Relationship Between the Level of Serotonin in Human Blood and Aggressive Behavior

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Abstract. Aggressive behavior phenomenon has shown its negative influence across societies all over the world. Number of studies has shown the relationship between the level of serotonin in the blood and aggressive behavior. In this study several blood samples were taken from a group of prisoners with different backgrounds to determine their level of serotonin. The results were analyzed using ANOVA, independent samples T-test and the Pearson Correlation to find the relationship between aggressive behavior and their level of serotonin with some degree of variation. A significance difference was found between the level of serotonin and gender (P < 0.001), nationality (P < 0.01) and more aggressive crimes (murder), in comparison with drug dealing crimes (P < 0.04), and other crimes like bribery, forgery, stealing (P < 0.01). On the other hand, there was no significance difference in the serotonin level with both vice crimes (P > 0.05) and age (P > 0.05). The result also showed a very weak relationship between the level of serotonin and responses on the aggression questionnaire (-.074), perhaps because there was no transparency or credibility from the prisoner while they were completing the aggression questionnaire.

Keywords: aggressive behavior, serotonin, prisoner, Blood analysis.

Introduction

The spread of individual and collective struggles, as well as the increase in people’s needs and the aspirations to a better life, has led to the emergence of aggressive behavior which takes several patterns. Such
phenomena, therefore, have received the attention of many scientists in an attempt to limit them. Abdul-Moatie\textsuperscript{[1]} states that the most important causes of developing the aggressive behavior include family disintegration and the continual disagreements among family members.

Number of psychologists believe that, aggression is a response to frustration as it increases with the increase in feelings of frustration\textsuperscript{[2]}. One of the most important psychic factors is mentioned by Al-Maghrabi\textsuperscript{[3]} who stated that the incidence of aggressive behavior is mainly due to the lack of self-confidence that leads to failure in assuring existence and exhibiting potentials promotes aggressive behavior.

From the biological side, emotional tension results hypertrophy of the thyroid gland and an increase in its secretions while depression leads to a lack of its activity and declining secretions\textsuperscript{[4]}. In addition, Hamuda\textsuperscript{[5]} points out that there is a close correlation between the testosterone hormone level and aggression.

The nervous system’s main function is to maintain the internal balance status which faces disturbance continually due to changes in life conditions\textsuperscript{[6]}. Therefore, as mentioned by different investigators many factors affecting aggression may arise. One of such new factors include the decline of serotonin from the brain than standard levels. As reported by Carper\textsuperscript{[7]} serotonin is considered the most studied neurotransmitter due to its effect on all brain aspects that regulate mood. People with low levels of serotonin are more subjected to depression, emotional performance, alcohol addiction, suicide, aggression and aggressive acts. The biological activity of serotonin was also supported by Virkkunen \textit{et al.}\textsuperscript{[8]}, which working on individuals characterized by temerity, criminals and alcohol addicts and postulated an obvious decline in serotonin levels in their cerebro- spinal fluid.

The recorded observation, however, was also supported by Moffitt \textit{et al.}\textsuperscript{[9]}, they concluded that there was a relationship between the decrease in serotonin level and aggressive criminals. The recorded data confirming significant relation between the decline in the level of serotonin and aggressive behavior. These results are in agreement with the result of Pivac \textit{et al.}\textsuperscript{[10]} who conducted a study to show the effects on serotonin level on alcohol addicts on both male and female. The study concluded that the serotonin concentrations in the addict group were less than in the
non-addict group. Likewise, this is consistent with Ferrari et al.[11] who confirmed that the factors affecting the development of aggressive behavior included disorder of society’s problems and serotonin metabolism.

Also as reported by Robson[12] there is a relationship between the rate of decline in serotonin levels in the serum and the aggressive behavior. The study sample contained 23 fierce dogs and 18 ‘regular’ ones. Robson found a significant decline in serotonin in the serum in the fierce dogs. Kavacic et al. [13] point out that serotonin has a huge role in controlling many behavior patterns such as worry, rashness, and aggression. In addition, their study showed that persons who committed suicide had low levels of serotonin.

**Materials & Methods**

The present study is an attempt to find the relationship between serum serotonin levels and different variants of aggressive behavior of prisoners of both sexes of different ages.

**Blood Collection**

In the present study blood samples of 49 adult males and 43 adult female’s prisoners of different ages were collected into serum separation tube gel. The obtained samples were centrifuged at 3000 rpm for 30 minutes and sera were separated to be used for determination of serotonin concentration according to the method of “Immunoassay kits, serotonin EIA, Alpco Diagnostics, USA”.

In addition to serotonin determination a questionnaire was prepared to scale the aggressive behavior rate of each prisoner according to Buss and Perry[14].

**Statistical Analysis**

The Statistical analysis was carried out on the result obtained in order to explore the significant correlation between serotonin level and each of aggressive behavior, age and nationality. Two types of tests were performed, student’’t’’ test and the analysis of variance (ANOVA) using SPSS for Windows (Howell[15]).
Results

The results of the relation between the level of serotonin in human blood and aggressive behavior are shown in Tables 1-6.

According to the data analysis conducted through Independent-Sample $t$-test with the gender variant, there was a significant difference ($t = 4.137$, $p < 0.001$).

**Table 1: Serotonin level of aggressive males and females.**

<table>
<thead>
<tr>
<th>Gender (sex)</th>
<th>Sample Number</th>
<th>Concentration (nanogram /ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>49</td>
<td>340.03 ± 20.51**</td>
</tr>
<tr>
<td>Female</td>
<td>43</td>
<td>205.10 ± 25.54</td>
</tr>
</tbody>
</table>

Values are tabulated as means ± standard errors

** Very highly significant difference $p < 0.001$ in the serotonin rate of decline in females when compared with males.

There is a significant difference $p < 0.001$ in the serotonin rate of decline in females when compared with males.

Likewise, the same test was used with the crime variant (Table 2), where the crime of murder, which represents the most aggressive with drugs promotion. There was a significant difference ($t = 2.025$, $p < 0.04$). In addition, there was a significant difference when comparing murder with other crimes (bribery, falsification and embezzlement), ($t = 3.019$, $p < 0.001$).
p<0.01) Table 3. However, there were not any significant differences when comparing the crime of murder with moral crimes (t =1.162, n.s; Table 4).

Table 2. Serotonin level in murder crimes and drugs promotion individuals.

<table>
<thead>
<tr>
<th>Crime</th>
<th>Sample Number</th>
<th>Concentration (nanogram /ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murder</td>
<td>15</td>
<td>185.01 ± 42.93 *</td>
</tr>
<tr>
<td>Drug dealing</td>
<td>31</td>
<td>289.23 ± 29.86</td>
</tr>
</tbody>
</table>

Values are tabulated as means ± standard errors (Mean ± S.E.)
* A significant difference p<0.04.

Fig. 2. Serotonin level in the serum of two different aggressive murder crimes and drug dealing.

- There is a significant difference p<0.04 of serotonin rate decline in murderers when compared with drug dealers.

Table 3. Serotonin level in the serum of murderers and other crimes individuals.

<table>
<thead>
<tr>
<th>Crime</th>
<th>Sample Number</th>
<th>Concentration (nanogram /ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murder</td>
<td>15</td>
<td>185.01 ± 42.93 *</td>
</tr>
<tr>
<td>Other crimes</td>
<td>28</td>
<td>317.71 ± 31.42</td>
</tr>
</tbody>
</table>

Values are tabulated as means ± standard errors (Mean ± S.E.)
* A significant difference p<0.01
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Fig. 3. Serotonin level in the serum of murderers and other crimes individuals.

- There is a significant difference $p<0.01$ of serotonin rate decline in murderers when compared with other criminal offenders.

Table 4. Serotonin level in the serum of murder crimes and moral crimes.

<table>
<thead>
<tr>
<th>Crime</th>
<th>Sample Number</th>
<th>Concentration (nanogram/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murder</td>
<td>15</td>
<td>$185.01 \pm 42.93$</td>
</tr>
<tr>
<td>Moral crimes</td>
<td>18</td>
<td>$254.13 \pm 39.19$</td>
</tr>
</tbody>
</table>

Values are tabulated as means ± standard errors (Mean ± S.E.)

- There is no significant difference of serotonin rate decline in murderers when compared with moral crimes offenders.

Data recorded for serum serotonin content of different aggressive individuals related to different nationalities (Table 5 and fig. 5), the minimal serum serotonin level was recorded in African individuals ($175.13 \pm 35.38$ ng/ml) followed by Asian individuals ($285.95 \pm 30.64$ ng/ml) and finally Arabian individuals ($314.58 \pm 24.72$ ng/ml) in an increasing order.
Table 5. Serum serotonin level of aggressive individuals related to different nationalities.

<table>
<thead>
<tr>
<th>Nationality</th>
<th>Sample Number</th>
<th>Concentration (nanogram/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arabian</td>
<td>43</td>
<td>314.58±24.72</td>
</tr>
<tr>
<td>Asian</td>
<td>28</td>
<td>285.95±30.64</td>
</tr>
<tr>
<td>African</td>
<td>21</td>
<td>175.13±35.38</td>
</tr>
</tbody>
</table>

Values are tabulated as means ± standard errors (Mean ± S.E.)

- There is a significant difference (p<0.01) in serotonin rate with nationality variant using ANOVA.
- There is a significant difference (p<0.01) of serotonin rate decline in the African nationalities when compared with other nationalities using multi-comparisons.

Fig. 4. Serum serotonin level of aggressive individuals related to different nationalities.

- There is a significant difference (p<0.01) in serotonin rate with nationality variant using ANOVA.
- There is a significant difference (p<0.01) in the serotonin rate of decline in the African nationalities when compared with other nationalities using multi-comparisons.

However, age variant did not show any significant differences in the serotonin levels (f = 0.081, df = 91, n.s).

Table 6. Serotonin level at different age classes.

<table>
<thead>
<tr>
<th>Age Classes</th>
<th>Sample Number</th>
<th>Mean ± S E</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-32 Years old</td>
<td>49</td>
<td>298 ± 39.68</td>
</tr>
<tr>
<td>33-46 Years Old</td>
<td>35</td>
<td>284 ± 44.47</td>
</tr>
<tr>
<td>47-60 Years Old</td>
<td>8</td>
<td>268 ± 67.36</td>
</tr>
</tbody>
</table>

Values are tabulated as means ± standard errors (Mean ± S.E.)
Generally, the relationship between Serotonin Level and Aggressive Behavior was clearly detected.

The aggressive behavior of prisoners was measured using Buss-Perry test \cite{14}. The statistical test used was Pearson’s Correlation Coefficient to scale the relationship between serotonin levels and aggressive behavior. The results of Pearson’s Correlation Coefficient was -0.074, referring to the low correlation between aggressive behavior and serotonin level. This may be attributed to the lack of prisoners’ credibility when answering the questionnaire.

**Discussion**

Aggressive behavior attracts many researchers and scientists looking for its causes - whether psychic, educational, social, economic, physiological or etc... Some studies relied on finding a relationship between serotonin levels in human blood and different patterns of behavior \cite{16-17}. Such studies attributed the change of serotonin levels to the change in tryptophan levels. Young et al. \cite{18} indicated that the decrease in serotonin resulted in a decline of man’s mood, which in turn works to increase irritation, nervousness and aggression. The decrease in serotonin level resulted from a decline in its precursor, the amino acid tryptophan.

The present study adopted measuring the serotonin level in the serum which showed a decline in the serotonin level in females when compared with males. This confirmed the results of Nishikawa et al. \cite{19} study conducted on two groups of males and females where the serotonin level in males and females was scaled through tracking its effect on the brain cortex. The study revealed low serotonin levels formed in females compared with males suggesting that gender may be an important factor for serotonin level differences.

The current study concluded that there was a relationship between serotonin levels and nationality as there was a significant difference in the decline in serotonin levels of subjects with African nationalities when compared with Arab and Asian nationalities. However, there were no previous studies conducted that compare serotonin levels with nationalities, however further studies must be carried out for significance.
The difference in serotonin levels in African subjects may be attributed to the nature of the crimes they committed (murder). Al-Quriti\textsuperscript{[4]} refers to the effect of natural geographical factors including weather, atmospheric pressure, topographic features, land nature, and soil factors on the life of any community, its social system, and the style of an individual’s life. Such factors contribute in affecting individuals’ growth and forming their personal features. In addition environment plays an important role in acquiring customs, traditions and moral character. Furthermore, the environment’s role exceeds such effects to include contributing in developing moods and mental abilities. That may explain the lowness of serotonin levels and increase of aggressive behavior in certain African nationalities as in Somali, Chad, Nigeria, and Ethiopia: nationalities suffering from hard environmental and regional issues and reflected through aggression in individuals.

With regard to the crime factor and its relationship with serotonin levels, results of the present study revealed a decline in serotonin levels in murderers when compared with drug dealers. Also, there was a significant difference in murderers when comparing them with other crimes offenders (bribery, falsification and embezzlement). There was no significant difference found in factors related to moral crimes. Okasha\textsuperscript{[20]} conducted a study on murderers looking at whether there were differences if they were in prison or in mental hospitals. He found that more than 50% of those criminals suffered from odd electroencephalograms as well as other psychic and mental disorders which led to increased aggression.

In addition, Okasha\textsuperscript{[20]} discovered that alcohol plays a serious role in the emergence of aggression and that half the aggressive crimes are accompanied by the criminal’s alcohol addiction. Likewise, stimulants such as nervous system tablets also lead to aggressive behaviors (Kamel\textsuperscript{[21]}). Although marijuana is believed to lead to isolation and quietness, there is some correlation between marijuana smoking and murder, especially assassination. Abdul Qawi\textsuperscript{[2]} refers to the relationship between alcohol and drug addiction and crime and aggression as he claims that one out of four murders is committed while the criminal is under the influence of drugs. In addition, a percentage of alcohol addicts in prisons vary from 40 to 55 %. Alcohol and drugs remove limitations and weaken awareness so that aggressive feelings are dismissed, making a man attack others and commit crimes.
Phil et al. [22] stated in the study conducted on normal males to identify the effect of alcohol on tryptophan amino acid where they were administered a mixture of amino acids as well as alcoholic drink and other nonalcoholic drink. Results showed a decrease of tryptophan amino acid accompanying the alcoholic drink leading to aggressive behavior increase. In a similar study Al-Essawi [23] stated that addicts of drugs and alcohol suffer from hallucinations, disturbances, confusion, disorder, and a lack of direction or place feeling. In addition, they may get a “message” urging them to murder or commit other aggressive crimes as well as commit sex violations, delinquent fire setting, etc.

These studies show the serious effect of alcohol addition and its effect on decreasing the serotonin levels which has a great impact on increasing aggressive behavior due the effect of alcohol on tryptophan amino acid level.

The results concluded through the present study the following: there is no relationship between the serotonin level and different age classes, contradicting the results reached by Frick et al. [24] where they measured the concentration of tryptophan, folate, and Vitamin B in a sample of 43 fit volunteers (21 females, 22 males) whose age classes varied from 34 to 93 years old. The sample was divided into three age classes: 34-60, 61-71, and 72-93. The researchers observed that tryptophan concentration was increased with an increase in age while the folate increased in the middle age group. On the other hand, the Vitamin B concentration did not change in any of the three age classes.

In conclusion - like previous studies:- Serotonin plays an important role in affecting man’s mood, thought, behavior and acts. It also shows a close relationship between its concentration and aggressive behavior. Serotonin as one of the most important neurotransmitter helps the brain to relax. Consequently, it makes man healthier and in better psychic condition which tends to reflect on man’s behavior and acts.

In order to limit the aggression and levels of violence in society, this study provides three recommendations:

1. The nutritional aspect should be attended to with regard to healthy foods which help in building bodies and minds, and this is reflected in improving mood status, behavior and acts. We suggest
serving prisoners meals with a high content of tryptophan such as beans, milk, barely, turkey, and honey.

2. We should care for our youth. The study revealed that they represent the highest sector of prisoners so we have to orient, guide, and help them to develop good behaviors as well as reorientation to spiritual and Islamic values while teaching them useful skills that replace aggressive behavior.

3. The study revealed that some nationalities are more violent and aggressive than others. This helps in identifying persons who try to destabilize home stability and security and precise choosing between nationalities.

References


العلاقة بين مستوى السيروتونين في دم الإنسان والسلوك العدواني

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المستخلص: يعتبر السلوك العدواني من الظواهر الخطيرة على العلاقات بين الأفراد والجماعات مما قد يصيبها بالانفكاك والتصدع ثم الانهيار. وقد أجريت عدة دراسات على السلوك العدواني فأظهرت بأن له علاقة بمستوى السيروتونين في الدم، وفي هذه الدراسة تم جمع عينات من أشخاص بالغين من الذكور والإناث وهم شريحة من السجناء وروعي أن تكون من فئات عمرية وجنسيات مختلفة وأنواع جرائم مختلفة، وذلك من أجل قياس مستوى السيروتونين في المصل بغرض إيجاد علاقة بينه وبين العديد من المتغيرات السلوكية وعلم أهمها نمط الجريمة والتي يتمثل بها السلوك العدواني، كما تم تعبئة استبيان خاص لقياس معدل السلوك العدواني لديهم ومن ثم عمل التحليل الإحصائي للنتائج باستخدام الاختبار الإحصائي ANOVA، واختبار Independent samples t-test وعلاقة مدى العلاقة بين الاستبيان بيرسون Pearson Correlation لمعرفة مدى العلاقة بين الاستبيان الخاص بقياس السلوك العدواني ومستوى السيروتونين لدى السجناء فأظهرت النتائج وجود علاقة بين مستوى السيروتونين وكلا من الجنس والجنسية، والجرائم الأكثر عدوانية، مثل القتل، وذلك عند مقارنتها مع جرائم ترويج المخدرات، مع وجود فرق معنوي عند مقارنة جرائم القتل مع الجرائم الأخرى (الرشوة، التزوير، الاختلاس)، بينما لم يكن
هناك فرق معنوي عند مقارنة جرائم القتل مع الجرائم الأخلاقية، كما أنه لم يظهر فرق معنوي في مستوى السيراتونين لدى الفئات العمرية كذلك كانت العلاقة ضعيفة بين مستوى السيراتونين والاستبيان الخاص بقياس السلوك العدواني وربما يرجع ذلك لعدم وجود المصادفية لدى السجناء أثناء تعبئة الاستبيان.