Systematic Review

Prevention and Control Policies of Dengue Vectors (*Aedes aegypti* and *Aedes albopictus*) in Iran

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ABSTRACT

Background and Purpose: Dengue fever has become a major public health problem in many world regions due to increased trade, travel, and problems controlling Aedes vectors. This policy brief aims to review, analyze, and present evidence-based policies for dengue prevention and control.

Materials and Methods: The present research is a compilation of a policy brief in Iran, carried out in 3 stages according to its methodology. In the first stage, the problem's justification and description were provided systematically by examining scientific documents by searching national and international scientific databases, websites, guidelines, and books. In the second stage, the first author prepared a draft of the priority elements related to the policy framework and discussed them with other authors. In the third stage, the draft questions were categorized and summarized, and subsequently, the policies were compiled in close discussion with all authors.

Results: According to the recommendations of the best available evidence in the literature, 5 policy options were presented for the prevention and control of dengue fever as follows: 1) developing basic, applied, and innovative research; 2) strengthening the capacity and capability of the human, infrastructural, and health system in all relevant sectors for the surveillance, control, monitoring, and evaluation; 3) strengthening inter- and intra-sectoral coordination and collaboration; 4) community engagement and mobilization; and 5) scaling up of functions and integrating tools.

Conclusion: To increase the long-term impact of policies, it is recommended to use an integrated approach with the continuous support of all stakeholders (local, national, and regional).

Keywords: *Aedes aegypti*, *Aedes albopictus*, Dengue, Prevention and control

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1. Introduction

Dengue fever is a worldwide public health concern as it has been the fastest-developing contagious disease in the past 5 decades (more than 30 times) [1]. This disease is created by a single-stranded RNA from the Flaviviridae family and Flavivirus type [2]. There are 4 distinct serotypes (dengue 1-4) regarding immunity. Each type can cause infection and illness in humans. Accordingly, infection with each serotype causes lifetime immunity problems toward the causing serotype and does not provide immunity toward other serotypes [3]. Clinical symptoms of this disease include fever with rashes, acute headache, pain behind the eyes, and pain in muscles and joints. Dengue fever is also known as bone-breaking fever, as due to its intense pain, patients feel as if their bones are being crushed [4]. Even though dengue fever is self-limiting, some patients may experience acute and life-threatening levels of the disease, such as bleeding dengue fever or shock-dengue syndrome, with high mortality rates [5]. According to the World Health Organization (WHO), dengue fever is native to 128 countries. A total of 3.6 billion people live in regions at risk of contracting the disease. It is estimated that 390 million dengue infections occur annually worldwide, with which 96 million report clinical symptoms, which shows the importance and intensity of the disease [6].

Additionally, dengue fever imposes high costs on the victim and the government health system. According to the data provided by the global burden of disease (GBD), dengue fever and mortality rates increased respectively from 30668000 and 28152 in 1990 to 56879000 and 36055 in 2019 [7]. Based on the distribution of cases and mortalities worldwide, adjusted life years with disability have increased from 2347000 in 1990 to 2383400 in 2019 [7]. On average, dengue fever imposes 1.2 billion US dollars (without considering the cost of controlling the vector) more than other virus-based diseases in the American continent [8]. In Southeast Asia, it is estimated that there are 2.9 million cases of dengue fever and 5906 deaths by this disease, with 950 million US dollars in costs occurring annually [9]. The fast pace of confirmed cases and the worldwide dengue disease burden, along with demographic and societal changes in the last 50 to 60 years, are related to the unprecedented population growth, climate change, uncontrolled urbanization, increased travel and trade, weakened public health infrastructures, and alterations in main vector distribution as well as issues in its control [10].

With a population of nearly 80 million people, Iran is the second biggest country in the Middle East, where dengue fever is considered a new phenomenon [2]. In recent years, evidence suggests an increasing trend of confirmed and unconfirmed cases of dengue fever in the country, especially in Sistan and Baluchestan, and Kurdistan provinces. Some cases had traveled to endemic regions, such as Malesia, India, and Thailand, and some had no experience of recent special travel [11, 12]. In addition, the presence and establishment of dengue fever vector, that is *A. aegypti*, in recent years, have been reported in Iran, which has raised the concerns of public health officials regarding the epidemic risk of this disease shortly [13-15]. Accordingly, an official country guideline based on trinary scenarios has been published on protocols to prevent and control *Aedes aegypti* and *Aedes albopictus* [15]. Simultaneously, training workshops and seminars have been designed and held at the university and ministerial levels. Also, reports have been made regarding the entomology of aggressive types of Aedes in the entrance and regions with high potential [14, 16, 17], which shows the awareness and initiatives of the healthcare system following the concerns. However, these initiatives and strategies should be supported and guided in line with the Framework of national macro strategy.

There are no effective vaccines or anti-viral cures for dengue fever [18]. However, Dengvaxia is the only vaccine for dengue fever that is proven by the American FDA and has received permission in 20 countries, WHO does not recommend its usage for patients with negative serum [19]. Therefore, the first preventive initiative is to control the vectors due to the lack of an anti-viral cure or effective vaccine for preventing and controlling dengue fever [20]. To strengthen the control of vectors worldwide, WHO has provided a strategic approach, the global vector control response (GVCR) 2017-2030, to confront vectors and vector-based diseases [21]. In addition, WHO has published the Framework for a National Vector Control Needs Assessment by which member countries can evaluate their existing situation in terms of vectors and vector-borne diseases (VBDs) and conduct national policies and strategies based on their gaps and opportunities to achieve their GVCR goals [22]. The dispersion expansion of vectors and the fast and unpredictable changes in the contagion of VBDs has compelled countries to continuously evaluate their executed initiatives. Accordingly, the circular approach has been suggested to respond to the dynamic and quickly changing nature of vectors and VBDs. This approach is based on the plan, do, check act (PDCA) framework [23]. Although WHO has devised the GVCR document

and member countries have tried to control vectors based on this Framework, the world still faces the increasing threat of controlling dengue fever for various technical and executive reasons [24-26].

Maintaining public health along with socioeconomic growth and development is among the priorities of countries. The number and diversity of existing frameworks and procedures at the national and international levels in controlling and managing vectors and VBDs may sometimes confuse involving departments. Hence, maintaining a policy brief in line with the needs and opportunities of each country can become a key to improving individual health and enhancing the maintaining society's public health [23]. A policy brief is critical for providing research results and recommendations based on evidence to non-expert audiences. It is a novel tool for facilitating the conveyance of knowledge and helping the audience regarding informed decision-making. A policy brief expresses study results in simple and plain language and creates clear connections with policy initiatives [27]. Hence, a policy brief has been designed in Iran to provide policy options based on the best evidence with advantages and disadvantages for controlling dengue fever vectors. Healthcare policymakers and planners can choose and execute their intervention program from the best and most effective strategies that suit their society's public culture more accurately.

2. Materials and Methods

The present study is a systematic review of conducting a policy brief for preventing and controlling dengue fever in Iran [28] in three stages. The first stage involved a complete and detailed explanation of the problem. The search was done on the Google Scholar search engine and international scientific databases, including PubMed, Science Direct, Scopus, and Lilacs, along with national databases, including Barakatkns, Scientific Information Database (SID), Magiran, and Civilica. The keywords were dengue, Aedes, prevention and control, policy, strengthening the capacity and capability of the human and infrastructure, health education, community engagement, scaling up tools and control techniques, and new techniques. The keywords were searched individually and with Boolean operators (AND, OR) in an advanced combinatory search fashion without time limitation. In addition to the search in the databases mentioned above, international websites, such as WHO, Ministry of Health and Medical Education, books, and related national guidelines and procedures, were investigated to attain more information. Next, the screening of articles and documents was done, and articles that lacked the following criteria were chosen: published in languages other than English or Persian, irrelevant to the study question, not in line with the practical description, provided the contents of the books, and duplicate article (Figure 1). The second stage involved the outline of suggested drafts from the priority components related to the policy framework by the first author, and the content was discussed between the first author and other authors of the article. The third stage included categorizing and compiling options and their effectiveness in execution by policymakers. The search and deletion flowchart of articles is provided in Figure 1.

3. Results

In the present study, according to the recommendations of the best evidence in the literature, 5 policies have been suggested for preventing and controlling the dengue fever caused by *A. aegypti* and *A. albopictus* in Iran, and the advantages and disadvantages along with their effectiveness are summarized and analyzed in Table 1. The policies are as follows: 1) developing base and practical research to support the optimized control of vectors and innovation in developing novel tools, technologies, and approaches; 2) enhancing the capacity and human, infrastructure, and public health systems in all related community levels for preventing, controlling, screening and evaluating vectors; 3) improving and enhancing inter-organization and outside-organization coordination and cooperation; 4) mobilization and participation of the society in controlling larva sources; and 5) increasing the scale of functions and merging tools in managing the disease. In addition, executive strategies for each policy option are conducted and provided.

4. Discussion

In recent years, growing attention has been paid to using research to increase health policies' effectiveness [26]. According to experimental evidence, epidemiologic data, field studies, and systematic evaluations, strengthening the use of evidence and capabilities of policymakers is optimal. It is a promising strategy for enhancing the achievements of public healthcare. The current policy brief is compiled for the first time for facilitating and enhancing the prevention and control of dengue fever vectors, in addition to creating capabilities for a better understanding of policymakers from the complied scientific information. It is hoped that policymakers can improve public health through this policy brief to provide executive plans, considering the society's cultural, social, and economic position in preventing and controlling dengue fever.

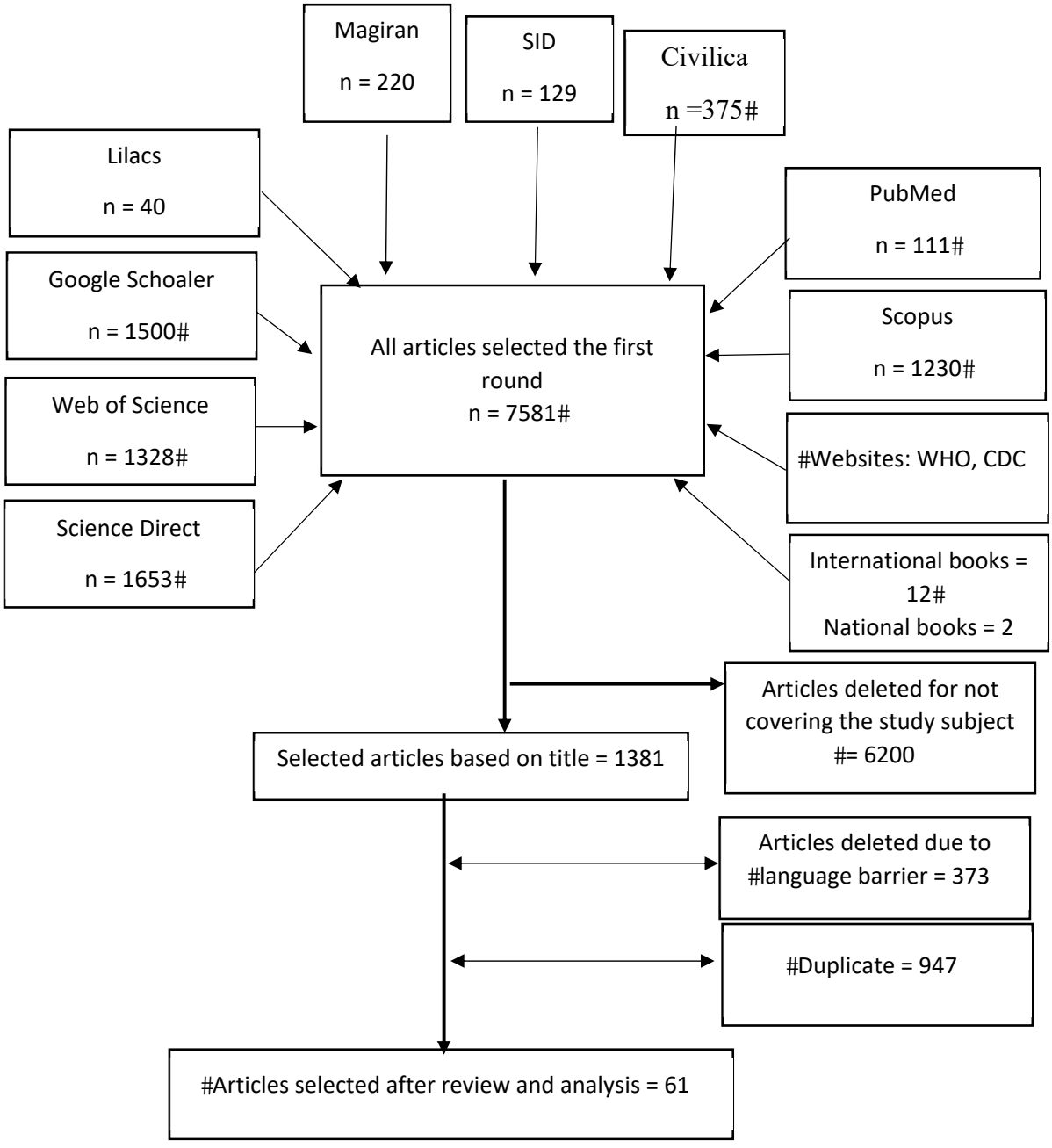

Figure 1. Search, deletion, and selection study flowchart to conduct the policy brief in controlling and preventing dengue fever

Increasing the number of fundamental and practical research to support the optimized control of vectors and innovation in developing new tools, technologies, and approaches is considered a critical component in controlling the vectors [21]. Research must act as a stepping stone upon which vector control programs should be based. Fundamental and practical research is needed to better understand the pathogens, vectors, and human and non-human hosts in relation to changes in the physical and social environment. The results of such research should demonstrate the development of approaches and innovative interventions for preventing VBDs [21]. Currently, Wolbachia bacteria and male sterilization are considered two innovative approaches and interventions compatible with the environment. They are economic and sustainable, without danger to human health. These approaches are being studied and tested in laboratories and field studies to control dengue fever worldwide [25]. Wolbachia is an in-cell, coexistence bacteria first reported by Herting and Wolbach in Culex pipiens in 1924 and was then scientifical-

ly titled "Wolbachia pipientis". These bacteria are naturally found in almost 60% of all insects, including Culex pipiens and *Aedes albopictus* [29]. The bacteria are transferred to the next generation via eggs and change the reproduction phenotype of the infected insect. They can result in the killing of the male, femalization, parthenogenesis, and usually cytoplasm incompatibility [30]. Currently, one of the reasons for using Wolbachia bacteria based on one-way cytoplasm incompatibility (which appears as fetal killing due to a cross between infected female and male) or two-way cytoplasm incompatibility (a cross between infected cases [male or female], different types of Wolbachia occur that result in sterilization) [31]. Based on the data provided by the best evidence, Mains et al., by releasing males infected by Wolbachia in a region in Miami, US, discovered a significant reduction in the number of *A. aegypti* [32]. Nordin et al., in a systematic review of 4 studies, demonstrated that all studies showed the reduction of dengue fever in intervention populations with Wolbachia [33].

Male sterilization is a special, non-pollutant, and environmentally-compatible procedure since 1977 to control insect pests [34]. This technique includes the release of a vast number of male insects under gamma radiation which results in an accidental injury on a macro scale to the chromosomes of insects or major fatal mutations in the sperm of the sterilized male. These sterilized males compete with wild, fertile males for mating. The results demonstrate the sterilization of eggs or alternation in sexual orientation toward males [34, 35]. Based on the data from the best evidence, in Sri Lanka [35] and Cuba [36] in the laboratory and field environment, using this technique to suppress *A. aegypti* has proven to be successful, and 5 weeks after release, the population of *A. aegypti* reached 0 (for 3 weeks).

The executable approaches for the policy brief

The first one is conducting and updating the comprehensive national program on fundamental and practical research by the Department of Controlling VBDs by the Ministry of Health, with the help of experts and funding for its implementation. These measures need the conduction of official organizational agreements to strengthen the link between upstream departments and research institutions, support in increasing the research capability of research institutions in planning and conducting innovative and practical research, active support for international cooperation for using technologies and advanced approaches along with improving the quality of research results, using national advising committees to investigate research results and scientific achievements along with the suggestion of conducting required strategies and guidelines to prevent and control the disease, setting up and updating the information platform regarding epidemiology and combative actions toward VBDs with easy access for researchers and research institutions [15, 21-23, 37-39].

The second approach is increasing the human, infrastructure, and healthcare system capacity and empowerment in all related departments regarding prevention, control, screening, and evaluation of vectors entomology is the second major component in controlling the vectors mentioned above [21]. Prevention, screening, and evaluation are considered the core of vector control programs and are a set of approaches used for aware decision-making to respond to the known risk of VBDs [39]. Effective and sustainable control of vectors with merely sufficient human resources, strong infrastructures, and a productive healthcare system is attainable. This measure requires a consistent and strong political decision and will [21]. Innovations in creating capabilities related to the healthcare system as improvement, development, and renovation of existing infrastructures, renovating the facilities of existing laboratories, providing the necessary scientific equipment, and providing proper identification test systems, are defined as the conveyance of technical and educational expertise [40]. In a study by Ulibarri et al. in Guatemala, financial, infrastructural, and personnel limitations resulted in inconsistent controlled interventions [41]. A systematic review has emphasized that insufficient resources, especially human resources, hinder the success of Aedes controlling interventions [37]. Human empowerment in the form of training includes transferring information and developing skills on the individual and social level, considering social, economic, and environmental determinates, which leads to positive change in the awareness, attitude, and function of people, along with adopting proper behavior to enhance public health. Based on the best evidence, empowerment in terms of training people can be directly done with individuals or groups, in the form of group discussions, speeches, panels, symposiums, and workshops, in addition to indirect training with the help of mass media equipment, such as radio, television, newspaper and journals, posters, pamphlets, and notes on the virtual world. Such training can be performed on different levels for healthcare providers as the first group of preventing and controlling the diseases (doctors, nurses, and healthcare staff) and people in other involving organizations that are dealing with preventing and controlling the disease (ports, airports), in addition to the public to alter the behavior for self-maintenance and active participation in managing the home environment and its surrounding to reduce the larva resources [46-48].

Table 1. Policy options in preventing and controlling the vectors of dengue fever in Iran

	Name of the Policy 1	Reference	Name of the Policy 2	Reference	Name of the Policy 3	Reference	Name of the Policy 4	Reference	Name of the Policy 5	Reference
Investigation aspects	Developing fundamental and practical research and innovation		Increasing the capacity and empowerment of human, infrastructural, and health systems in all related departments for prevention, control, screening, and evaluation of vector entomology		Strengthening the coordination and cooperation within and outside the organization		Mobilization and participation of the public in controlling larva resources		Increasing the scope of functions and merging tools in managing them	
Advantages	Achieving new approaches to controlling dengue fever or reducing the load of the disease, such as lack of pollution, lack of resistance, lack of adverse effects on the competitive characteristics of the insect	[21, 35, 42]	Sustained control of the dengue fever and reducing the load of the disease	[15, 21, 37, 41]	Sustained control of the dengue fever along with reducing the diseases load	[15, 21, 37, 41]	Improving awareness and attitude and translating them to sustained control of the dengue fever along with redoing the disease load	[15, 21, 37, 38]	Sustained control of dengue fever and reducing the load of the disease during the epidemic	[15, 21, 37, 38]
Disadvantages	Require conducting and designing a compressive national program to increase human, structural, and financial capabilities. In addition, achieving some innovative techniques, including sterilizing males, has disadvantages, such as their constant release because of the lack of establishment in the environment.	[43, 33, 44, 45]	-Need for identifying entomological capabilities, public health, and infrastructure at a national, provincial, and local level -Need for trained expert employees for doing constant training to people because of reasons such as occupational burnout, the retirement of workers, transfer of people to other health regions or other organizational departments, or exit to work in the private sector, either within or outside the country -Require sufficient financing to perform supportive activities	[15, 21]	-Require creating a ministerial strategic committee -Require trained experts or representatives from other organizations or ministries regarding the manner of policies, programs, guidelines, and predicted plans in the strategic committee -Require proper financing to perform encouragement-cooperation support	[15, 21]	-Require setting training campaigns at national, provincial, and local level -Require attracting expert workers to teach and attract participation -Require proper financing and performing supportive initiatives	[15, 21, 37, 38]	- Require the conduction and designing of a compressive national program with increasing the human, structural, and financial capabilities at the national, provincial, and local level -Require screening and evaluation of effective and economical approaches to expand and merge controlling tools and techniques at the national, provincial, and local level -Require proper financing to perform support initiatives	[15, 21, 37, 38]

	Name of the Policy 1	Reference	Name of the Policy 2	Reference	Name of the Policy 3	Reference	Name of the Policy 4	Reference	Name of the Policy 5	Reference
Costs and Effectiveness costs	High costs -High effectiveness	[21, 33, 36]	High cost, high effectiveness (this section is mentioned based on the data from the best national and international evidence in comparison to other controlling policies in a qualitative fashion)	[15, 21, 37, 41]	Low cost, high efficacy	[15, 21, 37, 41]	Low cost, high efficacy	[15, 21, 37, 38]	High costs, high efficacy	[15, 21, 37, 38]
Uncertainty regarding potential advantages and disadvantages	This policy, in combination with other options, is recommended to control and prevent the vectors of dengue fever.	[21, 33, 36]	This policy, in combination with other options, is recommended to control and prevent the vectors of dengue fever.	[15, 21, 37, 41]	This policy, in combination with other options, is recommended to control and prevent the vectors of dengue fever.	[15, 21, 37, 41]	This policy, in combination with other options, is recommended to control and prevent the vectors of dengue fever.	[15, 21, 37, 38]	This policy, in combination with other options, is recommended to control and prevent the vectors of dengue fever.	[15, 21, 37, 38]
Key Components of the option (how and why it works)	With the support of the Ministry of Health and the Center for Disease Control: -Based on an official order to provincial medical universities to execute the settled policies Based on an official order to other organizations regarding participation with provincial medical universities to help in executing the selected policy		With the support of the Ministry of Health and the Center for Disease Control: -Based on an official order to provincial medical universities to execute the settled policies -Based on an official order to other organizations regarding participation with provincial medical universities to help in executing the selected policy		With the support of the Ministry of Health and the Center for Disease Control: -Based on an official order to provincial medical universities to execute the settled policies Based on an official order to other organizations regarding participation with provincial medical universities to help in executing the selected policy		With the support of the Ministry of Health and the Center for Disease Control: -Based on an official order to provincial medical universities to execute the settled policies -Based on an official order to other organizations regarding participation with provincial medical universities to help in executing the selected policy		With the support of the Ministry of Health and the Center for Disease Control: -Based on an official order to provincial medical universities to execute the settled policies Based on an official order to other organizations regarding participation with provincial medical universities to help in executing the selected policy	
Stakeholders' viewpoints and experiences	Agreed The confirmation and agreement of the writers of the policy brief as experts of medical entomology and data based on the best evidence	[21, 36]	Agreed The confirmation and agreement of the writers of the policy brief as experts of medical entomology and data based on the best evidence	[15, 21, 37, 41]	Agreed The confirmation and agreement of the writers of the policy brief as experts of medical entomology and data based on the best evidence	[15, 21, 37, 41]	Agreed The confirmation and agreement of the writers of the policy brief as experts of medical entomology and data based on the best evidence	[15, 21, 37, 38]	Agreed The confirmation and agreement of the writers of the policy brief as experts of medical entomology and data based on the best evidence	[15, 21, 37, 38]

Executable and implementable approaches for this policy

The first approach is establishing the department of controlling VBDs under control merged policy, installing, updating, and executing national development, and empowering the human resources to prevent and control VBDs.

The second one is developing the infrastructures of entomology along with operational equipment in the vector prevention and control system, along with developing the infrastructures needed to identify viruses in the human healthcare system;

The third approach is conducting and executing retraining programs for experts and healthcare personnel regarding preventing and controlling dengue fever and other diseases transferred by the aggressive type of Aedes, such as prediction, identification, and reaction to the outbreak of the mentioned diseases.

The fourth one is conducting and executing re-training programs for the private section of the healthcare system regarding the prevention and control of dengue fever along with other diseases that are transferred by the aggressive type of Aedes;

The last is to interact with the Department of Training in the Ministry of Health to implement prevention and confrontation guidelines toward dengue fever and other diseases transferred by the aggressive type of Aedes in Higher Education institution programs [15, 21-23, 37, 38].

Strengthening the coordination and cooperation inside and outside the organization

Decreasing the load of the disease by controlling the Aedes vector is a shared responsibility among all society members. This control cannot succeed without effective coordination and cooperation inside and outside the organization [38, 49]. Controlling Aedes should not be imposed on only one department in the healthcare sector. Inter- and outer-organization cooperation is necessary for a successful program. Therefore, the department of controlling the vector should properly cooperate with other programs for controlling VBDs (for instance, containing the vector of malaria), epidemiologic observance department, veterinary observance, health training, environmental health, clinical identification and management, vaccine transfer (in case of need), and the health of the mother and child (such as the integrated management system). Also, the department should maintain strong communication with the Ministry of Education, Environment, Water, Housing, and Urbanization in the outer-organization domain and the private sector, NGOs, and municipalities [38, 49]. Based on the best evidence, in Brazil, the cooperation between the Ministry of Environment and the national tire industry community encouraged customers to return used tires to a collection site where they are recycled as alternative fuel or in floor covering and other products [50]. Based on a study in Mexico, the entomological indices could decrease by encouraging recycling by designing prizes for transferred unusable items in endangered areas. The local government organized this plan via the vector control department in cooperation with the Ministry of Social Development, Urbanization Development, Environment, and Education [51]. In a systematic study, sustained and effective inter- and outer-organization cooperation was emphasized as one of the operational initiatives and priorities for the integrated Aedes management (IAM) to broadcast the behavioral change communication for prevention and population control of Aedes and diseases transferred by it [38]. Therefore, strengthening the coordination and cooperation between the inside (disease control, environmental health, education, and training for improving the health status as three core pillars of the program) and outside organization is critically important as a national policy for preventing and controlling the dengue fever and requires the following initiatives:

Creating a ministerial strategic committee along with a national committee with the focus of preventing and controlling diseases that Aedes, especially the dengue fever transfer;

Creating strategic committees and coordination and execution workgroups at the level of related province level, with the active participation of all stakeholders and conduction of designed operation programs;

Ensuring that prevention and controlling initiatives for vectors are included in the executive program of stakeholders and partners, along with the active support of the Ministry of Health in the allocation of budget to involved organizations;

Empowering and enforcing the private sector in responsible and ethical management, especially in the industrial and production sector (such as the packing industry, producers of water reservoirs, producers and importers of tire);

Regular screening and evaluation of the performance of strategic committees and provincial workgroups for qualitative and quantitative improvement [15, 21-23, 37, 38].

Mobilization and cooperation of the society in controlling the larva sources

Human behavior is the main determinant in all scenarios of epidemics of viruses transferred by Aedes and the preventive and controlling strategies. The participation of society is a key factor in the success of methods to control Aedes and prevent the contagion of dengue fever [38]. This measure can be a good start to avoid dependence on an individual executive party and assurance regarding the sustenance of the program [52]. Controlling the vector depends mostly on using local knowledge and skill. Successful mobilization and participation of the society requires proper training for the resident and draw the participation of local leaders to improve the control of vectors and flexibility in facing the contagion of the disease in the future [21]. Based on the data provided by the best evidence [37, 53-55], the participation of the public in campaigns for the prevention and control of dengue fever has been effective in enhancing the knowledge and reducing the sites where flies grow, along with lowering entomological indices and the disease contagion. Providing training to attract the participation of the public (for instance, door-to-door visits, workshops, webinars) can help individuals regarding how to reduce the population of Aedes mostly by eliminating the proper places where larvae grow along with emptying and, cleaning, and covering the permanent water reservoirs with suitable covers to prevent the entrance of Aedes. In addition, other training initiatives, such as distributing published material, training sessions, creating urgency and sensitivity in schools, and using mass media platforms (radio, television, newspaper, brochure, poster, and virtual social media) can help in participation and empowerment of people in recognizing the affecting factors on the health of the individual and the society, along with proper and accurate decision-making in choosing health-related behaviors [55]. WHO suggests using COMBI (the Communication for Behavioral Impact) to merge behavioral and social communications to reduce the risk and prevent diseases. COMBI has been used in several countries to control dengue fever [56]. It is a tool that provides effective initiatives to respond to disease contagion. In practice, training and communication strategies often get executed after a long period [38, 57]. Social communication is more successful when the information is published earlier; that is, before the introduction of the vector or the virus, when the transfer has been done recently, or before the transfer reaches a peak [38]. Accordingly, implementing this policy option in preventing and controlling dengue fever and other VBDs by aggressive Aedes is critical. It requires the conduction and execution of a national program in training and improving the level of health in society with the purpose of social mobilization and participation, considering the culture and local requirements of the society. In this regard, creating a national advising committee with the presence of experts in training and improving the status of health, in addition to other related departments of the Ministry of Health (Department of VBDs and Department of Environmental and Occupational Health) to conduct the national program, screening, and evaluation are critically important. Using volunteer healthcare staff in constant contact with the under-the-cover population and repetition of training content, in addition to screening and evaluating prevention and control initiatives, play an important role in enhancing the health level of society. Interaction with the Ministry of Education in adding issues and environmental health initiatives to study curriculums and empowering students in the field of environmental health can have an effective role in this regard [15, 21-23, 37, 38].

Increasing operations and mergers measures and their management

A key initiative to maximize the control of vectors on public health is establishing and developing suitable interventions in epidemiology and entomology [21]. Vector control intervention chosen for use in a special field or occasion must be conducted based on clear effectiveness and optimal coverage evidence [21, 58]. Attaining sufficient coverage for endangered populations by economic tools and based on evidence is the biggest opportunity to reduce infections and diseases [21]. According to the data based on the best evidence, established control intervention in dengue fever vector prevention programs, including environmental management [37], training and participation of the public (toward environmental health) [37, 38], sinterability inside and outside the building [38, 59], biological control with anti-larva – bacterial [60, 61] and modern methods in controlling the vectors of the dengue fever [33, 35, 58] suitable to national scenarios are required [15]. Establishing and increasing the interventions regarding controlling vectors involves finishing tools, technologies, or additional approaches to confront unique challenges (such as resistance toward pesticides) and local information regarding vector and disease distribution, including places where the acceptance or potential to cause the contagion of the disease is high. The priori-

tization of control interventions should be done based on evidence with high efficacy, economical, executable in the local environment, and line with national scenarios [15, 21]. In addition, based on the data provided by the best evidence, it is emphasized that hybrid vector control interventions are more effective in lowering the transmission or disease load compared to single control intervention [38, 53-55]; therefore, it is recommended to employ control techniques in combination and based on priorities of the national scenario.

Execution and implementation approaches of this policy option require the following items:

1. Collecting and updating local information regarding biology, ecology, and capacity of aggressive Aedes vectors;

2. Collecting and updating the existing infrastructural, institutional, and financial information to employ the tools;

3. Evaluating strategies, approaches, tools, and techniques for controlling vectors and diseases based on effectiveness, executive abilities, and economics [15, 21-23, 37, 38].

The recipients of these services (policy options) are, at first, authorities, responsible agents, and employees at country entrances (ports, airports, transportation routes, and other entrance points such as railway stations, parking lots, and gas stations along roads that come from countries where vectors are native, and secondly, healthcare staff, government and private hospitals (doctors, nurses, ...), and thirdly the public.

The service providers are at first at the forefront of international health regulation with the support of downstream departments and experts in the field of entomology responsible for observance, providing technical guidance, and independent evaluations of prevention and control activities in all entrance points of the country. The second stage includes entomology experts, infection experts, and virology experts; and in the third, the healthcare experts at healthcare centers (especially environmental health experts, medical or biological entomology experts, and vector control experts).

Departments and organizations that provide services include national medical universities, healthcare departments, and the Department of Prevention and Controlling Vectors (institutional and field) responsible for providing guidance, support, observance, and maintenance of vector control activities.

Departments and organizations responsible for providing service at the macro level include the Supreme Council of Health and Food Safety, the Ministry of Health and Medical Education, and the Center for Infectious Diseases. Of the limitations in executing policy options, the lack of awareness in policymakers regarding the importance of VBDs transferred by Aedes. We can also mention the lack of creating capabilities and structural, managerial, and human resources empowerment, inter- and intra-department cooperations, the lack of financing and human resources, and the lack of equipment and observance facilities for controlling vectors.

5. Conclusion

Five policy options were provided in this study to prevent and control dengue fever in the country; their prioritizations are based on 3 national scenarios [15] and their potential for prevention and controlling the disease, determining how best options are combined, strengthening the observance and on-time reporting systems, quick response to opportunities and improving the healthcare infrastructures in all levels health maintenance by trained and committed employees. Since the problem of infectious diseases are new and are not limited to only one region, in addition to the suggested policy options, effective and sustained regional, national, and international cooperation for prevention and controlling the disease is necessary.

Among the study's limitations, we can mention the execution of complementary steps toward conducting policy briefs, including decision-making and policy-making from responsible authorities, evaluating policy effectiveness costs (quantitively), and comparing results based on regional, national, and international circumstances. Two policy options, namely policies 1 and 2 as fundamental options and other policies (3, 4, 5) as components of the vector-control program, are required in planning and execution to ensure the maximum efficacy of vector-control programs.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by Mazandaran University of Medical Sciences (Ethical Code: IR.MAZUMS.REC.1401.14363).

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Authors contributions

Conceptualization and Supervision: Seyed Hassan Nikookar, Ahmadali Enayati, Morteza Zaim; Methodology: Seyed Hassan Nikookar, Mahmoud Fazeli-Dinan; Investigation, Writing-original draft: Seyed Hassan Nikookar; Editing orginal draft: Ahmadali Enayati, Morteza Zaim; Data collection and analysis: Seyed Hassan Nikookar; Funding acquisition and Resources: Seyed Hassan Nikookar; All authors read and approved the final manuscript.

Conflict of interest

The authors declared no conflict of interest.

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