GENETIC AND SOCIO-ENVIRONMENTAL PREDISPOSITIONS OF VIOLENT BEHAVIOUR OF MALE CONVICTS IN SRI LANKA

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Criminal violence stands as one of the most pervasive societal issues that has affected the economy, health care and law enforcement of a country. Therefore, preventing violence is a critical global priority. Recently, much emphasis has been given to the behavioural genetic roots of criminal violence. The low allelic variants of the Monoamine Oxidase-A gene (MAOA-L) result in the accumulation of neurotransmitters and the high allelic variants of Dopamine Transporter-1 gene (DAT-1) cause increased expression of DAT protein. Consequently causing elevation of the rate of reuptake dopamine have been implicated in impulsive aggression potent towards violence. Thus far none of the studies in Sri Lanka has investigated the genetic and socioenvironmental predispositions of the development of violent behaviour in the Sri Lankan population. Therefore, the present study investigates the interplay between MAOA, DAT-1 allelic variants and childhood maltreatment, impulsivity on criminal violence. Male convicts' categories as violent (N=100), non- violent (N=90) in Welikada Prison, Borella and normal control, (N=100) were recruited for the study. All participants were surveyed for childhood maltreatment using the Childhood Trauma Questionnaire (CTQ) and impulsivity using Barratt Impulsivity Scale-Version 11 (BIS-11). Buccal samples were used to extract DNA and PCR was carried out to detect genetic variants. Resulted MAOA variants were 3R and 5R (L-MAOA), 4R and 6R (MAOA-H) and DAT-1 variants were 6R/9R and 9R (Low activity) and 9R/10R and 10R (High activity). The interplay between allelic variants and scores of the questionnaires was evaluated by developing a model using Partial Least Squares-Structural Equation Modeling (PLS-SEM) analysis which revealed significant total effects along with mediatory pathways for the DAT-1 affecting Crime ($p=0.045$), MAOA affecting Crime ($p=0.000$) and Maltreatment affecting Impulsivity ($p=0.000$). The 3R: the MAOA-L allelic variant, 9R/10R: the high activity DAT-1 gene variant, and childhood maltreatment triggered by negligence and impulsivity triggered by the lack of self-control were revealed to be the deciding factors of violent crimes, especially manslaughter. However, further studies with a higher number of participants are warranted to validate the proposed model. Nevertheless, this study initiated a new vista in behavioural genetic studies in Sri Lanka and provided a comprehensive understanding of the multiple factors contributing to criminal violence in Sri Lanka.

Keywords: Criminal violence, MAOA gene, DAT-1 gene, Childhood maltreatment, Impulsivity

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INTRODUCTION

Criminal violence stands as one of the most pervasive societal issues which is driven by an intricate interplay of biological, psychological, social and economic factors. Annually, approximately about 1.6 million individuals worldwide succumb to violent criminal activities. Daily, around 4400 deaths are attributed to deliberate self-inflicted, interpersonal, or group-based violence (World Report on Violence and Health, 2002). Moreover, countless lives are demolished, families are torn apart, and significant expenses are incurred in the provision of care for victims, supporting affected families, restoring infrastructure, prosecuting offenders, and addressing the ensuing productivity and investment losses (World Report on Violence and Health, 2002). Therefore, preventing violence is a critical global priority. The root causes of criminal violence stemming from political, social, or economic factors are well addressed, but more recently the awareness has grown towards its physiological and biological roots. Addressing the possible interplays between each factor, has provided a comprehensive understanding of the individual differences in predisposition to criminal violence.

Genes that regulate serotonergic neurotransmissions such as Monoamine Oxidase A (MAOA) and Dopamine Transporter-1 (DAT-1) are implicated in the development of violent behaviour (Hunsaker, 2012). A myriad of studies have documented that MAOA enzyme which is critical for the degradation of neurotransmitters such as serotonin and dopamine, which are essential for regulating mood, emotion, and cognitive functions. The low variants of the MAOA gene that result in lower enzyme activity has been studied to lead to reduced degradation of these neurotransmitters, causing their accumulation in the brain where this altered neurotransmitter balance, associates with an increased propensity for criminal violence.

Additionally, a limited number of studies have reported that the high activity variants of the DAT-1 40bp polymorphism resulting in increased expression of DAT protein that elevate the rate of reuptaking dopamine and impulsive aggression potent towards criminalism as well. Furthermore, it has been studied that certain socio-environmental factors such as childhood maltreatment and impulsivity interplay with a genetic factor in the establishment of criminal violence. Thus far, none of the studies have been carried out to investigate the factors that have influenced the criminal violent behaviour of convicts in Sri Lanka. Therefore, for the first time, the present study investigates the predisposition of MAOA gene activity, DAT-1 gene activity and childhood maltreatment, impulsivity along with their mediatory effects with one another on criminal violence behaviour of male convicts imprisoned in Sri Lanka.

1. METHODOLOGY

The study consisted of three groups: violent (100 participants), non-violent (90 participants) and normal control group (100 participants) (Ethical approval: ERC IOBSL 257 01 2022). Convicts were recruited from the Welikada prison located in Borella Colombo upon the permission of the Prison Headquarters. The violent group included convicts who have committed 1st and 2nd-degree murder, aggravated assault, voluntary manslaughter, and sexual offences. The non-violent group included fraud, burglary/robbery/theft, drug offences (Stetler et al., 2014). Males of age groups range from 20-70 years were recruited following the informed consent age and sex-matched controls were recruited without any criminal records. All the participants were provided with self-administrative questionnaires prepared: Childhood Trauma Questionnaire (CTQ) (Bernstein and Fink, 1998) and Barratt Impulsivity Scale-Version 11 (BIS-11) (Patton, Stanford & Barratt, 1995) which were first validated for the Sinhala

version. The CTQ assesses five types of childhood trauma: emotional abuse (EA), emotional neglect (EN), physical abuse (PA), physical neglect (PN), and sexual abuse (SA) which comprises of 28 items and each item is rated from 1 (never) to 5 (very often) whereas BIS-11 assesses attentional and cognitive instability (Attentional Impulsiveness), motor and perseverance (Motor Impulsiveness), and cognitive complexity and self-control (Non-Planning Impulsiveness) which comprises of 30 items and each item is rated from 1 (never) to 4 (very often).

The DNA was isolated using the chelex100 protocol from the buccal swabs obtained from participants (Livy et al., 2012). MAOA allelic variants were genotyped by PCR-based amplification using; forward, 5'-ACAGCCTGACCGTGGAGAAG-3' and reverse, 5' GAACGGACGCTCCATTCGGA-3' primers. DAT-1 allelic variants were genotyped by PCR-based amplification using; forward, 5'-TGCGGTGTAGGGAACGGCCTGAG-3' and reverse, 5'-CTTCCTGGAGGTCACGGCTCAAGG -3' primers. The PCR products were then run on a 2% Agarose gel visualized under UV light on a transilluminator and digitally photographed and the size of fragments was determined by comparison with the molecular weight marker (100 bp ladder, USA) (Speck-Hernández, 2015). The targeted genetic variants were verified by DNA sequencing and the interplay of allelic variants and scores of the questionnaires were evaluated by developing a model using Partial Least Squares-Structural Equation Modelling (PLS-SEM) analysis.

2. RESULTS AND DISCUSSION

The PCR implication of the DNA revealed the presence of 221 bp, 251 bp, 281 bp fragments that resemble the 3R (L-MAOA variant), 4R (H-MAOA variant) and 5R (L-MAOA variant) repeats of the MAOA gene, respectively where only one sample exhibited a 311 bp, 6R (H-MAOA variant). As for the DAT-1 allelic variants, four variant types were observed as 6R/9R low activity (321 bp/441bp), 9R low activity (441 bp), 9R/10R (441bp/481bp) and 10R (481 bp).

The questionnaire survey data and the genetic variants were then used to evaluate and ascertain the mediating impacts of DAT-1 gene, childhood maltreatment and impulsivity on crime types, a conceptual framework was adopted to construct the path model interpreting the cause-effects

An initial PLS-SEM model was constructed priory with 74 indicators (4 genetic variants from each gene, 28 CTQ items, 30 BIS-11 items and 8 crime types) and 64 indicators were filtered out from the dataset to construct the final model. The final model was comprised of 10 indicators including MAOA 3R variant, DAT-1 9R/10R variant, CTQ items-EN7, EN28, PN26, BIS-11 items-SC1, SC8, SC12,SC13 and manslaughter from the crime types (Figure 01). A consistent confirmatory factor analysis was conducted to examine the structure reflected in the indicators of the dataset. MAOA gene, DAT-1 gene and crime type committed were all single construct indicators where those latent variables were measured by only one observed indicator as 3R low allelic variant, 9R/10R risky allelic variant and manslaughter respectively. Then the mediating effects were integrated into the final model, and the model was bootstrapped to scrutinize the mediating effects of DAT-1 gene, Childhood maltreatment and Impulsivity of the impact of MAOA gene on the type of crimes that convicts have committed (Manslaughter, Murder, Assault, Sexual Offences, Drug Offences, Burglary and Fraud).

The bootsrapped total effects of the model results revealed significant association between DAT-1 and Crime (p=0.045), MAOA and Crime (p=0.000), and Maltreatment and Impulsivity (p=0.000). With regard to DAT-1 and Crime (p=0.045) pathway, it was revealed that DAT-1 and Impulsivity influence Crime, DAT-1 and Maltreatment influence Crime, and DAT-1 and Maltreatment along with Impulsivity influence Crime. Furthermore, with regard to MAOA and Crime (p=0.000) pathway, it was revealed that MAOA and DAT-1 influence Crime, MAOA and DAT-1 along with Maltreatment influenc Crime, MAOA and DAT-1 along with Impulsivity influence Crime, MAOA and DAT-1 along with Maltreatment and Impulsivity influence Crime, MAOA and Maltreatment influence Crime, MAOA and Impulsivity influence Crime, and MAOA and Maltreatment along with Impulsivity influence Crime. Therefore, the final model results based on the bootstrapped total effects concluded that the collective direct and indirect effects of DAT-1 and MAOA towards criminal violence are significant. To be precise, the presence of a 3R low allelic MAOA variant could cause criminal violence

mediated by DAT-1 9R/10R high activity and/or emotional and physical neglect forms of childhood maltreatment and/or lack of self-control triggering high impulsivity. In similar notes, it was proven that DAT-1 9R/10R variant could cause criminal violence mediated by emotional and physical neglect forms of childhood maltreatment and/or lack of self-control triggering high impulsivity.

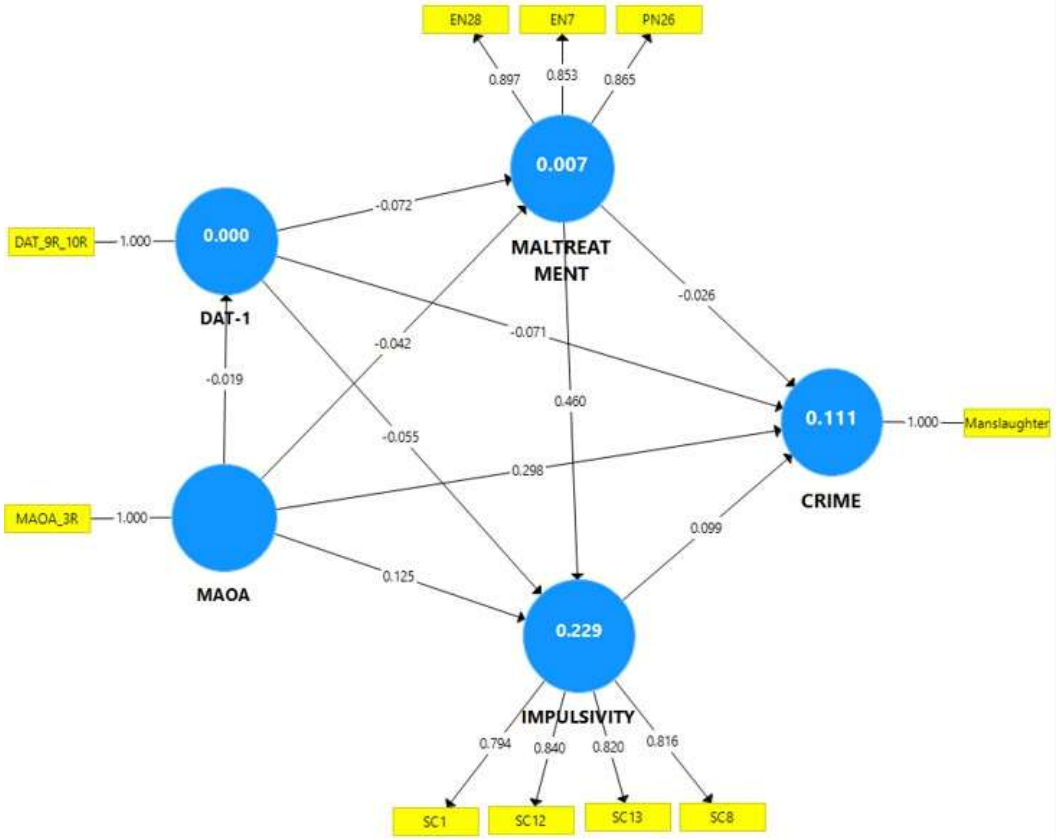

Figure 1 – The final PLS-SEM model indicating the mediatory and direct pathways of the latent variables (MAOA gene, DAT-1 gene, childhood maltreatment, impulsivity and crime)

3. CONCLUSIONS/RECOMMENDATIONS

In conclusion, the analysis of the bootstrapped total effects Partial Least Squares Structural Equation Modeling (PLS-SEM) provided valuable insights into the overall impact on criminal violence by MAOA gene activity and by the mediator variables: DAT-1 gene activity, childhood maltreatment and impulsivity. As the total effects account for both direct and indirect effects, they offered a comprehensive understanding of the relationships among our variables and their combined influence on the criminal violence which was the outcome of interest.

The final model developed revealed that MAOA gene variants (MAOA-uVNTR) have significantly contributed to the violent criminal acts through mediatory pathways emphasized by the total effects. The significant total effects were observed for the DAT-1 and Crime ($p=0.045$), MAOA and Crime ($p=0.000$), and Maltreatment and Impulsivity ($p=0.000$). For each proven pathway, the 3R: the MAOA-L allelic variant, 9R/10R: the high activity DAT-1 gene variant, childhood maltreatment triggered by physical and emotional neglect and impulsivity triggered by the lack of self-control were deciding factors on determining the commission of violent crimes, especially manslaughter.

However, further studies with a higher number of participants from all prisons are required to further solidfy the interplay between the genetic and social-environmental factors of violent behaviour among the Sri Lankans. This study may initiate a new vista in the behavioural genetic field in Sri Lanka and will be beneficial to understand the multiple factors contributing to criminal violence in Sri Lanka. Importantly, this study could pave the way to implement better rehabilitation for convicts that would improve their lives for the better and benefit society by preventing the occurrence of aggressive behaviours, which in turn aid in the mitigation of crime rates.

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