Juvenile's Delinquent Behavior, Risk Factors, and Quantitative Assessment Approach: A Systematic Review

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Abstract

Background: Not only in India but also worldwide, criminal activity has dramatically increasing day by day among youth, and it must be addressed properly to maintain a healthy society. This review is focused on risk factors and quantitative approach to determine delinquent behaviors of juveniles. **Materials and Methods:** A total of 15 research articles were identified through Google search as per inclusion and exclusion criteria, which were based on machine learning (ML) and statistical models to assess the delinquent behavior and risk factors of juveniles. **Results:** The result found ML is a new route for detecting delinquent behavioral patterns. However, statistical methods have used commonly as the quantitative approach for assessing delinquent behaviors and risk factors among juveniles. **Conclusions:** In the current scenario, ML is a new approach of computer-assisted techniques have potentiality to predict values of behavioral, psychological/mental, and associated risk factors for early diagnosis in teenagers in short of times, to prevent unwanted, maladaptive behaviors, and to provide appropriate intervention and build a safe peaceful society.

Keywords: Delinquent behavior, juvenile-delinquency, machine learning, risk-factors

Introduction

Juvenile delinquency is a habit of committing criminal offenses by an adolescent or young person who has not attained 18 years of age and can be held liable for his/her criminal acts. Clinically, it is described as persistent manners of antisocial behavior or conduct by a child/adolescent repeatedly denies following social rules and commits violent aggressive acts against the law and socially unacceptable. The word delinquency is derived from the Latin word "delinquere" which described as "de" means "away" and "linquere" as "to leaveor to abandon." Minors who are involved in any kind of offense such as violence, gambling, sexual offenses, rape, bullying, stealing, burglary, murder, and other kinds of anti-social behaviors are known as juvenile delinquents. Santrock (2002) defined "an adolescent who breaks the law or engages in any criminal behavior which is considered as illegal is called juvenile delinquent."[1] In India, Juvenile Justice (J. J.-Care and protection of Children) Act of 2000 stated that "an individual whether a boy/girl, who is under 18 years of age and has committed an offense, referred or convicted by the juvenile court have considered a juvenile delinquent."

Prevalence Rate: Juvenile Delinquency in India

According to the National Crime Records Bureau (India, 2019), statistical data of crimes in India show that overall, 38,685 juveniles were placed under arrest in 32,235 cases, among 35,214 juveniles were taken into custody under cases of IPC and 3471 juveniles were arrested under cases of special and local laws (SLL) during 2019. About 75.2% of the total convicted juveniles (29,084 out of 38,685) were apprehended under both IPC and SLL belonging to the age group 16–18 years. In 2019, 32,235 juvenile cases involving and recorded, indicating a slight increment of 2.0% over 2018 (31,591 cases). The rate of crime also indicates a slight increase from 7.1 (2018) to 7.2 (2019).[2] The total registered cases against juvenile delinquents are calculated as crime incidence rate per one Lakh population as shown in Figure 1.

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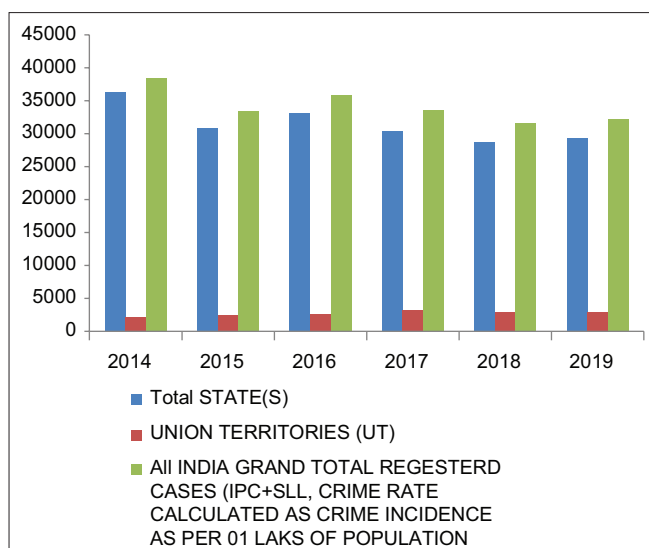**Website:**
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Figure 1: The graphical view of registered cases against Juveniles in conflict with law under Indian penal code and special and local laws crimes during 2014–2019 of all the State (s) and union territories of India Sources: Crime in India National (2014-2019), National Crime Records Bureau (NCRB), Ministry of Home Affairs, 2019

Risk-Factors Affecting Delinquent Behavior

Studies identify that multiple risk factors are responsible for delinquent behavior categorized as individual, parental, family, community, society, schools/educational, financial, mental as well as psychological factors of the individual and the family shown in Table 1. Adolescents involve themselves in various anti-social activities to fulfill their basic needs. Basically, "delinquency" is just a recreational activity for earning money. These risk factors differ from person to person during the early childhood period and very crucial because children, who are involved in any kind of deviant activity at an early stage, have a higher chance to adopt delinquent tendencies chronically.[33]

Juvenile delinquency is caused by a wide range of factors, such as conflicts in the family, lack of proper family control, residential environmental effects, and movie influence, along with other factors are responsible for delinquent behavior.[3] Family and environmental factors, namely restrictive behaviors, improper supervision, negligence, criminal activities of parents, improper motivation by peers, fear of peer rejection, poverty, illiteracy, poor educational performance at school, lack of moral education may turn the individual personality into delinquents. Moreover, in the environment, deteriorated neighborhood, direct exposure to violence/fighting (or exposure to violence through media), violence-based movies are considered major risk factors.[4] In India, a higher level of permissive parenting in low-income families had so many family members and due to economic conditions, the adolescents had pressure to search various income sources to sustain the family, and it has affected parental behavior toward adolescents.[5] The children who belong to the lower middle-socio-economical class and are rejected by society showed more aggressive behavior.[6]

Juvenile gang members exhibit significantly higher rates of mental health issues such as conduct disorders, attention-deficit-hyperactivity-disorders, antisocial personality disorder, posttraumatic-stress-disorders, and anxiety disorders.[7] As well as the intellectual level of young offenders is significantly different from nonoffenders. Emotional problems on adolescents are related to delinquent behavior and impulsivity directly associated with antisocial behavior among adolescents.[8] Poor self-control of adolescents involved them in substance use, affected harmfully, and increased involvements in anti-social activities.[9] Nonviolent people, who not involved in any gang, are less likely to utilize mental-health services, having lower levels of psychiatric morbidity, namely antisocial personality disorders, psychosis, and anxiety disorders, when compared with the group of violent offenders.[10]

Machine Learning: A New Quantitative Evaluation Approach

Machine learning (ML) is belonging to the multidisciplinary field that includes programming, math, and statistics, and as a new and dynamic field that necessitates more study. It is a branch of computer science that emerged through pattern recognition and computational learning theory of artificial intelligence. ML is exploring researches and development of algorithms that can learn and genera tea prediction besides a given set of data through the computer. It is a scope for the study that gives computers the capability to learn without being principally programmed.[11] Tom M. Mitchell explained ML as "a computer-based program to learn from action of "E" concerning any task of 'T's, and some performance evaluates "P," if its performance on "T," as assessed by "P," improves with action of E."[12] The goal of ML is to mimic human learning in computers.[13] Humans learn from their experiences and ML methods learn from data. The user provides a portion of a dataset designated to train by the algorithm. The algorithm creates a model based on the relationships among variables in the dataset, and the remaining dataset is used to validate the ML model. In simple words, ML approach is for risk indicator is meant to magnify the potential of current knowledge.[15] ML sits at the common frontier of many academic fields, including statistics, mathematics, computer science, and engineering.[14,17] ML models principally categorized into three categories, namely supervised, unsupervised, and reinforcement based on their task which they are attempting to accomplish. Supervised learning is relying on a training set where some characteristics of data are known, typically labels or classes, and target to find out the universal rule that maps inputs to outputs. Unsupervised learning has no design to give to the learning algorithm, balance itself to find out the patterns through inputs. In reinforcement, interaction with a dynamic environment happens during which a particular target such as driving a vehicle is performed without a driver principally involved in any activities, namely comparison. In numerous studies, pattern classification approaches based on ML algorithms are used to forecast human beings into various categories by maximizing the distance

Table 1: Developmental phases, risk-factors and developing delinquent behaviours of the child		
Developmental phase	**Risk-factors**	**Delinquent behavior**
During pregnancy to infancy period (initial phase)	The child	Complications during pregnancy and delivery of the child; exposure to neurotoxins or any early childhood serious diseases after birth; difficult temperament; impulsivity/hyperactivity; poor attention/concentration; below intellectual ability; male gender
	Family	Alcohol/any substance/drug/smoking by mother during pregnancy; teenage mother; parents poor education; maternal clinical depression; parent's involvement in drugs/substance abuse and antisocial/criminal activities; poor parent-child communication; poor socioeconomical conditions; serious marital conflicts; large family size
Toddler phase	Child	Aggressive/impulsive/disruptive behavior; persistent lying; attention seeking/risk-taking behavior; lack of guilt/empathy
	Family	Harsh/abusive/erratic discipline in the family or member's behaviors; lack of supervision/neglect/maltreatment; parental separation with child
	Community	Violence television shows; violent/abusive neighbors
Middle childhood period	Child	Disruptive behaviors; involving in criminal activities like stealing, pocketing, etc.,; early-onset of substance abusing and or sexual activities or as victims of early sexual and physical abuses; mood swings as high or low (manic/depressive); withdrawal behavior; positive attitude towards disruptive behaviors; exposure and victimization to any violence or abusive acts; hyperactivity, poor attention and concentration, restlessness, and/or risk-taking behaviors; violent behavior; involvement of antisocial activities; favorable beliefs and attitude of the individual to deviant/antisocial behavior
	Family	Lack of parental supervision; parental conflict; deprivation of basic need in the family
	School	Poor academic performance; negative attitude towards schools; lack of supervision by teachers and school staffs; truancy; poor organizational and management functioning of the school
	Peer groups	Rejection by peers; association with gang members or deviant peers and siblings; sibling's involvement in criminal activities; Peer's involvement in criminal activities; beliefs and attitude of peers to deviant/antisocial behavior
	Community	Residence in a disorganized/disadvantaged neighborhood; availability of arms/weapons; availability of drugs/substances; poverty/poor neighborhood; neighbor's involvements in criminal acts
Adolescent period	Adolescents	Psychological conditions - emotional, cognitive and intellectual ability, personality; physical disabilities; involvement in any drug or substance dealing activities; carrying arms or weapons; belief and attitude of the individual to deviant/antisocial behavior
	Family	Poor family management; low levels of parental supervision; family conflict or poor bonding of family members; parental involvement in any antisocial or criminal activities; child misbehave or maltreatment; parental separation with a child; socioeconomical condition of family and members
	School	School dropout; frequent school transitions; low attachment with teachers, school staffs, and mates
	Peer groups	Involving in a gang; peer groups engaged in criminal acts; peer's beliefs and attitude to antisocial behavior
	Community	Community and neighborhood disorganization; poverty; drugs, alcohol, etc., substances availability; neighborhood involvement in criminal acts; exposure to racial and violent prejudice and stigmas

among data groups. ML generally refers to all actions that train a computer algorithm to determine a complicated pattern of data that is conceivable used for forecast category of membership into a new theme (e.g., individual vs. controls).[32]

Rational of the Study

In the last decade, various researchers have been attracted to the use of quantitative computer-based techniques for analyzing various psychological and clinical aspects, which have greatly contributed to the area of modern psychology. In this analysis, most of the works are devoted to the use of various quantitative analysis techniques, namely ML and statistical methods which has utilized by the researchers for evaluating various risk and protective factors of juveniles. Henceforth, studies on the application of the ML model for risk-assessment of delinquent behavior on juveniles are limited as compared to other techniques, namely logistic regression. Hence, this review paper may explore the utilization of ML to get an easy and quick assessment on juveniles and helpful for future studies. It may help to determine the most significant risk

factors and establishment of a successful treatment program that prevents juveniles from delinquent activities and stops them from recidivism.

In this review, all these studies carried out which has used various quantitative techniques to detected juvenile delinquency with specially emphasis on ML and statistical approaches. The review is organized into four sections follows as: Section-I gives an overview of juvenile delinquency, prevalence rates in India, and various behavioral risk factors during the developmental period. It also provides general information about ML as a new approach and their application. Section-II included information about the methodology of the present review. Section-III explores the results and discusses which explore the ML and statistical methods for detecting juvenile behaviors and Section-IV concludes the extant research of the present review and the implications for future work.

Methodology

This review paper aim is to find the various quantitative techniques (computer-assisted techniques) ML and statistical

approaches which have been used for assessing/predicting delinquent behaviors, traits, and risk factors among juveniles.

Sources of information

For this review article, a total of 15 research articles were identified and selected through Google-scholar, Web of Science, Academia, PubMed, and Research-Gate, using the keywords, namely juvenile-delinquency, ML, Risk-factors, and delinquent-behavior. All relevant studies were selected for review of the quantitative approaches for identifying delinquent behavior and risk factors of adolescents and the preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram for articles search process as shown in Figure 2.[34]

Inclusion criteria

Research studies published since 2011–2019, case studies, empirical, quantitative, qualitative, and cross-sectional studies published in English were included, which used ML and statistical models to analyze behaviors, risk and associated factors among juveniles.

Exclusion criteria

Protocol, dissertations, prototype studies, and studies which published in other languages were excluded.

Results

Studies on machine learning and statistical methods among juvenile delinquency

In this review, we performed a rigorous search of the literature to provide a narrative description of the various quantitative computer-based approaches which are applicable to assess and identify the delinquent behaviors and risk factors on juveniles. Initially, the search identified 150 articles through various databases, search outcomes show in the PRISMA flow diagram [Figure 2]. One hundred and thirty-five articles were removed by screening through the title, text, removal of duplicate articles and based on inclusion and exclusion criteria, we identified 15 research articles in full text and these selected articles comprising through expert opinions. The findings of these articles tabulated the diverse approaches on the current state of knowledge about assessment of early diagnosis of delinquent behaviors and risk factors and tried to provide a summary which based on computer-based quantitative analysis [Table 2].

Discussion

In this systematic review, we performed a rigorous search of the literature to provide a narrative picture of various methods used to identify juveniles' behaviors. We identified 15 articles, with the objective to analyze the application of ML and other quantitative approaches to assess various delinquent behaviors and risk factors of juveniles. The studies revealed ML is a new quantitative method to identify the risk factors and delinquent behavior henceforth; there very few studies are conducted. In this study, we tried to provide a summary of selected articles on the current state of knowledge about quantitative analysis for assessment of delinquent behaviors of juveniles and there only few articles have used ML as quantitative analysis. The City Social Welfare Development Office of Butuan, Philippines, used a dataset to create predictive models for analyzing the
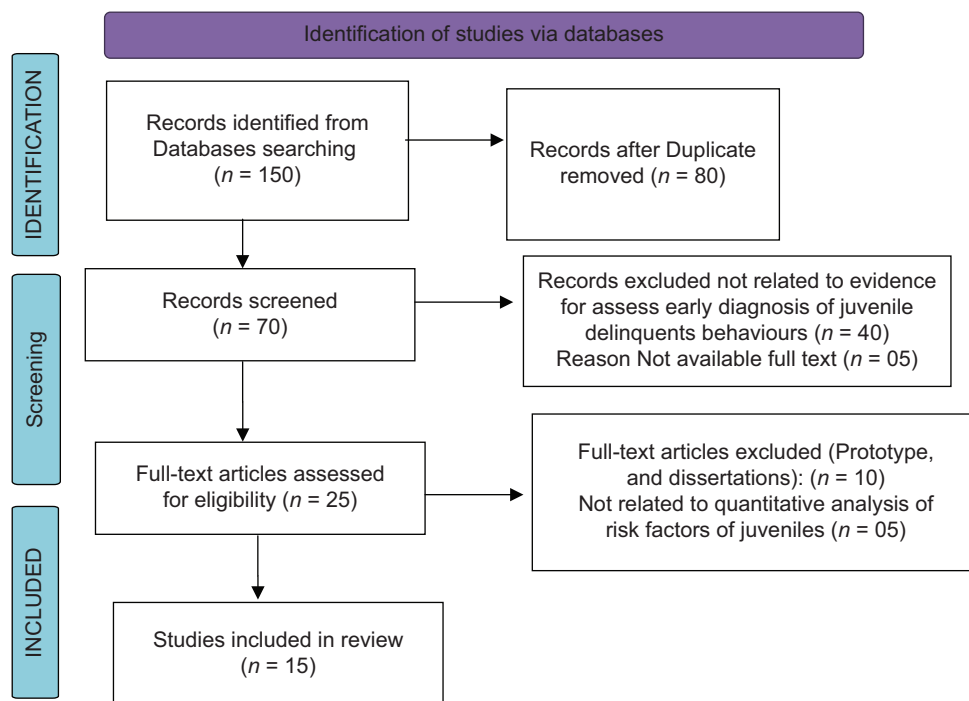

Figure 2: Preferred reporting items for systematic reviews and meta-analyses flow diagram for search outcomes of quantitative assessment of juvenile delinquent behaviors

Table 2: Summary table of relevant studies which used quantitative approach to detect delinquent behaviors and risk factors among juvenile behaviors

Author's name and year	Samples and sources	Aims/objectives	Model/methods for analyzing result	Findings of the study
Castro and Hernandez, 2019[16]	City Social Welfare Development Office, Butuan, Philippines, A total sample 360 children (177 chidren at risk, or have experience maltreatment and 183 children in conflict with law)	To develop a predictive model to analyze the children in conflict with law, and at-risk as well as compel the preventive options	Decision tree, Naive Bayes model, GLMs and logistic regression	Large numbers of children from 12–17 years are victims of maltreatment, and adolescents from 15–17 years are committed to severe criminal activities
Kim *et al.* (2019)[18]	Across various jurisdictions from Florida, New York, Oregon, Pennsylvania, and Virginia. A total of 8000 sexually offending juveniles, from 2009 to 2013	The study examined the present practice and policy for the assessment, treatment, and intervention of sexually offender delinquents	Traditional regression and ML algorithms	Criminal history, sexual offending experiences, delinquent peers are the most important risk factors. Some influential factors viz., school performance, peer connection; regretful feelings, impulsiveness, mental health, and substance abuse are theimportant predictive factors of sexual offenders for recidivism
Sumalatha and Santhi, 2018[31]	Juvenile delinquents	To establish a model for enhancing the efficiency of the Bayes algorithm classification for detecting juvenile affliction depends on paternity behavior and usage of digital gadgets. A model consisting of three phases' viz., ranking prototype, PEH model, and CAPM	Naive Bayes probabilistic model	Juvenile affliction is highly dependent upon parental behavior and influence by digital gadgets
Rokven *et al.* 2018[19]	12–17 years, Dutch juveniles	For comparison among four groups - Online delinquents, offline delinquents, nondelinquents, and both online and offline delinquents	Multinominal logistic regression	Juveniles who had a history of offline and online offenses belong to the high-risk profiles
Meldrum *et al.* 2015[20]	Multi-city cohort research study among adolescents, from birth to 15 years of age. A total number of 825 adolescents; 50% females; 82% white non-Hispanic, 59% two-parent or nuclear family	To measure the connection between sleep and delinquency	Regression model	Delinquency is indirectly related to sleep loss where poor self-control plays the role of catalyst
Castellana *et al.* 2014[21]	39 young offenders who did not have any previous mental problems, and 32 nonoffenders' young people with similar SES	To assess differences in psychopathic behavior between youths of offending and nonoffending people with the same SES	ANCOVA	The requirement of a wide variety of interventions including SES factors to control juvenile delinquency
DeLisi *et al.* 2013[22]	227 Juvenile delinquents (male and female), from nonprofitable juvenile residential facilities, western Pennsylvania	To find the correlation between violent video games and violence among youth	Negative binominal regression	Violent video games directly associated with anti-sociality, and multiple correlates viz., psychopathology
Fernández-Suárez *et al.* 2016[23]	A total of 218 juvenile male offenders and 46 females who arrested under a judicial penal code in Asturias (Spain) in the year 2012	Find the connection between school dropout with multiple causes' viz., individual and family factors	Multivariate logistic regression	School dropout has higher irresponsibility, illegal alcohol, and drugabuse, inadequate parental supervision, as compared to nondropout individuals
Margari *et al.* 2015[24]	135 juvenile offenders (male-female both), age range 14–18 years, adjudicated by the juvenile court of Puglia	To find out the impact of multiple predictor variables as academic performance and peer factors on conduct problem	Multiple regression	Educational achievements problems in 52% juvenile; 34% had a history of psychiatric problems in the family. 60% of juvenile delinquents involved in property-related crime, 54% were involved in drug and substance abuse-related activities; these factors affecting severely students academic achievements
Wu, 2015[25]	A total of 2690 secondary school students	To find out the school life based on academic performance, delinquency,	Multidimensional Scaling model	Dynamic cognitive mechanisms were utilized in which individual's measure and weigh their self as

Contd...

Table 2: Contd...

Author's name and year	Samples and sources	Aims/objectives	Model/methods for analyzing result	Findings of the study
		social, and financial factors to assess the behavioral similarity among adolescents		well as other person's position
Brunelle *et al.* 2014[26]	726 youth, enrolled in the addiction service center atQuebec City, from March 1999 to 2003.	To examine the time of youth's request for addiction services in the addiction rehabilitation center	MANCOVA	History of sexual abuse is one of the strongest factors connected with psychotropic substance-using severity
Gordon *et al.* 2014[27]	600 gang and nongang members, Pittsburgh Youth Study data	Involvement in serious delinquent behavior viz., drug business, serious violent and burglary acts, around 1990	Multiple logit model	Gang members having a high level of delinquent behavior were mainly involved in the drug business, serious theft, and violence as compared to nongang-members
Parks, 2013[28]	*n*=4389, data used from the national longitudinal study of adolescent health	To find out the variations among adolescent delinquency between cohabitating family, other family types, and the effect of parental social control on the variation of delinquency in different family compositions	Binary logistic regression along with multivariate models	No major differences in violent behaviors in both groups (cohabitating families and other family types). However, adolescents of cohabitating families have a higher risk of involving in a nonviolent form of delinquency compare with natural-parental families with marginal significance
Low *et al.* 2012[29]	244 families (122 younger brothers and 122 younger sisters)	To assess the economic strain of delinquency among adolescents	SEM	Sibling aggression has a very strong and harmful effect on adolescents who belongs to economically strained families. Economic conditions of the family are highly associated with the effect of parents, siblings, and peer as risk and juvenile delinquency
Gold *et al.* 2011[30]	112 adolescents (22 females and 90 males) from the age range of 12–19 years, staying in a Juvenile detention facility pending criminal charges	Assess the relationship between abusive and nonabusive parenting, adolescent shame (expressed and converted), and violent delinquency	Hierarchical regression model, ANOVA	Abusive parenting is connected to violent delinquency directly as well as indirectly through converted shame. Conversion of shame is the major cause of more violent delinquency when compared to expressed shame

GLM: Generalized linear model, ML: Machine learning, PEH: Probabilistic estimation hypothesis, CAPM: Categorization of anxiety predictor model, SES: Socioeconomic status, SEM: Structural equation model

minors at risk and children in conflict with poor financial status. And found children with age range 12–17 years are victims of maltreatment, and adolescents between the ages of 15–17 years commit severe crimes.[16] Kim *et al.*[18] used traditional regression, ML method and certified the predictive validity of the models in numerous ways, along with traditional hold-out validation k-fold cross-validation, and bootstrapping to examine the present practice and policy for assessment, treatment, and management of delinquents who have a history of sexual conviction in multiple jurisdictions from New York, Florida, Oregon, Virginia, and Pennsylvania. Results revealed that important risk factors among juveniles had some criminal history, sexual offending experiences, and delinquent peers. Some dynamic factors viz. performance in school, peer connection, sorrowful feelings, impulsiveness, mental health, and substance abuse are important anticipating factors among sexual offenders for recidivism.

Rokven *et al.*[19] used multinomial logistic regression technique to compare four types of delinquent groups: online delinquents, offline delinquents, nondelinquents, and delinquents who belong to both online and offline categories and found juveniles who having both online and offline criminal records are more likely to commit crimes. Delinquency is indirectly linked with sleep deprivation, with poor self-control acting as a catalyst proved by regression models with latent factors.[20] Violent video games directly associated with anti-social behavior, even though several correlates, such as psychopathologies has present in youth analyzed by negative binomial regression (extended version of Poisson regression).[22]

Fernández *et al.* analyzed through multivariate logistic regression and found, school dropouts' teenagers had a higher level of irresponsibility, substance, and illicit drug abuse compare then nondropouts.[23] In addition, lack of parental supervision plays a significant role in the prediction of deviant behaviors on school dropouts. School dropout teenagers have multi-dimensional problem that requires proper parental supervision and proactive school policies to reducing drug and alcohol abuse.[23] Fifty-two percent of juvenile offenders

had issues with academic performance, 34% had family history of psychiatric disorders, 60% of juveniles involved in property crime and 54% of offenders involved in drugs and alcohol use-related offenses had some deficiency in academic achievement evaluated by multiple regression techniques.[24] Wu (2015) created a multidimensional scaling model and found students used a complex cognitive-mechanism measured and compared their position to friends and others.[25]

Sexually assaulted history has strongly associated and one of the most powerful variables associated with the intensity of psychoactive substances using by juveniles.[26] Parks[28] has used binary logistic regression and multivariate models revealed that no major variations in violent juveniles belong to cohabiting families and other families. However, teenagers of cohabiting families have marginally higher risk to involving in nonviolent forms of crime.[28] Economic conditions of the family has strongly linked to the influences of parents, siblings, and peers at risk and delinquency. Economic stress, having an active sibling aggression, harmful, and more destructive events affected seriously on adolescent delinquent behaviors who belongs to economically poor families.[29] Coercive parents are directly associated with violent delinquency of adolescents on both ways as explicitly and indirectly and transformed shame on adolescents. As opposed to articulated guilt, shame conversion is the major cause for more violence.[30]

It is very difficult to evaluate all possible outcomes and explain a single quantitative approach as ML to early identification of delinquent behaviors and risk-factors of juveniles for intervene in the affected factors. Our study has several limitations. First, other studies rather than the English language were we not included in the study. Second, counties like India have very less evidence-based studies in the field of early detection of juveniles and computer-based assessment approaches as ML for quantitative analysis. Third, only 15 articles were considered which fulfilled the inclusion criteria.

IMPLICATION

The modern world is fully based on computers and technology for making works easy and faster. ML model is an emerging future technology in the field of health and mental health. It has the potential to predictive ability to detect health/mental health-related problems as well as for early diagnosis of problems behaviors. This review is acknowledging the use of quantitative analysis focused on ML algorithm as a new research area for early identification of delinquent behaviors of children, to prevent the deviant behaviors and related risk-factors and may be beneficial for future studies and contribute to make a peaceful society and worthful young generation for the nation.

CONCLUSION

This review showed that available literature based on ML and other quantitative methods to identify the risk factors and delinquent behaviors of juveniles. Young peoples are

at a higher risk to learn maladaptive/deviant behaviors as violent, aggressive, hyperactive, and easily involved in criminal activities. According to studies, individual factors, family environment, family structure, size/type of the family, parental status (single/separate/divorces) are highly affected adolescent's behaviors. In addition, social, environmental, and economic conditions are lead to adapt conductive and delinquent behaviors. There highly need to identify delinquent behaviors in the initial stage to prevent with affected risk factors. It is very crucial for early screening and intervention.

Conflicts of interest
There are no conflicts of interest.

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