Why is Dengue Fever still a public health issue in Saudi Arabia?
Addressing prevention and control in the context of Health Promotion

Zainab Alsharef
Saudi Arabia

Master in International Health

Why is Dengue Fever still a public health issue in Saudi Arabia? Addressing prevention and control in the context of Health Promotion

A thesis submitted in partial fulfilment of the requirement for the degree of Master in International Health

By

Zainab Alsharef
Saudi Arabia

Declaration:
Where other people's work has been used (either from a printed source, internet or any other source) this has been carefully acknowledged and referenced in accordance with departmental requirements.

The thesis **(Why is Dengue Fever still a public health issue in Saudi Arabia? Addressing prevention and control in the context of Health Promotion)** is my own work.

Signature:

Master in International Health
10 September 2018 – 6 September 2019
KIT (Royal Tropical Institute)/ Vrije Universiteit Amsterdam
Amsterdam, The Netherlands
September 2019

Organized by:
KIT (Royal Tropical Institute)
Amsterdam, The Netherlands
In co-operation with:
Vrije Universiteit Amsterdam/ Free University of Amsterdam (VU)
Amsterdam, The Netherlands

Table of contents

List of Abbreviations:

Ae.	Aides
BHCE	Bloomberg Health Care Efficiency
BI	Breteau Index
CDC	Disease Control and Prevention
CHE	Current Health Expenditure
DCP	Dengue Control Program
DF	Dengue Fever
DSS	Dengue Shock Syndrome
EBM	Evidence Based Medicine
GDP	Gross Domestic Product
GMMs	Genetically modified mosquitos
HCS	Health Care System
HDF	Haemorrhagic Dengue Fever
HE	Health Education
HP	Health Promotion
IgM/G	Immunoglobulin M/G
IoM	Institute of Medicine
IRS	Indoor Residual Spraying
ITNs	Insecticide Treated Nets
ITSs	Insecticide Treated Screens
KAP	Knowledge, Attitude and Practice
MBIs	Mosquitoes-borne infections
MCP	Malaria Control Program
MeSH	Medical Subject Headings
MG	Mass Gathering
MOE	Ministry of Education
MOF	Ministry of Finance
MOL	Ministry of Labour
MOT	Ministry of Transport
NEA	National Environmental Agency
NTDs	Neglected Tropical Diseases
PDC	Partnership for Dengue Control
PHC	Primary Health Care
PM	Population Movement
QoC	Quality of care
RDT	Rapid Diagnostic Test
SA	Saudi Arabia
SDH	Social determinant of health
SES	Socioeconomic Status
VU	Vrije Universiteit
WHO	World Health Organization

List of figures, tables and textboxes: **Page**

Abstract

Introduction: Dengue fever (DF) is one of the most common mosquito-borne infections (MBIs), it's one of the haemorrhagic fevers DF. As mentioned by WHO, DF cases number is increasing globally and it affects around 50-100 million per year and 128 countries facing endemics of DF.

DF is still a public health problem (HP) in Saudi Arabia (SA). For that, the aim of this review is to analyse the role of Health promotion in influencing the occurrence of DF in SA to provide valid recommendations.

Methods: A Literature review was done using the Dengue control program framework (modified from Malaria control program) linking to HP model for analysis

Results: There are many factors which influencing HP and resulting in ineffective DF prevention and control in SA, they mainly are: there are no preventive policies to control the unexpected rainy seasons and floods, poor planning of slums and lack of preventive measures at construction sites and improper practices of indoor spraying with no alternative methods considered. In addition to passive community participation in the prevention program and lack of collaboration between responsible sector and weak surveillance system

Discussion and conclusion: There is clear gap in the literature which addressing DF problems in SA, as such information will help to avoids past fails and make better national control program (NCP). Using Hajj plan for controlling MBIs, adding to that Singapore's and Japan's successful outbreak experiences will make major improvements in the routine NCP.

Key words: Dengue fever, Health promotion, Saudi Arabia, Prevention, Control

Word count: **12,416**

Introduction:

DF is one of the most common mosquito-borne infections (MBIs), it's one of the haemorrhagic fevers and the main vector is Aides Aegypti (Ae. Aegypti), there are 4 serotypes of DF infection (DEN-1, DEN-2, DEN-3 and DEN-4), The symptoms of dengue fever ranging from acute mild viral infection to Haemorrhagic Dengue Fever (HDF) and Dengue Shock Syndrome (DSS).(1),(2),(3)

DF is still considered as one of the public health issues world-wide. As mentioned by the world health organization (WHO), DF cases number is increasing globally and it affects around 50-100 million per year and 128 countries facing endemics of DF.(1),(4),(3)

In Saudi Arabia (SA), number of DF cases reported in last statistics of 2017 was 3462 and no more recent data could be found.

I am a senior medical resident, was working in one of the biggest governmental hospitals in Jeddah, SA for 5 years. On daily basis, I was admitting at least 2 patients with DF. That triggered me, because DF can be prevented and controlled and this can be achieved by integrated national control program (NCP) by using the domains of health promotion (HP).

Studies showed that, the main preventive measure is to control the vector breeding sites and that's can be done by collaboration between many sectors (governmental and private) and the community.

However, with the recurrence of dengue patients presenting almost daily to hospitals, which reflects that there's lack of well-integrated control plan in SA. In this thesis, factors which led to insufficient dengue control will be addressed and linking that with HP domains.

Chapter 1

Background:

Saudi Arabia (SA) is the largest country in the Arabian peninsula, with an estimated area around 2,149,790 square kilometers and a total number of population around 33 million, its located at the southwest of Asia.(5),(6),(7)

It's a high-income country, the socioeconomic status (SES) of Saudis population have been studied for all country governates based on the level of education and the monthly income. And it showed that, around 45% of governates are in the upper-middle income class "class 2" meaning that the income/month is around 2500 euro net amount, and 11% are classified as deprived "class 4" and the rest are affluent and lower middle class, See Fig.1(8),(9),(10)
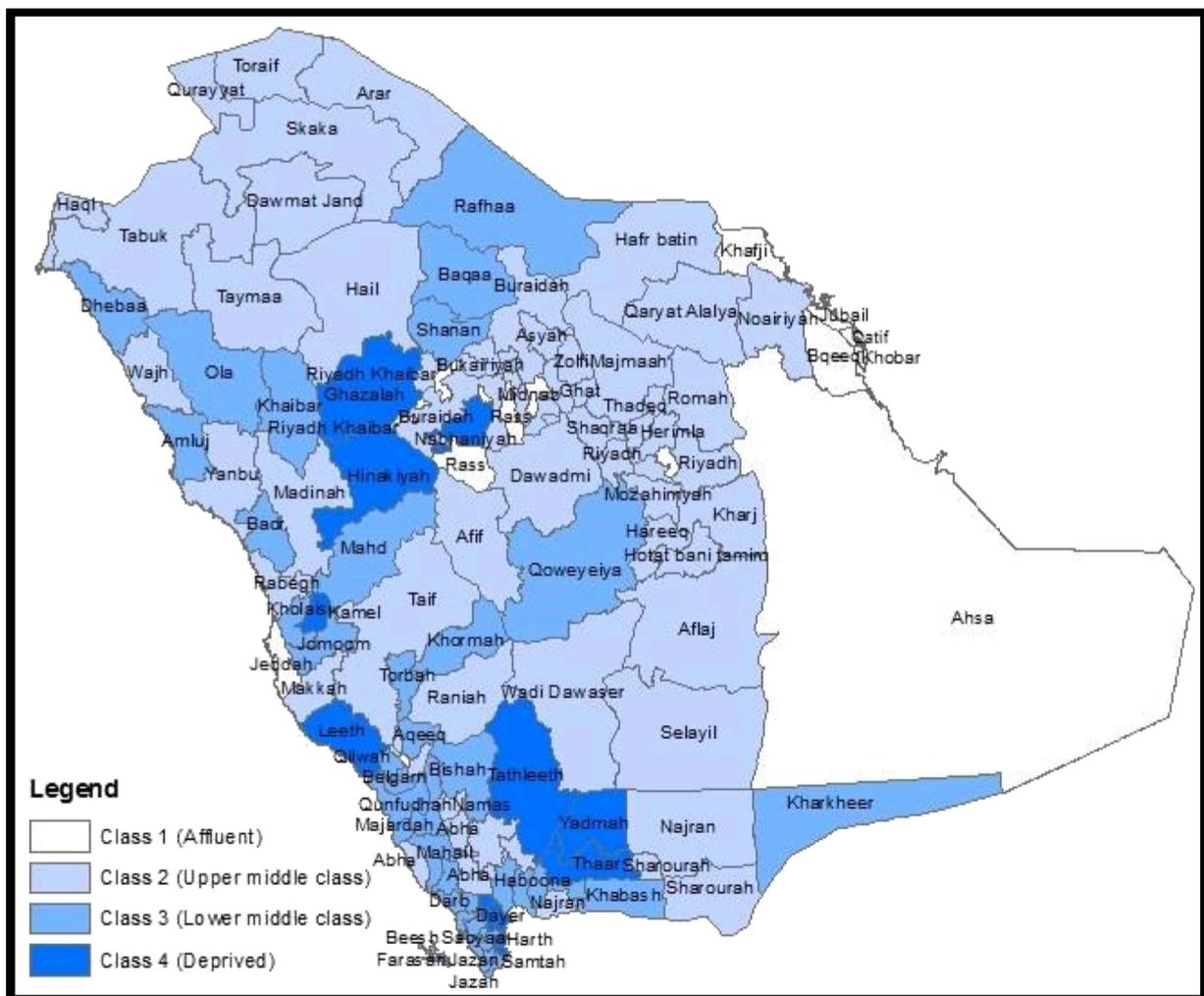
Fig.1 Map of SA showing the governates and SES for each one,2018 (9)

The Saudi culture is defined as an Islamic heritage, and the society generally is religious, family oriented and traditional but still they are adapting with modernization.(11),(12)

The health care system (HCS) in SA is provided by 3 main sectors, the governmental sector is operated by the ministry of health (MOH), other governmental organisations and the private sector.Fig.2 (13)
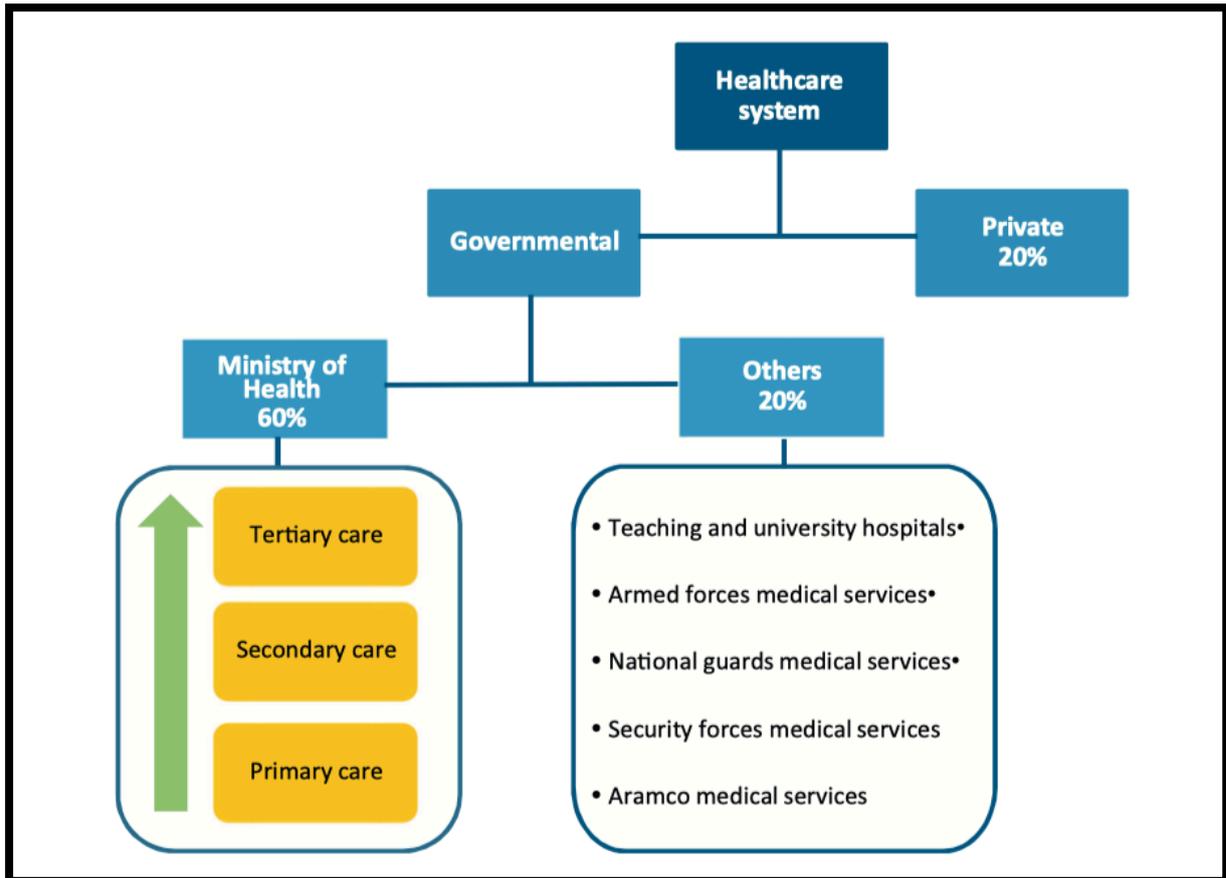
Fig.2 The structure of the health care system in SA,2018 (13)

The main bulk of public health services are provided by MOH for all citizens free of charge aiming to achieve fair and equitable access to health care services. In addition, the Saudi government obligates the private companies and sponsors of foreign workers to provide an insurance for them for getting easier access to health care facilities (13),(14),(15)

And the last data of 2016 showed, The Current Health Expenditure (CHE) as % Gross Domestic Product (GDP) is 6% and the CHE per capita in US$ is 1147.(16)
The capital of SA is Riyadh, it's the largest city in the country, the second is Jeddah.
Jeddah is located in the west and it's the main port for all Muslims coming to Makkah during the religious seasons.(5),(6)

The climate of SA is very diverse and different from one region to another, at the center of the country its dry and very hot weather, while in west and east it is humid, because SA is bounded by the red sea in the west and the Arabic gulf in the eastern area. The country is receiving rainfall mainly in the winter and spring, sometime its heavy and causes floods but generally rainfall is scarce in the most regions.(17),(5)
As what has been explained in the studies, the hot weather, humidity and scattered rainfall, made SA an endemic area for DF and it's an ideal environment for the vector breeding .(1),(18)

Chapter 2

Problem statement and justification:

In SA, DF is commonly spreading in the west and south regions of the country (mainly Jeddah, Makkah and Jazan), the number of cases in SA is still high around 3462 total reported cases in 2017. Fig.3 (3),(19),(20),(17)
DF is still a public health problem in SA, and it's one of the neglected tropical diseases (NTDs). SA is at high risk of dengue fever infection because of pilgrimage every year and a lot of Muslims are coming from endemic areas such as: Indonesia, Pakistan and India.Fig.4 (21)
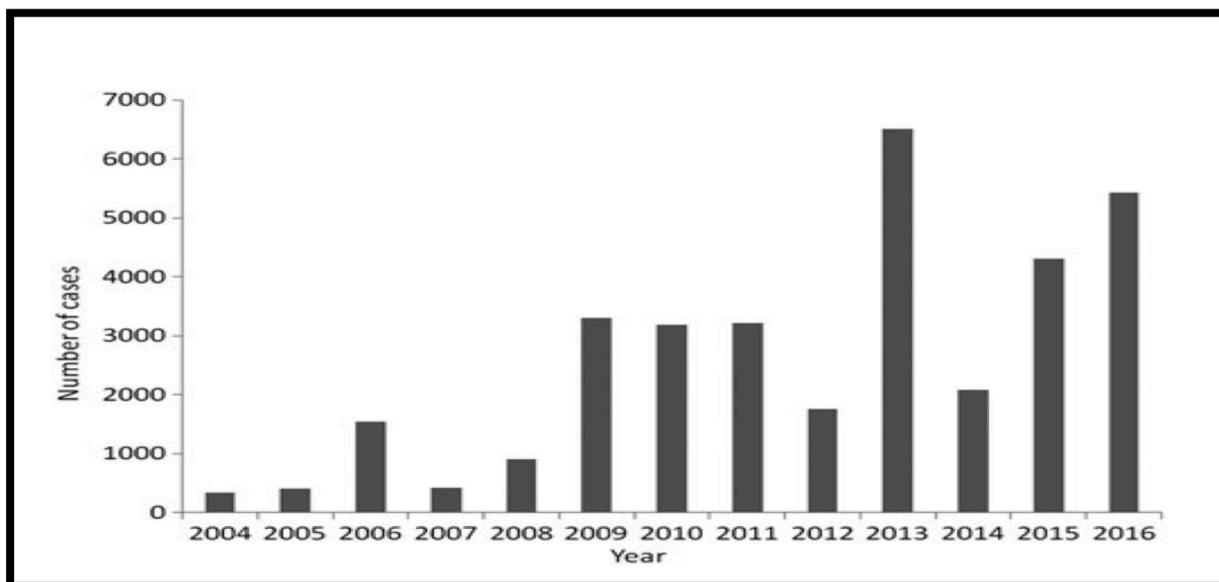
Fig.3 Number of dengue cases per year in Saudi Arabia,2018 (3)

Rank [3]	Country [3]	Major NTDs [4]	Number of Hajj pilgrims in 2015 [3]
1	Indonesia	Dengue, Lymphatic Filariasis, Soil-transmitted Helminthiases, Leprosy	168,000
2	Pakistan	Dengue, Trachoma, Kala-azar, Cutaneous Leishmaniasis	143,368
3	India	Dengue, Lymphatic Filariasis, Soil-transmitted Helminthiases, Leprosy, Rabies, Kala-azar, Trachoma	136,020
4	Bangladesh	Dengue, Lymphatic Filariasis, Soil-transmitted Helminthiases, Leprosy, Kala-azar	101,758
5	Nigeria	Schistosomiasis, Intestinal helminth infections, Lymphatic Filariasis, Onchocerciasis, Rabies	76,000
6	Egypt	Schistosomiasis, Intestinal helminth infections	63,000
	Total		688,146

Abbreviations: NTDs; neglected tropical diseases

Fig.4 Major NTDs in the countries with the highest number of pilgrims,2017 (16)

Also, the number of pilgrims is estimated to increase to 12-17 million by 2025. And dengue virus can be imported to non-endemic areas if the pilgrim is coming from Europe for example.(19),(17),(21)
Jeddah and Makkah, as previously mentioned, are having the highest number of dengue cases in the country, as what the last statistics showed by general authority of statistics

in their last report in 2017, that the number of DF cases in Makkah region ,including Jeddah, was 3034 cases in Jazan 320, while in Riyadh and eastern region there are no cases were identified.(21),(22),(23),(24)

The humidity and hot weather of SA are a favourable environment for DF vector, as their life span and reproductively increases during the summer (from June-September). Sometimes the Hajj season happens at the same period of summer like as in 2015 – 2016, it was in September and in 2017 it was in August. As per Alshehri M. concluded in a study about DF outburst and its relationship with climatic factors that SA have an obvious risk for DF activity, due to local factors as well as the risk during Hajj and Umrah seasons. (1),(3),(17),(25)

Fig.5. is showing the number of cases in specific times of the year, based on the seasonality and times of rain that falls, some months are not mentioned as there was no outbreak in months already demonstrated on the graph.(1),(3),(17),(25)
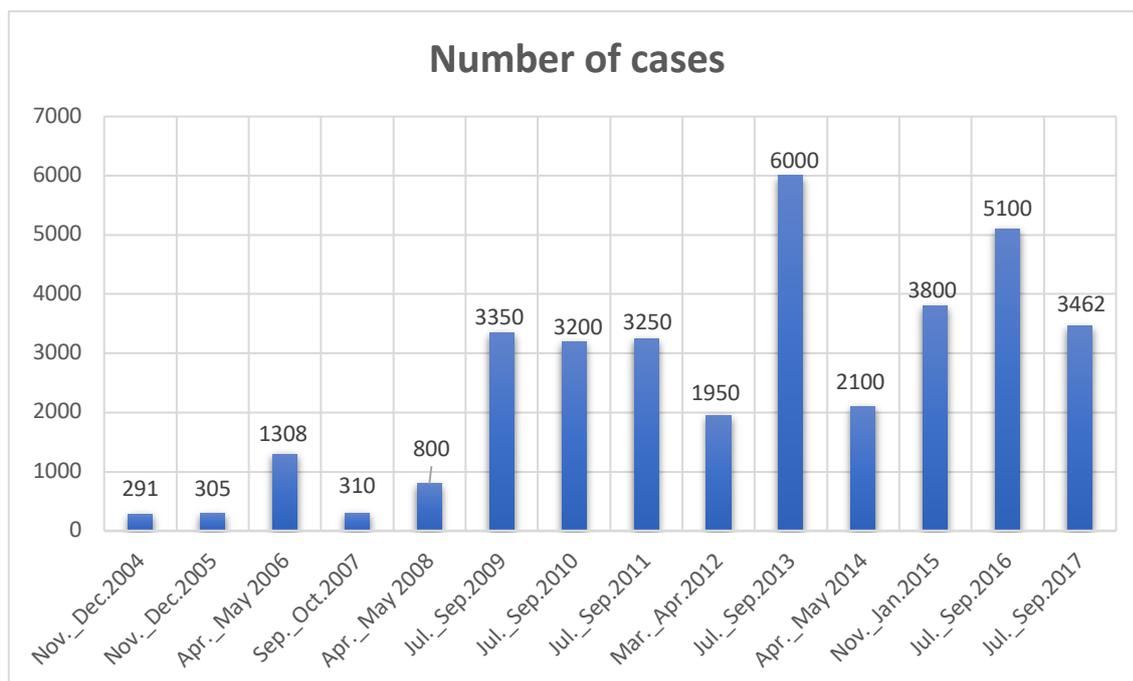
Fig.5 Graph showing the relationship between seasonal changes and number of DF cases (17),(1),(3)

There are other factors increasing the risk of DF: the presence of stagnant water at the drainage holes, living in an area near a building still under construction and minimal public awareness about DF and preventive measures.(1),(20)

At the global level, around 500 000 people are hospitalized because of sever dengue every year. If kept without proper management, it could lead to serious complications due to HDF/DSS with a case fatality rate (CFR) of 12-44% or if it happens in a person with pre-existing haematological disease with mortality rate of more than 20%. But this morality rate can be declined to less than 1% with appropriate prevention or with early recognition and treatment (26),(20),(27),(28),(29),(30)

DF vector control measures, include chemical, biological and physical control. Chemical control with pyrethroids (insecticides) like: lambdacyhalothrin, cyfluthrin, deltamethrin, permethrin, it can also be with insecticide treated curtains (ITCs) or outdoor by spraying with organophosphates.(3),(31),(32),(33),(34),(19)

Biological methods and that depends on parasitic or predatory organisms targeting the vector by fish or copepods.(35),(36)

Physical control in done   by community-based control programs, a   geographical information system (GIS) mapping of dengue foci, this will help to locate dengue concentrations and education of prevention strategies.(34)

Despite all measures which have been applied by the MOH and municipalities of the most affected cities and spending around 1.5 billion Euro by Saudi government in 2009 only for Jeddah to manage DF spreading and prevention, it is still not well controlled in SA.(20)

SA is an endemic area for DF, beside the imported cases coming from other countries and this needs to be controlled and managed with well-planned strategies for prevention and control.(37)

As mentioned, in the article of a comprehensive integrated approach for DF prevention by the WHO, that long term and sustainable control for DF needs a multisectoral involvement and community participation and this can be achieved by HP.(38),(37)

The WHO in 2016 described HP as "Health promotion enables people to increase control over their own health. It covers a wide range of social and environmental interventions that are designed to benefit and protect individual people's health and quality of life by addressing and preventing the root causes of ill health, not just focusing on treatment and cure"(38)

Key Strategies of DF prevention and control as per the WHO global strategy of 2016-2020 are: advocacy and communication, evidence-based clinical care, sustainable vector control and robust dengue surveillance. (39),(37)

All aspects of HP can be applied to these key strategies, however; there is no study been found mainly in SA, addressing DF in the context of HP.(39),(37)

In this review, the possible causes which influence DF prevention and control in SA, will be addressed and analysed to provide recommendations with an applicable plan for DF prevention.

General objective/Study question:
To analyse the role of health promotion in influencing the epidemiology of dengue fever in Saudi Arabia in order to provide valid recommendations to policymakers

Specific objectives:
-to analyse the factors which influence HP for DF prevention with a focus on SA

-to analyse existing HP for DF in SA

-to explore existing dengue control programs and best practice of HP for DF from other countries

-to provide recommendations to policymakers

Methods:

A literature review was done in PubMed database with Medical Subject Headings (MeSH) terms has been used in addition to Google, Google Scholar, WHO, Saudi MOH, and Vrije Universiteit (VU) library. The main search and Keywords are shown in this table1:

Objective	Search engine	Main terms with linked keywords	Number of matched articles	Number of articles included
-To analyse the factors which influence DF prevention and related to HP in SA -To analyse existing HP for DF in SA	PubMed, VU online library, google scholar, Saudi MOH	Dengue fever, dengue haemorrhagic fever, dengue shock syndrome, with:	---	---
		Saudi Arabia	20	12
		Health Promotion	5	3
		Community health education	36	17
		Climate, tropical, environmental	12	6
		Life style	3	1
		SES, occupation	12	8
		demographic	3	2
		Income	5	4
		Age	8	5
		construction	10	8
		Preventive measures	23	19
		Knowledge and attitude	14	8
		Mosquito control	39	18
		Diagnosis and treatment	20	8
		Health policy, health care system	12	6
	Google, google scholar, WHO, Saudi MOH	Pilgrimage, Hajj, Jeddah, Makkah	13	10
-To explore the existing programs and best practice of HP for DF from other countries	PubMed, VU online library, google scholar, WHO	prevention and control	4	1
		national control program	3	2

Table1: Main terms/keywords used in searching

Inclusion criteria: Articles related to HP, prevention and control measures of DF, DF in SA and other countries in Asia and Latin America which are known to be DF endemic areas were included. Because these countries have a common characteristic with SA in regards of preventive measures have been applied and also season similarity and they have successful examples of DF control.

All peer reviewed journal articles, governmental reports and WHO factsheets, related to this review topic, were added. The language selected was English and there is no time limit because I aimed to see the progression in DF in terms of epidemiology, prevention and control, diagnosis and treatment through the years. Because as this helps to have an overview about the gaps and failures of past years from above mentioned countries to avoid them in applying a new program.

Exclusion criteria: Articles related to DF in other countries, which didn't meet the above described inclusion criteria, and articles not linked to the study objectives or which were not related to DF prevention in the context of HP, were excluded.

Conceptual framework:
To analyse the study objectives, the 2016 malaria control program (MCP) framework from the MEASURE evaluation organization Fig.6 (refer to Annex1) (40), has been used.
It was modified for dengue control program (DCP) for this review (see Fig.7).
This was chosen because it covers all prevention and control measures of MBIs, similar as dengue in the context of HP. Also, it is comprehensive, and very appropriate to use for implying some interventions and recommendations for communicable diseases control such as Dengue.
HP model Fig.8 (see Annex1) with seven domains and all components of it, has been linked to DCP framework as following table3:

Health promotion model	DCP
3- preventive policies 7- policy support	External factors like: environmental, SEC and demographic
3-preventive policies 7- policy support	Program factors and health care system factors
2-life style 4-policy maker education 5-health education	Knowledge: cause, prevention methods, early treatment, cultural beliefs, information
1-Prevention 3- preventive policies	Early diagnosis and treatment
1-Prevention 3- preventive policies 6- health protection	Prevention with: ITNs, IRS, IPT and environmental management

Table2: The link between HP model and DCP (41),(40)
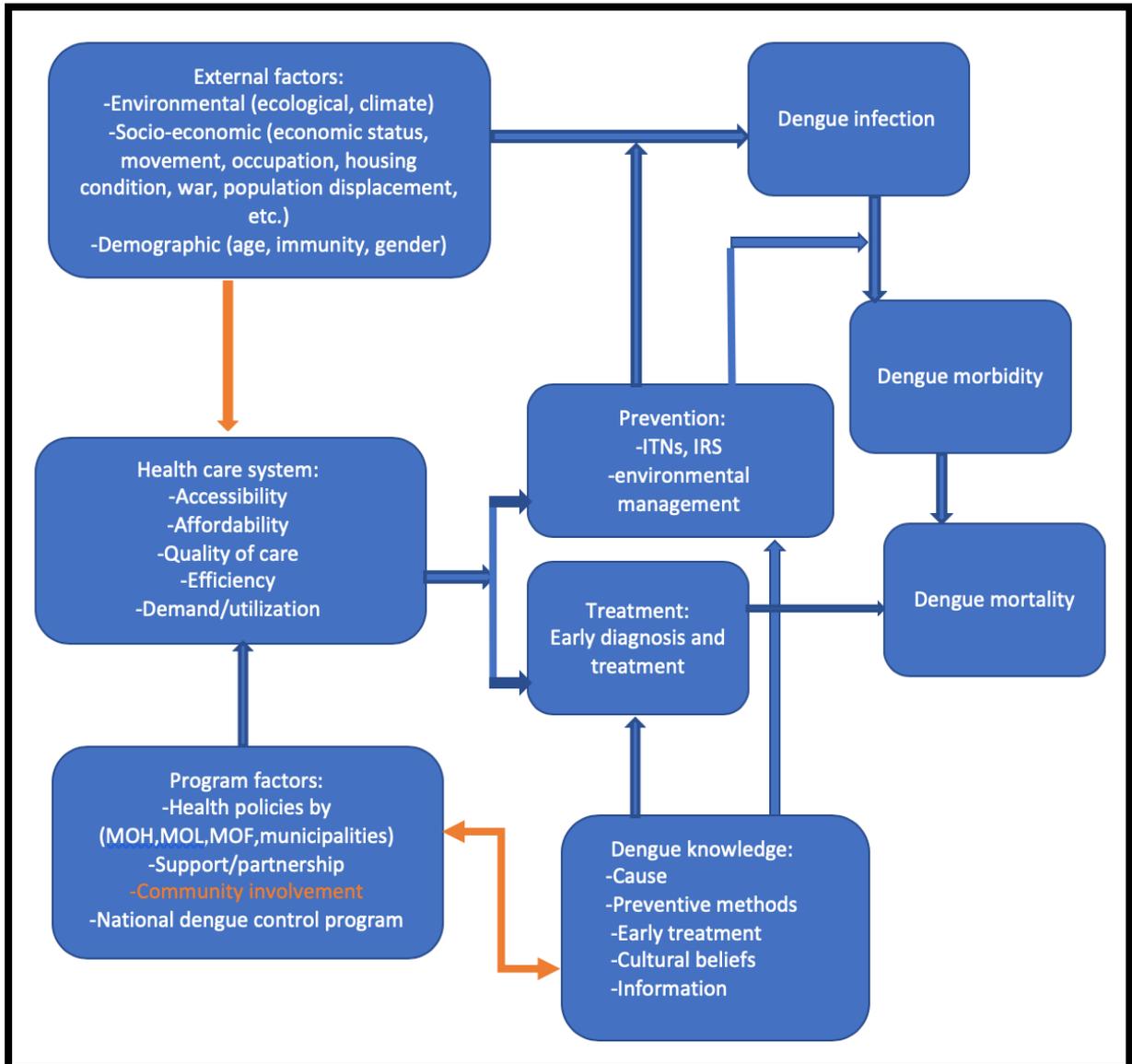
Fig.7: The modified dengue control program framework

Regarding the link in the between the 2 frameworks:
- **Prevention, preventive policies and health protection** domains on HP model are linked to the prevention section on DCP framework. Because prevention with different measures like ITNs, IRS and environmental management needs policies by policy makers. Health protection involves communicable diseases transmission by setting some activities within the public health function. Also, these policies can lead to secondary prevention by early diagnosis and treatment.

- **Life style** in regard to HP is related to a person's behaviour toward preventive measures, his/her knowledge about them and how to practice and apply these measures.

- **Preventive policies and policy support** are links to program/health care system factors. They are also related to external factors: environmental, SEC and demographic (social determinant of health, SDH). As what has been mentioned by the WHO "promoting health and reducing health inequities by addressing the social determinants of heath"(42). That can be achieved by making policies and implementing programs which enhance the health equity.

- **Policy maker education and health education** are both connected to the knowledge in DCP framework. Because policy makers and the public should be aware about the different aspects of DF, to make comprehensive policies and an effective prevention program

Limitations and Modification of MCP conceptual framework:

1-The link between aspects of the control program is not well integrated. However, there is a link between some external factors: socioeconomic status and health care system, and other link between knowledge and program factors. For these linkages, some changes have been added (with 2 arrows in orange colour) on DCP framework Fig.6.

2- Actors and sectors which are assigned for health policy, are not mentioned in the program factors part.

3- The role of the community was not included, while it is an important part in the program factors to achieve effective HP

4- Both, governmental sectors and community, have been added to DCP framework

Limitation of the study:

As it is a literature review study addressing HP for DF control, the literatures and data which used HP specifically for DF prevention and control were very limited. This is led to link HP model and DCP framework

Chapter 3

Results:

This chapter will analyse the results according to the main study objectives. The analysis will be done using DCP framework.

3.1 External factors
It includes Environmental, Socioeconomic and Demographic factors:

3.1.1 Environmental (ecological and climate)
Ae. aegypti, the vector of DF, is anthropophilic closely associated with human beings and their habitats with high preference for urban areas. As humans are making a good environment for their growth, by using water-holding containers and presence of stagnant water after rainfall or flooding, without taking the measures which helps to reduce this preferable growth environment. Because their main habitat is aquatic and they thrive better in cavities of trees and toilets with poor drainage. They also prefer darker areas like staying in closets, which allows them to bite indoors.(43,44)

Due to the high sensitivity of Ae. Aegypti to humidity, rainfall and the temperature, all these factors are influencing the behaviour and physiology of the mosquito vectors, leading to a clear effect of the transmission of mosquito borne diseases including DF. However, the studies that have been done are based on mechanistic and statistical models about the transmission and its relation to the temperature and it showed a wide range of results. The mechanistic models predict that the transmission for dengue virus in Ae. Aegypti should peak at 29 degrees, but on the other hand, the quantifying statistical models of Thailand showed a high transmission rate at ≥30 °C, while in Taiwanese data it showed that DF transmission peaked at >18 °C.(44)

By applying this to SA, the mean average temperature in SA is around 29 degree but in the coastal regions like Jeddah and Japan, the temperatures are consistent through the year, from 30-40 °C and the humidity also remains around 80% -100%.(44)
The other environmental factor in SA is rainfall, even with the scarce rainfall in the country, it is still a risk because of the presence of stagnant water. This is due to the lack of effective preventive policies and no preparedness of the infrastructure by the municipalities and ministry of economy and planning, for natural and environmental hazards like: poor drainage and sewage system, and this is what happened during Jeddah's flood in 2009,2010 and 2011 and appearing of many cases of DF. (19),(20),(23),(41),(45)

3.1.2 Socioeconomic (economic status, movement, occupation, housing condition, war, population displacement)
As per T. Bonifay et al., many studies have demonstrated the link between NTDs including DF and poverty. However, Mulligan et al. have stated that in a systematic review, the relationship between DF and poverty is not well-established, even when poverty has long been linked to DF and considered as a determinant. (46),(47)
Some studies done, to show this link, were using many indicators to reflect on poverty such as: income, education, housing condition and overcrowding. And other studies relate to water access and sanitation as indicators. But, the most consistently used poverty indicators associated with DF, were income and physical housing conditions.(46),(47)

-Economic status
The general economic condition of the Saudi population has been shown briefly in chapter 1, but by focusing on the economic status of the affected regions by DF, mainly Jeddah and Makkah, see Fig1, its class 1 and 2 respectively. However, the same study which mentioned the economic status have not taken into consideration non-Saudis people whose living in slums. And, there is no other study found which covers the income status of this group (9)

There is a clear literature gap addressing this indicator in SA as a determinant for DF. It was briefly mentioned in study held in Jeddah about DF risk factors by Kholedi A. et al. that economic factors (having a low income) are playing an important role in acquiring the disease. But this factor was not studied on the study population, it was only hinted in the discussion. And there are other factors has been focused on like: age, sex, nationality, working environment and presence of indoor breeding sites.(1)

There are 2 studies from French Guiana and Brazil, focusing on income as a variable to measure poverty and the risk of acquiring DF. The result of the first one was that DF virus appeared to affect the richer population by 56% compared to other arbovirus which is (Chikungunya virus), as it was in the poorest by 82%.(47)
The other study from Brazil, which was done to establish a link between economic status and the risk to develop DF and concluded that, there is a positive relationship between low SES in terms of income, schooling and housing condition and the high risk of dengue.(48)

Because of the lack of a large scale study, addressing the economic factor in SA, including citizens and foreigners specially whose living in slums , preventive policies measures the vulnerable areas, whether they are in a "rich or poor" neighborhood are missed in the case of SA.(18),(48)

-Movement
Population movement (PM) and the risk of vector-borne disease transmission has been studied and reviewed in the case of malaria. It revealed that it's an important factor to get the disease. It was significant to understand the concepts and typology of PM to make this correlation. As per P. Martens and L. Hall, PM it can be explained and understood by using "push and pull" forces. People can move from their country to another or moving within the country. Pushing factors could be environmental degradation due natural disasters, or economic, like loss or lack of employment. Pull factors, like improved living conditions, or other socioeconomic opportunities.(49)

The typology of PM should be classified and applied to the context of the country and the mode of the disease transmission, see Table 3.
Moving people can be classified either as active transmitters or passive acquirers.(49),(50)
Active transmitters harbor the virus and transmit the disease when they move to areas of low or sporadic transmission, while Passive acquirers are exposed to the disease through movement from one area to another; they are maybe non-immune or may have low-level immunity, which increases their risk for the disease. All these concepts were applied on malaria transmission, and it was found that many forms of the PM like: urbanization, colonization of new territory refugees, imported malaria and intercontinental travel, are contributing in an increasing malaria transmission.(49)

Circulation				
Daily	Periodic	Seasonal	Long-term	Migration
Commuting	Trading	Fishing	Laboring	Urbanization
Trading	Pilgrimage	Pastoralism	Colonization	Refugees
Cultivation	Mining	Laboring		Colonization
Wood-cutting	Tourism			

Table 3: Typology of temporal PM, "Malaria on the Move: Human Population Movement and Malaria Transmission" by P. Martens and L. Hall,2000 (49)

Based on types of PM, SA is dealing with 4 main kinds of movement, which has been studied for DF: pilgrimage, tourism, labouring and urbanization.(44),(49)

As mentioned in chapter 2, about the pilgrimage (Hajj) and the risk of importation of NTDs, including DF from endemic countries of vector borne diseases. Hence, Mass Gathering (MG) is a definite risk for infectious diseases transmission, including vector-borne diseases like DF and as defined by the WHO, MG is "the influx of a large number of people at a specific location, for a specific purpose, and for a defined period of time".(51) There is a wide range of MGs activities, it can be for a religious purposes like Hajj and Umrah, or sports events such as Olympic games or football world cup, educational and political events.(51)

The largest annual MG in the world is the pilgrimage to Makkah, where around 2 million Muslims will be coming every year. For this, the Saudi government has taken an advanced planning every year to prepare for it. These preparedness policies are undertaken by the ministry of hajj and MOH, as both ministries are providing updated travel advice and health regulations on their websites. They also disseminate this information through liaising with international public health agencies including the WHO, the Centres for Disease Control and Prevention, public health England and the European centre for disease prevention and control and travel agencies that provide Hajj services and many religious organizations. (21),(44),(52),(53)

To highlight the vector-borne diseases preventive policies during hajj, the ministry of hajj is preparing for an intensified vector control program, including widespread insecticide spraying campaigns before pilgrims arrival, in collaboration with MOH and the ministry of agriculture in Makkah, to assess and identify the areas of most mosquitoes density and there are specific teams are responsible for spraying, they starts with housing units of pilgrims, coming from endemic countries of dengue like India, Pakistan and Bangladesh and they are using a long-lasting pesticide also they spray governmental departments used by pilgrims. Additionally, all ship carriers and aircrafts have to provide for an official valid certificate to carry sanitation and to verify that spraying with insecticide was done before arriving to the port.(52)

The positive impact and effectiveness of these preventive measures have been achieved, as what was announced by the minister of health in the hajj season of 2018 that, "the hajj season of this year is free of epidemics and public health threats, and that Hajj health plans are successful"(54)

However, there is no study found mentioning fails or defects in the hajj's prevention plan, either or the current of previous plans, which will help to be avoided in the next programs, during either during pilgrimage season or for a routine DF control plan.(55),(52)

Other forms of MG which have been studied are sports mass gatherings. In Brazil they have evaluated the effectiveness of an early warning system, using the seasonal forecast model 3 months before 2014 football world cup and it was successfully predicted 57% microregions with high levels of dengue.(56)

Regarding the tourists risk to acquire DF, as Saudis who are travelling to DF endemic countries, either for business or holidays, are creating another source of disease importation, but there is no preventive policy to limit this risk.(44)

Regarding other types of PM in SA labouring and urbanization, will be discussed in the "occupation and housing conditions" sections.

-Occupation

Working in a particular occupation may put the person at direct risk of contracting specific infections. In a review by V. Lim, about occupational infections, it mentioned about dengue that all workers living in endemic areas of DF, regardless of the type occupation, increased the risk of contracting the disease. Expatriates who are coming from non-endemic areas

of DF are at higher risk, because they are mostly non-immune (passive acquirers). By stating this, the author is declining the positive relationship between the type of occupation and the high risk to acquire DF.(57)

The finding, in the Saudi context, about occupations was that farming and shepherding as out-door working, increased the exposure to the vector. Thus they are being at risk to contract DF as what has been mentioned by K.Altassan, et al., but the writer was not explicitly mentioning figures with numbers of increasing risk of DF compared to other occupations (44)

Other occupations considered to be risk to get DF are: being a construction worker, working in municipals activities and maintenance. And non-Saudis are making the major labour force in these jobs with 4.4 million only working in the construction industry, a study of DF risk factors in Jeddah showed that a significant proportion of cases were non Saudis with 48.1% compared to controls.(58),(1)

The evidence showed that, by A.Kholedi et al., all these activities are likely to bring workers closer to water collection areas, which increased the dengue virus transmission, it also extends and spills-over the virus to the surrounding areas.(59),(1)
There are huge construction works is ongoing now in SA, mainly in the main cities (Jeddah and Makkah). A clinic-epidemiological study showed, that construction workers are creating a "good" number of dengue cases, either they have acquired the disease at the work place as a primary infection or they have imported other DF serotypes and got a more severe secondary infection, as stated by Fakeeh and Zaki. These data were shown about Jeddah but there was no exact number mentioned for those cases and no data came from other Saudis regions.(18),(60),(61)

Ministry of Labour (MOL) and the municipality are not taking the proper preventive measures at the work place, like collecting unwanted containers, provide a well-covered water container and to add larvicides, with the recommended dose, or have a preventive strategy for the workers, by wearing long sleeves. All these kinds of measures couldn't be found, neither at MLO nor at the largest construction companies websites as stated as an obligation for the construction workers and their managers to apply.(62),(63),(64),(65)

-Housing condition
Housing or "living" conditions as described by Carabali et al. is another socioeconomic determinant for DF. Living in an urban overcrowded area is increasing the risk to acquire the disease. In SA, particularly in Jeddah, there are many pilgrims who remain illegally after finishing the hajj and foreign workers are living in slums. These slums account for 55 out of 102 districts distributed throughout the city. The overcrowded areas with poor housing conditions and infrastructures, as the number of populations living there is more than 1 million and that's represents 43% of city population, all these living conditions are ideal for vector breeding and more dengue virus transmission.(44)

In addition to the previous risk factor, targeting illegally staying pilgrims, there is another study held in Jeddah as well, aiming to analyze factors associated with the spread of DF, they found that 71% of DF cases that were included in the study are living in an area close to buildings under construction, they are storing water in uncovered containers and presence of indoor stagnant water, at the drainage holes, was another living condition factor found that was significantly higher in the cases houses by 25% compared to the controls with 15.5%.(1)

Most of the above-mentioned factors were present in the slums of Jeddah, as a result of urbanization, as these areas were named as "informal" districts by the local municipal because it is missing the good infrastructure and an adequate water supply. But, the municipality of Jeddah failed to implement their urban planning, to regulate the slums, because of rapidly growing areas of unexpected slums with a high number of populations

on a scale beyond control. Another factor which makes implementation difficult is the absence or restriction of funds for such big plans, which was not appropriately tackled before more expanding of these areas.(66),(44)

A study was done in Singapore, comparing high rise (13 stories or above) to low rise (1-6 stories) and to investigate the influence of the urban drainage and outdoor breeding on the distribution of the dengue incidence. It showed that low rise subareas have more outdoor breeding sites in drains, there also are denser drainage networks compared to high rise housing. This finding suggests that living in urban planned agglomerations won't increase the risk of the disease transmission.(67),(68)

-War and population displacement
Dengue virus transmission and association with wars have been acknowledged after the second World War. The ongoing civil war in Yemen, which started in Mach 2015, has destructed the infrastructure and displaced many people, around > 2.2 million persons, 603,833 of them were received by SA as what mentioned in the last statistics of 2017 by the United Nations.(69),(70)

Most of those displaced people have been pushed to live in shelters with poor health care support and other basic needs. Living in such areas will create several potential breeding sites for DF vector. The last data by The Centers for Disease Control and Prevention (CDC) and as stated in an article by K.A. Alghazali et al. about DF outbreak, during the ongoing civil war in Yemen stated that, suspected cases in 2015 were a total of > 6777 and 1178 cases were reported in the weeks 32-36 of the war, compared to only 54 suspected cases in 2013 in the same period. And they refer to that as a consequence of the war and all risk factors related to it, which make this increment in number of dengue cases.(69),(44)

As DF is already an endemic in Yemen, the number of reported cases in 2014, before the war, was 1034. Also, there are illegal infiltrators with an estimated number that reached 695,000 in the last official statistics. However, there is no data about the statistics of the yearly number of Yemenis crossing the border. (71),(72)
This creates a potential risk for increasing the DF cases in SA, and that creates another form of importing of dengue virus. But there are no policies to regulate the influx of Yemenis refugees or any kind of screening for suspected cases of mosquito borne diseases, including DF.(73),(69)

3.1.3 Demographic (Age, Immunity, Gender)
-Age
DF has been classically considered to be a paediatric disease. In Asia, DF and HDF are affecting mainly children younger than 15 years of age and this is supported by many studies form South-East Asia and the average age from 5-9 years. However, the age distribution of this disease has been rising, for example in Asia, now it affects mainly adults more than children with the mean age of 22-25 years, as what is shown in a study in Sri Lanka, addressing the demographics and its relation to DF and found that 73.5 % of cases were adults. While in Latin America, the age distribution is different as DF is targeting all age groups as stated in article by T.Tantawichien (74),(75)

There is a review done in Brazil in 2019, analysing the age from a different view, as it was showing the occurrence of more severe cases of DF and fatality based on age. It concluded that DF fatality was predominantly in adults individuals (15 years and above) with a case-fatality rate around 50%.(76)

In SA, the mean age for DF is between 15-30 years, although the facts that report that mortality is higher with 50% in adult patients than in children, but interestingly these mortality findings are opposite to what has been shown by Carabali et al. That fatal outcomes occurred more in children and that it was not only depends on their age but it

also relates to the adequate management, provided by health staffs and parents care-seeking behaviour.(44),(67),(2)

-Immunity
They are 4 serotypes for dengue virus, however there are a few studies done globally and in SA, focusing on immunity as a demographic determinant for DF and how to use this link to make a preventive policy.(77),(78)

It is important to know about immunity and serotypes, because infected persons by DF, via Ae. Aegypti, can transmit the infection after appearing of first symptoms during 4-5 days; and maximum 12 days from being exposed to the virus. After the first exposure to dengue virus, the patient will develop a lifelong immunity to the infecting serotype and that's called (homotypic immunity). The data showed that those patients are temporarily protected against other serotypes (heterotypic immunity), but no study mentioned how long they are protected, as this has a value to be known, because after the period of protection, the previously infected individuals are at risk of a severe secondary dengue infection (heterotypic immune enhancement).(77),(78)

In Brazil, the circulating dengue serotype is DEN-1, so all infected people will have lifelong immunity and it's easier to control, unless they have another imported serotype, by tourists for example. While in Thailand all four serotypes are there, so that's will lead to the appearing of more cases in severe form.(79),(77)
Currently in SA, the predominant dengue serotypes are DEN-2/4, while DEN-1/3 has been circulating since 1994, this means that SA is having the same pattern of Thailand's serotypes, sharing the same risk of developing complicated cases of DF (44),(80)

Three articles from different countries including SA, are mentioning about the significance of knowing the immunological memory of dengue serotypes, because this helps to guide preventive efforts, which should be directed to areas with more than one serotype circulating. But, even with the evidence of this important knowledge of immunity as an important factor to acquire DF, these studies didn't mention any policy.(44),(78),(77),(79)

-Gender
Many authors have described gender as a "socially constructed" factor, so from this point it should be differentiated from sex, as gender roles in the community context plays a role in the increasing risk of the disease.(67)
In Singapore, men are part of a higher number of reported cases compared to women, with 57% in the 5-14 years age group and 61% in 15 years and above. But, this result was inverse to the findings in Brazil, with 59% of reported cases among females during epidemics in certain years, and this distribution is not constant.(81) However, The main reason for this result was not mentioned.(1)

In SA, the number of dengue cases is higher in men, with 65.1% compared to females. As most of men let their occupations and their gender role keep them to work outdoors. While females, even if they worked outside, were covered due to the cultural norms, that is why they are less exposed to the vector bites.(44),(1)

It's important to focus on females living in the slums, there is no study was highlighting on this group, because they are at risk for DF due to the poor housing conditions and indoor drainage as what mentioned before.(66)

There is direct link between gender and occupation and this statement is supported by M.Stergiou-Kita et al.(82) The preventive policies are already deficient and were not placed clearly by MOL and municipalities, the gender related as a risk factor remains as an issue in SA.

3.2 Health care system (HCS)

This includes Accessibility, Affordability, Quality of care, Efficiency and Demand/utilization: there is an overlap between all elements of HCS, and this will be explained in this section.

3.2.1 Accessibility

Access is a complicated concept and there are at least 3 aspects needed to be evaluated to assess accessibility: starting with availability of services, if there is enough supply, and then the opportunity to attain health care exists. Facilitating access, is aiming to help people to find an appropriate health care resources, in order to improve or preserve their health.(83)

The range of which a population get access, depends on organizational, financial, cultural and social barriers. The access of health services in term of utilisation can be measured by affordability, acceptability and physical accessibility.(83)

There is an article from Brazil, showing the role of access to HCS and availability of primary health care (PHC) in providing the relevant kind of management at the first entry point to the health system. What has been mentioned in the introduction, that neighbourhoods with larger numbers of PHC, in relation to population size, were having less dengue cases developing to severe forms. However, they didn't give a clear figure of how many PHC centres were available and the number of population that has been served.(84)

There is no study was addressing the point of health care access, in relation to DF directly, however, there is data describing the situation of the HCS in SA in term of access with a focus on PHC. (85)

Corresponding with the Alma Alta Declaration of 1978 issued by WHO in 1983, Saudi MOH started to promote the idea of PHC and stated strategies, to provide optimal health care by development of 2259 PHC centres throughout the country. And they are aiming to provide comprehensive services including preventive and curative care.(85)

The distribution of PHC centres was not appropriate, as what has been mentioned in one study, showing the current MOH statistics, that there is maldistribution of health professionals and health care services, as the most are concentrated in large cities. But, the exact number of PHCs in large cities out of the total number in the country, was not stated in the study. So, people living in rural areas are having a difficult time to access health care facilities, specially PHC. This difficulty, is in terms of long travel distance from their villages, which creates a negative impact on the severity of DF, based on what has been shown by the article of Brazil.(86)

But again, with all data about HCS in SA, any of them have addressed the situation of the slums populations, in term of health care access.(87),(86)

Regarding pilgrims, SA is providing free health care services through MOH facilities, as they assigned 156 PHC centres and 22 hospitals around Jeddah and 2 holy cities (Makkah and Madinah). On the other hand, the non-eligible staying pilgrims, after the season they are receiving care after arranging with their embassies to provide the government with their identification. After this to arrange for their travel after receiving the full health care.(87)

3.2.2 Affordability

As shown earlier in this section, about accessibility of health care system, affordability is one aspect to be considered to measure the utilization.(83)

In one study done in Colombia, to analyse how access to health care can affect public health problems, such as the control of infectious diseases including DF, they considered the role and implication of the insurance system on the access, as they have 2 different insurance schemes (contributive and subsidized) and it showed unequal access for services between two groups, as the contributive group offered more health benefits as they can pay for more. So, having a national insurance still cannot guarantee a better access. That's

why they concluded that accessibility should be a fundamental consideration in health related policy.(88)

There is data from Vietnam, about the cost of DF, it showed that the average cost for each DF case was 139.27 \$ ± 61.68 \$ including direct and indirect costs per case. The average cost of the direct (medical and non-medical) cost is 88.2 \$ ± 69.9 \$, while indirect average cost is 51 \$ ± 22.7 \$. But, the highest proportion of the total amount was the hospital bed cost, compared to other components with 50.2%. The cost of treating children is found to be higher than adults, with 151.03 ± 63.52 \$ and 132.73 \$ ± 59.94 \$, for direct and indirect costs respectively. And the calculated GDP per capita is 2110 \$, this is considered to be a significant loss for middle income Vietnamese families.(89)

As mentioned before, about the insurance system and affordability of health care in SA, this is mainly provided by the government with 80% coverage. While the private sector is making 20%, and the governmental services are free of charge for Saudi citizens and non-Saudis are having cooperative insurance as it is obligatory to be given by their sponsors.(15)

There is no study in SA that focused on the affordability and the cost of DF specifically. The general health policy of Saudi MOH aims for fair and affordable care for the whole population, as mentioned earlier. In this sense, DF affordability is not directly affecting the prevention of DF in SA. However, this cannot be applied to the marginalized group (slums dwellers).(14)

3.2.3 Quality of care

Quality of care (QoC) is a very important element to assess and evaluate the health care system, however; the quality of health care remains operationally and conceptually vague, as mentioned by A. Allen-Duck et al. in an article analysing the concept of QoC. The most clear and reliable definition of QoC, as defined by the Institute of Medicine (IoM) and the WHO, is that: "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge".(90)

There are six domains to measure QoC in health, as released by IoM, that it should be: safe, equitable, effective, patient-centred, timely and efficient.(90),(91)
There is very limited data are focusing on the QoC and DF outcome, but there is study was done in Malaysia showing that "cohorting", putting all patients in one group under care of one team, adult patients with DF in a designed ward and to be treated by infectious disease team, led to improvement in the QoC and a substantial clinical outcome. However, this study gives only a general conclusion about improving health QoC and they didn't mention exactly which indicator of QoC was used to measure the good clinical outcome.(92)

There are number of studies addressing specific elements of health QoC in SA, although they were not exclusively for DF and were describing QoC of the whole Saudis HCS.(86),(93),(94),(95)
The evidence showed that, public health care facilities are not providing good QoC to the patients in PHC centres in term of: safety, patient cantered care and timely.(93),(94)

Literature data about QoC in the public health facilities in SA shows the following:

Safety: only 30% of the total of public hospitals had a medication safety committee and just 9% have a medication safety officer, there is an unsafe prescribing practice in PHC centres because of poor dissemination of evidence-based medicine (EBM) and national guidelines. Additionally, because of the multicultural and multilingual environment mainly between nursing staff, this influenced their communication with patients and the service provided.(93),(94),(95)

Patient centred care: a lot of surveys are done to assess the patient's satisfaction and it showed; 74.8% were not aware of their rights to be fully informed about the diagnosis and treatment, as the physicians are not spending enough time with patients, to keep them satisfied, and around 69% were unsatisfied with health information given to them during discharge.(93),(94),(95)

Timely: a systematic review about QoC in SA showed that there is a delay in providing services and a delay to be seen by a specialist, due to workload, or because of difficult geographical access and long travel distance, so patients can't be on time.(86),(95)

But, all these studies didn't focus on the effect of these failures in QoC indicators on the clinical outcome. Furthermore, there was no preventive policies, in this context, were considered to overcome those failures.(86),(93),(94),(95)

3.2.4 Efficiency

Efficiency is one of the six domains, to measure QoC and it is concerned with a relation between resources inputs (costs in term of: equipment, capital or labour) and either intermediate outputs (waiting time, or number of treated cases, etc.) or final clinical outcomes (life years gained, lives saved or quality adjusted life years (QALYs)).(91),(96)

Many evaluations used intermediate outputs to assess the effectiveness, but to give the optimal recommendations, it is better to measure and focus on the final outcomes.(96)
The Bloomberg health care efficiency (BHCE) index, is using the life expectancy (output) and health spending measures (input) for evaluation, SA ranked 46 out of 56 countries with an efficiency score of 37.5 %, life expectancy is 74.4 and the absolute GDP is 1147$.(97) Efficiency plays an important role in reflecting the overall situation of the health system, as per Bloomberg index, because it gives an overview on the economic and medical impacts of diseases.(97)

There is no study found, to give the full picture of efficiency as what has been described in the definition in regard of DF. What could be found specifically for DF and efficiency is the economic impact, as a part of BHCE index.
Singapore did a study, addressing the economic burden of DF and the cost effectiveness of the future dengue vaccination program if implemented with reasonable prices.(98)

There is no data found from SA in this context, but the Bloomberg index of SA explains that there is a defect in the Saudi's health care efficiency.(97)
No preventive measures could be found to tackle efficiency of HCS in SA, however; the Singapore's study highlights the role and future of vaccination programs and that's can be considered as a preventive measure.(98)

3.2.5 Demand/utilization

Demand and utilization for health care services comes from the desire of the consumer (the patient) to gain good health. There are some factors influences demand and utilization: SES of the patient, prices of the health care services, governmental policies such as subsidy, supply and availability of services, and demographic characteristics (age, gender).(99),(100)

There is a study done in Colombia which analysed the health care utilization, during a DF outbreak in an urban area. And it concluded that, over 90% of patients are utilizing the private health facilities more than public, regardless the distance. As they are travelling around 8.03 minutes with a car to the facility over the closest one, which can be reached within 2 minutes from their home. They travel this distance, for better quality in term of well-equipped facility and higher beds capacity, however this study addressed the utilization issues using only the geographical access and transport, and they didn't mention other factors which may have influenced the utilization.(101)

SA had the same findings as the Colombia's study, with several data showing that a higher utilization of private health care facilities, by Saudis, for the sake of good quality compared

to the public health sector, in terms of timely services and more patient centred care. And that has led to overutilization of the limited number of private services and an imbalance between the demand and supply. Data from a report about Saudi's HCS in 2018 showed that, utilization of outpatients clinics in MOH hospitals decreased from 51.7% to 49.4%, while it was increasing in private hospitals from 32.5% to 35.5%.(93),(94),(95),(102)

In the HP context, the preventive policy needs to solve the overutilization problem and should consider SES, availability of enough services that match the number of patients, which are not available in SA.(99),(100)

3.3 Program factors
It includes: Health policies by (MOH, MOL, Ministry of Finance (MOF), municipalities), Support/partnership, Community involvement, National dengue control program

3.3.1 Health policies by (MOH, MOL, MOF and municipalities)
Health policy as defined by the WHO is "decisions, plans, and actions that are undertaken to achieve specific health care goals within a society".(103)
Any policy for prevention and all control programs should be evidenced-based, taking into consideration gender ethics, equity and the available knowledge and expertise at the local level. Every country has to develop its own specific context scheme, and any effective program should distinguish clearly between policies for routine and outbreak interventions. (104),(105)

A systematic review was evaluating and assessing the contingency DF prevention and control plan in Brazil, Malaysia, Mexico, Dominican Republic, and Vietnam. These countries were selected, based on the dengue burden, dengue endemicity and if they have had frequent dengue outbreaks. It was found that most of those countries did not have a comprehensive, detailed prevention strategies. Because, they depended mainly on an intensified vector control, without focusing on other aspects of integrated management, with clinical, laboratory and vector surveillance, epidemiological and risk communication.(105)

This study highlights the importance of distinguishing between planning policies in routine and outbreak prevention interventions, however: they didn't describe explicitly which measures should be used in a routine situation, because that will help to avoid going to an outbreak condition.(105)
SA does have some instructions and information about DF and its prevention on the MOH website, as they mentioned about the virus, mode of transmission via mosquitoes, symptoms and signs and when the suspected case should seek medical care, and how to limit indoor breeding sites of the vector. But, there is no clear policy describing the prevention program, with involvement of other sectors like: MOL, MOF and municipalities of cities with a high number of cases.(106)

From the HP perspective, about the health policy and by applying "one health" approach, as described by the WHO as "is an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes".(107) So, based on that It is important to involve all responsible sectors to achieve the concept of "healthy policy" instead of just health policy.(107),(108)

3.3.2 Support/partnership
Partnership for Dengue Control (PDC) was established in July 2013, after expansion of the epidemic dengue disease, it's a unique global collaboration of international health agencies, leaders in public health and dengue experts. It aims to create a synergetic control plan with the partnership of stakeholders and policymakers, to ensure the most effective control strategy.(109)

PDC is contributing to achieve the WHO global strategy, for dengue prevention and control 2012-2020, to reduce the DF mortality by 50% and morbidity by 25% in 2020. However, this target couldn't be achieved as what mentioned earlier, that DF is still a global health issue, because the reported number of cases is increasing from 2.2 million in 2010 to 3.34 million in 2016 as stated in the last statistics by the WHO.(109),(26)

Singapore is making a good example of support and partnership, at the country level, as they have introduced a nationwide integrated program and this focused on 3 key approaches: risk-based prevention and intervention, inter-epidemic surveillance and control as well as coordinated intersectoral cooperation.(110)
This cooperation was as a response to the 2013 outbreak, when the number of cases reached 22,170, due to: entomological, immunological, climatic and ecological factors, so this gives an insight to make a multi-pronged approach, through an integrated vector management, taking in consideration previously mentioned factors, which paved the way for a better DF prevention as the number of reported cases in 2018 is 3285. (110),(111)

In this study they have mentioned that 27 stakeholders, from different sectors, were comprising in the country integrated vector control program. However, they didn't stated exactly which sectors were involved.(110)
There is a lack of such integrated DF control program in SA, which led to ineffective management and the prevention of the disease. As outbreaks of the vector mosquito population are still appearing frequently. Although, integration plan between sectors for vector-borne diseases control, including DF, was implemented during Hajj season, as shown in the section of the SES, movement factor. But, the government did not take in consideration, to apply the Hajj experiences, in term of sectors partnership to be used for the control program after the Hajj.(52),(55),(20),(19)

3.3.3 Community involvement:
Community participation is important to prevent the spread of DF, the social mobilization and behavioural change, at the community level is a necessary part in the integrated management strategy, as it allows the local population to prompt eradication of the disease in their environment.(112)
Social communication and mobilization, integrates several members of the community, from householders to policy makers, in order to raise the awareness about DF, deliver services and recourses as well as to ensure sustained community participation, and this should be developed through multiple channels, to assure that all information passes through out all levels of the community.(112)

There is a cluster randomized trial done in Cuba and it showed that community based environmental management, incorporated with routine DF prevention and a control program, can reduce levels of Ae. Aegypti infestation by 50-75%, compared to a single strategy routine program.(113)
In Mexico, specifically in Guerrero (a state in the south of the country), they have employed the concept of social mobilization, aiming to raise awareness of the consequences of DF and to explore how this can impact the risk of acquiring the disease. This has been carried out through 'clean backyard' campaign, as they put emphasis on the importance of each household in fighting against the dengue vector and to work together to achieve living in a dengue-free community. They have found that 54% of houses were clean, there were no breeding sites found, as these houses were visited by an activator who was training, supervising, and doing monthly assessment for them. On the other hand, households not visited by the activator, had a 2.4 times higher risk of contracting DF.

After 1 year of this campaign, only 30% of trained households were having clean backyards, this refers to the sustainability of the effect of this kind of campaigns that is making an issue and in encouraging people to maintain efforts to keep their environment dengue free. For this, encouraging continuity of program effect it is important to take into

consideration the role of the community leaders as an effective channel, through which to educate communities, disseminate information and create behavioural change at households level (112)

In Jeddah, a study addressed risk factors of DF in Jeddah governate and they have focused on a door to door campaign, which was designed and implemented by Jeddah municipality, preventive health affairs, department of religious affair, the information department at Jeddah governate and king Abdul-Aziz university. The goal of this campaign was to strengthen community participation in prevention and control of DF, also to support preventive measures conducted by MOH and other related governmental sectors. But, they didn't mention what the effect of the campaign was at the community level in decreasing the risk of acquiring the disease.(1)

3.3.4 National dengue control program
As mentioned by the WHO, about describing key elements and enabling factors for implementing dengue control and prevention program at the country level:(104)
  1- Skill, processes and resources 2- Monitoring, review and corrective action
  3- Risk communication 4- Partnership, coordination and collaboration
  5- Advocacy and resource mobilization 6- Research

The Singapore national DCP has been used to cover the WHO elements as following:
In Singapore, the National Environmental Agency (NEA) is handling the dengue prevention and control program through many activities, they have conducted many rounds of inspection for vector breeding in dengue cluster areas in addition to outreach activities, such as community events and visiting houses. They have collaborated with Grassroots Leaders and Advisors, Dengue Prevention Volunteers and members of the community, to increase awareness, by distributing educational pamphlets and insect repellent to the residents, during house visits.

For source eradication of breeding sites of mosquitoes and spraying of insecticides, various agencies and stakeholders, represented in the inter-agency dengue task force, have stepped up checks to eliminate potential vector breeding inhabitants.
Also, by collaboration with MOH, they are daily reporting new dengue cases and that shows a good surveillance system. see Fig.9 (114)

Dengue Cases

Dengue
  Dengue Cases
  Dengue Clusters
  Stop Work Orders
  Quarterly Dengue Surveillance Data
  Dengue Community Alert System
Zika
Prevent Aedes Mosquito Breeding

It is important to note that the day-to-day numbers fluctuate, as they depend on the number of cases notified each day. Therefore, weekly numbers are a better reflection of actual trends.

Number of Reported Cases

27-Jul	28-Jul	29-Jul	30-Jul	31-Jul	01-Aug	02-Aug at 3pm
63	52	97	108	87	112	49

Number of Reported Cases by E-week (from Sun 0000hrs to Sat 2359hrs)

E-week 25 (16-22Jun19)	E-week 26 (23-29Jun19)	E-week 27 (30Jun-06Jul19)	E-week 28 (07-13Jul19)	E-week 29 (14-20Jul19)	E-week 30 (21-27Jul1
433	498	593	663	649	610

Cumulative No. of cases for 2019 (First 30 E-weeks): 8630
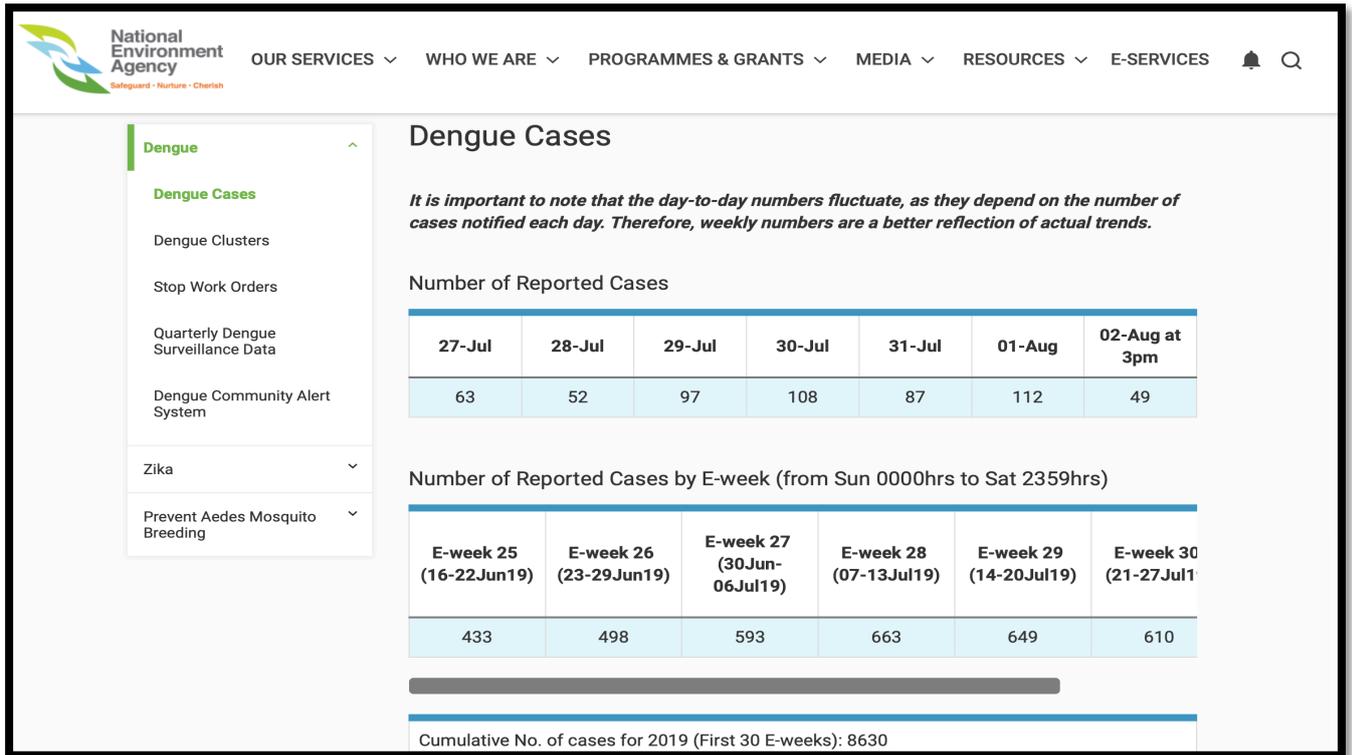
Fig.9 NEA website, with daily reported dengue cases showing a strong reporting system in Singapore, 2019 (114)

In SA there is lack of clear prevention and control program catalogue mentioned in any of the governmental websites. Only some information was in MOH and local journals websites about educational campaigns for households, and spraying with insecticides at mosquitos breeding sites in most affected areas in Jeddah and Makkah, has been done during DF outbreaks. Regarding surveillance and reporting, there is a clear gap in reporting as the last statistics found by MOH for dengue cases, were in 2017. Additionally, there is lack of quantitative DF researches, due to the limitation of the accessibility for environmental and social variables data.(44)

3.4 Dengue knowledge
It covers: Cause, Preventive methods, Early treatment, Cultural beliefs and Information

3.4.1 Cause, Preventive methods, Early treatment
Health Education (HE) is an important tool for controlling diseases such as DF, as well as it assures that community members have enough understanding of the infection including aspects of the transmission, preventive measures and the importance to seek immediate treatment.(115)
Many studies are done for testing the impact of HE on the knowledge, attitude and practice (KAP) towards DF, were at school level among students and teachers.(116),(117),(118),(119)

In Malaysia, they have conducted educational intervention with a 2 parts study (baseline and post intervention) among university students, to determine KAP levels and it showed that, for the baseline only 26.1% have good knowledge. On the other hand, they showed a good attitude and were practicing some preventive methods with 88.6% and 73.3%, respectively.
Post intervention tests, showed an increase in all KAP, with mean scores: 12.61 ± 0.17 for knowledge, 9.01 ± 1.09 for attitude, and practice 7.11 ± 2.49.(115)

In SA there are two studies done in 2 cities (Jeddah and Jazan), both studies were conducted for secondary school students, teachers and supervisors.

In Jeddah, a mass communication campaign was done in 20 schools for females, they have used pre-post-intervention questionnaires and all information is presented through lectures and audio-visual aids. The results showed that students had marked improvements in all areas of KAP, compared to the other 2 groups (teachers and supervisors). Post intervention scores for KAP were 99%, 95.4% and 95.7%, respectively.(116)

The study of Jazan, tested baseline KAP of students in six schools, without intervention and results showed that, poor knowledge with about dengue symptoms, vector, and mode of transmission with 46.7%. But they showed a good attitude and practice with 93.2% and 85.5%, respectively.(117)

However, all these studies didn't show the impact of poor KAP and didn't refer to the way to keep this kind of KAP interventions sustainable.(116),(117)

Regarding the policy makers education, there is a lack of evidence to focus on this HP domain.

3.4.2 Cultural beliefs

Deep understanding of health beliefs and behaviours, gives an insight for sustainable community-based dengue prevention and control.(120),(121)

There was a focus group study done in Malaysia, with 84 multi-ethnic Malaysian citizens they were studying their health beliefs related to DF, and it showed that two third of the participants had a low perceived susceptibility of getting dengue. In addition, they believed that traditional medicine is efficacious and common to be used for DF, so this gives a clue on how cultural beliefs and behaviour can affect dengue prevention and control.(120)

In SA, the previously mentioned studies about KAP in schools ,conducted in 2 cities, the results revealed that ,the participants beliefs that applying preventive measures is essential and DF can be prevented with 78.5%.(117),(116)

And no study in SA showed that DF patients are seeking any traditional or unproven therapy, and most of them preferred to be treated by qualified health professionals either in PHC centre or in a hospital for more severe cases.(2),(122)

3.4.3 Information

For effective HE materials, the information provided should be by health professionals, patient oriented, easy to be understood and remembered, and designed based on the best practice principles in HE.(123)

HE information should be disseminated by the most used and popular channels and to put in consideration the targeted audiences. For example, the study conducted in Malaysia for university students, reflecting their KAP, showed that they are using the social media applications as a source of DF information with 44%. While in SA the study of Jazan's secondary schools showed 48.1% and 44.5% got dengue information from PHC centres health staffs and TV, respectively.(115),(117),(123)

3.5 Treatment

3.5.1 Early diagnosis and treatment

Early diagnosis and treatment of DF is crucial to prevent the severe forms of dengue: HDF and DSS.(26)

Due to the increasing incidence of DF in dengue endemic countries, the early diagnosis allows for a timely clinical intervention and treatment. Therefore, getting the diagnosis of dengue, during the acute phase, is a priority and it's a public health concern.(124)

DF patients are treated supportively with a main approach, to treat symptomatically as there is no special treatment.(44)

Early diagnosis should depend on either: clinical recognition or a bedside rapid diagnostic test (RDT).(125),(126) refer to Table 4. Annex2

Regarding the RDT, there are a number of rapid serological test kits, using the Dengue Duo rapid test kit for detection of dengue virus NS1 antigen and immunoglobulin M (IgM)/IgG antibodies. Although it gives a result within 15 minutes, the WHO are not recommending its usage, because it's not accurate and not validated, as it yields false positive results. But, some studies showed a high percentage of its sensitivity and specificity with 88.65% and 98.75%, respectively.(125),(124)

Evidence showed that RDT can be used during outbreaks in resource limited regions, and this has been done during large outbreaks in Brazil, as they used NS1 protein test, but their study showed a low sensitivity, with a less than 40% for DEN-2 serotype which was predominant during that outbreak. However, this test sensitivity is depending on the serotype and if it's a primary or secondary infection.(127)

In SA, there a cross sectional study is done in Jeddah to assess PHC physician clinical practice for DF and the result was: 80.5% always ordering dengue testing if suspected, compared to 7.2% never performed tests for suspected cases. The most commonly utilized tests were leukocyte, platelets, and hematocrit with 75.7%, followed by IgM/IgG dengue serology with 31.5%. Physicians whose did not perform dengue tests explain this to unavailability of the tests at their centres.(128)

3.6 Prevention
It includes 2 aspects: ITNs, IRS, Environmental management

Dengue prevention and control is relying mainly on vector control methods. Still no ideal treatment is targeting the virus and the vaccine is not approved yet for all population, it is mainly for adults, with a previous dengue infection, as recommended by the WHO, because if it is received by dengue naïve persons it will increase their risk of hospitalization in the future. The safe and efficacious vaccine is under trial to be produced globally.(33),(44),(129)

3.6.1 Insecticide treated nets (ITNs), Indoor residual spraying (IRS)
It's important to focus on effective mosquito control measures because it showed effectiveness if applied in a proper way. For instance, in a systematic review showing the effectiveness of IRS. The result was, BI (Measures for immature Aedes: Breteau Index) dropped from m above 35 to under, after spraying, this was done in Taiwan. Another study from Peru, showed that IRS reduced the Adult mosquitoes index from 18.5 to 3.1.(130)

The kind of method applied, depends on the context. For example, ITNs were more used in case of malaria over IRS, because it's a nocturnally transmitted vector-borne disease, this was evident in the WHO review, as ITNs usage reached 56% compared to only 11% for IRS in malaria endemic areas.(131)

In case of dengue, Ae. Aegypti is biting in the daytime, this is why there were very limited uses of bed nets for the DF vector, ITNs for dengue control have never been studied, except one and first study was conducted in Haiti. It was showing its effectiveness for DF control, and it showed immediate effect with a decrease in dengue vector populations by 95% after 1 month from intervention. But, they have stated that bed nets are not providing a protective barrier against mosquito bites, it repels and /or kills Ae. Aegypti if trying to enter houses.(132)

Insecticide treated screens (ITS) were more popular used in Mexico and Brazil, as screened houses had >50% less chance to have Ae. Aegypti indoors, and more importantly had >50% fewer Ae. Aegypti females, compared to non-screened houses. The impact was sustained for 2 years, which showed more sustainability than bed nets.

However, the working of insecticidal power can be lost duo to climatic changes like: exposure to sunlight, rain and dust, this is why the impact of ITS was not 100% and should be integrated with other methods.(33)

But, both studies didn't show data about the number of cases that have been reported during using either ITNs or ITS, to reflect on the clinical impact of using such preventive interventions.

In the context of SA, municipalities of Makkah and Jeddah were applying IRS mainly, as ITS are not widely used there. Many factors are influencing the effectiveness of IRS: first, municipalities have contracted private companies to do the vector control work, but they lack the precise knowledge about mosquito control and the use of science-based strategies. Secondly, there was no continuous supervision by professionals from the company or municipality. Preventive policies were in place to limit these improper spraying practices.(19),(17)

3.6.2 Environmental management

From the HP perspective, health protection in the context of DF, in terms of genetically modified mosquitoes (GMMs), can be used as environmental management. This technique has been done in trials and it showed a positive impact by decreasing the number of dengue cases.(133)

One of the biggest trials and frequently used study, to show the GMMs effect, was in Brazil, as mosquito's larvae were reduced by 81%, which led to a huge drop in dengue cases by 91% in one year.Fig.10 (134)
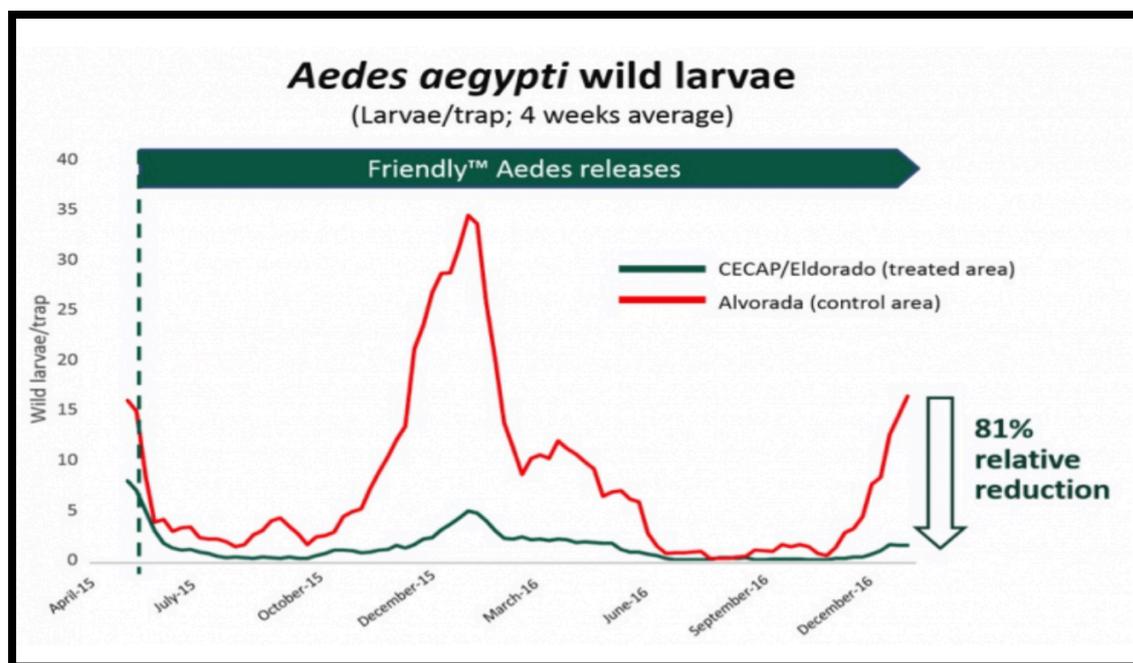

Fig.10 A graph showing the decrease in Ae. Aegypti larvae after release of GMMs,2017 (134)

But interestingly, with all this success, there is a concern from the public by 75% in Brazil, and resistance to apply such intervention. This concern driven by the individuals trust in the scientific authorities.(135)

At the end of DCP analysis, there are 2 examples (see textbox1) has been selected based on DCP framework aspects, which were found insufficient in SA according to the analysis done:

Singapore, national dengue control program

After a major outbreak of DF in 2005, with 14,006 cases and 27 deaths, the government of Singapore has established a **laboratory-based dengue virus surveillance** as a part of an **integrated vector control program** for close monitoring and investigation of the circulating serotype. This surveillance program was activated in 2007, and it was helped in early detection of the serotype switch from DEN-1 to DEN-2, which was a warning for an upcoming outbreak. This led to an interruption of a high trend of dengue cases, with a significant drop by 7,032 cases reported in 2008 and 4,498 in 2009. Through the years, this program was improving until it became a well-developed integrated one as what shown earlier in Fig.9.(136),(114)

Japan, quality of care

In 2014, Japan has experienced first unexpected dengue outbreak in 70 years with reported cases around 200, all were imported cases. As the country was not prepared for such outbreak, so number of failures happened. Those failures were in term of **safety and efficiency**. Safety issues were that many clinicians don't have experience in DF management since it's not common before this outbreak beside lack of knowledge in tropical diseases. As all cases were imported so most travellers had poor communication with health professionals. Regarding efficiency, there are only 1049 board-certified infectious disease clinicians in japan in 2014. The number of physicians working in infectious disease department only 492 which accounts 0.2% of the total working clinicians in hospitals and clinics. All these deficiencies were addressed by the government and they have worked to improve them to prepare for coming outbreaks. This improvement plan implemented in 2018, there are 36 accredited medical facility 9 of them were in Tokyo, the Japanese institute of global health by collaboration with private sectors are offering medical translation services to support internationals and to facilitate hospitals and this service available in 17 languages. Direct after dengue outbreak in 2014, the ministry of health, labour and welfare and national institution of infectious diseases have developed a comprehensive, publicly available guideline for managing mosquito-borne infections.(137)

Textbox 1. Exemplary best practice DF prevention and control in Singapore and Japan

Chapter 4

Discussion:

No study was found addressing DF prevention and control from HP perspective in SA. This thesis therefore reviewed existing literature on DF from SA and other countries and analysed all factors in the DCP framework, combining them with the HP model domains. This analysis revealed that:

The most important factors, which increased contracting DF and was creating a favourable environment for the vector in SA are: the environmental factors and SES.(44)
That was in term of: a hot and humid climate, especially in Jeddah, Jazan and Makkah, with temperatures ranging from 28-40 degrees, and humidity from 80-100%, which is consistent with Thailand's environmental result.(44)
SA is receiving a few rainy seasons, however with the lack of a good sewage and drainage system, even if the rainfall periods are not long, it can make the best environment for vector breeding, beside hot and humid weather through the whole year.

Regarding SES, DF is a disease of poverty and there was a discrepancy in the evidence about which poverty indicators can be used, in case of dengue, but the most relevant and frequently used, were income and housing condition.
The economic status and its relation to dengue was not studied well in SA, specially the status of slums dwellers. But, some studies were indirectly linking economic status to poor housing conditions as people whose living in slums, mainly illegally staying pilgrims, with overcrowding and poor infrastructure are more at risk to get the disease.

However, the ministry of hajj is creating every year a very well-prepared vector control plan, targeting all mosquito-borne diseases, including DF, to tackle this periodic movement risk. As they are starting to prepare with spraying campaigns before the season, by collaboration with other ministries like MOH, ministry of agriculture and municipalities, they are also providing all related information to the official websites of infection control agencies of other countries. But this Hajj experience in the vector control plan, reporting of cases and dissemination of DF information, is not used after the season, for the routine national control program and this creates another factor of poor handling of DF.

Another form of movement, which is not well managed, is labouring, there are many foreign workers are coming to SA, from endemic areas and they are working mainly in construction sites this is about 4.4 million. However, there is a literature gap highlighting this group as a risk group even with the evidence of the link between construction, as an occupation or living in an area close to a building under construction.(1)

As what found in one study in SA, they have only mentioned, that construction workers responsible for making up a "good" number of total dengue reported cases in Jeddah, but this is a vague term and is not forming a clear picture.
Beside neglecting to study a large group in the labour market to be studied, there is a lack of preventive policies and measures stated by MLO, municipalities and the largest construction companies on their websites.

The evidence supported the link between war and the risk of spreading of infectious disease including DF.
DF is an endemic in Yemen before the war, and the ongoing conflict created an ideal environment for mosquito-borne diseases and a re-emergence of DF, with higher number of cases.
Because of poor living condition there, many Yemenis people were displaced 603,833 of

them were in SA in 2017. Despite all these potential risks, which increased the number of DF cases and created more disease transmission, there is no data have focussing on this factor, although it is important to do this and to address it in the context of HP, to give insights for the policymaker, to create proper preventive policies.

In SA, being male, between 15-30 years old, will increase the risk of getting DF. The first factor (gender) has been explicitly addressed, as their gender role in the community makes them more exposed to the vector, in contrast to females, as they are staying indoors or covered outside, because of religious and cultural norms. For the (age), there are many studies mentioning the most affected age group but they didn't explain the reason what made them more vulnerable.

The health care system in SA has many failures in terms of: access as most of PHC centres and hospitals are in big cities, and rural areas are not well covered, and QoC in term of safety, patient centred care and timely services. But all this data is describing the health system in SA in general and was not specifically for DF, additionally this general data didn't mention how the Saudi's HCS is dealing with the dwellers accessibility and affordability of health services.

Regarding the program factors, the concept "health policy" is not fulfilling the aim of HP, to make an integrated policy by responsible governmental sectors for DF prevention and control. And that aim was best described by the WHO as "one health", however there is no data found in SA to apply this concept to DF.
There is also a lack of active community participation in the vector prevention and control programs, there is no study showing the long-term effects of the educational campaigns that have been held in schools on the KAP, and no study showed if any campaigns were done for the public.

Another factor influencing the DF prevention, is improper spraying practices by private companies which have been contracted by the government and are not using an alternative method like ITS or indoor insecticidal paint, to overcome failures or the use of other preventive measure.

As DF is still a global public health issue, it was hard to find a variety of examples for success. However, experiences found in Singapore and Japan were more relevant to the SA control program deficiencies in terms of: surveillance and QoC of HCS.

The analytical framework which was been used to address DF prevention and control issues was relevant, as it was modified by using MCP framework and both are mosquito-borne diseases.
It was interesting to combine the HP model with DCP framework, but it was also difficult and challenging to link all aspects of HP domain and relate that to DF. Specially, the policy maker education and health policy factor.

Limitation of the study and using DCP framework for analysis:
1- It was difficult to find data, either in SA or other countries, to cover all HCS factors and to analyse/apply them to DF as factors influencing prevention and control.
2- Limited data was found focusing on DF prevention and control in SA.

Conclusion and Recommendations:

DF is an important public health issue in SA and presently there is still a serious of absence of a focus on health promotion by policymakers, which should be available for effective prevention and control program.

The most relevant factors, that influence HP and DF control in the context of SA, are mainly related to a poor implementation of integrated prevention and control plan, between governmental/ non-governmental sectors, reflecting in an ineffective control of DF and lack of preventive policies, which can handle the high-risk groups to acquire the disease.

There is no integrated prevention program that includes responsible sectors, there is a shortage of an up to date surveillance system, which provides the latest information about DF and its incidence in the country and a lack of a future plan that ensures a sustainable positive impact.

There is also a clear gap in the literature addressing DF problems in SA, because availability of such information will help to avoid past fails and make a better national control program. Therefore, more research is needed.

Recommendations:

1-It's very important to study and address "the income" as an indicator, because in developing preventive policies measures for the vulnerable areas, whether in "rich or poor" neighborhoods should be identified to give them the priority in making strategy control.

2- To make the previous study stronger, it's important not to neglect slums dwellers and to get them involved in the study, also to add how they are dealing with THE Saudi's HCS and to take the perspectives of a policy maker

3-At the national level, to take the experience of mosquito borne diseases prevention and control plan during Hajj, by intersectoral collaboration, and using it after the Hajj season. For example, to supervise spraying practices, which are done by private companies, by assigning an expert from the ministry of agriculture. Also, to use all informations about DF and preventive measures which has been disseminated during Hajj season and add them to MOH/MOL websites

4-Making a collaboration between MOH, MOF and MOT to allocate PHC centres in underserved rural areas, mainly around the most affected cities (Jeddah, Makkah, Jazan) with DF. All these sectors will be assigned, to develop an appropriate plan for PHC, based on the number of populations and the best location for each centre to be more accessible.

5-To improve KAP, adding DF in the schools and university curriculums, with a periodic check, by public health professionals to make sure that there is sustainability of the information which students have learned and how they are applying the preventive measures.

6-To strengthen the community participation, using the experience from Mexico by assigning an activator, to give knowledge and train households how to identify and eliminate breeding sites and perform a monthly assessment of the area under their supervision. In the Saudi context, to choose a female activator and perform this in the morning because of the conservative culture as its more convenient to housewives or for housemaids.

7-By applying the successful experience from Singapore with a laboratory-based surveillance system, SA can do this through collaboration between west/south regional laboratories and MOH. By doing timely tests and direct reporting on their websites also to disseminate this data to other governmental sectors namely MOL and municipalities

8-Using the example from Japan to improve QoC in governmental hospitals, by accreditation and partnership with private sectors for making medical translation services specially for patient- nursing communication

References:

1. Kholedi AAN, Balubaid O, Milaat W, Kabbash IA, Ibrahim A. Factors associated with the spread of dengue fever in Jeddah Governorate , Saudi Arabia. East Mediterr Heal J. 2012;18(1):15–23.

2. Badreddine S, Al-dhaheri F, Al-dabbagh A, Al-amoudi A, Al-ammari M, Elatassi N, et al. Clinical features of 567 consecutive patients admitted to a tertiary care center in Saudi Arabia. Saudi Med J. 2017;38(10):1025–33.

3. Al-tawfiq JA, Memish ZA. Dengue Hemorrhagic Fever Virus in Saudi Arabia : VECTOR-BORNE ZOONOTIC Dis. 2018;18(2):75–81.

4. Chang C, Chen CS, Tien C, Lu M. Epidemiological , clinical and climatic characteristics of dengue fever in Kaohsiung City , Taiwan with implication for prevention and control. PLoS One. 2018;13(1):1–15.

5. MOE. Geography of Kingdom of Saudi Arabia [Internet]. 2019 [cited 2019 May 27]. Available from: https://www.moe.gov.sa/en/TheMinistry/AboutKSA/Pages/GeographyofKingdomof SaudiArabia.aspx

6. CIA. Middle East :: Saudi Arabia — The World Factbook - Central Intelligence Agency [Internet]. 2019 [cited 2019 May 27]. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/sa.html

7. vector image. Kingdom of Saudi Arabia - map Royalty Free Vector Image [Internet]. 2019 [cited 2019 May 27]. Available from: https://www.vectorstock.com/royalty-free-vector/kingdom-of-saudi-arabia-map-vector-2090146

8. the world bank. Saudi Arabia | Data [Internet]. world bank group. 2017 [cited 2019 Jun 8]. Available from: https://data.worldbank.org/country/saudi-arabia

9. Alomar RS, Parslow RC, Law GR. Development of two socioeconomic indices for Saudi Arabia. BMC Public Health. 2018;18(791):1–10.

10. world bank. World Bank Country and Lending Groups – World Bank Data Help Desk [Internet]. 2018 [cited 2019 Jul 3]. Available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

11. saudi cultural mission. Culture, Traditions and Art – Saudi Arabian Cultural Mission | SACM [Internet]. SACM. 2009 [cited 2019 Jun 8]. Available from: https://sacm.org.au/culture-traditions-and-art/

12. Long DE. Culture and customs of Saudi Arabia. Westport, CT: Greenwood Press; 2005. 124 p.

13. Khalil MKM, Al-Eidi S, Al-Qaed M, AlSanad S. The future of integrative health and medicine in Saudi Arabia. Integr Med Res [Internet]. 2018;7(4):316–21. Available from: http://dx.doi.org/10.1016/j.imr.2018.06.004

14. Al-Hanawi MK. The healthcare system in Saudi Arabia: How can we best move forward with funding to protect equitable and accessible care for all? Int J Healthc. 2017;3(2):78–94.

15. Yusuf N. Private and Public Healthcare in Saudi Arabia : Future Challenges. Int J Bus Econ Dev. 2014;2(1):114–8.

16. WHO. Global Health Expenditure Database [Internet]. 2016 [cited 2019 Jun 2]. Available from: http://apps.who.int/nha/database/ViewData/Indicators/en

17. Alhaeli A, Bahkali S, Ali A, Househ MS, El-metwally AA. The epidemiology of Dengue fever in Saudi Arabia : A systematic review. J Infect Public Health [Internet]. 2016;9(2):117–24. Available from: http://dx.doi.org/10.1016/j.jiph.2015.05.006

18. Al-Tawfiq JA, Memish ZA. Dengue Hemorrhagic Fever Virus in Saudi Arabia: A Review. Vector-Borne Zoonotic Dis. 2018;18(2):75–81.

19. Aziz AT, Al-shami SA, Mahyoub JA, Hatabbi M, Ahmad AH, Rawi CS. An update on the incidence of dengue gaining strength in Saudi Arabia and current control approaches for its vector mosquito. Parasit Vectors. 2014;7(1):1–4.

20. Aziz AT, Al-shami SA, Mahyoub JA, Hatabbi M, Ahmad AH, Rawi CS. Promoting

health education and public awareness about dengue and its mosquito vector in Saudi Arabia. Parasit Vectors. 2014;7(1):1–2.

21. Almutairi MM, Alsalem WS, Hassanain M. Hajj , Umrah , and the neglected tropical diseases. PLoS Negl Trop Dis. 2018;1(1):1–9.

22. Shafi S, Dar O, Khan M, Khan M, Azhar EI, McCloskey B, et al. The annual Hajj pilgrimage—minimizing the risk of ill health in pilgrims from Europe and opportunity for driving the best prevention and health promotion guidelines. Int J Infect Dis [Internet]. 2016;47(1):79–82. Available from: http://dx.doi.org/10.1016/j.ijid.2016.06.013

23. European Centre for Disease Prevention and Control. Public health risks related to communicable diseases during the 2018 Hajj, Saudi Arabia, 19–24 August 2018 [Internet]. Stockholm; 2018 [cited 2019 Mar 13]. Available from: https://ecdc.europa.eu/sites/portal/files/documents/risks-diseases-hajj-saudi-arabia-rapid-risk-assessment-24-august-2018.pdf

24. General Authority for Statistics. Chapter 04 | Health | General Authority for Statistics [Internet]. 2017 [cited 2019 May 28]. Available from: https://www.stats.gov.sa/en/868

25. Alshehri MSA. Dengue fever outburst and its relationship with climatic factors. World Appl Sci J. 2013;22(4):506–15.

26. Brady OJ, Gething PW, Bhatt S, Messina JP, Brownstein JS, Hoen AG. WHO | Dengue and severe dengue [Internet]. WHO. World Health Organization; 2018 [cited 2019 Mar 15]. Available from: http://origin.who.int/mediacentre/factsheets/fs117/en/

27. Wijayaratne D, Ranasinghe P, Mohotti SP, Dilrukshi SA, Katulanda P. Dengue fever in a patient with severe haemophilia : a case report. Wijayaratne al BMC Res Notes. 2015;8(78):1–3.

28. Sharma SK, Seth T, Mishra P, Gupta N, Agrawal N, Broor S. Clinical Profile of Dengue Infection in Patients with Hematological Diseases. Mediterr J Hematol Infect Dis. 2011;3(1):1–4.

29. Ong A, Sandar M, Chen MI, Sin LY. Fatal dengue hemorrhagic fever in adults during a dengue epidemic in Singapore. Int J Infect Dis. 2007;11(3):263–7.

30. Alejandria M. Dengue haemorrhagic fever or dengue shock syndrome in children. BMJ. 2015;4(917):1–11.

31. Kalra NL. Comprehensive Guidelines for Prevention and Control of Dengue/DHF. 1999. 135 p.

32. Vectors V, Manrique-saide P, Che-mendoza A, Barrera-perez M, Guillermo-may G, Herrera-bojorquez J, et al. Use of Insecticide-Treated House Screens to Reduce Infestations of Dengue Virus Vectors, Mexico. Emerg Infect Dis. 2015;21(2):308–11.

33. Contreras-perera Y, Correa-morales F, Ranson H, Lenhart A, Mccall PJ, Kroeger A, et al. House screening with insecticide-treated netting provides sustained reductions in domestic populations of Aedes aegypti in. PLoS Negl Trop Dis 12. 2018;12(3):1–17.

34. Rather IA, Parray HA, Lone JB, Paek WK, Lim J, Park Y. Prevention and Control Strategies to Counter Dengue Virus Infection. Front Cell Infect Microbiol. 2017;7(1):1–8.

35. Huang YJS, Higgs S, Vanlandingham DL. Biological control strategies for mosquito vectors of arboviruses. Insects. 2017;8(21):1–25.

36. Mesocyclops D, International L, Ijb B. Biological control of dengue mosquito (Aedes aegypti L.) with the copepod (Mesocyclops aspericornis D.) and fish (Tilapia nilotica L.). Int J Biosci. 2015;6(9):82–9.

37. Tissera H, Pannila-hetti N, Samaraweera P, Palihawadana P, Amarasinghe A. Sustainable dengue prevention and control through a comprehensive integrated approach : the Sri Lankan perspective. WHO South-East Asia J Public Heal. 2016;5(2):106–12.

38. World Health Organization. WHO | What is health promotion? [Internet]. WHO. World Health Organization; 2016 [cited 2019 Mar 12]. Available from:

https://www.who.int/features/qa/health-promotion/en/

39. World Health Organization. World Health Organization, Health Promotion Strategies [Internet]. SEARO. World Health Organization, South-East Asia Regional Office; 2017 [cited 2019 Mar 10]. Available from: http://www.searo.who.int/entity/healthpromotion/health-promotion-strategies/en/

40. measure evaluation. M&E of Malaria Control Programs- 1 Day Module — MEASURE Evaluation [Internet]. 2016 [cited 2019 Apr 7]. Available from: https://www.measureevaluation.org/resources/training/capacity-building-resources/copy_of_folder.2011-09-14.5845501387/document.2011-09-14.6822502385

41. R.S.Downie, C.Tannahill AT. health promotion:models and values. 2nd ed. Oxford University Press; 1996. 234 p.

42. Grant M, Mitcham C, Tsourou C. Healthy urban planning in European cities. Health Promotion International 24 [Internet]. 2009 [cited 2019 Aug 12]. Available from: http://www.euro.who.int/__data/assets/pdf_file/0016/141226/Brochure_promoting_health.pdf

43. Paridah M., Moradbak A, Mohamed A., Owolabi F abdulwahab taiwo, Asniza M, Abdul Khalid SH. Ecology of Aedes Mosquitoes, the Major Vectors of Arboviruses in Human Population. In: Dengue Fever - a Resilient Threat in the Face of Innovation. 2018. p. 39–56.

44. Altassan KK, Morin C, Shocket MS, Ebi K, Hess J. Dengue fever in Saudi Arabia: A review of environmental and population factors impacting emergence and spread. Travel Med Infect Dis [Internet]. 2019;1–8. Available from: https://doi.org/10.1016/j.tmaid.2019.04.006

45. Ameur F. Floods in Jeddah, Saudi Arabia: Unusual Phenomenon and Huge Losses. What Prognoses. E3S Web Conf. 2016;7(04019):1–10.

46. Mulligan K, Dixon J, Joanna Sinn C-L, Elliott SJ. Is dengue a disease of poverty? A systematic review. Pathog Glob Health. 2015;109(1):10–8.

47. Bonifay T, Douine M, Bonnefoy C, Hurpeau B, Nacher M, Djossou F, et al. Poverty and Arbovirus Outbreaks: When Chikungunya Virus Hits More Precarious Populations Than Dengue Virus in French Guiana. Open Forum Infect Dis. 2017;4(4):1–8.

48. Farinelli EC, Baquero OS, Stephan C, Chiaravalloti-Neto F. Low socioeconomic condition and the risk of dengue fever: A direct relationship. Acta Trop [Internet]. 2018;180:47–57. Available from: https://doi.org/10.1016/j.actatropica.2018.01.005

49. Martens P, Hall L. Malaria on the Move: Human Population Movement and Malaria Transmission. Emerg Infect Dis. 2000;6(2):103–9.

50. Stoddard ST, Forshey BM, Morrison AC, Paz-Soldan VA, Vazquez-Prokopec GM, Astete H, et al. House-to-house human movement drives dengue virus transmission. Proc Natl Acad Sci. 2013;110(3):994–9.

51. Tabatabaei SM, Metanat M. Mass Gatherings and Infectious Diseases Epidemiology and Surveillance. Int J Infect. 2015;2(2):1–4.

52. Memish ZA, Zumla A, Alhakeem RF, Assiri A, Turkestani A, Al Harby KD, et al. Hajj: Infectious disease surveillance and control. Lancet. 2014;383(9934):2073–82.

53. Memish ZA, Al-Rabeeah AA. Public health management of mass gatherings: the Saudi Arabian experience with MERS-CoV. Bull World Health Organ [Internet]. 2013 Dec 1 [cited 2019 Aug 1];91(12):899-899A. Available from: http://www.who.int/entity/bulletin/volumes/91/12/13-132266.pdf

54. MOH. News - Minster of Health: Hajj Season Free of Epidemics and Public Health Threats [Internet]. 2018 [cited 2019 Aug 1]. Available from: https://www.moh.gov.sa/en/Hajj/News/Pages/News-2018-08-24-001.aspx

55. Razavi SM, Mardani M, Salamati P. Infectious diseases and preventive measures during hajj mass gatherings: A review of the literature. Arch Clin Infect Dis [Internet]. 2018;13(3):1–7. Available from: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=

L623467710%0Ahttp://dx.doi.org/10.5812/archcid.62526

56. Lowe R, Coelho CA, Barcellos C, Carvalho MS, Catão RDC, Coelho GE, et al. Evaluating probabilistic dengue risk forecasts from a prototype early warning system for Brazil. Elife [Internet]. 2016 Feb 24 [cited 2019 Aug 1];5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26910315

57. LIM V. Occupational Infections. Malaysian J Pathol. 2009;31(1):1–9.

58. Al-Emad NH, Rahman IA. Issues engulfed Saudi Arabia construction workers. IOP Conf Ser Earth Environ Sci [Internet]. 2018 [cited 2019 Aug 1];140(012097):1–9. Available from: https://iopscience.iop.org/article/10.1088/1755-1315/140/1/012097/pdf

59. Liang S, Hapuarachchi HC, Rajarethinam J, Koo C, Tang CS, Chong CS, et al. Construction sites as an important driver of dengue transmission: Implications for disease control. BMC Infect Dis. 2018;18(382):1–10.

60. Eldeib A, Hammad S. Clinico-epidemiological features of dengue fever in Saudi Arabia. Asian Pac J Trop Med [Internet]. 2010;3(3):220–3. Available from: http://dx.doi.org/10.1016/S1995-7645(10)60013-2

61. FAKEEH M, ZAKI A. Virologic and serologic surveillance for dengue fever in Jeddah, Saudi Arabia, 1994-1999. Am J Trop Med Hyg. 2001;65(6):764–7.

62. Official Website Department of Occupational Safety and Health - Dengue [Internet]. Department of Occupational Safety and Health Malaysia. 2016 [cited 2019 Jun 22]. Available from: http://www.dosh.gov.my/index.php/en/occupational-health/1547-dengue

63. MLSD. Ministry of Labor and Social Development [Internet]. 2019 [cited 2019 Jul 3]. Available from: https://mlsd.gov.sa/en/node

64. El Seif [Internet]. 2018 [cited 2019 Aug 2]. Available from: http://www.el-seif.com.sa/careers.php?lang=0

65. Alturki Holding | Building Great Business [Internet]. 2019 [cited 2019 Aug 2]. Available from: http://alturkiholding.com/#

66. Mortada H. ANALYTICAL CONCEPTION OF SLUMS OF JEDDAH , SAUDI ARABIA. worldresearchlibrary. 2017;1–13.

67. Carabali M, Hernandez LM, Arauz MJ, Villar LA, Ridde V. Why are people with dengue dying? A scoping review of determinants for dengue mortality. BMC Infect Dis [Internet]. 2015;15(301):1–14. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26223700%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC4520151

68. Seidahmed OME, Lu D, Chong CS, Ng LC, Eltahir EAB. Patterns of Urban Housing Shape Dengue Distribution in Singapore at Neighborhood and Country Scales. GeoHealth. 2018;2(1):54–67.

69. Alghazali KA, Teoh B-T, Loong S-K, Sam S-S, Che-Mat-Seri N-A-A, Samsudin N-I, et al. Dengue Outbreak during Ongoing Civil War, Taiz, Yemen. Emerg Infect Dis [Internet]. 2019;25(7):1397–400. Available from: http://wwwnc.cdc.gov/eid/article/25/7/18-0046_article.htm

70. Saudi Arabia hosts 895,175 Yemeni, Syrian refugees as guests: KSRelief chief [Internet]. ARAB NEWS. 2017 [cited 2019 Aug 2]. Available from: http://www.arabnews.com/node/1095621/saudi-arabia

71. Al-Garadi MA. Epidemiological review of dengue fever in Yemen. Int J Adv Res. 2015;3(7):1578–84.

72. Securing the Saudi – Yemeni Border [Internet]. Saudi Research and Marketing UK Ltd; 2010 [cited 2019 Aug 2]. Available from: https://eng-archive.aawsat.com/theaawsat/features/securing-the-saudi-yemeni-border

73. UNHCR. Yemen Refugee Crisis: Aid, Statistics and News | USA for UNHCR [Internet]. 2018 [cited 2019 Jun 25]. Available from: https://www.unrefugees.org/emergencies/yemen/

74. Murugananthan K, Kandasamy M, Rajeshkannan N, Noordeen F. Demographic and clinical features of suspected dengue and dengue haemorrhagic fever in the Northern Province of Sri Lanka, a region afflicted by an internal conflict for more than 30 years-a retrospective analysis. Int J Infect Dis [Internet]. 2014;27:32–6.

Available from: http://dx.doi.org/10.1016/j.ijid.2014.04.014

75. Tantawichien T. Dengue fever and dengue haemorrhagic fever in adolescents and adults. Paediatr Int Child Health. 2012;32(S1):22–7.

76. Nunes PCG, Daumas RP, Sánchez-Arcila JC, Nogueira RMR, Horta MAP, Dos Santos FB. 30 years of fatal dengue cases in Brazil: A review. BMC Public Health. 2019;19(329):1–11.

77. Salje H, Lessler J, Endy TP, Curriero FC, Gibbons R V., Nisalak A, et al. Revealing the microscale spatial signature of dengue transmission and immunity in an urban population. Proc Natl Acad Sci. 2012;109(24):9535–8.

78. Zellweger RM, Cano J, Mangeas M, Taglioni F, Mercier A, Despinoy M, et al. Socioeconomic and environmental determinants of dengue transmission in an urban setting: An ecological study in Nouméa, New Caledonia. PLoS Negl Trop Dis. 2017;11(4):1–18.

79. Johansen IC, Carmo RL do, Alves LC, Dias Bueno MDC. Environmental and demographic determinants of dengue incidence in Brazil. Rev Salud Pública. 2018;20(3):346–53.

80. WHO | The human. WHO [Internet]. 2017 [cited 2019 Jun 28]; Available from: https://www.who.int/denguecontrol/human/en/

81. Anker M, Arima Y. Male-female differences in the number of reported incident dengue fever cases in six Asian countries. West Pacific Surveill response J [Internet]. 2011 Apr [cited 2019 Aug 2];2(2):17–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23908884

82. Stergiou-Kita M, Mansfield E, Bezo R, Colantonio A. Danger zone: Men, masculinity and occupational health and safety in high risk occupations. Saf Sci. 2015;1(80):213–20.

83. Gulliford M, Figueroa-Munoz J, Morgan M, Hughes D, Gibson B, Beech R, et al. What does "access to health care" mean? J Health Serv Res Policy [Internet]. 2002 Jul 23 [cited 2019 Jun 30];7(3):186–8. Available from: http://journals.sagepub.com/doi/10.1258/135581902760082517

84. Freitas DA de, Souza-Santos R, Wakimoto MD. Access to health care facilities of suspected dengue patients in Rio de Janeiro, Brazil. Cien Saude Colet. 2019;24(4):1507–16.

85. Jahan S, Al-Saigul AM. Primary health care research in Saudi Arabia: A quantitative analysis. Int J Health Sci (Qassim) [Internet]. 2017;11(2):9–15. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28539857%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC5426411

86. Almalki M, Fitzgerald G, Clark M. Health care system in Saudi Arabia: an overview. East Mediterr Heal J [Internet]. 2011;17(10):784–93. Available from: http://search.proquest.com/docview/905897303?accountid=44936

87. Walston S, Al-harbi Y, Al-omar B. The changing face of healthcare in Saudi Arabia. Ann Saudi Med. 2008;28(4):243–50.

88. Carabalí JM, Hendrickx D. Dengue and health care access: The role of social determinants of health in dengue surveillance in Colombia. Glob Health Promot. 2012;19(4):45–50.

89. Dinh PL, Tran PNH, Dang LNT, Quang VT. Economic report on the cost of dengue fever in Vietnam : case of a provincial hospital. Clin Outcomes Res. 2017;9:1–8.

90. Allen-Duck A, Robinson JC, Stewart MW. Healthcare Quality: A Concept Analysis. HHS Public Access. 2017;52(4):377–86.

91. Donabedian A. The quality of care. How can it be assessed? JAMA [Internet]. 1988 Sep 23 [cited 2019 Jul 5];260(12):1743–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/3045356

92. Lum LCS, Omar SFS, Ponnampalavanar SSLS, Tan LH, Sekaran SD, Kamarulzaman A. Cohorting dengue patients improves the quality of care and clinical outcome. PLoS Negl Trop Dis. 2015;9(6):1–10.

93. Al-Ahmadi H, Roland M. Quality of primary health care in Saudi Arabia: A comprehensive review. Int J Qual Heal Care. 2005;17(4):331–46.

94.   Almutairi KM, Moussa M. Systematic review of quality of care in Saudi Arabia: A forecast of a high quality health care. Saudi Med J. 2014;35(8):802–9.

95.   Aljuaid M, Mannan F, Chaudhry Z, Rawaf S, Majeed A. Quality of care in university hospitals in Saudi Arabia: A systematic review. BMJ Open. 2016;6(2):1–10.

96.   Palmer S, Torgerson DJ. Economic notes: definitions of efficiency. BMJ [Internet]. 1999;318(7191):1136. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10213735%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC1115526

97.   Lee J Miller and Wei Lu. These Are the Economies With the Most (and Least) Efficient Health Care Bloomberg [Internet]. 2018 [cited 2019 Jul 7]. Available from: https://www.bloomberg.com/news/articles/2018-09-19/u-s-near-bottom-of-health-index-hong-kong-and-singapore-at-top

98.   Carrasco LR, Lee LK, Lee VJ, Ooi EE, Shepard DS, Thein TL, et al. Economic impact of dengue illness and the cost-effectiveness of future vaccination programs in singapore. PLoS Negl Trop Dis. 2011;5(12):1–9.

99.   Babalola O. Consumers and Their Demand for Healthcare. J Heal Med Econ. 2018;3(1:6):1–3.

100.   Morreale M. How Does SES Have an Effect on Health Care Utilization? [Internet]. 1998 [cited 2019 Jul 8]. Available from: http://www.fhs.mcmaster.

101.   Casas I, Delmelle E. Landscapes of healthcare utilization during a dengue fever outbreak in an urban environment of Colombia. Env Monit Assess. 2019;191(279):1–15.

102.   Albert I, Ahmed M, Damrah I. Kingdom of Saudi Arabia Healthcare Overview 2018 [Internet]. 2018 [cited 2019 Aug 4]. Available from: https://www.colliers.com/-/media/files/emea/uae/case-studies/2018-overview/ksa-healthcare-overview-thepulse-8th-edition.pdf?la=en-gb

103.   WHO. WHO | Health policy [Internet]. WHO. World Health Organization; 2013 [cited 2019 Jul 10]. Available from: https://www.who.int/topics/health_policy/en/

104.   Young-soo S. Dengue Prevention and Control (2016). WHO Western Pacific Region publication; 2016. 48 p.

105.   Runge-Ranzinger S, Kroeger A, Olliaro P, McCall PJ, Sánchez Tejeda G, Lloyd LS, et al. Dengue Contingency Planning: From Research to Policy and Practice. PLoS Negl Trop Dis. 2016;10(9):1–16.

106.   MOH. Infectious Diseases - Dengue Fever [Internet]. MOH. 2018 [cited 2019 Jul 10]. Available from: https://www.moh.gov.sa/en/HealthAwareness/EducationalContent/Diseases/Infectious/Pages/DengueFever.aspx

107.   WHO | One Health. WHO [Internet]. 2017 [cited 2019 Aug 4]; Available from: https://www.who.int/features/qa/one-health/en/

108.   Rabinowitz PM, Pappaioanou M, Bardosh KL, Conti L. A planetary vision for one health. BMJ Glob Heal [Internet]. 2018 Oct 2 [cited 2019 Aug 4];3(5):e001137. Available from: http://gh.bmj.com/lookup/doi/10.1136/bmjgh-2018-001137

109.   Gubler DJ. The partnership for dengue control – A new global alliance for the prevention and control of dengue. Vaccine [Internet]. 2015;33(10):1233. Available from: http://dx.doi.org/10.1016/j.vaccine.2015.01.002

110.   Hapuarachchi HC, Koo C, Rajarethinam J, Chong CS, Lin C, Yap G, et al. Epidemic resurgence of dengue fever in Singapore in 2013-2014: A virological and entomological perspective. BMC Infect Dis [Internet]. 2016;16(1):1–13. Available from: http://dx.doi.org/10.1186/s12879-016-1606-z

111.   gov.sg | Weekly dengue cases in Singapore spike to highest in more than 3 years [Channel NewsAsia] [Internet]. 2019 [cited 2019 Aug 4]. Available from: https://www.gov.sg/news/content/channel-newsasia---weekly-dengue-cases-in-singapore-spike-to-highest-in-more-than-3-years

112.   Tapia-Conyer R, Méndez-Galván J, Burciaga-Zúñiga P. Community participation in the prevention and control of dengue: the patio limpio strategy in Mexico . Paediatr Int Child Health. 2012;32(sup1):10–3.

113.   Vanlerberghe V, Toledo ME, Rodríguez M, Gomez D, Baly A, Benitez JR, et al.

Community involvement in dengue vector control: Cluster randomised trial. BMJ. 2009;338(7709):1477–9.

114. NEA. NEA | Dengue Cases [Internet]. 2019 [cited 2019 Jul 16]. Available from: https://www.nea.gov.sg/dengue-zika/dengue/dengue-cases

115. Rosalina W, Rosli W. Positive impact of educational intervention on knowledge , attitude , and practice towards dengue among university students in Malaysia. J Public Health (Bangkok). 2018;1(1):1–11.

116. Ibrahim NK, Abalkhail B, Rady M. An educational programme on dengue fever prevention and control for females in Jeddah high schools. East Mediterr Heal J. 2009;15(5):1058–67.

117. Binsaeed AA, Sahli AA, Noureldin EM, Mohammed WS. Knowledge , Attitudes and Preventive Practices of Dengue Fever among Secondary School Students in Jazan , Saudi Arabia. Curr World Environ. 2015;10(3):747–57.

118. Usman HB, AlSahafi A, Abdulrashid O, Mandoura N, Al Sharif K, Ibrahim A, et al. Effect of Health Education on Dengue Fever: A Comparison of Knowledge, Attitude, and Practices in Public and Private High School Children of Jeddah. Cureus. 2018;10(12):e3809.

119. Alhazmi S, Khamis N, Abalkhail B, Muafaa S, Alturkstani A, Turkistani A, et al. Knowledge, attitudes, and practices relating to dengue fever among high school students in Makkah, Saudi Arabia. Int J Med Sci Public Heal [Internet]. 2016;5(5):930–7. Available from: http://www.scopemed.org/fulltextpdf.php?mno=218082

120. Wong LP, AbuBakar S. Health Beliefs and Practices Related to Dengue Fever: A Focus Group Study. PLoS Negl Trop Dis. 2013;7(7):e2310.

121. Ng SW, Lim SY, Rani M, Beth M, Mini M, Mary R. A study to determine the effectiveness of health education on knowledge of dengue fever and preventive measures among high school students in a selected private school , Malaysia. Int J Contemp Pediatr. 2016;3(2):553–8.

122. Ahmed MM. Original Article Clinical profile of dengue fever infection in King Abdul Aziz University Hospital Saudi Arabia. J Infect Dev Ctries. 2010;4(8):503–10.

123. Hoffmann T, Worrall L, Hoffmann T, Worrall L. Designing effective written health education materials : Considerations for health professionals. Disabil Rehabil. 2004;26(19):1166–73.

124. Wang SM, Sekaran SD. Early diagnosis of Dengue infection using a commercial Dengue Duo rapid test kit for the detection of NS1, IGM, and IGG. Am J Trop Med Hyg [Internet]. 2010 Sep [cited 2019 Jul 19];83(3):690–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20810840

125. Comprehensive Guidelines for Prevention and Control of Dengue and Dengue Haemorrhagic Fever [Internet]. 2011 [cited 2019 Jul 19]. Available from: http://apps.searo.who.int/pds_docs/B4751.pdf

126. Chaterji S, Allen JC, Chow A, Leo YS, Ooi EE. Evaluation of the NS1 rapid test and the WHO dengue classification schemes for use as bedside diagnosis of acute dengue fever in adults. Am J Trop Med Hyg. 2011;84(2):224–8.

127. Felix AC, Romano CM, De Campos Centrone C, Rodrigues CL, Villas-Boas L, Araújo ES, et al. Low sensitivity of NS1 protein tests evidenced during a dengue type 2 virus outbreak in Santos, Brazil, in 2010. Clin Vaccine Immunol. 2012;19(12):1972–6.

128. AlGhamdi S. Knowledge and practice of primary care physicians about preventive and clinical aspect of dengue fever in Jeddah city, 2014. Int J Med Sci Public Heal. 2015;4(7):991–6.

129. Swaminathan S, Khanna N. Dengue vaccine development: Global and Indian scenarios. Int J Infect Dis [Internet]. 2019;1–7. Available from: https://doi.org/10.1016/j.ijid.2019.01.029

130. Samuel M, Maoz D, Manrique P, Ward T, Runge-Ranzinger S, Toledo J, et al. Community effectiveness of indoor spraying as a dengue vector control method: A systematic review. PLoS Negl Trop Dis. 2017;11(8):1–13.

131. Review of current evidence on combining indoor residual spraying and long-lasting

insecticidal nets [Internet]. [cited 2019 Aug 5]. Available from: https://www.who.int/malaria/mpac/background-combining-irs-llins-mar2014.pdf

132. Lenhart A, Orelus N, Maskill R, Alexander N, Streit T, McCall PJ. Insecticide-treated bednets to control dengue vectors: Preliminary evidence from a controlled trial in Haiti. Trop Med Int Heal. 2008;13(1):56–67.

133. Friedrich MJ. Dengue Cases Decline After Release of Modified Mosquitoes. JAMA. 2018;320(15):1527.

134. CLARA RODRÍGUEZ FERNÁNDEZ. New Results Show GM Mosquitoes Keep Dengue and Zika at Bay in Brazil [Internet]. 2017 [cited 2019 Jul 17]. Available from: https://labiotech.eu/medical/oxitec-dengue-zika-brazil/

135. Samantha Jones, Tiffany Fox. New Study Reveals Public Resistance to Use of Genetically Engineered Mosquitoes for Disease Control [Internet]. 2017 [cited 2019 Jul 17]. Available from: https://ucsdnews.ucsd.edu/pressrelease/new-study-reveals-public-resistance-to-use-of-genetically-engineered

136. Lee KS, Lai YL, Lo S, Barkham T, Aw P, Ooi PL, et al. Dengue virus surveillance for early warning, Singapore. Emerg Infect Dis. 2010;16(5):847–9.

137. Yanagisawa N, Wada K, Spengler JD, Sanchez-Pina R. Health preparedness plan for dengue detection during the 2020 summer Olympic and Paralympic games in Tokyo. PLoS Negl Trop Dis. 2018;12(9):1–14.

Acknowledgement

I would first like to thank my thesis advisor and my academic tutor, as their door was always open, whenever I ran into a spot of trouble spot or had a question about my writing. They were consistently allowed this thesis to be my own work, and steered me in the right direction whenever they thought I needed it.

And I must express my very profound gratitude to my parents (Hmazah and Noor), to my siblings and to a special person Mr. Maurice van Houwelingen, for providing me with unfailing support and continuous encouragement throughout my study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

Zainab Alsharef

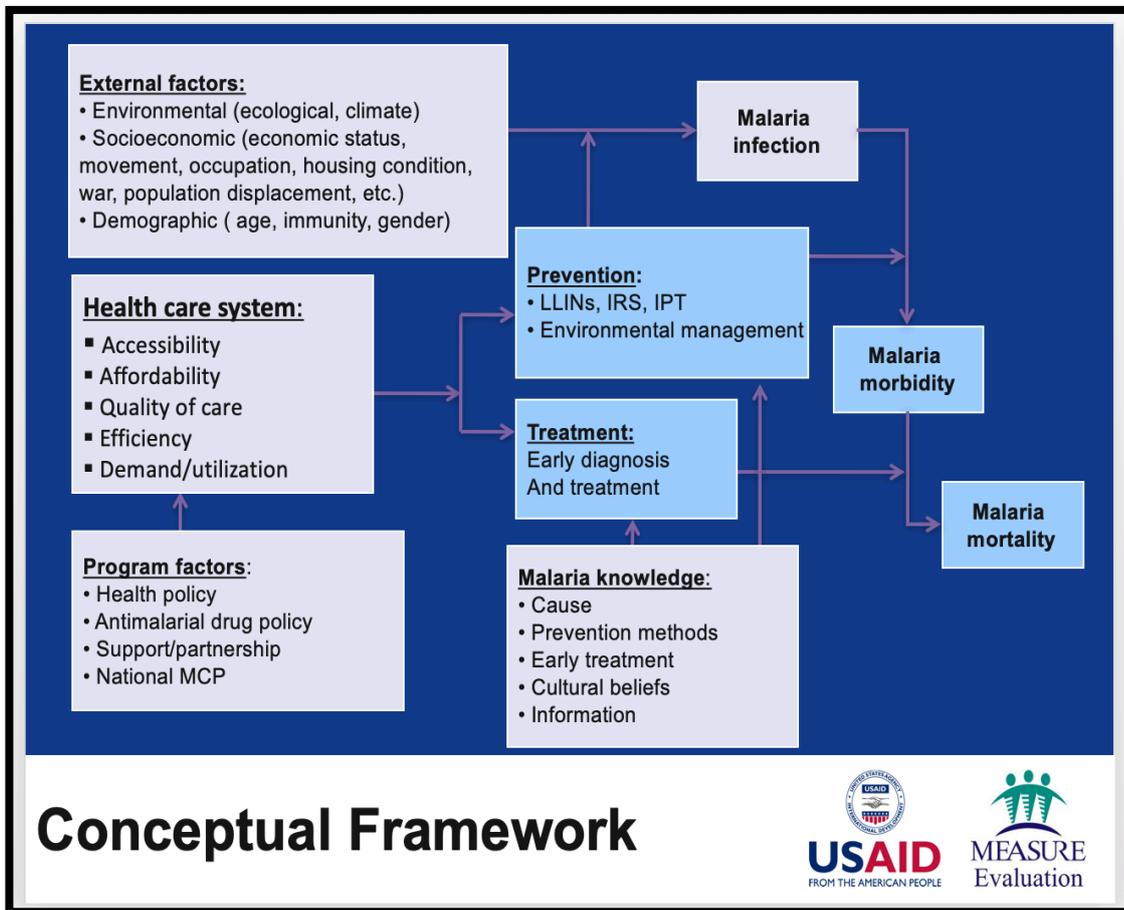Fig.6 Malaria Control Program framework (MCP),2016 (40)
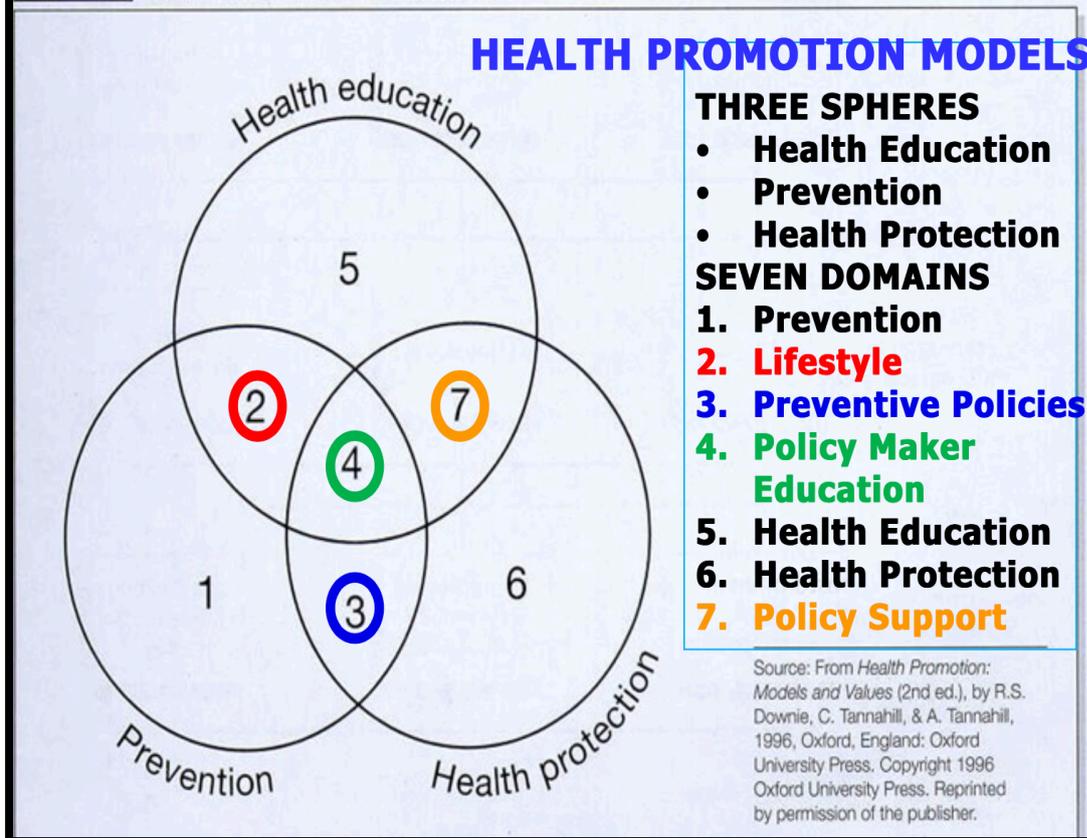
Fig.8 Health promotion triad spheres and domains,1996 (41)

Annex (2)

DF/ DHF	Grade	Signs and Symptoms	Laboratory
DF		Fever with two of the following: • Headache. • Retro-orbital pain. • Myalgia. • Arthtralgia/bone pain. • Rash. • Haemorrhagic manifestations. • **No evidence of plasma leakage.**	• Leucopenia (wbc ≤5000 cells/mm³). • Thrombocytopenia (Platelet count <150 000 cells/mm³). • Rising haematocrit (5% – 10%). • No evidence of plasma loss.
DHF	I	Fever and haemorrhagic manifestation (positive tourniquet test) and **evidence of plasma leakage**	Thrombocytopenia <100 000 cells/mm³; HCT rise ≥20%
DHF	II	As in Grade **I plus** spontaneous bleeding.	Thrombocytopenia <100 000 cells/mm³; HCT rise ≥20%.
DHF#	III	As in Grade **I or II plus** circulatory failure (weak pulse, narrow pulse pressure (≤20 mmHg), hypotension, restlessness).	Thrombocytopenia <100 000 cells/mm³; HCT rise ≥20%.
DHF#	IV	As in Grade **III** plus profound shock with undetectable BP and pulse	Thrombocytopenia < 100 000 cells/mm³; HCT rise ≥20%.

Table 4: WHO classification for dengue infection and severity grading,2011 (125)