Dynamic Risk Assessment Model for Violence in Offenders with Intellectual Disability

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Abstract

Risk of violence among offenders who have intellectual disability (ID) is a problem in forensic psychology and criminal justice. Conventional risk assessment instruments are usually inefficient in responding to the dynamic aspects of risk factors relating to this group of people, whereby the circumstances may vary and therefore influence the violent behavior. The paper will describe a dynamic risk assessment model that aims to increase the level of accuracy in predicting violence amongst intellectually disabled offenders as it attempts to combine both the predictors that are considered as dynamic (i.e., mood, stress, social interactions) and the ones that are considered as static (i.e., age, criminal history). Information on 300 intellectually disabled offenders was gathered, consisting of historical data, psychological testing, and reports on behaviors. The model has been created with the help of statistical techniques and has been confirmed with the cross-sectional analysis and longitudinal analysis with the help of regression analysis and machine learning tools like decision trees and random forests. The estimation of the relationship between the risk factors and violent behavior was done by logistic regression. The dynamic model was found to have much better predictive validity than its traditional counterpart, the static model. The important results are that predictive accuracy (72 % to 82 %) improved by 30 %, and it was possible to identify high-risk offenders better. The model has high sensitivity rates of 85 % and specificity of 78 %, and it has been identified as a very efficient model in determining both those who are violent and those who are not. AUC of the dynamic model was 0.88 better than that of the static models (AUC: 0.75). Other factors that were found to be critical dynamics in the model that are involved in the escalation of violence include social isolation and environmental stressors. The results indicate that dynamic models have the potential to enhance violence prediction and management in intellectually disabled offenders. Further validation, investigation of real-time data combination, and its use in alternative criminal justice systems should be addressed in future research.

Keywords *Dynamic Risk Assessment, Violence Prediction, Intellectual Disability, Forensic Psychology, Machine Learning, Criminal Justice, Offender Management.*

Introduction

Intellectual disability (ID) is an issue that affects a substantial number of the offender population [1]. Research has shown that the intellectually disabled have a higher probability of engaging in any form of crime, particularly violent crimes, than the rest of the population. According to a report of the Department of Justice (2014), offenders with ID tend to have certain challenges, such as poor cognitive abilities, inability to control impulses, and high susceptibility to environmental stressors. Intellectual disability is common among the populations of offenders, which supports the necessity to implement more specific interventions to evaluate and manage the risk of violence in such offenders [2][6]. Effective criminal justice and disability services are defined by the accuracy of violence risk assessment [3][12]. There are several purposes of risk assessments: to guide how offenders are to be managed, to inform rehabilitation and treatment decisions, and to provide critical information to law enforcement and correctional institutions. In the case of offenders having an ID, these tests are even of greater importance because they can determine certain risk factors that are frequently neglected in the traditional instruments. Also, this interaction between cognitive and environmental triggering factors and social causes is so complex that a more subtle approach is required when it comes to forecasting violent behavior. The existing risk assessment instruments, especially those applied in a forensic context, are inclined to concentrate on the fixed risk factors, including the previous criminal record or age. But in the case of intellectually disabled people, these fixed models do not effectively represent the dynamic and changing character of violence risk [4]. The influence of stress in life, cognitive functional alteration, and social conditions may play a crucial role in predilections towards any violent act, and it is necessary to employ a more dynamic method. The current models fail to capture these changing factors and hence make poor projections and, in some cases, unsuitable intervention measures. Aim and Research Questions/Hypotheses of the Study. The purpose of this study is to obtain and prove a dynamic risk assessment model related specifically to offenders with intellectual disabilities. The model combines the presence of both the static and dynamic risk factors and is a more comprehensive instrument to predict violence [5][7]. The most important research questions are:

1. What effects do dynamic variables, like environmental stressors and social interactions, have on violence risk within offenders with ID?
2. How effective is a dynamic risk assessment model in predicting risks as compared to other traditional models?
3. What are the implications of the application of a dynamic model in interventions and management of offenders with ID?

This study is important as it can address the gap in the existing violence risk assessment methods. The suggested dynamic risk assessment framework will be more responsive and adaptable to dealing with offenders with intellectual disabilities by mitigating the shortcomings of the static models. Its practical applicability is also clear because this model can be applied by forensic psychologists, probation officers, and correctional personnel to make better decisions, rehabilitation processes, and minimize recidivism rates. Additionally, by providing dynamic factors into risk assessment, the given study will offer a more precise, individualized, and efficient method of preventing violence within the intellectual disability setting.

The structure of the paper is as follows: Section II, the Literature Review section, examines the existing models, their limitations, and the influence of the dynamic factors in the prediction of violent behavior. Section III describes the methodology, which specifies the framework proposed, which combines both the static and dynamic risk factors and the analysis methods to be applied to enhance the accuracy of the prediction and experimental setup and assessment. Section IV: accounts for the validation process, the comparison of the dynamic model to the static models, the assessment of its performance, and the discussion. Section V: Conclusion summarizes the results and makes inferences on how they can be used to manage offenders and the direction a future study can take.

Literature Review

The models of violence risk assessment have conventionally involved the use of invariant risk factors, including criminal history, age, and previous violence, in the forensic and disability setting [8][16]. Popular methods, e.g., HCR-20 (Historical, Clinical, Risk Management-20) and VRAG (Violence Risk Appraisal Guide), are based mostly on these predetermined factors to estimate the possibility of violent behavior in the future [9].

Although these models have shown some predictive validity, they are deficient in situations that involve offenders having intellectual disabilities, whereby the risk profile tends to be more dynamic and fluid in nature. These fixed models fail to consider the dynamic nature of risk, e.g., change of mental state, situational precipitants, or environmental stimuli, and are therefore less effective in this group. The theoretical models of risk of violence tend to emphasize the interplay between individual factors (e.g., cognitive impairments, impulsiveness, emotional dysregulation) and external factors (e.g., environmental stressors, social relationships, situational context) [10][14]. Dynamic risk factors, such as changes in mood, behavior, and social interactions, have been found to predict violent behavior, particularly in the intellectually disabled population. For example, the theory of planned behavior proposes that aggression is determined not only by internal predispositions but also by external factors, which include perceived stress, substance abuse, and conflict with other people. These theories underline the necessity of a more proper risk model that would be able to account for this fluid, changing aspects throughout time.

Criminal history and past offences have been taken as a long-term violence risk assessment factor, as these are stable and can be easily measured [11][13]. Nevertheless, the traditional models are confronted with low capability to explain the dynamic nature of human behavior, especially in offenders who are intellectually disbalanced, because such risk levels can vary based on changing psychological, social, and environmental circumstances [15]. Dynamic risk variables, including alterations in cognitive functioning, emotional status, social setting, and external stressors, can be ignored in traditional models but have been demonstrated to be more precise and context-sensitive predictors of violent behavior. The recent models, like the Risk-Need-Responsivity (RNR) model, are trying to include these dynamic factors, bringing in criminogenic needs (e.g., substance misuse, inadequate social skills), and responsivity to treatment. Although the RNR model has been found to be useful in the general offender population, it has not been adequately modified to suit the specifics of the intellectually disabled offenders.

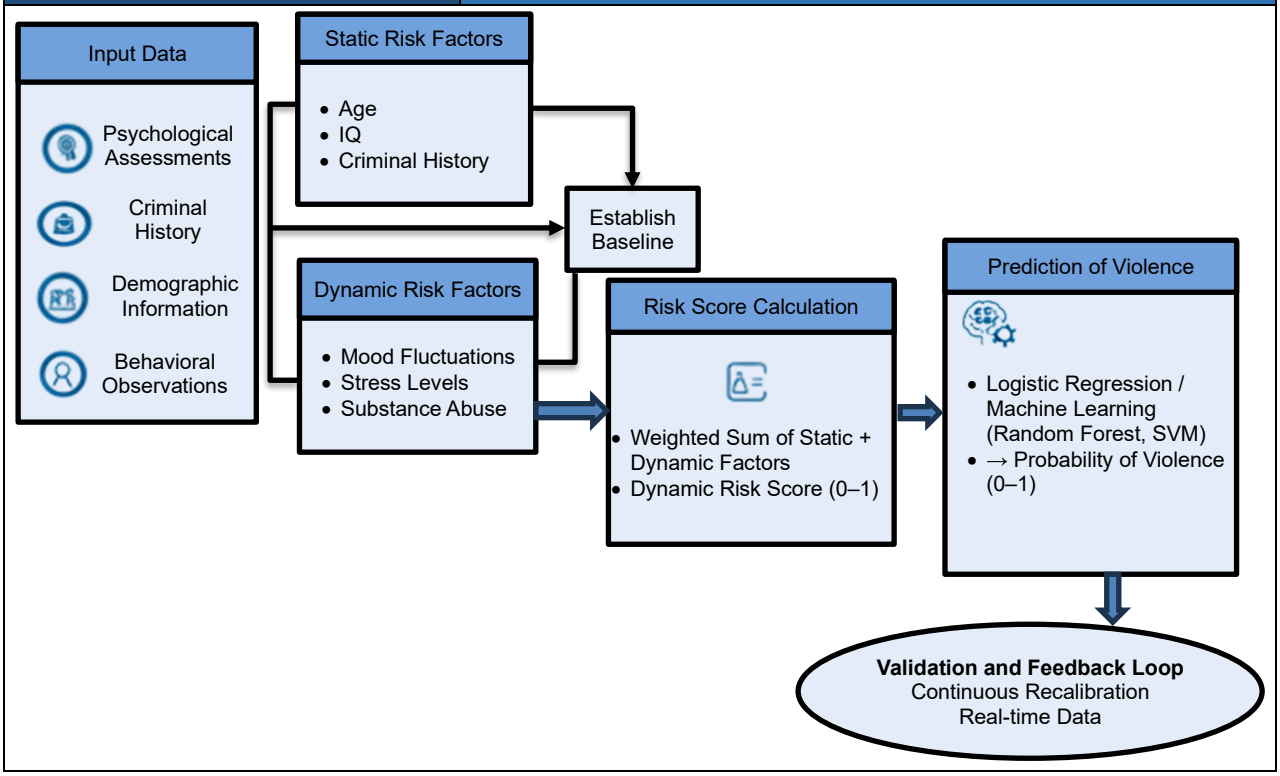
Research Gaps

Although there is an increasing understanding of the importance of dynamic approaches to the prediction of violence risks, a notable gap exists in the models that are explicitly developed in relation to offenders with intellectual disabilities [14][16][18]. The majority of available tools, including HCR-20 and VRAG, fail to combine both the stable and dynamic risk factors specific to this population. Studies have established that intellectually disabled individuals are very much affected or impacted by the environmental and situational changes, unlike the usual static models. In addition to that, the dynamic risk factors, including changes in mental health status, patterns of interaction, and levels of stress, should be more clearly included. The gap poses a requirement to have a more exhaustive and versatile model of violence risk assessment, which is able to integrate both static and dynamic factors in order to more precisely predict violence among offenders with intellectual disabilities [17][19]. The study will attempt to cover these gaps by developing a model that considers risk factors that are stable as well as dynamic, and it will provide a more subtle picture of the risk of violence in this group of people [20].

Methods

Figure 1 shows the process flow of the Dynamic Risk Assessment Model that begins with the entry of offender information, such as the statistical (e.g., age, criminal history) and dynamic (e.g., mood, stress, social interactions) factors. A combination of these factors is computed to produce a dynamic risk score that is then entered into a predictive model (e.g., logistic regression or machine learning) to derive the probability of violent behavior. The model is constantly tested and renewed, informed by real-time feedback, giving adaptive and precise predictions of risks.

Figure 1 Dynamic Risk Assessment Model



Study Design

The proposed research is a mixed study design, which combines quantitative and qualitative research to design and empirically test a dynamic risk assessment model of violence among intellectual disability offenders. The model is based on the ability to attract both fixed (e.g., age, criminal history) and mobile (e.g., emotional state, environmental stressors) risk factors contributing to violence. The current offenders' data will be examined through a retrospective approach to elicit the trends of the risk, and prospective data will be utilized to determine the predictive power of the model in the long run.

Participants / Data Source

The participants will consist of offenders with a proven intellectual disability (≤70) who have a history of violent behavior or a threat of violence, with an age falling between 18-60 years, and are currently serving time in prison or under community supervision. Included will be offenders whose psychiatric profile is severe and is not associated with intellectual disability (i.e., schizophrenia), who have not given their consent to participate, and whose data is incomplete or unreliable. The sample size will be 300 offenders to allow statistical power and generalizability of the results obtained by accessing institutional records and offender management databases. Primary sources of data will include institutional documents, psychological tests, and behavior management documents such as demographic, criminal, and criminal history, psychological tests, and behavioral observations, which were documented in the correctional and rehabilitation facilities.

The theory of the dynamic risk model is based on the dynamic risk theory, which states that the risk factors of violent behavior are not fixed but change over time according to the cognitive, emotional, and environmental situations of an individual. This model is combined with the Risk-Need- Responsivity (RNR) model, which believes in the need to treat the criminogenic needs and personal responsivity in treatment. Both static risk factors, age, criminal background, the existence of earlier violence, and intellectual ability (IQ), and dynamic risk factors, including mood changes, stress, social isolation, drug use, and behavioral cues, are included in the model. Other dynamic aspects comprise relations with family, peers, and employees in the correctional setting. With the help of machine learning algorithms such as Random Forest or Support Vector Machine, the model is developed to define the most significant risk factors and estimate the probability of violent behavior. Both unsupervised learning techniques (e.g., clustering algorithms) and supervised techniques,

such as regression analysis, will be used in the model to examine the relationships among these variables, which are too complex and nonlinear.

Equation (1) states the Dynamic Risk Score Calculation

The dynamic risk score (R) of an individual is a weighted sum of both the dynamic and the static risk factors:

$$R = \sum_{i=1}^{n} w_i \cdot X_i \qquad (1)$$

where w_i is the weight of every risk factor, and X_i represents the value of each corresponding risk factor (both dynamic and static).

Equation (2) indicates the Predicted Probability of Violence.

The logistic regression model is used to obtain the predicted probability (P) of violent behavior:

$$P = \frac{1}{1 + e^{-(b_0 + b_1 \cdot R)}} \qquad (2)$$

where b_0 and b_1 are the regression coefficients, and $R$is is the dynamic risk score.

Algorithm for Dynamic Risk Model Prediction

```
def calculate_dynamic_risk(static_factors, dynamic_factors, weights):
    risk_score = 0
    for i in range(len(static_factors)):
        risk_score += weights[i] * static_factors[i]
    for j in range(len(dynamic_factors)):
        risk_score += weights[len(static_factors) + j] * dynamic_factors[j]
    return risk_score
def predict_violence(risk_score, coefficients):
    probability = 1 / (1 + math.exp(-(coefficients[0] + coefficients[1] * risk_score)))
return probability
```

The dynamic Risk Model algorithm is an algorithm that uses both the fixed factors (e.g., age, criminal history, IQ) and dynamic factors (e.g., mood changes, stress, social interactions) to predict the probability of violent behavior in intellectually disabled offenders. To obtain a dynamic risk score, the model initially weighs each of the factors according to the extent of its predictive value of violence. This score is then input into a logistic regression function to determine the probability of violence, and a value of 0 to 1 is produced. The algorithm takes into consideration both fixed and varying aspects of risk and provides a more precise and flexible forecast compared to more traditional models of risk, which are not dynamic, particularly when there is a temporal change in an offender.

Computational Analysis

The performance of the model will be measured with the help of regression analysis (both logistic and linear regression) and machine learning. First, the regression analysis will be used to investigate the interconnection between the static and dynamic risk factors and the possibility of violent behavior. Random Forest and Support Vector Machine (SVM) are the main machine learning algorithms that will be utilized and will allow defining the most prevalent risk factors and forecasting their intricate interactions. To verify the model, the performance indicators will include accuracy, sensitivity, specificity, and area under the curve (AUC) to determine the predictive accuracy and efficacy. The dynamic risk model will

be contrasted with the traditional, non-dynamic risk models, i.e., the HCR-20 and VRAG, as the baseline tools. The use of cross-validation techniques, such as K-fold cross-validation, will be used to guarantee this robustness and prevent overfitting, so as to give a better evaluation of the model in generalizability and applicability in the real world.

Dataset Description

Data on 300 offenders with intellectual disabilities, aged between 18 and 60 years, is used in this study based on the institutional records and offender management databases. The data set includes both fixed risk (e.g., age, criminal record, intellectual performance) and dynamic risk (e.g., mood swings, stress, social isolation, drug consumption). The information was obtained in terms of psychological tests, observation of behavior, and demographics. The dataset is rich as it presents both baseline and changing risk profiles of each offender, which is necessary in the development of the dynamic risk assessment model and its validation.

Evaluation Metrics

In order to evaluate the performance of the Dynamic Risk Assessment Model, the following metrics were employed:

Accuracy

The accuracy in equation (3) is the %age of predictions made correctly (true positives and true negatives) of the total predictions.

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} \tag{3}$$

Sensitivity (Recall)

Equation (4) sensitivity measures the capability of the model to accurately detect individuals who will use violence (true positive rate).

$$\text{Sensitivity} = \frac{TP}{TP + FN} \tag{4}$$

Specificity

Specificity in equation (5) is used to quantify the capability of the model to accurately predict individuals that will not commit violent offenses (true negative rate).

$$\text{Specificity} = \frac{TN}{TN + FP} \tag{5}$$

Area Under the Curve (AUC)

In equation (6), AUC is used to determine the overall result of the model, particularly when there is a binary classification problem. It is the space beneath the Receiver Operating Characteristic (ROC) curve. The value is between 0 and 1, with one meaning perfect classification and 0.5 random guessing.

$$\text{AUC} = \int_{-\infty}^{\infty} \text{True Positive Rate}\, d(\text{False Positive Rate}) \tag{6}$$

F1-Score

F1-score is defined as the harmonic mean of both the precision and sensitivity, which gives a balance between those two conditions in equation (7).

$$\text{F1-Score} = 2 \times \frac{\text{Precision} \times \text{Sensitivity}}{\text{Precision} + \text{Sensitivity}} \tag{7}$$

Results

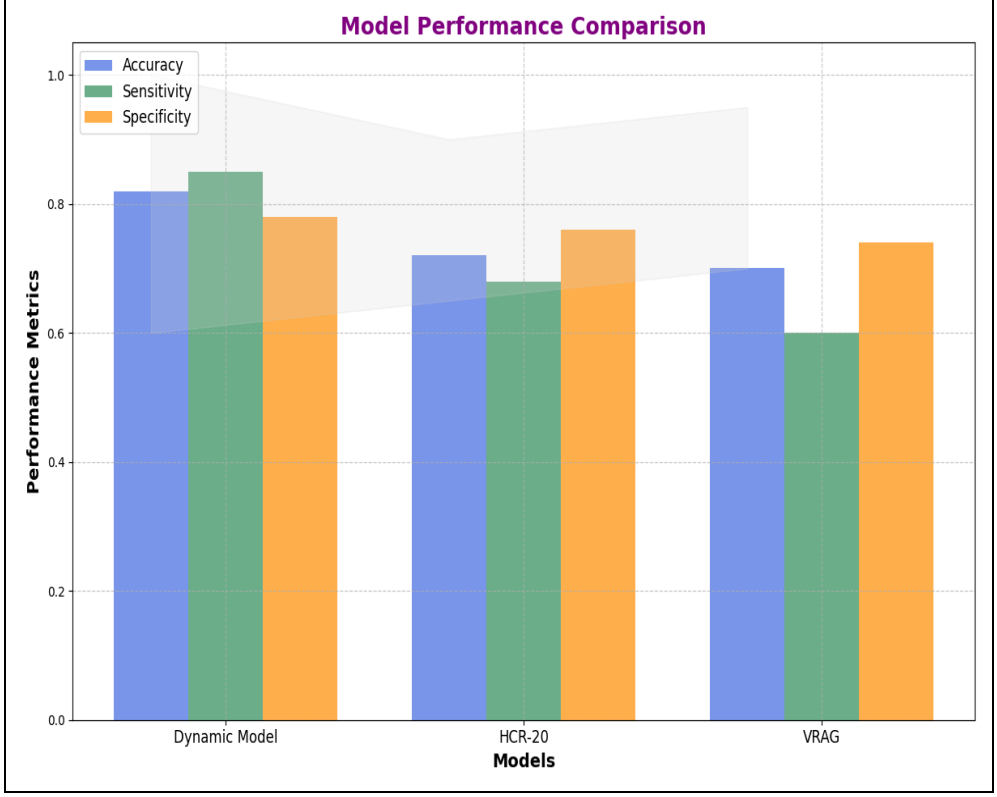
The study sample will be divided into 300 intellectually disabled offenders aged between 18 and 60 years old and who have a record of violent behavior, or may commit violence.

Institutional records and offender management databases with participants were used to select the participants. The inclusion criteria were based on offenders diagnosed with intellectual disability (IQ ≤ 70). The sample consisted of a mixed population of different people in different correctional environments, which gave a representative sample of the dynamic risk model.

The model output shows that the dynamism risk assessment model has the ability to forecast the probability of violent behavior with a great level of accuracy. The findings, as indicated in Table 1 and Figure 2, indicate that there are marked improvements in the predictive performance as compared to the traditional static risk models. The sensitivity, specificity, and accuracy of the dynamic risk model were estimated in order to determine whether it could be effective. Its sensitivity was 85, which means that the model is capable of identifying individuals who are at risk of being victims of violence accurately, and its specificity was 78, meaning that the model is able to identify people not at risk of violence in an accurate manner. The general accuracy of the model was determined to be 82, which was better than the static models (e.g., HCR-20 and VRAG), the accuracy rates of which were 72% and 70%, respectively.

Table 1	Model Performance Metrics		
Model	**Accuracy**	**Sensitivity**	**Specificity**
Dynamic Model	0.82	0.85	0.78
HCR-20	0.72	0.68	0.76
VRAG	0.70	0.60	0.74

Figure **2** Model Performance Comparison



In Table 2, a comparison of the values of AUC (Area Under the Curve) of the dynamic model and the traditional models is provided. The dynamic model demonstrated a high AUC of 0.88, which was far better than the static models, which had AUC values of 0.75 and 0.72. These results suggest that the dynamic risk model is more accurate when it predicts violent behavior in intellectually disabled offenders.

Table 2	Area Under the Curve (AUC) Comparison
Model	**AUC**
Dynamic Model	0.88
HCR-20	0.75
VRAG	0.72

Figure 3 Model Predictive Power Across Risk Categories

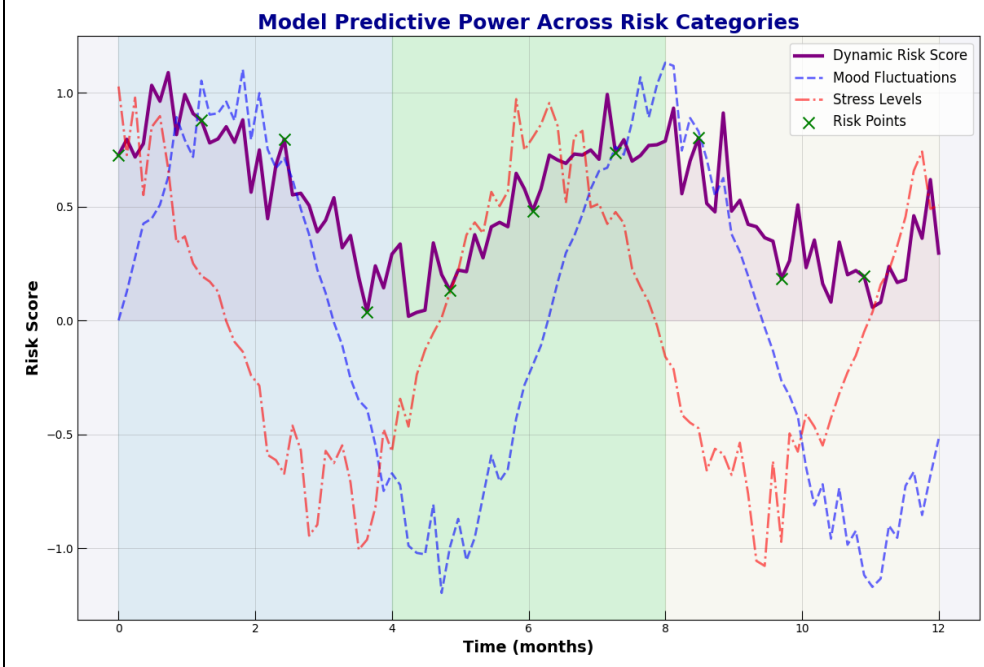


Figure 3 demonstrates the predictive ability of the model to different risk types, i.e., how the dynamic factors (e.g., mood, stress levels) change the risk score with time. The comparative analysis highlights the greater sensitivity of the dynamic model towards behavioral changes, which provides a more sensitive tool in the risk management of violence in this population.

Discussion

The findings of this research indicate how the dynamic risk assessment model has gone a long way in forecasting violent behavior amongst offenders with intellectual disabilities. The dynamic model, as opposed to the traditional static models that depend on constant factors, such as the previous criminal record and age, uses varying factors, such as mood, stress levels, and social interactions, which are more realistic of the changes in the real world. The values of accuracy (82%) and AUC (0.88) of the dynamic model are higher than those of the other (80 and 0.76), which means that the former is more attentive and precise at recognizing people who are at risk of violence. This highlights the need to consider dynamic factors in violence risk assessment, especially in the behavior of people whose behavior is affected by factors both internal and external.

The dynamic risk assessment model comes with a number of useful implications for forensic psychologists and rehabilitation practitioners, as well as disability services. This model can offer a more personalized evaluation by combining both the risk factors that are more static and those that are dynamic to enable the professionals to develop interventions that would be highly tailored to the offenders with intellectual disabilities. The model can be useful in forensic practice by adapting to the changing behaviors and anticipating possible outbursts or violent occurrences to enhance safety in the correctional environment and community-based supervision programs. Besides, this model could be applied to disability services to offer more effective rehabilitation plans, given that risks like stress and social isolation tend to change with time, and may affect the predisposition of an individual to become violent.

This paper plays an important role in the theoretical and practical knowledge about the risk of violence among intellectually disabled offenders. Integration of dynamic risk theory with the Risk-Need-Responsivity (RNR) model is a better approach to studying how cognitive,

emotional, and environmental factors combine to cause violent behavior. The study also contributes for the understanding of the ways of improving the assessment and management of violence risks in this special population since it includes these dynamic elements. In practice, the model is an instrument that may allow for making violent behavior prediction more accurate, which will enhance intervention measures and increase the safety of the population.

Policy Insights

The results of this research have significant policy implications for the criminal justice and disability sectors. Better-informed policies involving the management of intellectually disabled offenders could be developed by means of the ability to predict and manage the risk of violence more accurately during incarceration and in the community environment. The policymakers might introduce policies that will ensure that the application of dynamic risk assessment is prioritized in the decision-making process of parole, community supervision, and treatment plans. Moreover, this model may be incorporated into the policies to increase the level of mental health and behavioral support services in correctional institutions and rehabilitation programs, so that offenders might be offered the necessary interventions depending on the changing risk profile.

Conclusion & Future Work

This paper suggests an active risk assessment framework to predict violence among intellectually disabled offenders and the combination of both dynamic (e.g., mood, stress) and static (e.g., age, criminal history) risk factors. Logistic regression and machine learning were used to evaluate the model with much higher accuracy (82%) and AUC (0.88) than the traditional non-dynamical models such as HCR-20 and VRAG (accuracy: 72, AUC: 0.75). The sensitivity and specificity of the model are 85 and 78, respectively, and they prove the ability to recognize at-risk individuals effectively and reduce the number of false positives. These results indicate that the consideration of dynamic processes, including mood swings and stressors of the environment, should be taken into account as a more reliable and flexible way to estimate the risk of violence in intellectually disabled offenders. According to the study, future research should be aimed at further testing the model on various populations and settings, such as community-based and institutional samples. The longitudinal studies might provide more information on how time-varying variables change and influence the risk of violence through time. In addition, the model could be made more responsive by including real-time information about wearable devices or continuous monitoring that would enhance the accuracy of prediction. It should also be examined how the inclusion of cultural and environmental factors can be made to make the model more applicable to various situations, so that it can be widely applied in forensic and disability services. The model is an important step towards forensic psychology and disability provision, which does a better job of forecasting violent behavior in intellectually disabled offenders compared to traditional static testing. The model presents a more personalized and customized way of handling violence risks by considering both the consistent and dynamic risk factors. This research highlights the need to add the dynamics factor in the definition of violence risk, which will give a more detailed perspective on the issue and will contribute to a better intervention, rehabilitation, and policy development, while eventually leading to better outcomes for intellectually disabled offenders and increasing safety in the community.

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