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Preventive Machine learning Models for Suicides Rates

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Abstract— *Suicides have been the cause of 1.4% of deaths worldwide. The reasons can be not limited to stress due to work, home and family stress, and lockdown. According to the WHO research, 77% of suicides occurred in low and middle-income countries in 2019. This paper's primary goal is to figure out the risk factors, which are static and dynamic, in children, adolescents, and adults and find a methodology using machine learning. The authors have used Linear Regression, Logistic Regression, Support Vector Machine, and Random Forest for the machine learning model.*

Keywords— *Suicide, WHO, static risk factor, dynamic risk factor, machine learning, regression, logistic regression, support vector machine, random forest.*

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I. INTRODUCTION

Stress plays a crucial part in today's environment. Depression, hypertension are common adjectives in our current life. Because of this, Suicide has become a significant public health concern across the world, affecting individuals of all ages, with devastating and lasting effects on families and communities.

"In this literature review, we examine the risk factors associated with each stage of life (children/adolescents, adults, elderly), effective assessment strategies of suicide risk in each stage, and the management of individuals who are at risk for suicide."[1]

This review also discusses the methodology for making a model using Machine Learning, deep learning, regression, logistic regression, support vector machine, random forest, and other methods that could predict suicide rates by considering various risk factors. We have also discussed how different Machine Learning techniques can be used to create the model and explained the rules with the help of examples for using Machine Learning in creating a Prediction Model.

Risk factors are of two types: static risk and dynamic risk. Static risk factors are stable or fixed characteristics that confer a "baseline" risk of Suicide. Sex, race, age, sexual orientation, family history, and a personal history of suicide attempts are all factors to consider. Dynamic risk factors are the second type of risk factor. Emotional risk factors change throughout an individual's life; for example, current symptoms of mental illness, substance use, firearm possession, and access to healthcare are all examples of dynamic risk factors. "Although the current literature falls short of identifying specific factors that consistently and reliably distinguish low-risk individuals from high-risk individuals, general categories affecting vulnerability to suicide have been reported across age groups, including social stressors, recent loss, and emotional states."[1]

Risk Factors are also categorized depending on the age of a person. We can classify a person as a youth or adult depending upon their age. "Youth consists of children, adolescents, and students between the ages of 7-20 years old. This category is naturally most vulnerable to mental health problems during the years of adolescence"[2]. Movement, changes, and transitions characterize different risk factors from one state to another5 in several domains simultaneously. Young people, especially during adolescence, have to make concrete decisions in life, for example, schooling, living, peer group. Also, high expectations, sometimes too high, from significant relatives and peers contribute to tremendous stress to the youth. They, too, must address new challenges in terms of developing their own identity, enhancing self-esteem, gaining increased independence, taking on new responsibilities, forging new intimate relationships, and so on.

II. LITERATURE REVIEW

"In recent decades, several population-based psychological autopsy studies of suicides have been conducted, involving interviews with key informants and examination of records, as well as follow-up studies of people who have attempted suicide, revealing important information about the risk factors for youth suicide" [3]. "Everyone agrees that numerous factors can contribute to suicide and that ultimately each suicide is caused by a highly unique, dynamic and complex interplay of genetic, biological, psychological and social factors" [4].

"Nevertheless, it is possible to identify different types of factors that are associated with an increased risk of youth suicide, so this is highly relevant about prevention" [5].

"TABLE 1—Child (5–11 years old) & adolescent(11-20) dynamic risk factors."[1]

Current psychiatric disorder (depression most common)
Psychological symptoms:
• Insomnia
• Burdensomeness
• Impulsivity
• Active suicidal ideation
Access to lethal means:
• Firearms
• Means for suffocation
Interpersonal conflicts:
• Parents (children)
• Romantic Partner (adolescents)
Bullying:
• Victim
• Perpetrator
• Both
Legal trouble/incarceration (adolescents)
Current substance abuse
Social isolation

In adults, salient static risk factors include male gender, a personal history of suicide attempts, and a previously diagnosed mental illness. Concerning gender, men make fewer suicide attempts but employ more lethal means such as hanging and firearms. They are up to four times more prone to complete suicide than women, two to three times more likely to attempt suicide. "A prior diagnosis of mental illness increased the risk for suicide in part due to resultant functional, occupational, social, and economic impairments; thus, increased impairment is correlated with a higher risk for suicide."[1]

"Table 2—Adult (20–64 years old) static risk factors."[1]

Male gender
Caucasian
Personal history of:
• Suicide attempt(s)
• Any NSSI
○ Higher frequency and amount of NSSI
○ More NSSI methods used
• Any diagnosed psychiatric disorder
• Abuse (physical and/or sexual)
• Serving in the military
• Being arrested (more arrests increase risk)
Family history of suicide
Less than high school education

NSSI = Nonsuicidal self-injury.

Machine Learning program has the requirement of data as input and provides the processed data based on the training that has been given to it as the output. There are mainly three steps that are part of every machine learning algorithm :

1. Depiction: represent the knowledge discovered from mining the data.
2. Judgment: calculate the quality of the program.
3. Development: approach toward the generation of the program.

The majorly used method is supervised learning which is generally called inductive learning. The main focus of this method is to form f(x), where x is considered as data, and f(x) is considered as the output. In this method, rules are generated by observing several examples. For this purpose, the simplest and most generally used is the RULES algorithm which means the Ruel extraction system under which the user decides the no. of rules that have to be extracted. There are several variants of the RULES algorithm, which includes the following :

1. RULES-1: In this, the resulting rules are generated after the attributes are examined. It confirms that all the points are under one of the classes of the rules, and if any issues are left out, then a new class is allocated to them. This process repeats until all the classification is completed w.r.t all attributes.
2. RULES-2: This Rule performs the task faster than RULES-1, taking every unclassified attribute to generate rules. It takes one ungrouped element to create a rule, whereas prior takes all ungrouped features and generates rules.

3. RULES-3: It considers certain situations and restrictions for creating rules to be more intact than RULES-2. RULES-3 plus is an improved version of the prior one, which uses a search strategy in which H-measure is used to select the rules.
4. RULES-4: Here, the rules are created using the incremental algorithmic approach. Pham and Dimov developed RULES-4 in 1997**.** It is considered as an improved version of the RULES-3 plus, having the ability to store SHORT TERM MEMORY (STM) Storage, giving the users the flexibility to decide the storage size.
5. RULES-5: It takes the closest example and creates the rules, using continuous and discrete variables, both of which take less time to generate fewer rules with high accuracy. Also, the search time required to create rules is relatively short.
6. RULES-6: This rule was developed by Pham and Afify in 2005, which uses IF-THEN rules and continuous variables. It uses the INDUCE_ONE_RULE method for the creation of regulations.
7. RULES-7: This is an algorithm also known as RULe Extraction System Version 7, the improved version of RULE-6. The best rule is derived using the basic beam search technique, including MS (minimum no of instances).
8. RULES-8: This rule considers the incremental approach for creating rules by taking each time a condition.
All these variants have their specialty and benefits that are used for different purposes.
Linear Regression, Logistic Regression, Support Vector Machine, and Random Forest were used for the machine learning model. The steps for the implementation of the machine learning model are as follows :
1. Read the CSV file (data file).
2. Check whether the data is preprocessed or not.
3. If the data preprocessing is :
a. Not done, then give the data regression model.
b. Is done them convert the data to a suitable format
4. Perform linear regression
5. Perform logistic regression
6. Perform support vector machine
7. Perform random forest
8. Then compare all the results.

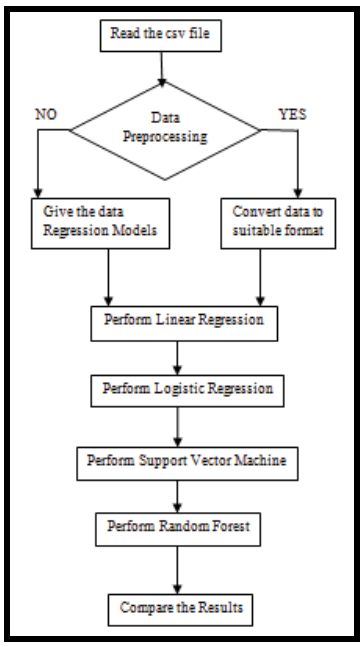


Fig: Steps of Machine Learning model

The data set considered for the model shows that the number of suicides in India has an alarming value. Most of them have no reason declared, and every day the issues like family problems and love failures.

III. FACTORS INFLUENCING SUICIDE RATES

The table below shows different attributes associated with an increase in suicide rates across the world in some way. We have analyzed each attribute and have given a concise review of how they affect suicide rates.

A. Health system and societal risk factors

Different cultural stigmas, taboo, shame, guilt, obscure suicidal behavior must every day be addressed proactively by supporting health systems and societies**.** Some of the vital risk determinants related to health systems and culture are presented and analyzed.

B. Barriers to accessing health care

Timely and effective health care is essential to decrease the risk of Suicide. Due to limited or complex resources, lower health literacy in countries worldwide is a barrier to easy access to health care.

C. Access to means

There is direct access to different means or resources in today's world, contributing to suicide rates. The availability of and choice for distinct means of Suicide also depend on terrestrial and social settings**.**

D. Inappropriate media reporting and social media use

Nowadays, inappropriate reporting of suicides by well-known people in different fields significantly impacts an individual and contributes to increasing the chances of Suicide, leading to an overall increase in suicide rates. By inappropriate reporting and easy access to 100 websites and accessibilities of social media can lead to new ideas/means/ways of Suicide.

E. The stigma associated with help-seeking behavior

Mental health is not yet given that much importance in many parts of the globe, which works as a Stigma against seeking help for suicidal behaviors. It can be a substantial barrier to people receiving the help they require. Humiliation can also disincline the colleagues and relatives of helpless people from presenting them with the assistance they might necessitate or even from recognizing their situation**.**

F. Community and relationship

Worldwide, various cultural, religious, legal, and historical factors have developed the state and perception of Suicide, identifying a wide range of community factors that influence suicide risk. A person's close relationships with family, close friends, and significant others can also impact suicidal behaviors.

G. Disaster, war, and conflict

Experiences of natural disasters, war, and civil conflict can increase the risk of Suicide because of the destructive impacts on cultural well-being, health, residence, profession, and financial soundness. Paradoxically, suicide rates may diminish during and instantly after a disaster or disagreement, but this varies between various people's societies. Overall, there appears to be no distinct direction in suicide fatality following natural catastrophes, as various studies show different patterns.

H. Strain of acculturation and dislocation

The strains of acculturation and disorder represent a strong suicide chance that impacts several vulnerable groups, including autochthonous peoples, asylum-seekers, refugees, somebody in confinement centers, internally displaced people, and newly arrived migrants. Suicide is prevalent among indigenous peoples, and all have measures of suicide that are much more distinguished than those of the rest of the population. This is incredibly genuine for young people, and young males in particular, who constitute some of the most vulnerable groups in the world. Territorial, political, and economic autonomy among indigenous groups often meddles, and indigenous culture and language are negated. These happenings can cause emotions of depression, loneliness, and discrimination, followed by bitterness and mistrust of state-affiliated social and healthcare assistance, primarily if these services are not delivered in culturally appropriate ways.

I. Differentiation

Differentiation against subgroups inside the society may be continuous, endemic, and systemic. This can lead to the vast event of stressful life circumstances such as lack of independence, denial, stigmatization, and brutality that may provoke suicidal behavior.

Some associations between discrimination and Suicide include:

- Somebody who is held or detained.
- Somebody who recognize themself as lesbian, gay, bisexual, transgender, and intersex,
- Somebody who are harmed by bullying, cyberbullying, and peer victimization**.**
- Refugees, asylum-seekers, and migrants.

J. Trauma or abuse

Trauma or abuse increases emotional stress and may trigger depression and suicidal behaviors in people already unprotected. Psychosocial stressors linked with Suicide can originate from various sorts of traumas, disciplinary or judicial trials, economic difficulties, educational or work-related obstacles, and bullying. The consequences of inopportune childhood factors lead to be interrelated and correlated and act cumulatively to enhance mental disorders and suicide risks.

K. Sense of loneliness and lack of social support

Loneliness occurs when a person feels detached from their closest social circle. A sense of isolation can often happen when a person has an adverse life situation or other psychological burden and fails to share this with someone close. Compounded with other factors, this can increase the risk for suicidal behavior. Suicidal

behavior often occurs due to personal psychological stress in a social context where sources of support are lacking and may reflect a more extended inadequacy of well-being and adherence. Convivial cohesion is the foundation that unites people at various societal levels – individuals, families, schools, neighborhoods, local communities, cultural groups, and society. People who share close, personal, and enduring relations and preferences typically have thought of purpose, assurance, and connectedness**.**

L. Relationship conflict, discord, or loss

Relationship conflict, discord, or loss can cause grief and situational psychological stress and are associated with an increased risk of Suicide. Violence, including intimate violence, against women, is a common phenomenon and is frequently committed by an intimate companion**.** Globally 35% of women have experienced physical or sexual violence by an intimate partner or sexual violence by a non-partner.

M. Individual risk factors

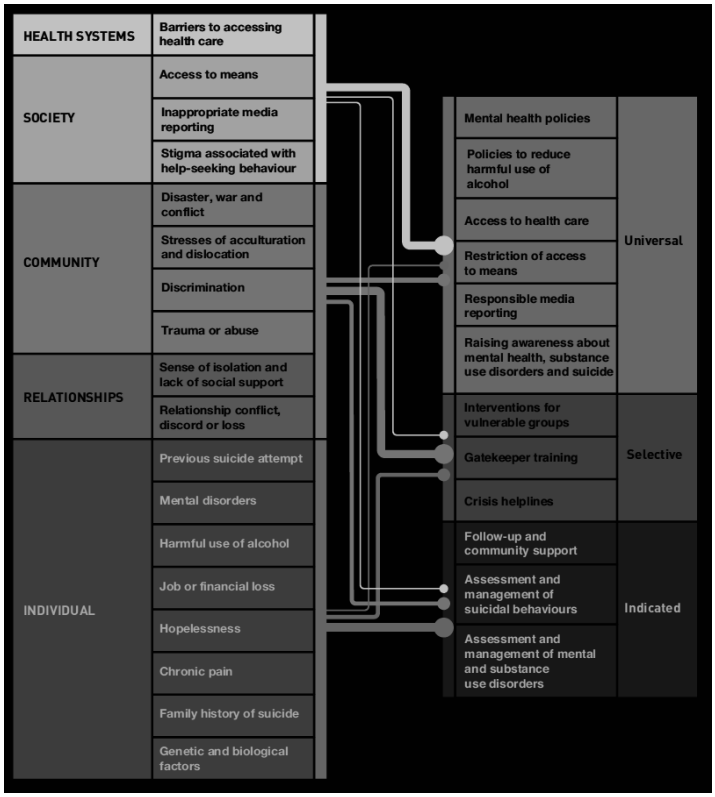
The risk of Suicide is often affected by individual vulnerability or resilience. Personal risk determinants correlate to the reasonableness of individuals developing suicidal behavior.

N. Previous suicide attempt

"By far, the strongest indicator for future suicide risk is one or more prior suicide attempts"[21]. Even one year after a suicide attempt, the danger of Suicide and premature death from other causes remains high.

O. Mental disorders

In high-income nations, mental disorders exist in up to 90% of individuals who die by Suicide. Among the ten without specific diagnoses, psychiatric symptoms resemble those of individuals who die by Suicide. However, mental disorders seem to be less widespread (around 60%) among those that die by Suicide in some Asian nations, as shown in studies from China and India. This risk factor should be addressed with some attention. Depression, substance use disorders, and antisocial habits are relatively standard, and most people affected by them will not display suicidal form. However, people dying by Suicide or attempting Suicide may have substantial psychiatric comorbidity. Suicide risk varies with the sort of disorder, and therefore the most familiar conditions related to the suicidal practice are depression and alcohol use disorders. The lifetime danger of Suicide is expected to be 4% in patients with mood disorders, 7% in alcohol dependence, 8% in people with manic depression, and 5% in schizophrenia. Significantly, the danger of suicidal behavior increases with comorbidity; individuals with quite one mental disturbance have substantially higher stakes.



P. Harmful use of alcohol and other substances

All substance use disorders increase the danger of Suicide. Liquor and other substance use complications are encountered in 25−50% of suicides, and suicide risk progresses if liquor or substance use is comorbid with other psychiatric complications. Of all departures from Suicide, 22% are often attributed to the utilization of alcohol,

which suggests that each fifth Suicide would not occur if alcohol were not consumed within the population**.** Addiction to other substances is additionally a risk factor for Suicide.

Q. Job or financial loss

Losing employment, home foreclosure, and financial uncertainty increases the danger of Suicide through comorbidity with other risk factors like depression, anxiety, violence, and, therefore, the harmful use of alcohol. Consequently, as they relate to non-public adversity through work or loss, economic recessions are often related to personal suicide risk.

R. Hopelessness

Hopelessness has often indicated suicidal risk when including mental disorders or prior suicide attempts as a cognitive aspect of psychological functioning. The three significant hopelessness aspects relate to a person's feelings about the longer term, loss of motive, and expectations.

S. Chronic illness

Chronic distress and sickness are major risk factors for suicidal behavior. Suicidal behavior is 2−3 times higher in those with chronic pain compared to the overall population. All illnesses related to pain, physical disability, neurodevelopmental impairment, and distress increase the danger of Suicide. These include cancer, diabetes, and HIV/AIDS.

T. Family history of Suicide

Suicide by a family or community member is often a very disruptive influence on a person's life. Losing someone on the brink of an individual is devastating for many people; additionally, to grief, the character of the death can cause stress, guilt, shame, anger, anxiety, and distress to relations**.** Family dynamics may vary, common support roots could also be disrupted, and stigma can hinder help-seeking and inhibit others from offering support. The Suicide of a beloved or loved one may lower the edge of Suicide for somebody grieving. For these reasons, those affected or bereaved by Suicide have an increased risk of Suicide or mental disturbance.

U. Genetic and biological factors

Genetic or developmental alterations in several neurobiological systems are related to suicidal behavior. For example, low serotonin levels are related to serious suicide attempts in mood disorders, schizophrenia, and personality disorders. A case history of Suicide may be a vital risk factor for Suicide and suicide attempt.

IV. CONCLUSION

The conclusion for this paper on Preventive Prediction & Analysis for Global Suicide Rate using Personality Prediction is that there are two types of risk factors. Static risk factors which are stable or fixed characteristics grant a "baseline" risk of Suicide. Factors like sex, race, age, sexual orientation, family history, and personal history are considered. The second type of risk factor is dynamic risk factors which change throughout life. Examples include current symptoms of mental illness, substance use, firearm possession, and access to healthcare. The methodology consists of the usage of machine learning models primarily. The immensely used method is supervised learning which is generally called inductive learning. For the same, the RULES algorithm is most popularly used, which means the Rule extraction system, which has been discussed and explained in this paper. The authors have used models such as Linear Regression, Logistic Regression, Support Vector Machine, and Random Forest.

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