

Primordial and Primary Prevention of Ischemic Stroke in Saudi Arabia: A Combination Approach and Evolving Concepts

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Abstract

Ischemic stroke is a considerable public health hazard and a significant cause of disability and mortality in Saudi Arabia. Primary prevention strategies in the country are currently limited. With the health sector transformation program that depends on the principles of value-based care and applying the new model of care in disease prevention, aggressive and serious steps for primary stroke prevention are expected to be implemented. This article reviews primordial and primary prevention of ischemic stroke in Saudi Arabia and suggests a combination approach and framework for implementation. We provide a pragmatic solution to implement primordial and primary stroke prevention in Saudi Arabia and specify the roles of the government, health professionals, policymakers, and the entire population. Currently, there are several key priorities for primordial and primary stroke prevention in Saudi Arabia that should target people at different levels of risk. These include an emphasis on a comprehensive approach that includes both individual and population-based strategies and establishing partnerships across health-care providers to share responsibility for developing and implementing both strategies. This is an urgent call for action to initiate different strategies suggested by experts for primary stroke prevention in Saudi Arabia.

Keywords: Ischemic stroke, primary prevention, risk factor, Saudi Arabia

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INTRODUCTION

Stroke is the second leading cause of death worldwide and the third leading cause of combined functional disability and mortality.^[1] The estimated global prevalence of stroke is in excess of 100 million with around 15 million annual strokes, more than 5 million deaths, and 5 million permanently disabled.^[2] Two hundred million stroke survivors are expected by 2050 with over 30 million new

strokes and 12 million deaths each year thereafter.^[3] Patients with stroke may suffer from residual damage in their physical, psychological, cognitive, and social functions.^[4]

In Saudi Arabia, there is no nationwide research on the incidence and prevalence of ischemic stroke. Based on a few small studies, the stroke incidence and prevalence were low compared with Western countries (29.8–43.8/100,000/

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year).^[5] This might be explained by the high percentage of the younger age groups in Saudi Arabia. The most frequent stroke subtype was the ischemic subtype.^[6] It is expected that Saudi Arabia will encounter a high burden of stroke with an increase in incidence and mortality rates to be as nearly double by 2030.^[7] The causes are multifactorial and include the increase in the aging population and unhealthy lifestyle choices.

Although preventable with modifiable risk factors, the future of stroke, if no immediate action is taken, is looming and may threaten the sustainability of health-care systems worldwide. For example, a recent study found that interventions for primary stroke prevention were insufficiently implemented, sub-optimal, and fragmented.^[8] Current strategies include an integrated approach that targets behavioral and pharmacological interventions implemented at an individual level. The other strategy includes population-wide measures that are designed and effectively implemented by governments and policymakers at the national, regional, and international levels.^[9]

In Saudi Arabia, primary stroke prevention strategies are limited. With the health sector transformation program that depends on the principles of value-based care and applying the new model of care in disease prevention, aggressive and serious steps for primary prevention of stroke are expected to be implemented. In this article, we review the primordial and primary prevention of ischemic stroke in Saudi Arabia and suggest a combination approach and framework for implementation. Important definitions to facilitate the discussion in this article are listed in Table 1.

RISK FACTORS TARGETED FOR PRIMORDIAL AND PRIMARY ISCHEMIC STROKE PREVENTION

Primordial and primary prevention of ischemic stroke is based on identifying and modifying several risk factors that contribute to stroke risk even in the absence of a previous history of cerebral ischemia.^[10] According to a study on the importance of conventional and emerging risk factors of stroke in different regions and ethnic groups of the world (the INTERSTROKE study), 10 modifiable risk factors for stroke were identified. These include hypertension, cardiac causes, abnormal lipids, lack of physical activity, alcohol consumption, unhealthy diet, abdominal obesity, diabetes mellitus, current smoking, and psychological factors.^[11] Saudi Arabia was one of the countries involved in this study, and according to their conclusion, these 10 risk factors were responsible for 90% of the stroke risk. Since Saudi Arabia is still considered a

Table 1: Important definitions

Term	Definition
Developing countries	Sovereign state with a lesser developed industrial base and a lower human development index relative to other countries
Developed countries	Sovereign state that has a high quality of life, developed economy, and advanced technological infrastructure relative to other less industrialized nations
High-income countries	Defined by the World Bank as a nation with a gross national income per capita of \$13,205 or more in 2021
Middle-income countries	Defined by the World Bank as lower middle-income economies (those with a gross national income per capita between \$1086 and \$4255 in 2021) and upper middle-income economies (those with a gross national income per capita between \$4256 and \$13,205 in 2021)
Low-income countries	Defined by the World Bank as a nation with a gross national income per capita of \$1085 or <2021
Primordial prevention	Set of interventions targeting people without risk factors through a focus on restoration of favorable social and environmental conditions and the promotion of healthy behavioral patterns to prevent the development of risk factors
Primary prevention	Preventing a disease from ever occurring in a susceptible population or individual
Secondary prevention	Early disease detection in healthy-appearing individuals with subclinical forms of the disease
Tertiary prevention	Reducing the severity of the disease as well as of any associated sequelae
Quaternary prevention	Action taken to identify patients at risk of over medicalization, to protect them from new medical invasion, and to suggest to them interventions that are ethically acceptable

developing country, despite the fast and huge growth in the economy and gross domestic product, other stroke risk factors may still operate, including infections, sickle cell disease, and environmental factors.^[12] Risk factors for stroke can be broadly divided into modifiable and non-modifiable factors [Table 2].

Hypertension

Hypertension is the prime modifiable stroke risk factor with more than half of all strokes being attributed to hypertension.^[13] Controlling blood pressure continues to be one of the key helpful interventions to decrease stroke risk. Mass-level hypertension screening and providing therapies have resulted in reducing the incidence, prevalence, and mortality of stroke.^[14] In a cross-sectional epidemiological analysis of 550 adults in Saudi Arabia visiting primary care clinics, hypertension was documented in 41.8% of the patients.^[15] Normal blood pressure is defined as <120/80 mmHg by current recommendations aimed at individualizing risk assessment. Blood pressure reduction is highly effective in preventing ischemic stroke in persons with hypertension: every reduction in systolic blood pressure by 10 mmHg and a reduction in diastolic blood pressure by 5 mmHg decreased the stroke risk by 41%. In addition, this

Table 2: Ischemic stroke risk factors

Nonmodifiable	Modifiable
Age (older population with the risk of stroke doubles for each decade after the age of 55)	Hypertension
Male sex	Dyslipidemia
Ethnic race/group (African Americans and Hispanics)	Tobacco smoking
Low birth weight (stroke risk doubles in persons with birth weight <2.5 kg)	Diabetes mellitus
Genetic susceptibility	Physical inactivity and sedentary lifestyle
	Obesity and body fat distribution
	Diet and nutrition
	Oral contraceptive use
	Alcohol abuse
	Drug abuse
	Air pollution
	Obstructive sleep apnea
	Migraine
	Hyperhomocysteinemia
	Elevated lipoprotein
	Hypercoagulability
	Inflammation
	Infection
	Sickle cell disease
	Atrial fibrillation and other cardiac conditions
	Asymptomatic carotid disease
	Kidney disease
	Metabolic syndrome

approach reduced the risk of death.^[16] Anti-hypertensive medications and lifestyle modifications including lowering dietary salt intake, effective weight control, and avoiding excessive alcohol use are recommended to reduce blood pressure.^[17]

Lack of physical activity and sedentary lifestyle

Physical activity has several advantages, including decreased risk of total mortality and stroke.^[18] Men and women who are physically active have a 25% to 30% lower risk of stroke or mortality compared with the least active.^[19,20] In a systematic review that examined the physical activity status of the Saudi population, the majority of Saudis were not active enough to meet the recommended guidelines for moderate to vigorous physical activity (80% to 90% of children/adolescents and 50% to 95% of adults had low or insufficient physical activity).^[21] Adults are advised to carry out moderate-intensity aerobic exercise for 40 minutes on a daily basis or at least 3–4 days per week.^[22] The protective effect of physical activity is explained by its role in decreasing blood pressure and controlling other cardiovascular risk factors such as diabetes mellitus and obesity.^[23] Citizens bicycling to work in a cross-sectional study conducted in India were 50% less likely to have hypertension and 35% less likely to have diabetes mellitus.^[24] Physical activity is not only important for stroke prevention but also in case

of stroke, as those having at least half an hour, three times a week of physical activity for 6 months before stroke had milder strokes, fewer complications, reduced mortality, and superior functional outcomes.^[25]

Dyslipidemia

Most studies found that elevated total high cholesterol is associated with a raised ischemic stroke risk.^[26] The Asia-Pacific studies, for example, reported a 25% increase in the rate of ischemic stroke for every increase of 1 mmol/l in total cholesterol.^[27] In a cross-sectional community-based study conducted in 13 governorates across Saudi Arabia, the prevalence of dyslipidemia was 33%.^[28] A meta-analysis reported a significant reduction in the relative risk of ischemic stroke (primary prevention) by statin treatment in subjects with no cardiovascular disease.^[29]

Diet and nutrition

In a national survey of >10,000 Saudi individuals aged ≥15 years (the Saudi Health Interview Survey), only a limited proportion of Saudis met the dietary recommendations, and young adults' consumption of processed foods and sugar-sweetened beverages was high.^[30] Several studies have repeatedly shown that individuals eating a healthy diet high in fruits, vegetables, fibers, omega-3 fatty acids and mono-unsaturated fats have lower rates of stroke, likely through antioxidant mechanisms or by raising potassium levels.^[31] Reducing salt intake to <5 grams per day is another strategy considered to reduce the risk of cardiovascular mortality in hypertensive participants.^[32] Another primordial prevention strategy is to limit the intake of foods associated with overnutrition (e.g., sugar-sweetened beverages). A study reported that a reduction in the consumption of sugar-sweetened beverages by 10% would result in 20,000 fewer strokes and 19,000 fewer deaths annually.^[33] Adding taxes and increasing prices on sugar-sweetened beverages were among the steps done in several countries, including Saudi Arabia, with success in reducing sales and purchasing of these beverages.^[34]

Obesity and body fat distribution

The prevalence of obesity has increased alarmingly over the past decades and is considered a major public health concern.^[35] In a nation-wide cross-sectional survey with >4700 participants from Saudi Arabia, the weighted prevalence of obesity was 24.7%.^[36] Weight reduction lowers the risk of diabetes, hypertension, and stroke.^[37] Avoiding weight gain in early adult life is a key preventive strategy in primary stroke prevention, as weight gain of ≥5 kg in early adult life was reported to increase the long-term risk of stroke compared with individuals with no or minimal weight gain.^[38] Treatments for obesity include

dietary restrictions, behavioral modifications, exercise, and bariatric surgery.^[39]

Tobacco smoking

Smoking is one of the major modifiable risk factors for cerebrovascular disease, and current smoking increases stroke risk 2–4 times. In fact, even passive exposure to second-hand smoke increases the risk of stroke by 25%.^[40] Studies have shown a significant decrease in vascular risk after a few months of abstinence from smoking and the elimination of risk after about 5 years.^[41] The prevalence of smoking among adolescents in Saudi Arabia ranged from 2.4% to 39.6%.^[42] Measures to monitor and prevent smoking and aid smokers quitting include raising the cost of tobacco, smoke-free area legislation, bans on advertising and promoting tobacco products, mass-media campaigns, and increasing the legal age of smoking to ≥ 21 years.

Atrial fibrillation

Atrial fibrillation is a significant cause of cardioembolic stroke, especially in the elderly population, affecting 5% of people aged >70 years.^[43] Atrial fibrillation is behind around one-quarter of strokes in persons aged >80 years.^[44] The risk of stroke is from both paroxysmal and permanent atrial fibrillation and can be assessed using the CHA₂DS₂-VASc score. Patients who have a lower score (0-1) carry a risk of around 1% per year (low risk), those with a score of 2 carry a risk of around 2.5% per year (moderate risk), and those with a score of >3 carry a risk of 5% per year (high risk). Patients with an annual risk of stroke of $>4\%$ require treatment with oral anticoagulation (warfarin or direct oral anticoagulant), whereas aspirin is sufficient for patients with a risk of 1% per year or less (low stroke rate).^[45]

Alcohol abuse

Several studies have shown the deleterious effects of heavy alcohol drinking. Consumption of higher than 5 standard alcoholic drinks daily carries a 69% increased risk of stroke compared with non-users. Heavy drinking of alcohol can cause hypertension, reduced cerebral blood flow, hypercoagulability, and a higher probability of atrial fibrillation.^[46] Heavy drinking elimination can decrease the risk of stroke. It is not recommended to encourage non-drinkers to start consuming alcohol due to the possible protective effects of light and moderate alcohol drinking.^[47] Saudi Arabia is one of the Islamic countries where alcohol is prohibited, and thus alcohol abuse is not common.^[48]

Diabetes mellitus

Diabetes mellitus affects around one-third of ischemic stroke patients and doubles their recurrence risk. Duration of diabetes of >3 years increases the stroke risk by

74%.^[49] A goal of glycated hemoglobin (hemoglobin A1c) of $<7\%$ is recommended to prevent microvascular complications.^[50] The prevalence of diabetes in Saudi Arabia was 18.3%.^[51] A multifaceted approach to glycemic control or even eliminating diabetes is recommended, including weight loss through dietary changes or surgery and controlling vascular risk factors such as hypertension and dyslipidemia.^[52]

Oral contraceptive use

The prevalence of oral contraceptive use among Saudi females was found to be 31.8%.^[53] The current use of oral contraceptive pills is associated with an increased risk of ischemic stroke. The higher estrogen dose (containing >50 μg of estradiol) and the longer duration of oral contraceptive use greatly increase the ischemic stroke risk. Women aged >35 years, current cigarette smokers, with hypertension, diabetes, migraines, or a history of thromboembolic event are at an increased risk of stroke when they use oral contraceptive pills.^[54] Further studies, guidelines, and recommendations are required to investigate the underlying mechanisms of increased brain vulnerability to ischemic stroke by oral contraceptive pills and alternative options in this category of the population. Educating the young female population about the hazards of estrogen-containing pills may be considered to enable them to make informed decisions.

CHALLENGES IN PLANNING ISCHEMIC STROKE PREVENTION IN SAUDI ARABIA

The population of Saudi Arabia was 34.1 million in 2021, of which around two-thirds are Saudi nationals, and the remaining one-third is composed of working immigrants from several Asian, African, and other countries.^[55] The median age of the Saudi population was 31.8 years in 2020, which is younger than that of the United States (38.3 years) and the United Kingdom (40.5 years).^[56] Although the birth rate is declining in Saudi Arabia (16.81 per 1000 population in 2020 from 22.12 per 1000 population in 2010), the population annual growth rate is 2.52%, reflecting an improvement in life expectancy and an increase in the aging population.^[57] This increase in the aging population and population growth is expected to make stroke a considerable emerging public health problem in Saudi Arabia.

The major provider and financier of health care in Saudi Arabia is the Ministry of Health, with health-care expenditure of 5.69% of the gross domestic product, a figure lower than that of other developed countries such

as the United States (16.77%), United Kingdom (10.15%), and France (11.06%).^[58] Despite the presence of >350 publicly funded, well-functioning hospitals, only a few stroke units are functioning.^[59] Collaboration, organization, and coordination between different health-care sectors are needed to improve the primary prevention of stroke, as the government is providing free health care to its citizens. In addition, improvement in ambulance services and rehabilitation facilities is of paramount importance. Over the past three decades, health-care services have improved greatly in Saudi Arabia. During the COVID-19 pandemic, health-care services further improved.^[60]

Stroke is the second major cause of death in Saudi Arabia with around 15,000 deaths annually. Only 1% of patients with ischemic stroke in urban areas receive tissue plasminogen activator (compared with 6.5% in the United States).^[61] This discrepancy between the tremendous effort and expenditure to provide health care for stroke patients and the rising number of cases and deaths is probably attributed to several factors, including a low level of stroke awareness in the population, lack of data and statistics on stroke, and failure of primordial and primary prevention of the disease. This worryingly conflicting information and data are considered an urgent call for the establishment of a nationwide registry of stroke, which should succeed if done in the same way as the COVID-19 statistics were collected. The current challenges are mainly to increase awareness about stroke and its risk factors.

Another major challenge in the planning of primary stroke prevention in Saudi Arabia is convincing people to use modern medicine rather than complementary and alternative medicine. In a study conducted by Alhawsawi *et al.*, in 2020, around 60% of ischemic stroke survivors also used cauterization and Quran recitation.^[62] People, especially in rural areas, might be used to having a disease diagnosed and treated rather than understanding the concept of primary stroke prevention. This may lead to resistance to the use of medications and other interventions implemented in primary stroke prevention. A nation-wide campaign to educate people and disseminate knowledge about primary and secondary stroke prevention and the use of evidence-based medicine is important. The shortage of doctors familiar with stroke, preferably stroke neurologists, is a major barrier to creating a screening and therapeutic strategy to aggressively address modifiable risk factors for the primary prevention of stroke.

RECENT PROMISING CHANGES IN SAUDI ARABIA THAT SUPPORT PRIMORDIAL AND PRIMARY ISCHEMIC STROKE PREVENTION

Health sector transformation program

This program is one of the national Vision 2030 realization programs that targets restructuring the health sector in Saudi Arabia to be a comprehensive, effective, and integrated health system. It is focused on both the health of the individual (i.e., citizen, resident, or visitor) and society. The program relies on the principles of value-based care that ensure transparency and financial sustainability. It promotes public health and prevents diseases, including the new model of care related to disease prevention. In addition, one of its objectives is to improve access to health services through optimal coverage in a comprehensive and equitable geographic distribution. This program harmonizes and coordinates between all health sectors and entities, relevant government entities in alignment with strategic national goals during the journey of transformation.^[63] Primordial and primary ischemic stroke prevention should, and will be, an important part of this huge project.

Walking and cycling paths

The nationwide development of sports paths for walking, cycling, and horse-riding is in alignment with the goals of the Saudi Vision 2030, which includes encouraging the citizens of major cities to follow a healthy lifestyle in a rich cultural, environmental, and recreational ambiance. Many zones of sports are/will be established that cover long distances that encourage walking and cycling and reduce exposure to pollution with access to fresh and healthy food.^[64]

Saudi Green Initiative

This initiative will chart a path in protecting the planet, improving the quality of life, and offsetting the impact of fossil fuels. By planting 10 billion trees, Saudi Arabia will spearhead regional efforts to achieve global targets to combat climate change. Other important steps in this initiative are to increase the share of energy from renewables from 0.3% to 50% by 2030, reduce carbon emissions by >4% of global contributions, and raise the percentage of protected areas to >30% of the total land area of Saudi Arabia. This initiative will prepare for the establishment of healthy cities.^[65]

Digital health

The growth in using digital health has significantly changed clinical practice in Saudi Arabia. This became more obvious in 2019, when the COVID-19 pandemic solidified the use of these technologies, including the use of a smartphone app to implement various strategies to combat the pandemic

through different methods, including vaccinations.^[66] Currently, there are several stroke-related apps that target primary prevention, acute stroke management, chronic management, and secondary prevention.^[67] Saudi Arabia is rich in communication technologies with fast internet, and access to all these apps is available. All that is needed is the education of the Saudi public about the importance and usefulness of these apps.

STRATEGIES FOR PRIMORDIAL AND PRIMARY ISCHEMIC STROKE PREVENTION IN SAUDI ARABIA

There are several strategies to improve both primordial and primary stroke prevention [Figure 1].

The individual strategy

This strategy is implemented by health-care providers where modifiable risk factors can be targeted. This includes risk assessment and management of major lifestyle factors and preventative strategies to manage behavior risk factors with a special focus on high blood pressure, diabetes, and smoking.^[8] The prevalence of people with a higher risk of stroke might be notably high in some communities. Therefore, it is thought that a preventive approach based on the risk of stroke requires implementation and application to a larger segment of the population.^[68] The use of the Stroke Riskometer app has been shown to be highly acceptable, potentially efficacious, and motivating to users. It is not recommended to categorize individuals

into low, moderate, and high-risk for stroke, but instead, consider the risk of stroke as a continuum.^[69]

The population-based strategy

This strategy aims to decrease the prevalence of stroke risk factors in the general population. It is believed that a population-wide decrease in the risk factor levels results in large beneficial effects. This strategy is implemented by governments or health systems with mass mobilization, policy, and legislative changes. There is increasing interest in population-based strategies for stroke risk reduction given the limitation of the individual-based strategy.^[70] One of the successful examples of a population-based strategy in a developing country is Mauritius, where promoting smoking cessation, healthy nutrition, reduction in alcohol intake, and increase exercise using legislative measures, mass media, and health education in the community, school, and workplace resulted in a decrease in the prevalence of high blood pressure, tobacco smoking, heavy alcohol consumption, a reduction in serum cholesterol levels, and an increase in moderate physical activity.^[71] Another successful example is from Nepal, where a lifestyle modification program successfully decreased blood pressure, confirming the feasibility of this approach.^[72] The free Stroke Riskometer app can also be used in a motivational population-wide strategy to reduce lifestyle and other risk factors in adults at any increased risk of stroke development. Another population-based strategy is to establish stroke prevention clinics. Stroke prevention clinic is well-known to decrease

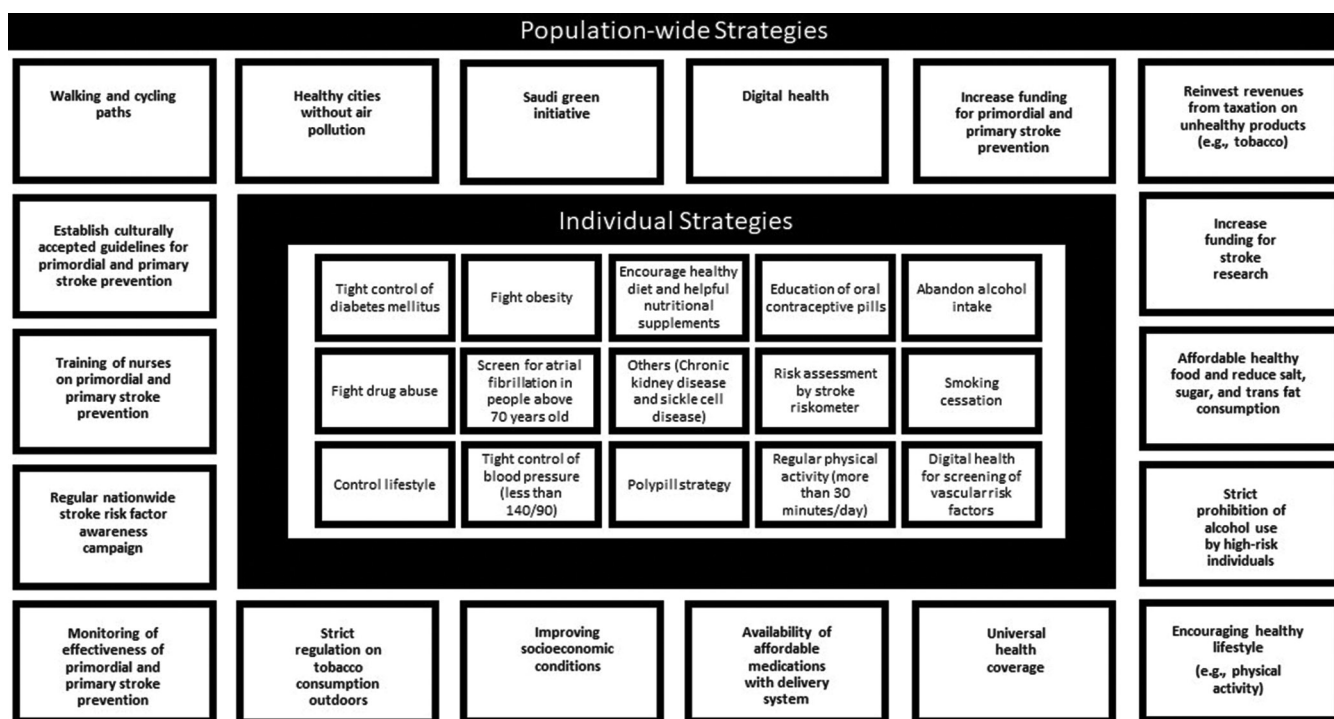


Figure 1: Population-wide and individual strategies for primordial and primary stroke prevention

the chance of dying within a year in around one-fourth of patients who suffered from a transient ischemic attack or stroke as compared with those who did not go to a stroke prevention clinic. In addition, treating transient ischemic attacks decreases the risk of stroke.^[10,73]

KEY PRIORITIES AND RECOMMENDATIONS FOR PRIMORDIAL AND PRIMARY ISCHEMIC STROKE PREVENTION IN SAUDI ARABIA

Currently, there are several key priorities for primordial and primary stroke prevention in Saudi Arabia that should target people at different levels of risk. These include an emphasis on a comprehensive approach that includes both strategies (individual and population-based) and establishing partnerships across health-care providers, including non-governmental and governmental entities, to share responsibility for developing and implementing both strategies. In addition, the establishment of electronic health information technologies and incorporation of affordable, reliable, widely accessible, and validated mobile technologies for primary prevention of ischemic stroke for use by both health-care providers and lay persons should be implemented. The government should implement education programs about a healthy lifestyle in the standard education curricula early in life with re-enforcement across the lifespan. Other recommended preventive steps include:

- Increase funding for primordial and primary ischemic stroke prevention;
- Establish stroke prevention clinics in all hospitals in Saudi Arabia, if possible, and increase the number of stroke units to cover all regions in Saudi Arabia;
- Collaborate, organize, and coordinate between different health-care sectors to improve the primary prevention of stroke;
- Invest revenues from taxes on unhealthy products such as tobacco into health-care and preventive strategies;
- Establish an action plan for ischemic stroke prevention on both the individual and community levels;
- Establish culturally appropriate guidelines for the primary prevention of stroke utilizing validated mobile phone apps;
- Transfer tasks of primary prevention of ischemic stroke from an experienced health-care professional to less experienced health-care workers after training;
- Establish collaboration between different national and international agencies and organizations involved in the primary prevention of ischemic stroke (e.g., World Stroke Organization). These include stroke experts, epidemiologists, and medical educators;
- Establish nation-wide ongoing stroke awareness campaigns about primary prevention of ischemic

stroke that involve the entire population using mass communication media;

- Establish monitoring systems and frameworks for the evaluation of the effectiveness of the primary prevention program for ischemic stroke. This requires high-quality country-specific epidemiological data on the burden of stroke and risk factors;
- Increase funding of primordial and primary ischemic stroke research nationwide through health research funding agencies in consultation with recognized regional and international experts on stroke and public health; and
- Utilize appropriate assessment methods that evaluate accurately the conduction and usefulness of the previously mentioned recommendations and actions.

PRACTICAL IMPLEMENTATION

To implement an effective primary stroke prevention program, all sectors providing health care to patients should collaborate and establish guidelines, protocols, and regulations. They should also exchange data and statistics, prevent repetition to reduce workload, distribute the roles, and meet regularly. Although there is a stroke registry that was established several years ago, it has not been properly activated or well utilized. In addition, the Saudi Stroke Society, which was established in 2007, is not conveying with the Saudi Vision 2030 and Health Transformation Strategy,^[74] with their current role being mainly educational through an annual conference and few online courses. The Society also only allows neurologists with training in vascular neurology to be members, despite the very limited number of stroke neurologists in Saudi Arabia. However, for wider participation, the Society could invite all neurologists, residents, internists, nurses, and the general public, especially families with a member who suffered from stroke, to join the society and actively participate in the primary stroke prevention mission. The Society can further take an active role and lead strategies under the umbrella of the Ministry of Health.

CONCLUSION

Ischemic stroke is a leading cause of death and disability worldwide, including in Saudi Arabia. It constitutes a huge burden that is increasing rapidly with escalating challenges. We provide a pragmatic solution to implement primordial and primary stroke prevention in Saudi Arabia and specify the roles of the government, health professionals, policymakers, and the entire population. This is an urgent call for action to immediately start different strategies

suggested by experts in the field of stroke and is considered the foundation stone for primary stroke prevention in Saudi Arabia.

Peer review

This article was peer-reviewed by four independent and anonymous reviewers.

Data availability statement

Data sharing is not applicable for this article, as no new data were created or analyzed.

Author contributions

Conceptualization: H.A. and V.H.; Methodology: H.A., B.S., and V.H.; Writing—original draft preparation: H.A. and B.S.; Writing—review and editing: H.A., B.S., and V.H.; Supervision: V.H.

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Conflicts of interest

There are no conflicts of interest.

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