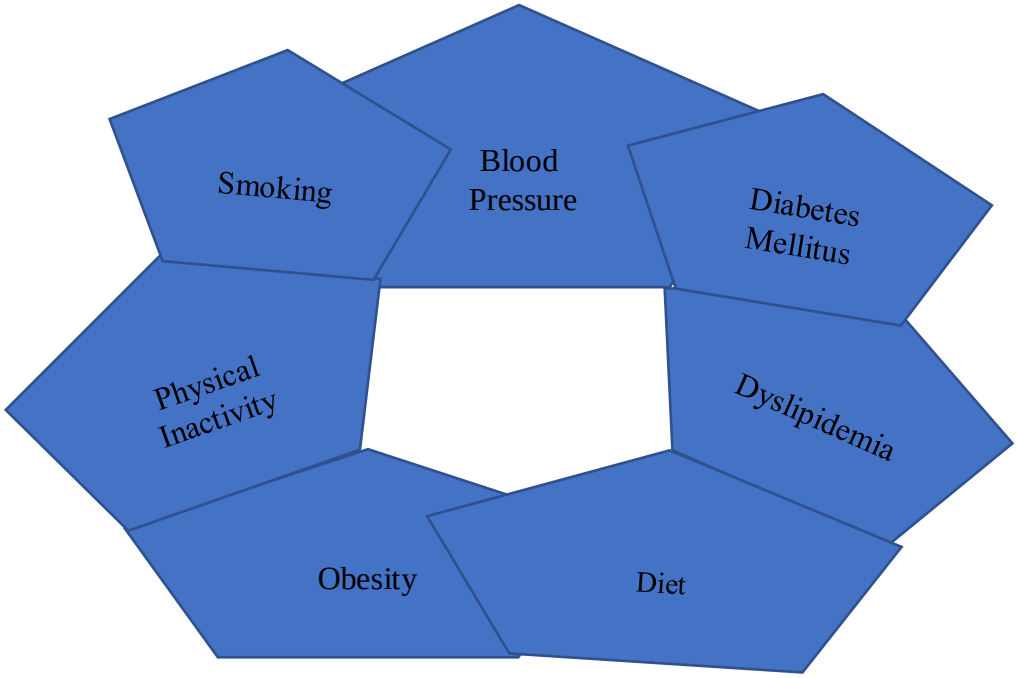

Figure 1. Risk factors for cardiovascular diseases and stroke