



Geospatial Analysis of Communicable Diseases in Madurai District

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Date of Submission: 01-06-2024

Date of Acceptance: 10-06-2024

Abstract

The health care services cover a wider range of activities, like medical care, sanitation, immunization, counseling, health education, and social security rehabilitation etc. The spatial distribution of communicable diseases is a crucial aspect of public health surveillance, as it helps in identifying patterns and hotspots of disease outbreaks. This study focuses on the spatial distribution of communicable diseases in the Madurai district, located in the southern part of Tamil Nadu, India. The present study was collected from both primary and secondary sources. The important tool of analysis is the cartographic interpretation and analysis of data with the help of GIS maps. The primary survey conducted was based on the method of stratified random sampling and a total of 260 samples were collected. The random sampling technique is adopted to collect the primary data in all 13 blocks of Madurai district. The study will analyze data collected from health departments, hospitals, and other relevant source. The Z score statistical techniques are used to identify the statistical associations between diseases, socio-economic characteristics, and health care among the patients. It is important to identify certain areas and people which exhibit health disease and these must react to the responses of physical and social environments. The help of the Z score matrix, which is derived using a SPSS.10 statistical package. This information can be utilized by public health authorities to design targeted intervention strategies and allocate resources more effectively to control and prevent outbreaks.

Keywords: Diseases, GIS, PHC, Ranking techniques, SPSS, Z score

I. Introduction

Health services are primarily social services. It is a significant aspect of socioeconomic growth. PHC focuses on the comprehensive and interconnected facets of physical, mental, and social health and wellbeing while addressing the larger determinants of health. (<https://www.who.int/about/accountability/governance/constitution>). Communicable diseases, also known as infectious diseases, are illnesses caused by microorganisms such as bacteria, viruses, fungi, and parasites. These diseases can be transmitted from one individual to another, either directly through contact or indirectly through vectors like mosquitoes [1-4]. PHC addresses the broader determinants of health and focuses on the comprehensive and interrelated aspects of physical, mental, and social health and well being. [5]The latest trends in emerging infectious diseases, focusing on the impact of climate change, global travel, and antimicrobial resistance. It discusses the challenges in surveillance and control, highlighting the need for global cooperation. [6-9]. The recent advancements in vaccine technology, including mRNA vaccines, vector-based vaccines, and their efficacy against various communicable diseases. It also explores the role of public health policies in vaccine distribution. [10-14].The transmission of zoonotic diseases from animals to humans, the ecological and biological factors involved, and their impact on global health. It stresses the importance of the One Health approach in preventing outbreaks [15-18]. The concept of primary health care is



based on practical, scientifically sound and socially acceptable methods and technology. [19-22]. Dengue is a viral disease spread by Anes Mosquitoes. [23-27]. Dengue virus has expanded its range over the past several decades, following its principal vector, *Aedes aegypti*, back into regions from which it was eliminated in the mid-20th century and causing widespread epidemics of hemorrhagic fever. [28-32]. Infections of malaria and dengue occur when both of these mosquito-borne diseases occur simultaneously in an individual [33-36]. The virus that causes COVID-19 spreads mainly when an infected person is in close contact with another person [37-40]. Land use and land cover changes have significant health and environmental consequences at the local level [41-43]. The main objective of the present study is to

bring to light the health disease status in Madurai r district. In the health status of an area may better be understood through the analysis of Communicable diseases that are prevalent in that area.

Study Area

Madurai district is located in the central part of southern Tamilnadu of India. It is bordered by Dindigul and Tiruchirappalli district on the north, Sivagangai district on the east, Virudhunagar on the south and Theni on the west. [44] (Statistical hand book of Madurai district 2018). Madurai district is at 9° 30' and 10° 50' of North Latitude and from 77° 00' to 78° 30' of East longitude. (Fig 1). The total geographical area is 384,680 hectares.(Fig 2).

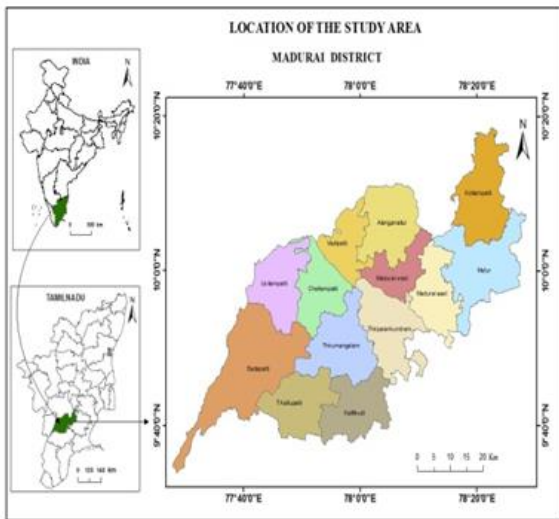


Fig 1 Location of the study area

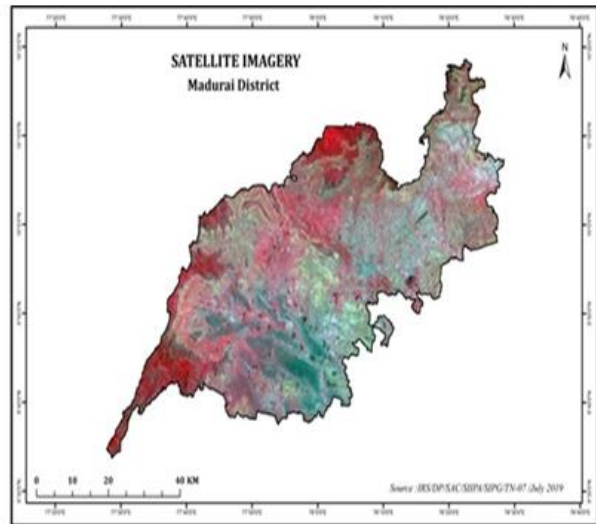


Fig 2 study area satellite Imagery

Objectives

To identify the communicable diseases in Madurai district.

To analyze the spatial distribution of communicable diseases in the Madurai district.

II. Methodology

Both primary and secondary sources of information have been collected with the objective of fulfilling the mentioned purposes. Cartographic interpretation and data analysis using GIS maps are the most significant analytical tools. 13 PHC centers in the study area were selected through a stratified random sample approach to serve as the sites for the primary data collection for this study.

Techniques used

The primary survey conducted was based on the method of stratified random sampling, and a total of 260 samples were collected. Apart from this, the Z-score statistical techniques are used to identify the statistical associations between diseases, socio-economic characteristics, and health-care variables among the patients. A Z-score is a statistical measurement of a score's relationship to the mean of a group of scores. A Z-score 0 means the score is the same as the mean. A Z-score is positive or negative, indicating whether it is above or below the mean and by how many standard deviations.

$$z = \frac{x - \mu}{\sigma}$$



The standard score (Z-score) technique, one of the methods of scale transmission, is used to synthesize the relationship between the sets of variables, and this enables the exposition of the total conditions of selected environmental variables with the disease incident rate. It is important to identify certain areas and people that exhibit health diseases, and these must react to the responses of their physical and social environments. The help of the Z score matrix, which is derived by using the SPSS.10 statistical package,.

Spatial distribution of Communicable disease in Madurai district:

Dengue:

Dengue is a viral disease spread by Andes Mosquitoes the Bites in Day time. A mosquito-borne viral disease occurring in tropical and subtropical areas. In the year of 2023-24 (Table 1). Dengue mostly affected blocks are Alanganalur(12.73%),T.Vadipatti (12.73%), Madurai East (10.91%),Madurai west (10.91%). Medium Level cases of blocks are Kottampatti (9.09%), Melur(9.09%),Kalikudi(7.27%),Thirumangalam(7.27%),Thiruparangundram(1.81),T.Kallupatti(3.64 %),Chellampatti(5.45%), Usilampatti (5.45%), Sedapatti(3.64%), are low level of dengue affected blocks in Madurai district.(Fig 3).

Table 1
COMMUNICABLE DISEASE IN MADURAI DISTRICT (PERCENTAGE) 2023-24

Name of the block	Dengue	Cholera	Malaria	Leptospriya	Chikengunya
Madurai East	10.91	12	12.5	11.32	5.45
Madurai West	10.91	10	12.5	11.32	1.83
Alanganalur	12.73	12	7.5	11.32	10.91
T. Vadipatti	12.73	12	7.5	11.32	12.73
Kottampatti	9.09	6	7.5	1.89	9.09
Melur	9.09	6	5	1.89	7.27
Thiruparangundram	1.82	2	2.5	7.55	9.09
Kallikudi	7.27	8	5	3.77	7.27
T. Kallupatti	3.64	4	5	5.66	9.09
Thirumangalam	7.27	8	5	9.43	7.27
Chellampatti	5.45	8	10	9.43	5.45
Usilampatti	5.45	8	10	7.55	10.91
Sedapatti	3.64	4	10	7.55	3.64
Total	100	100	100	100	100

Source: Compiled by author

Cholera disease

Cholera is a bacterial disease usually speeds through contaminated water. Cholera causes server diarrhea and dehydration. Cholera in the year to 2023-24 (Table 1) is highly affected blocks one Madurai east (12%), Alanganallur (12%), T.Vadipatti (12%), Madurai west (10%), Medium affected blocks one Kallikudi (8%), Thirumangalam(8%), Chellampatti (8%), Usilampatti (8%), Kottampatti(6%), Melur (6%), and low level of affected are T.Kallipatti(4%),

Sedapatti (4%), Thiruparangundram (2%), in Madurai district.(Fig 4).

Malaria

Malaria is a mosquito born disease. A disease caused by plasmodium parasite, transmitted by the bite of infected mosquitoes. In 2023-24 has highs concentrated of 10 to 13 percent cases in five blocks are (Table 1) Madurai east (12.5%), Maduari west (12.5%), Chellampatti (10%). Medium concentra=ted of 5-8 percent cases in 7 blocks are Melur (5%), Kallikudi (5%),



T.Kallupatti (5%), Thirumangalam (5%), Alanganallur (7.5%), T Vadipatti (7.5%), Kottampatti (7.5%), and low level of cases in the

blocks are Thiruparangundram (2.5%) in the Madurai district.(Fig 5).

Table 2
COMMUNICABLE DISEASE IN MADURAI DISTRICT 2023-24

Name of the block	Dengue	Cholera	Malaria	Leptospriya	Chikengunya	Rank
Madurai East	6	6	5	6	3	7
Madurai West	6	5	5	6	1	7
Alanganalur	7	6	3	6	6	6
T. Vadipatti	7	6	3	6	7	6
Kottampatti	5	3	3	1	5	4
Melur	5	3	2	1	4	4
Thiruparangundram	1	1	1	4	5	1
Kallikudi	4	4	2	2	4	2
T. Kallupatti	2	2	2	3	5	1
Thirumangalam	4	4	2	5	4	5
Chellampatti	3	4	4	5	3	3
Usilampatti	3	4	4	4	6	2
Sedapatti	2	2	4	4	2	1

Source: Compiled by author

Leptospriya

A bacterial disease spread through the urine of infected animals. Humans can get leptospirosis through direct contact with urine from infected animals or through water, soil, or food contaminated with their urine. It's most common in warm climates.(Table 1) Leptospriya disease in 2020-21 highly affected blocks are Madurai east (11.32%), Madurai west (11.32%), Alanganallur (11.32%), T.Vadipatti (11.32%). Medium affected blocks are Thiruparangundram (7.35%),

Thirumangalam (9.43%), Chellampatti (9.43%), Usilampatti (7.35%), Sedapatti (7.35%), T.Kallupatti (5.66%), and the low level of cases are Kallikudi (3.77%),, Kottampatti (1.89%), Melur 91.89%), in Madurai district.(Fig 6)

Chikengunya

A viral infection transmitted by mosquitoes. The common symptoms of infection are fever and joint pain. In the year of 2023-24 , More than cases found in T.Vadipatti (12.73%), Alanganalur

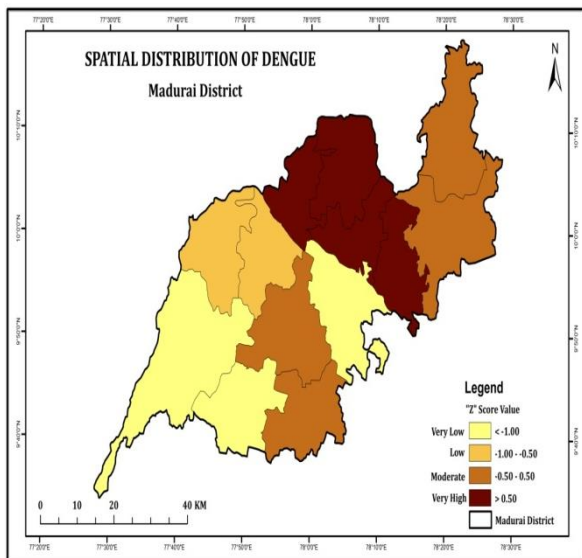


Fig 3. Spatial distribution of Dengue in Madurai district

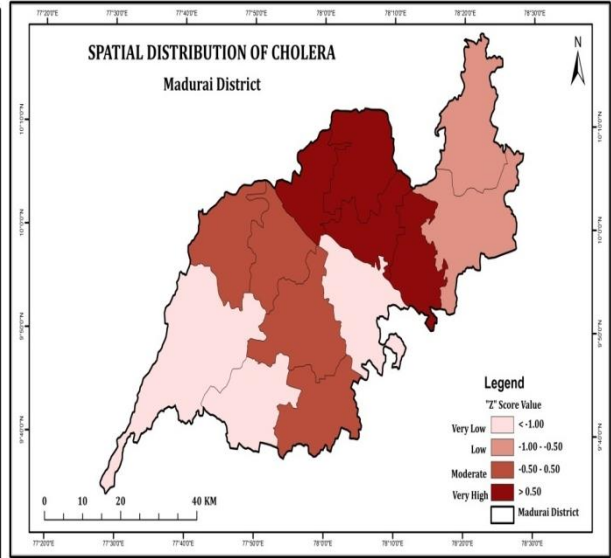


Fig 4. Spatial distribution of Cholera in Madurai district

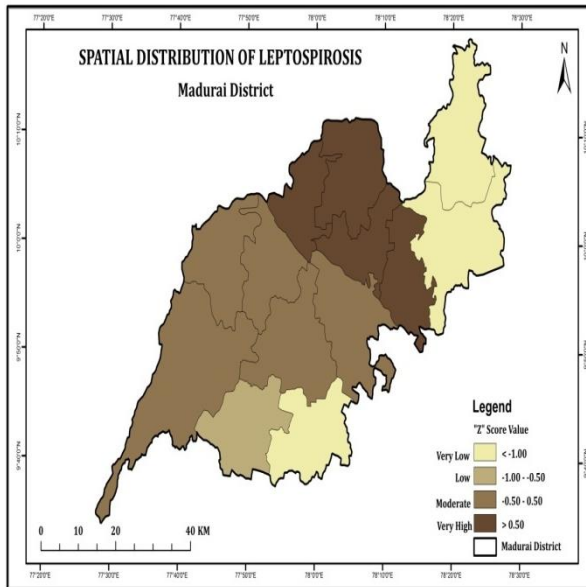


Fig 5. Spatial distribution of Leptospirosis in Madurai district

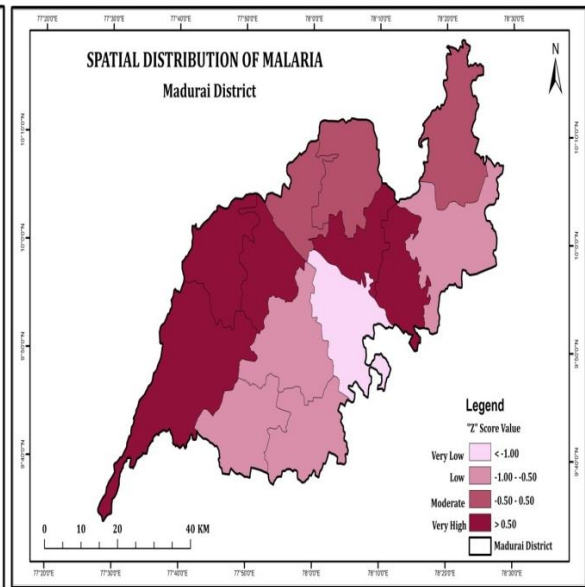


Fig 6. Spatial distribution of Malaria in Madurai district

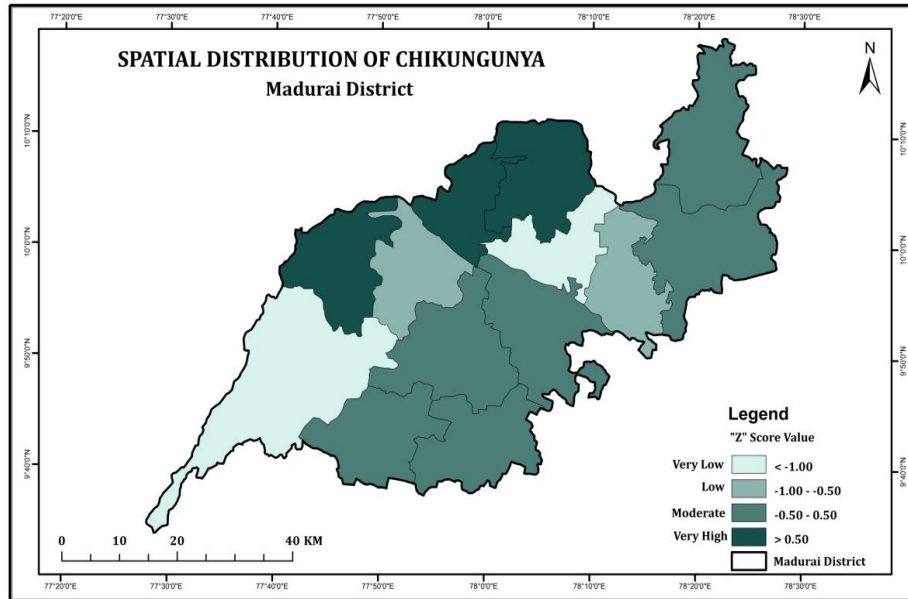


Fig 7. Spatial distribution of Chikungunya in Madurai district

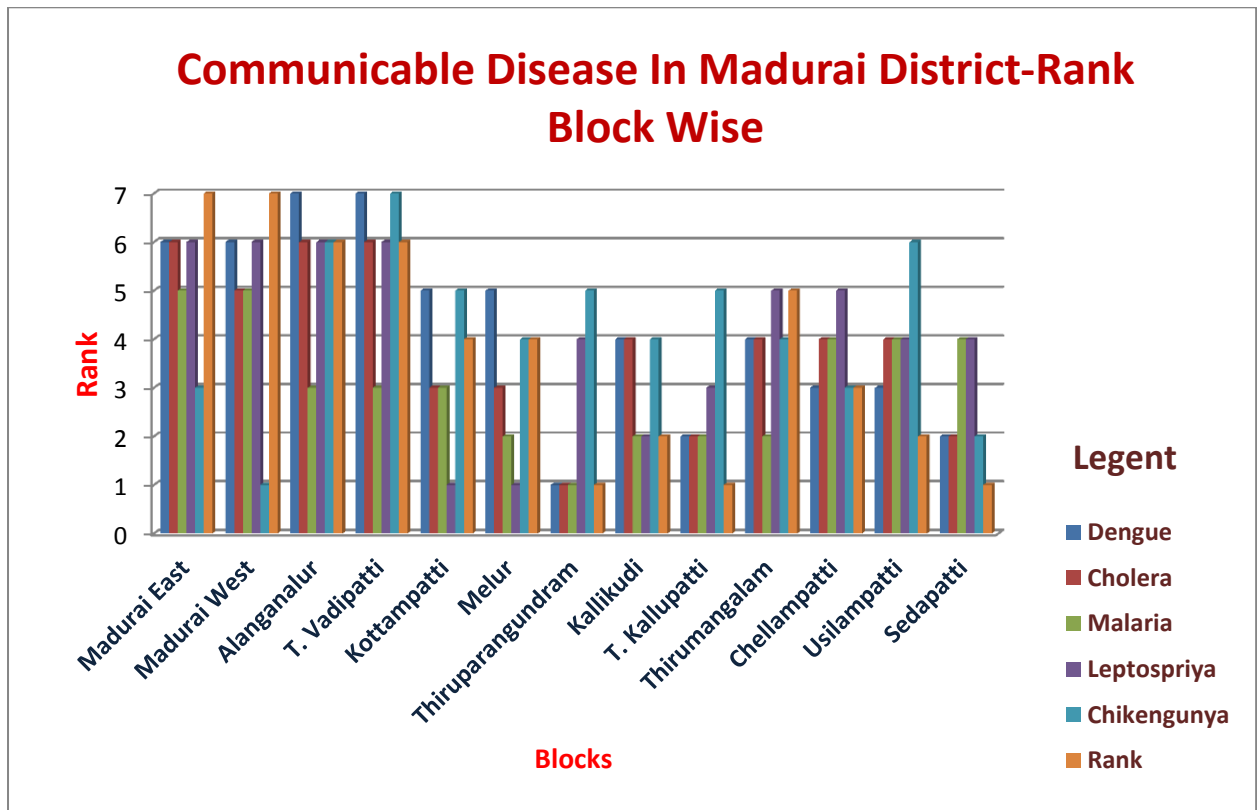


Fig 8. Communicable Disease In Madurai District-Rank Block Wise

(10.91%), Usilampatti (10.91%) and Medium level of cases are 7-9 percent in Kottampatti (9.09%), Melur (7.27).(Table 1)Low level of cases are below 6 percent Madurai east (5.45%), Madurai west (1.83%), chellampatti (5.45%), Sedapatti (3.64%) in Madurai district.(Fig 7).



Ranking of Communicable disease block wise in Madurai district:

Geography ranking is a technique. It used to identify the significance of the selected variable in its order of importance. The selected variable in its order of importance. A ranking is a relationship between a set of items such that, for any two items, the first is either “ranked higher than”, “ranked lower than” or “ranked equal to” the second.

The number of cases registered in each block of primary health care centre for each of the disease is calculated as percent to the total number of cases in each primary health centre, for the purpose of the interpretation the seven ranking disease are selected, in 13 blocks. The ranking disease thus arrived in (Table 2).

First ranking blocks are Thiruparangundram, T.kallupatti, sedapatti. Second rank Block is Kalikudi, Usilampatti. Third rank block is chellampatti and fourth ranking blocks are Kottampatti, Melur. The fifth ranking block is Thirumangalam. Sixth rank block is T.Vadipatti, Alanganallur. Finally seventh rank block is Madurai east, Madurai west. 1-4 ranking blocks are high level of cases and 4-6 ranking blocks are medium level of cases, above 6 ranking blocks is low level of cases. (Fig 8).

III. Conclusion

Communicable diseases, particularly vector-borne diseases such as dengue and malaria, are highly concentrated in urban areas of Madurai. This is primarily due to the high population density, inadequate waste management, and poor sanitation conditions that facilitate the breeding of disease vectors. There is also a noticeable spread of waterborne diseases like cholera in the peripheral and rural areas of the district. This can be attributed to limited access to clean water and sanitation facilities, coupled with lower health literacy rates in these regions. The incidence of certain diseases, such as dengue and chikungunya, shows a marked seasonal pattern, with peaks during and after the monsoon season. This correlates with the increase in stagnant water bodies, which serve as breeding grounds for mosquitoes. Socioeconomic factors play a significant role in the distribution of communicable diseases. Areas with lower socioeconomic status tend to report higher disease incidences due to overcrowding, lack of access to healthcare, and poor living conditions. The distribution also highlights disparities in healthcare access and response times. Urban areas benefit from better healthcare infrastructure and quicker response times, whereas rural areas often suffer

from delayed healthcare services and lack of immediate medical attention. Cases ranging into the ranges of 1-4, 4-6, and above 6 are classified as high, medium, and low, respectively. Ongoing public health interventions, including vaccination drives, public awareness campaigns, and improvements in water and sanitation infrastructure, have shown positive impacts in reducing the spread of communicable diseases. However, these efforts need to be consistently reinforced and expanded to achieve long-term control and prevention.

Acknowledgment

The authors gratefully acknowledge the RUSA-Phase (Rashtriya Uchchatar Shiksha Abiyan Ref MKU/RUSA/RP/Sanction Order/2020), Department of Earth and Atmospheric Science, Madurai Kamaraj University, Madurai, 625021, for their financial support in carrying out the study and publishing of this research work.

Declarations

Conflict of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical Approval Ethical approval not required.

Human or Animal rights This article does not contain any studies with human participants or animals performed by any of the authors, since only the secondary data collected at various centre's are used in the study.

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