**Using psychopathic personality traits, testosterone and cortisol in predicting and preventing violent delinquency among delinquent male adolescents**

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Assignment: Master Thesis

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Date: 20-04-2022

Word count: 4138

**Abstract**

This study investigated if testosterone, with cortisol as a moderator, and psychopathic personality traits are a strong predictor for violent delinquency among delinquent adolescents. The sample consisted of 416 clinical delinquent male adolescents. Psychopathic personality traits and violent delinquency were measured with the YPI-s and the RPQ respectively. Testosterone and cortisol were measured with salivary samples. Results showed that testosterone with cortisol as a moderator did not have any predictive value, but psychopathic personality traits did have a strong predictive value. Future research should therefore focus less on the testosterone and delinquency relation among adolescents and shift the attention more towards psychopathic personality traits in order to develop interventions which can help reduce violent delinquency among adolescents.

**Keywords**: adolescents, violent delinquency, psychopathic personality traits, testosterone, cortisol

**Introduction**

Violent delinquent behaviors among adolescents remains to be a problem. Although the rates of committed crimes among adolescents in the Netherlands dropped around 50% from 2000 to 2010, the number of adolescents committing more than one crime raised significantly (Willemen et al., 2010). In 2019 there were 18 thousand adolescents in the Netherlands registered at the national police for crimes, the first increase since 2009 (Nederlands Jeugdinstituut, 2021). Furthermore, the national average of stabbings among adolescents doubled since 2017 (NOS, 2021). In 2017 there were 160 stabbing cases in which adolescents were involved, with 100 adolescent victims as well. In 2019 it rose to 380 stabbing cases in which adolescents were involved, with 200 adolescent victims as well, which means, on average, there was a stabbing among adolescents more than every day. Additionally, the national police collected 1286 knifes from adolescents in 2019, compared to 454 in 2017 (NOS, 2021).

The public ministry in the Netherlands aims to prevent violent delinquent adolescents to engage in a criminal career in their adulthood, which is understandable, since childhood aggression is a predictor for adult aggression (Kokko et al., 2009). Willemen and colleagues (2010) also state that it is more effective to prevent this behavior, than to punish the behavior. To prevent violent delinquency among delinquent adolescents, strong predictors are needed. Good predictors for adult violent behavior would be testosterone and cortisol, since these hormones are related to delinquent behavior (Van Bokhoven et al., 2006; Popma, et al., 2007). However, this is more complicated when it comes to adolescents, because testosterone levels are steadily increasing due to puberty. Van Bokhoven and colleagues (2006) did a longitudinal study to investigate testosterone levels and delinquency among 96 boys between 12 and 21 years of age. Results show no relation was found, because the high levels of testosterone found during puberty meant that individuals who scored low on delinquency, could still score high on testosterone. However, this was a non-clinical sample and delinquent adolescents did have higher levels of testosterone at the age of 16 then non-delinquent adolescents. This indicates that there might be a positive relationship, but puberty makes this hard to find in a non-clinical sample. Therefore, to predict violent delinquent behavior among adolescents, testosterone and cortisol are not sufficient. Adding another variable to testosterone and cortisol could make the predictability of violent delinquency among adolescents stronger compared to just testosterone and cortisol. Psychopathic personality traits seem to be an enhancing addition for the predictability. Psychopathic personality traits are personality traits that refer to interpersonal, affective, and socially deviant functioning (Cleckley, 1988; Hare, 2003).

A meta-analysis showed that psychopathic personality traits do correlate positively with delinquency among adolescents (Asscher et al., 2011). Additionally, psychopathic traits have been positively related to testosterone as well (Welker et al., 2014), which suggest that these variables combined should be a stronger predictor for violent delinquency among delinquent adolescents. Furthermore, it is worth mentioning that this combination of testosterone, cortisol and psychopathic personality traits has not been combined before when trying to predict violent delinquency among delinquent adolescents. To outline the different relationships among violent delinquency, testosterone, cortisol and psychopathic personality traits, the relationships need to be explained further.

 The first relationship is the relationship between testosterone and violent delinquency. Dabbs and colleagues (1991) investigated the relationship between testosterone and violence among incarcerated violent males. A negative moderating role was found for cortisol. High levels of testosterone and a positive relation between testosterone and violence was found when the cortisol levels were low. A similar study was done among a non-clinical sample of adolescents. In this study the relationship between testosterone and overt aggression was investigated (Popma et al., 2007). With overt aggression being visible and physical aggression. The relationship between overt aggression and testosterone was negatively moderated by cortisol. These results are in line with the results from Dabbs and colleagues (1991). The negative moderating effect of cortisol in the relationship between testosterone and aggressive behavior might be explained by the fact that cortisol is related to social withdrawal and inhibition. This is due to alteration of the HPA-axis. When cortisol levels rise, often activated by a stressor, the HPA-axis ensures a change of behavior to deal with the stressor. This often results in social withdrawal and inhibition (Kagan et al., 1988; Goldsmith & Lemery, 2000; Klimes-Dougan et al., 2001).

The second relationship is the relationship between psychopathic personality traits and violent delinquency. A study was done among a non-clinical sample of boys and girls (Marsee et al., 2005). Aggression and delinquency were measured with self-report questionnaires and psychopathic personality traits were measured with both a self-report questionnaire, as well as a teacher’s questionnaire. Psychopathic personality traits were positively related to aggression, with both the teachers and the self-reported measures. For delinquency only the self-reported measures of psychopathic personality traits related positively. A meta-analysis with a combined number of 53 studies and 10.000 participants found a moderate association between psychopathic personality traits and juvenile self-reported delinquency (Asscher et al., 2011).

Lastly, the third relationship is the relationship between testosterone, cortisol and psychopathic personality traits. High levels of testosterone in the uterus, high levels of testosterone in social challenges and high levels of testosterone throughout important life phases, with the emphasis on adolescence, are thought to be an important etiological risk factor for the onset of psychopathic behavior (Yildrim & Derksen, 2012). A positive relation between psychopathic personality traits and testosterone was found among men and women (Welker et al., 2014). Another study examined a forensic psychiatric population consisting of men, on testosterone levels. Results show a clear association between different measures of testosterone and behavioral symptoms such as committed violent crimes. Furthermore, the testosterone measures were associated with the impulsive sensation seeking scale of the Karolinska Scales of Personality, a questionnaire used for measuring pathological personality traits which are related to psychopathy (Schalling, 1978; Hare et al., 1990; Schalling & Edman, 1993; Stalenheim et al., 1998). The role of cortisol on the relationship of testosterone and psychopathic personality traits is ambiguous. The dual-hormone hypothesis states the relationship between testosterone and psychopathic personality traits only exists when cortisol levels are low (Dekkers et al., 2019; Glenn et al., 2011). However, Welker and colleagues (2014) found the exact opposite. That study showed the relationship between testosterone and psychopathic personality traits could only exist when cortisol levels were high (Welker, et al., 2014). Additionally, it was mentioned in each of those studies that the role of cortisol on the relationship between testosterone and psychopathic personality traits remained unclear and that more research is needed (Dekkers et al., 2019; Welker et al., 2014; Glenn et al., 2011). Because of this ambiguity, no clear effect of cortisol on the relationship between testosterone and psychopathic personality traits can be expected.

 This study aims to investigate the predictability of violent delinquency among delinquent adolescents through testosterone, cortisol and psychopathic personality traits. Based on the information described above, an explanatory model was designed to visualize the expected effects (Model 1).

**Model 1**

*Explanatory model of testosterone, cortisol and psychopathic personality traits on violent delinquency.*



*Note.* This model demonstrates the expected explanatory relationship between the given variables on the basis of the existing literature on the variables and their relations.

The question to which this study should provide an answer is: can violent delinquency among adolescents be predicted by testosterone, cortisol and psychopathic personality traits? To answer this question, one hypothesis is made, based on the explanatory model. H1: violent delinquent behavior among delinquent adolescents can be predicted with high levels of testosterone (with cortisol as a negative moderator for testosterone) and psychopathic personality traits.

**Method**

**Participants**

The sample of participants was provided by the research department of University Medical Centre of Amsterdam (AMC). These participants were used for a different study (de Ruigh, et al. 2019). De Ruigh and colleagues recruited the participants from youth care institutions in the Netherlands. For inclusion it was compulsory that the adolescents were placed in a closed facility for their behavior, giving the sample a clinical nature. Informed consent was signed by all the participants older than 18 years of age and by all participants under 18 years of age and their parents/caretakers. For exclusion criteria please see the respective study (De Ruigh, et al. 2019). The respective study was approved by the ethics committee of the University of Amsterdam. A total of 799 participants were selected for the study of which 354 did not participate for several reasons. Furthermore, the sample only contained 29 girls. Because of this small number and the possibility of differences in sex, the 29 girls were excluded. The total number of participants used in the respective study, as well as in this study, are 416 participants. The age of the participants ranged from 14 to 24 years of age (M = 18.58, SD = 1.70), all of which were male adolescents. Most of the participants had a middle socioeconomic status (62.7%), the next biggest group had a low socioeconomic status (24.8%), and the smallest group had a high socioeconomic status (3.6%). For the rest of the participants (8.9%), the socioeconomic status could not be determined. Most of the participants were non-western (67.3%), meaning one or both parents were originally from a non-western country. The other participants were either Dutch (26.2%), or from another western country (3.4%). The remaining participants did not provide any information on the birthplace of their parents (3.1%). An a-priori G-power analysis was performed to investigate whether the number of participants was sufficient for this study (see Appendix A). The G-power analysis was done with a small effect size (0.05). This was because the combination of predictors of violent delinquency was not used before and therefore no particular effect size could be expected. After running the analysis it turned out that the number of participants needed to be at least 262. This is easily met.

**Self-report measures**

Psychopathic personality traits are measured with the Youth Psychopathic Index-short (YPI-s, van Baardewijk et al., 2010). The YPI-s consist of 18 items that measure three different dimensions of psychopathic personality traits, namely: affective callous-unemotional traits (e.g., a lack of guilt and remorse, shallow affect and callousness), interpersonal grandiose-manipulative traits (e.g., lying, manipulation and glibness or superficial charm), and impulsive and irresponsible behaviors (e.g., impulsiveness, and excitement seeking) (Cooke & Michie, 2001; van Baardewijk et al, 2008). The items of the YPI-s were measured on a 4-point Likert scale (ranging from 1: Does not apply at all, to 4: Applies very well; for example: ‘It’s easy for me to manipulate people’), with a minimum score of 18 and a maximum score of 72. The short instruments reliability could be classified as good (Cronbach’s α of .85 for boys and Cronbach’s α of .83 for girls). Additionally, the short version showed a high convergence with the longer versions of the questionnaire (r = .95 and .93) (van Baardewijk, et al. 2010).

 Violent delinquency was measured with the Reactive-Proactive Aggression Questionnaire (RPQ) (Raine, et al. 2006). The RPQ consist of 23 items that measure two subscales, namely: reactive aggression (e.g., damaged something because you felt angry) and proactive aggression (e.g., had fights to show who was on top). The items are measured on a 3-point Likert scale (ranging from 1: never to 3: often; for example: ‘How often have you yelled at others when they have annoyed you’), with a minimum score of 0 and a maximum score of 69. The questionnaire has a high internal reliability. A Cronbach’s α of .90 for the total questionnaire, a Cronbach’s α of .84 for the reactive subscale and a Cronbach’s α of .86 for the proactive subscale. The construct validity of the RPQ was significant when correlated with the Schizotypal Personality Questionnaire (Raine, 1991) and the mother’s ratings of psychopathy.

**Neurobiological measures**

Neurobiological measures include measures of testosterone and cortisol. Salivary samples of 0.1ml minimum were gathered for both testosterone and cortisol. This was done with Salivette® (Sarstedt, Nümbrecht, Germany). The data contained free testosterone (measured in pmol/L) and not total testosterone (measured in nmol/L). Free testosterone is testosterone which is not attached to a protein and can travel freely to the body, meaning this form of testosterone is available to enter the brain, muscles and organs (Mijnlabtest, 2020). All samples were gathered on weekdays between 12:00 and 18:00. A day and an hour before the samples were taken, the participants were reminded of the procedure. The procedure meant that the participants were asked not to eat, drink anything but water, smoke or brush their teeth in the hour before the sampling. Ten minutes before the sampling the participants were asked to rinse their mouth with water and a researcher gave instructions before and during the sampling. After the sampling, a different researcher noted the number of the participants sample, the date and the exact time the sample was taken. All the samples were stored in the freezer (-20 Celsius) the same day.

**Data analysis**

The dataset that was provided by AMC, was already checked on inconsistencies and LOG-transformations were performed to acquire normality. No further inconsistencies were found. The explanatory model as a whole was also tested by means of a multiple linear regression. Furthermore, the subscales of the YPI-s and the RPQ were taken into account in a bivariate correlation analysis to check whether certain effects could be described predominantly to a certain subscale. To test the assumptions for the linear regression, different plots were made.

**Results**

**Descriptive Results**

 A descriptive table (Table 1) was made for the given answers at the self-report measures, to give an overview of the frequencies of the given scores among the participants.

**Table 1**

*Score frequencies.*

|  |  |  |
| --- | --- | --- |
|  | **YPIs Total** | **RPQ Total** |
| **Mean** | 33,37 | 38,62 |
| **SD** | 7,781 | 8,730 |
| **Minimum** | 18 | 23 |
| **Maximum** | 57 | 67 |

Furthermore, two reliability analyses were performed for the YPIs and the RPQ. Resulting in an excellent reliability for the RPC (Cronbach’s α of .914) and an acceptable reliability for the YPIs (Cronbach’s α of .792).

**Correlation Tables**

 Three correlation tables were made to show the correlations between the described variables, including the subscales of the RPQ and the YPIs.

**Table 2**

*Correlations between psychopathic personality traits and violent delinquency.*

|  |  |  |  |
| --- | --- | --- | --- |
|  | **RPQ Total** | **RPQ Reactive** | **RPQ Proactive** |
| **YPIs Total** | .566\*\* | .512\*\* | -.051 |
| **YPIs Affective** | .362\*\* | .320\*\* | -.035 |
| **YPIs Interpersonal** | .464\*\* | .388\*\* | -.053 |
| **YPIs Behavioral** | .425\*\* | .424\*\* | -.027 |

*Note.* \* Correlation is significant at the .05 level (two-tailed), \*\* Correlation is significant at the .01 level (two-tailed).

**Table 3**

*Correlations between testosterone/cortisol and psychopathic personality traits.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **YPIs Total** | **YPIs Affective** | **YPIs Interpersonal** | **YPIs Behavioral** |
| **Testosterone** | -.091 | -.076 | -.028 | -.119\* |
| **Cortisol** | -.046 | -.022 | -.010 | -.077 |

*Note.* \* Correlation is significant at the .05 level (two-tailed), \*\* Correlation is significant at the .01 level (two-tailed).

**Table 4**

*Correlations between testosterone/cortisol and violent delinquency.*

|  |  |  |  |
| --- | --- | --- | --- |
|  | **RPQ Total** | **RPQ Reactive** | **RPQ Proactive** |
| **Testosterone** | -.023 | -.055 | -.016 |
| **Cortisol** | -.099\* | -.090 | .029 |

*Note.* \* Correlation is significant at the .05 level (two-tailed), \*\* Correlation is significant at the .01 level (two-tailed).

**Hypothesis**

To test hypothesis 1, a multiple regression analysis was performed in order to investigate whether testosterone (with cortisol as a moderator) and psychopathic personality traits were significant predictors for violent delinquency. This resulted in a significant regression equation: F(3,389) = 58.663, p < .001. However, not every variable was equally responsible for the explained variance in violent delinquency (See Table 5). Testosterone did not have a significant main effect on violent delinquency (p = .143). Additionally, no interaction effect between testosterone and cortisol was found (p = .184). Psychopathic personality traits were a significant predictor for violent delinquency (p < .001). To test the assumptions of a multiple linear regression; a scatterplot was plotted to investigate the linearity of the relation and a Q-Q-Plot was plotted to investigate normality. Multicollinearity could be checked in the correlation matrix (See Table 3). To check for homoscedasticity, a scatterplot of residuals versus predicted values was plotted. All the assumptions were met, therefore the outcome of the multiple linear regression could be interpreted.

**Table 5**

*Coefficients of the multiple linear regression*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Unstandardized B** | **Coefficients Std. Error** | **Standardized Coefficients Beta** | **t** | **Sig.** |
| **(Constant)** | -53.259 | 14.707 |  | -3.621 | .000\*\* |
| **Psychopathic Personality Traits** | 47.990 | 3.636 | .557 | 13.198 | .000\*\* |
| **Testosterone x Cortisol** | -.010 | .008 | -.117 | -1.331 | .184 |
| **Testosterone** | 9.110 | 6.2 | .129 | 1.466 | .143 |

*Note.* \* Correlation is significant at the .05 level (two-tailed), \*\* Correlation is significant at the .01 level (two-tailed). Dependent variable is violent delinquency.

**Discussion**

In this study the predictive relationship of testosterone, cortisol and psychopathic personality traits on violent delinquency among male adolescents is investigated. It was tested if violent delinquent behavior among delinquent adolescents can be predicted with high levels of testosterone (with cortisol as a negative moderator for testosterone) and psychopathic personality traits. The hypothesis was accepted. However, there is no significant moderation found of cortisol on the testosterone and violent delinquency relationship, also no main effect of testosterone on violent delinquency was found. Testosterone did not correlate to any other variable or subscale than cortisol, which is unexpected. Psychopathic personality traits are a strong predictor for violent delinquency. The explanatory model, as described in the introduction, tested significant. However, this is mostly because of the strong relationship between psychopathic personality traits and violent delinquency. Adding testosterone with cortisol as a negative moderator did not add predictive value. The model was equally significant (p < .001 and p < .001 respectively) without testosterone and cortisol, meaning testosterone and cortisol might not be useful in practice when trying to predict violent delinquency.

An explanation of the absence of most expected relations of testosterone might be the nature of the data. The testosterone data used for this study has been LOG-transformed to acquire normality, suggesting the data was skewed. LOG-transformations can result in a lack of variability which can cause the fact that no relationship is found. However, when analyzing the frequencies of the non-LOG-transformed testosterone data, the mean score of 289.26 pmol/L is not high compared with reference values among the general population, being between 250 pmol/L and 800 pmol/L (ReferentiewaardenTestosteron*-*SHBG, 2020). The distribution of the non-LOG-transformed data was close to normality. However, after running the same analysis as was done for the hypothesis, testosterone still did not have a relation with other variables, except cortisol and the YPI behavioral subscale. This means the nature of the testosterone data cannot be the explanation of the absence of any relation.

A second explanation could be the type of measured testosterone, since there are two types. However, the data contained free testosterone (measured in pmol/L) and not total testosterone (measured in nmol/L). This form of testosterone has the most influence on the body and behavior (Mijnlabtest, 2020). Additionally, previous studies did not specify which type of testosterone was used (Dabbs, et al. 1991; van Bokhoven, et al. 2006; Popma, et al. 2007). Both explanations considered, it must be concluded based on the results of this study that testosterone cannot be used as a predictor for violent delinquency among delinquent male adolescents.

**Limitations**

 A major downside of this study is the normality of the gathered data. As shortly discussed above with testosterone, other data in the dataset was skewed as well. Only the reactive and total scale of the RPQ are normally distributed. This means that the analyses were done with a high number of LOG-transformed variables. This can result in a lack of variability in the data and therefore the results must be carefully interpreted. However, the expected relationship for psychopathic personality traits is found and the skewness of the testosterone data is not the cause of the absent relationship. This means the skewed data could still be used for this study. Another limitation lies in the nature of the sample. Since the inclusion criteria resulted in a sample with adolescents who were already in a closed facility for their delinquent behavior, the only difference that could be investigated was violent delinquency versus non-violent delinquency. This limits the relevance of the outcome of this study if the results were to be generalized to the total population, since both groups are delinquent in the first place. The nature of the sample did also have an important upside. The literature suggested a relationship between testosterone and delinquency among adolescents when non-delinquent adolescents are compared with delinquent adolescents (Dabbs, et al. 1991; Van Bokhoven, et al., 2006; Popma, et al. 2007). However, with this large clinical sample there is no relationship found for testosterone. This could mean that the literature on the relationship between testosterone (cortisol) and delinquency among adolescents needs some careful interpretation.

 A second limitation is the partial overlap in the operationalization of psychopathic personality traits and violent delinquency. For example, impulsivity is assessed in both questionnaires and a lack of empathy can also play a part in the overlap. This may lead to some form of multicollinearity. This must be further investigated to validate the value of psychopathic personality traits as a predictor for violent delinquency.

**Future research**

Future research should be more focused on psychopathic personality traits, once the value of psychopathic personality traits is validated. These traits can be a strong predictor for violent delinquency among adolescents. A broader sample will be of more relevance in predicting violent delinquency among adolescents. Based on the results of the current study, testosterone does not seem to be a predictor of value. However, Popma and colleagues (2007) did find a significant moderation effect of cortisol on the relationship between testosterone and aggression, as well as a main effect. This could be due to the use of a different questionnaire to measure aggression, since the nature of the sample was relatively comparable (including delinquent male adolescents). It can be investigated further to clarify the role of these hormones on violent delinquency, but it seems better to shift the focus more towards psychopathic personality traits and different samples. Anyhow, it has become more clear that there is a lot to learn about which traits or biological measures are most responsible for the development of violent delinquency, since there are contradictories in the literature.

**Conclusion**

The most important finding is the predictability of violent delinquency among delinquent adolescents by means of psychopathic personality traits. When investigated further, it can be of great use in predicting and preventing violent delinquent behavior. If so, it might help dropping the rates of committed crimes by adolescents along with all the collateral damage. Testosterone and cortisol should not be the main predictor in this relationship, since their predicting value does not seem to be present for adolescents. If these results are to be found in a broader sample, the relationship would be valuable in assessing risks and preventing crimes. This can be done in several ways. Firstly, by introducing the YPI-s at elementary schools to figure out which children are sensitive for the development of violent delinquency. When some of these children score high on the questionnaire, they can receive a course to help mitigate their behavior in the future. This way violent delinquent behavior can be prevented before it happens. Secondly, the YPI-s can be used among adolescents who have committed their first offense. When they score high on the YPI-s they have a greater chance that they will repeat their violent delinquent behavior. They can receive extra guidance or a form of schema therapy to prevent them to engage in these behaviors again. Schema therapy seems to be a good strategy to approach the behavioral problem, since schema therapy focuses on the core needs of an adolescent and is used for treating personality disorders by changing their core motivators for their behavior. Lastly, if the YPI-s is to be introduced in elementary school, the parents of children with a high score can be informed of the risk of their child getting violent delinquent in the future. With pedagogic strategies the parents may prevent it in their upbringing of the child. However, a label of possible violent delinquent behavior for a child which has not yet displayed any of this behavior might have negative consequences for the child.

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**Appendix**

**Appendix A**

*A-priori G-power analysis*



*Note.* An a-priori G-power analysis was performed with a small effect size, resulting in a required sample size of 262.