The Prevalence of 47, XYY Males among Collegiate Basketball Players

Joy Ann Price
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Joy Ann Price
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CHAPTER I

• Introduction

In 1968 Court Brown\(^1\) categorized the acquisition of knowledge concerning the \(47,\text{XY}Y\) male into three major phases. The first phase came about through the accidental discovery of \(\text{XY}Y\) males undergoing treatment for various physical abnormalities. Jacobs\(^2\) ushered in the second phase of research on the \(\text{XY}Y\) after she surveyed maximum security prisoners at a State mental hospital in Scotland and found seven of the 197 examined had an \(\text{XY}Y\) constitution. She described the men as being tall, below average intelligence, and aggressive. Following her discovery intense efforts were made to locate subpopulations of \(\text{XY}Y\) males, particularly in criminal settings. The third phase was to determine the true incidence of the \(47,\text{XY}Y\) anomaly in the newborn population. This was aided in 1971 by the discovery of the fluorescent characteristic of the long arms of the \(Y\) chromosome. This enabled large-scale surveys of male populations to detect multiple \(Y\) anomalies similar to those already being done to identify multiple \(X\) chromosomes. A fourth phase of research into the \(\text{XY}Y\) anomaly was labeled by Borgaonkar\(^3\) in 1974. This phase includes double-bline comparisons of \(\text{XY}Y\) newborns and carefully matched controls, identified at birth and subsequently

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studied at various stages of development, in order to note any differences in XYY males compared with XY controls.

First Phase

In 1961 the first individual reported with a 47,XYY karyotype was described by Sandberg and Koepf\(^4\) as both phenotypically normal and fertile. The man had been married twice and had normal children by both marriages. The man had been karyotyped because he had a child with Down's syndrome.

Cases of XYY karyotypes among phenotypic females have been reported in the literature.\(^1,3,5\) In most instances it has been shown that the individual was a mosaic \((45X/47,XYY)\) and that the 45X line of cells dominated.

In the first extensive review of the XYY karyotype written by Court Brown\(^1\) in 1968, there is a list of 25 of the original articles published on individuals found to possess an XYY constitution. The most common reason for the individuals being studied was for undescended testes and hypogonadism. At that time, Court Brown speculated there might be some association between impaired testicular development and the XYY constitution, as well as a possible link with bone disorders.
Second Phase

Surveys of Mental-Penal Institutions

Although the $47,XYY$ anomaly was reported as early as 1961 it didn't receive significant attention until 1965 when Jacobs reported identifying 3.5 percent XYY males in a survey of a mental-penal hospital in Scotland. She described the XYY patients as tall (mean height of XYY men was 71.3 inches as compared to 67.2 inches for XY controls), below-average intellectually and aggressive. She also examined 266 newborn male babies and 209 randomly selected adult males and found no XYYs. She concluded that a man more than 72 inches tall and in a maximum security prison had approximately a 50 percent chance of being XYY. Her findings ushered in a variety of surveys of special facilities, many of which found high frequencies of XYY men (Table I).

Welch et al.\textsuperscript{6} in 1967 reported a comparable survey done on a prison population in the United States. Only one XYY individual was found in a population screened for height and mental defectiveness and failed to show a strong association between the XYY constitution and either mental retardation or aggressiveness. One factor in his study which might have contributed to its failure was the fact that most of the cases studied were blacks (21 of 35). Later studies\textsuperscript{7,8} show a racial differential in the
Table I

Surveys of Mental-Penal Institutions

<table>
<thead>
<tr>
<th>Author(s) and year</th>
<th>Location</th>
<th>Selection Criteria</th>
<th>Number Examined</th>
<th>Number 47, XYY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jacobs et al., 1965</td>
<td>Scotland</td>
<td>None</td>
<td>197</td>
<td>7</td>
</tr>
<tr>
<td>Welch et al., 1967</td>
<td>Maryland</td>
<td>74 inches*</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>Goodman et al., 1967</td>
<td>Ohio</td>
<td>73 inches</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Telfer et al., 1968</td>
<td>Pennsylvania</td>
<td>71 inches</td>
<td>129</td>
<td>5</td>
</tr>
<tr>
<td>Marinello et al., 1969</td>
<td>New York</td>
<td>72 inches</td>
<td>162</td>
<td>3</td>
</tr>
<tr>
<td>Daly, 1969</td>
<td>Wisconsin</td>
<td>72 inches</td>
<td>210</td>
<td>10</td>
</tr>
<tr>
<td>Debault et al., 1972</td>
<td>Iowa</td>
<td>None</td>
<td>300</td>
<td>1</td>
</tr>
<tr>
<td>Finley, 1973</td>
<td>Alabama</td>
<td>72 inches</td>
<td>208</td>
<td>2</td>
</tr>
<tr>
<td>Wiener et al., 1968</td>
<td>Australia</td>
<td>68 inches</td>
<td>34</td>
<td>3</td>
</tr>
<tr>
<td>Knox and Nevin, 1969</td>
<td>Northern Ireland</td>
<td>70 inches</td>
<td>67</td>
<td>0</td>
</tr>
</tbody>
</table>

*inches refers to height of individuals selected
incidence of XYYs. Similarly Goodman et al.\textsuperscript{9} in 1967 reported 2 XYYs out of a hundred screened at the Ohio Penitentiary. In a Pennsylvania prison Telfer et al.\textsuperscript{10} found five XYYs among 129 surveyed over 71 inches tall. Marinello et al.\textsuperscript{11} examined 162 men over 6 feet tall at Attica Prison, New York and found 3 XYYs. Daly\textsuperscript{12} at the University of Wisconsin examined 210 men over 6 feet tall at four Wisconsin maximum security prisons. Ten XYY males were karyotyped and data collected relating to their psychiatric history, developmental and other physical parameters. The only significant findings were abnormal neurological patterns. The author proposed that a brain dysfunction indicated that the emotional disturbances of XYY men came about from their abnormal genotype. Debault et al.\textsuperscript{13} at the Iowa Security Medical Facility found only 1 XYY out of 300 subjects examined. Finley\textsuperscript{7} in 1973 examined Alabama prisoners and found two XYYs out of 100 white prisoners but no XYYs out of 108 blacks karyotyped, suggesting a bias.

Studies done in other countries include Australia where Wiener et al.\textsuperscript{14} in 1968 found 3 XYYs among 34 prisoners over 68 inches tall. In a prison in Belfast, Northern Ireland Knox and Nevin\textsuperscript{15} found no XYYs when 67 males over 70 inches in height were karyotyped.

Since the majority of the evidence showed an increased incidence of XYY males in prison settings, various inves-
tigators sought to see if the XYY male also showed an increased risk of being found in delinquent juvenile settings (Table II). Hunter in 1968 studied 29 tall males (over the 90th percentile for their ages) in an approved school for boys in England and found 3 XYYs. Hook and Kim karyotyped four XYYs from 337 institutionalized juvenile offenders. Jacobs et al. in 1971 did chromosome surveys in borstal institutions and approved schools on males over 70 inches tall since the previous histories of more than half of the 47,XYY men identified in her Carstairs survey had been in such institutions. Among 1726 juvenile offenders, 5 47,XYY males were identified. Similarly, Duffy and Cervenka in 1971 selected young boys who exceeded the 90th percentile for height for their ages and who showed behavior disturbances, antisocial, asocial, or aggressive behavior. Of 46 juveniles examined no XYYs were found.

During the past decade, from 1965 to 1975, there have been several reviews published on the topic of the XYY male (Table III). Since the majority of the surveys on the XYY were restricted to men over 72 inches tall and were conducted in penal institutions, it is not surprising that the reviews noted an unusual tendency of XYY males to display antisocial behavior and above average height. With respect to physical factors Money, Pitcher, Owen, Borgaonkar and Shah, Kivowitz (with respect to children),
Table II
Surveys of Delinquent Juvenile Settings

<table>
<thead>
<tr>
<th>Author(s) and year</th>
<th>Location</th>
<th>Selection Criteria</th>
<th>Number Examined</th>
<th>Number 47, XYY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunter, 1968</td>
<td>English Approved School</td>
<td>90th percentile* for age</td>
<td>29</td>
<td>3</td>
</tr>
<tr>
<td>Hook and Kim, 1970</td>
<td>Two New York Institutions for Nonretarded Boys</td>
<td>None</td>
<td>337</td>
<td>4</td>
</tr>
<tr>
<td>Jacobs et al., 1971</td>
<td>Scottish Borstal Institutions and Approved Schools</td>
<td>None</td>
<td>1726</td>
<td>5</td>
</tr>
<tr>
<td>Duffy and Cervenka, 1971</td>
<td>Division of Child Psychiatry (U. of Minnesota), Minnesota Juvenile Detention Center</td>
<td>90th percentile for age</td>
<td>46</td>
<td>0</td>
</tr>
</tbody>
</table>

* 90th percentile for age refers to the height of the individuals selected
<table>
<thead>
<tr>
<th>Author(s) and Year</th>
<th>Number of Articles Reviewed</th>
<th>Topic Reviewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Court Brown, 1968</td>
<td>70</td>
<td>XYY Literature up to 1968</td>
</tr>
<tr>
<td>Money et al., 1970</td>
<td>21</td>
<td>Impulse, Aggression and Sexuality in the XYY</td>
</tr>
<tr>
<td>Kessler and Moos, 1970</td>
<td>108</td>
<td>XYY and Criminality</td>
</tr>
<tr>
<td>Pitcher, 1971</td>
<td>48</td>
<td>XYY Syndrome</td>
</tr>
<tr>
<td>Fox, 1971</td>
<td>93</td>
<td>XYY and Criminality</td>
</tr>
<tr>
<td>Owen, 1972</td>
<td>225</td>
<td>XYY Syndrome</td>
</tr>
<tr>
<td>Gardner and Neu, 1972</td>
<td>23</td>
<td>XYY and Aggression</td>
</tr>
<tr>
<td>Kivowitz, 1972</td>
<td>20</td>
<td>XYY Syndrome in Children</td>
</tr>
<tr>
<td>Hook, 1973</td>
<td>139</td>
<td>Behavioral Implication of the XYY</td>
</tr>
<tr>
<td>Borgaonkar and Shah, 1974</td>
<td>282</td>
<td>XYY Syndrome</td>
</tr>
</tbody>
</table>
and Hook\textsuperscript{24} all found no striking mean differences between XYY criminals and XY criminals (excluding height). Owen\textsuperscript{21} speculated that possible neurological aberrations, alterations in testicular cells, and slight cardiac anomaly might, with further data, prove to be predictable with the XYY genome.

In reference to increased aggressive tendencies in XYY males, Kessler and Moos\textsuperscript{25} implicated that there are several types of aggression: predatory, inter-male, irritable, fear-induced, territorial, maternal and instrumental. XYY males may show only certain types of aggression with increased frequency. Fox\textsuperscript{26} pointed out that criminals are not qualitatively different from non-criminals. Non-criminals, as well as criminals, have within themselves the inclination for murder, rape, theft, and criminality in general. The differences between the two groups lay more in their internalized controls and external constraints which bring about or prevent criminal behavior. From the overwhelming evidence reviewed by Gardner and Neu\textsuperscript{27} showing an increased incidence of XYYs in penal settings (1.8 to 12 percent), it would appear that many of these individuals have difficulties with internalized controls and external constraints. With the newborn frequency of XYY males being around 1 per 1000 newborn males, it is evident that many XYYs have succeeded in avoiding penal institutions or, more likely, have succeeded in controlling their behavior through
other means and possibly other forms of aggressive behavior such as athletic competition which, in Kessler and Moos' terms, would come under inter-male aggression.

Surveys Outside of Mental-Penal Settings

In the "Report on the XYY Chromosomal Abnormality" published by The National Institute of Mental Health in 1970, some of the nations leading authorities on the 47,XYY chromosome anomaly cited a need for more research on populations of aggressive men outside penal and related institutions in order to determine whether there are XYY males who have succeeded in directing their aggressive tendencies into more socially acceptable behavior. "It is apparent that there are very complex and varied interactions between heredity and social and environmental influences involved in the social and psychological behavior of the XYY individuals. Under certain conditions the trait of aggressiveness ascribed to the XYY male might manifest itself with maladaptive patterns of behavior while under other conditions the trait might lead to social acclaim."

There have been a few other subpopulations of males, other than institutionalized males, screened in an attempt to find an increased concentration of XYY men (Table IV). Goodman et al. in 1968 examined the chromosomes of 36 basketball players who, by nature of their sport, were
<table>
<thead>
<tr>
<th>Author(s) and year</th>
<th>Selection Criteria</th>
<th>Number Examined</th>
<th>Number 47, XYY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goodman et al., 1968</td>
<td>basketball players</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>Voorhees et al., 1970</td>
<td>severe cystic, scarring acne</td>
<td>300</td>
<td>6</td>
</tr>
<tr>
<td>Vianna et al., 1972</td>
<td>electrocardiograms with prolonged P-R intervals*</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Noel et al., 1974</td>
<td>70 inches tall</td>
<td>2002</td>
<td>7</td>
</tr>
</tbody>
</table>

*P-R Intervals - represents the duration of impulse conduction from the sinoatrial node in the heart.
tall men. Their average height was 76 inches and ranged from 71 to 82 inches. No players were found with an XXY complement but five of the 36 players were black.

In 1970 Voorhees et al.\textsuperscript{30} at Ann Arbor, Michigan examined 300 males with severe cystic, scarring acne and found six XYY men. Since severe cystic acne is rare in women it was thought that comparisons between XY and XYY men with and without cystic acne might help in the identification of Y-regulated gene products involved in the pathology of acne. In 1972 Voorhees et al.\textsuperscript{31} wrote a review of all XYY cases in which nodulocystic acne (NCA) was noted or not noted. From their findings, the authors proposed that NCA might be a more useful phenotypic clue than even height as a determinant of an XYY karyotype.

Vianna et al.\textsuperscript{32} in 1972 attempted to identify XYY males by screening a large sample of clinically normal males using their electrocardiograms (ECG). From a file of 30,000 ECGs 34 were selected because of their long P-R intervals. Karyograms from fourteen were obtained and one 47,XYY was identified along with four others possessing abnormally long Y chromosomes. The authors suggested that the great size of the Y chromosomes in the 4 individuals might possibly be duplicate segments. Their finding of 4 males with long Y chromosomes among 14 studied (28.6 percent) is much higher than their incidence in the general population.
(1.5 percent). The finding of one XYY among 14 males studied because they possessed prolonged P-R intervals is suggestive of a correlation between the two abnormalities.

Noel et al.\textsuperscript{33} in 1974 attempted to show that XYY males from the general population could be identified by means of a double-blind psychological evaluation. A sample of the general population was screened from individuals donating blood and undergoing regular health checkups. 2002 males with heights greater than 70 inches were karyotyped and seven XYYs were found. Seven of the XYY subjects and 28 46,XYs then underwent psychological testing by examiners who had no knowledge of the number of XYY persons present. All seven XYYs were correctly identified. The tests involved an examination of maturity level, degree of emotionality and emotiveness and their use of defense mechanisms. From their study the authors saw a need for further investigations into the differences psychologically between normal and XYY men, especially in the realm of aggressive behavior and how these individuals incorporate aggression into their daily lives.

From the evidence collected thus far no one knows with certainty what behavioral or physiological factors are associated with the XYY anomaly. Jonathan Beckwith of Harvard and Jonathan King of the Massachusetts Institute of Technology are of the opinion that further studies of the genetic basis for antisocial behavior in the XYY are ill-
advised. They charge that studies are unethical and harmful to subjects who would be stigmatized by being labeled XYY. Culliton quotes them as saying "...we feel that the major effort in approaching the issue of behavioral problems should be one of changing the social and psychological condition which generate them." On the other hand, Stanley Walzer and Park Gerald of Harvard Medical School believe that by identifying and studying the development of XYY individuals that behavioral difficulties might be helped. A parent of an XYY wrote in favor of the latter theory which she felt offered more benefit to the XYY individuals as well as the families of such persons.

Third Phase

In 1969 Sergovich et al. screened 1066 consecutive newborn males and found four XYY infants. This gave an incidence rate of 1 XYY in every 250 newborn males which misled many into thinking it might possibly be the most common form of aneuploidy in humans. Then in 1970 Ratcliffe et al. surveyed 3500 newborn males in England and reported five 47,XYY karyotypes giving an incidence of 1 per 700 newborns. Lubbs and Ruddle in 1970 examined 2184 consecutively born males and found 3 47,XYY males, an incidence of about 1 per 700 also.

Prior to 1970, screening of large numbers of male populations for aneuploidy of the Y chromosomes was time-
Table V

Incidence Rates for XYYs in Newborn Populations

<table>
<thead>
<tr>
<th>Author(s) and year</th>
<th>Location</th>
<th>Number Newborns Examined</th>
<th>Number XYYs</th>
<th>Incidence Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sergovich et al., 1969</td>
<td>London, Ontario</td>
<td>1066</td>
<td>4</td>
<td>1/250</td>
</tr>
<tr>
<td>Ratcliffe et al., 1970</td>
<td>Edinburgh</td>
<td>3500</td>
<td>5</td>
<td>1/700</td>
</tr>
<tr>
<td>Lubbs and Ruddle, 1970</td>
<td>New Haven</td>
<td>2814</td>
<td>3</td>
<td>1/700</td>
</tr>
<tr>
<td>Friedrich &amp; Nielsen, 1973</td>
<td>Denmark</td>
<td>2615</td>
<td>3</td>
<td>1/1000</td>
</tr>
<tr>
<td>Walzer et al., 1969</td>
<td>Boston</td>
<td>1931</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Hamerton et al., 1972</td>
<td>Winnipeg</td>
<td>3476</td>
<td>1</td>
<td>3/1000</td>
</tr>
<tr>
<td>Bell and Corey, 1974</td>
<td>Toronto</td>
<td>5395</td>
<td>5</td>
<td>1/1000</td>
</tr>
</tbody>
</table>
consuming and costly. In 1970 reports\textsuperscript{38,39} showed the specific localized fluorescence of \textit{Y} chromosomes using quinacrine mustard or quinacrine hydrochloride provided the needed tool for the easy identification of \textit{Y} chromosomes. Robinson\textsuperscript{40} in 1971 did a pilot study on the applicability of using the fluorescent "\textit{Y} body" from buccal mucosa cells to screen a newborn population. Her results, compared with those done from metaphase analysis of peripheral blood cells, demonstrated little difficulty in identifying double \textit{Y} chromosomes.

Friedrich and Nielsen\textsuperscript{41} in 1973 published the incidence rate for \textit{XXY} males included in chromosome studies done on 5049 consecutive newborn children (2615 males). They identified 347,\textit{XXY} males, an incidence of 1.15 per 1000 male newborns. The authors pooled their data with five other leading research divisions on incidence rates of chromosome abnormalities located at: Boston; New Haven; London, Ontario; Edinburgh; and Winnipeg. The compiled data represented 31,801 consecutive liveborn children (18,254 boys). Incidence rates obtained for the 47,\textit{XXY} karyotype were: London, Ontario\textsuperscript{35} 3.64 per 1000; Boston\textsuperscript{42} 0 per 1931; Winnipeg\textsuperscript{43} .29 per 1000; New Haven\textsuperscript{37} 1.35 per 1000; and Edinburgh\textsuperscript{36} 1.59 per 1000. The average rate was 1.21 47,\textit{XXY} individuals per 1000 male births with the 95 percent confidence limits being 0.77 to 1.81 per 1000 newborn males.
In June 1974 Bell and Corey\textsuperscript{44} published their results at Toronto after screening 5395 newborn males. They identified five XYY babies for an incidence rate of .93 per 1000 newborn males.

Also in 1974, Jacobs\textsuperscript{45} published her results after screening 7849 newborn males and identifying 10 with a 47,XYY constitution, 1.27 per 1000. She noted that the children were phenotypically normal and that none were unusually long. The author combined her data with five other studies from Denmark, Ontario, Winnipeg, Boston and New Haven and came up with an overall incidence rate for the XYY anomaly of .91 per 1000 which is very close to the 1.21 per thousand averaged by Friedrich and Nielsen.

Fourth Phase

As a result of these large-scale screening programs a number of research teams have engaged in long-range studies on these newborn XYY individuals along with matched control 46,XY newborns. The teams are located in Denver, New Haven, and Boston in the United States; Winnipeg and London in Canada; Edinburgh, Scotland; and Denmark. The researchers had hoped to follow the individuals into adolescence in order to better understand any possible physiological or psychological variations in these persons. A great deal of controversy resulted due to this research. Beckwith, King and others claimed that prior knowledge on
the part of the parents and physicians would inadvertently affect the outcome of such studies and that studies done without informed consent violate the individual's rights. As a result of these complaints the screening was stopped and as far as was known in the summer of 1975, no XYY newborn screening was going on in the United States.

One of the first reports published as a result of these studies was by Leonard et al.\(^46\) in 1974 and represented the data collected after 2\(\frac{1}{2}\) years of development. There were only 3 XYY patients of a total of 10 examined with sex chromosome abnormalities. At the age of 2\(\frac{1}{2}\) years the XYY individuals showed no clear evidence of excessive size or aggressive behavior and were indistinguishable from the controls physically and psychologically. A report was planned at 5 years but has been discontinued.

Aetiology, Familial and Ethnic Considerations

It has been shown that the danger of giving birth to a Down's Syndrome child (trisomy chromosome 21) increases with maternal age.\(^47\) The mean maternal age does not appear to be raised in the 47,XYY. The mean age of 55 mothers of cases was 27.8 years, analogous to a control average of 28.\(^47\) Since an abnormal meiotic event must occur in the father in order to produce an XYY, there is no direct reason why maternal age should be raised. The average
paternal age in the cases studied was 30.1 years which is also within the normal range for the general population.

Bell and Cripps in 1974 published chromosome reports on parents and siblings of the XYYs identified in their survey of Toronto newborns. They found no other aneuploidies in XYY parents or sibs but after studying reports of other sex chromosome abnormalities they suggested that the risk to sibs includes autosomal anomalies as well as possible risks of additional sex chromosome aneuploidies.

McWhirter in 1970 considered the possibilities of different incidence rates for XYYs in different ethnic groups. He noted that "since the 'normal' 46,XX and 46,XY karyotypes must be maintained by natural selective forces, it would not be unexpected to find that different types of stabilization may have developed unequally in various ethnic groups of man."

Hook reviewed the possibility of racial differences between blacks and whites in the occurrence of XXY and XYY karyotypes from criminal studies done in the United States. He showed that there were three times as many whites as blacks with these anomalies. He reviewed several studies done on newborn populations, none of which identified any black XYYs out of a total of 19,515 screened whereas 18 white XYYs were found.

No studies were found in the literature which compared the mortality rate for XYY males to that of XY males.
The Purpose of the Research

It was the intent of this research to examine a population of male athletes using fluorescent staining of the Y chromosome to determine if there is a significant difference in the prevalence of 47,XYY males compared to their incidence in the newborn population as reported in the literature.

The study was designed to answer the following questions:

1. What is the prevalence of 47,XYY males among collegiate basketball players?

2. Is there a significant difference in the prevalence of 47,XYY males among collegiate basketball players versus the incidence of 47,XYY males in the newborn population?
CHAPTER II

RESEARCH DESIGN

This research study was undertaken during the winter semester, 1975 at the University of Wisconsin-Oshkosh (UW-O). The population consisted of basketball players, freshmen and varsity, from UW-O and its visiting teams. Seventeen of the original twenty-three teams scheduled participated in the study giving a population size of 184 active players with nineteen individuals on the participating teams refusing smears to be taken. Eighteen former UW-O varsity basketball players were located in the Oshkosh area and included in the study to give a final population size of 202 collegiate basketball players.

The head-coach of each team was contacted when he arrived at the UW-O campus for a basketball game. If permission was granted by the coach each player was also given the option of refusing to participate. Buccal smears were obtained from the subjects in the locker room, either before or, in one instance, immediately following the game. Each player was given a toothpick to scrape the inside of his cheek and then asked to rub the smear onto a fluorescent antibody slide which provided space for two smears. Information concerning the players' heights was obtained from the players' roster. The smears were labeled, air-dried,
and then transferred to a classroom adjacent to the locker room for immediate staining by the method of Klinger and Moser. Labeling of the slides was done either alphabetically or numerically so that the characteristics of the player were unknown to the person staining and viewing the smears. The dried smears of oral mucosa cells were fixed in 95 percent ethanol for about 30 seconds to one minute, air-dried, placed in 3N hydrochloric acid for 1–2 minutes, rinsed in distilled water, placed in McIlvaine's pH 4.1 buffer for 3 minutes and then placed in staining solution (0.05g quinicrine dihydrochloride, G.T. Gurr Ltd., in 100ml McIlvaine's pH 4.1 buffer). After approximately three minutes the slides were rinsed in fresh pH 4.1 buffer and run through 70 percent, 95 percent and two changes of absolute ethanol for about one minute each and immersed in xylene. The preparations were mounted with Neutral Mounting Medium (G.T. Gurr, Ltd.) and the coverslip sealed with clear nail polish to prevent evaporation. Slides were kept refrigerated and viewed, within a week, using a Zeiss fluorescent microscope with an HBO 200 W/4 super-pressure mercury lamp. A BG 38 exciter filter was permanently mounted in the illuminator carrier to allow high transmission of 300nm to 600nm light. Barrier filters 53/44 were used to sharpen the contrast between the fluorescing specimen and its background. The nuclei were very distinct.
and the cytoplasm of the cells fluoresced slightly allowing for clear identification of the cells.

After examination of the 202 slides, four slides were noted with a high frequency of cells with two fluorescent Y bodies. One individual's slide had approximately 50-60 percent of the cells with two Y bodies and the other three had at least 25 percent with double Y bodies. One of the individuals with 25 percent double Y bodies was located on the Oshkosh campus and a blood sample was obtained for chromosome analysis. During the summer of 1975 two of the other three subjects were located at their homes near Milwaukee and blood samples obtained. The fourth subject was not contacted. Written permission was received from all subjects providing blood samples. Two sample tests of each person were run to help assure a successful culture. A modification of a microculture technique developed by Shaw was used to culture leukocytes. The end of the subject's finger was cleansed with 70 percent ethanol, dried and pricked with a sterile lancet. At least three drops of blood were placed into each of two 5ml vials of GIBCO Chromosome Medium 1A with phytohemagglutinin (Grand Island Biological Co., Grand Island, N.Y.). The vials were capped tightly, mixed gently and placed in a 37°C incubator for 3 days. On the third day, three hours before harvesting the cultures, 0.3ml of Colcemid (GIBCO) (10 micrograms per milliliter) was added to each tube to arrest the cells at
metaphase, the cells were mixed and returned to the incubator. At the end of the three hours, the culture was gently resuspended, transferred to a 12ml centrifuge tube and centrifuged at about 600rpm for 2-3 minutes. The supernatant was discarded and 3ml of warm (37°C) 1 percent sodium citrate added using a 9 inch disposable glass Pasteur pipette. Care was exercised not to draw the cell suspension above the narrow portion of the pipette since the cells tend to stick to glass. The cell suspension was allowed to stand at room temperature for 10 minutes, recentered and all but about 9.1ml of the supernatant carefully removed. The tip of the Pasteur pipette was used to resuspend the button of cells, and 2-4ml of freshly prepared cold Carnoy fixative (1 part glacial acetic acid to 3 parts reagent grade methanol) were added. The mixture was stirred immediately. The suspension was allowed to stand for 3 minutes before centrifuging. The old fixative was removed and 1-2ml of fresh cold Carnoy added with mixing. This mixture was allowed to stand five minutes, centrifuged and the fixative removed. Another 1-2ml Carnoy added and the mixture allowed to stand seven minutes. After 7 minutes the suspension was centrifuged, the old fixative removed and 1-2ml of cold Carnoy added with mixing. After standing for 10 minutes the suspension was centrifuged and most of the fixative removed down to about 0.3ml and then the cells were resuspended. Microscope slides (soaked in
70 percent ethanol at room temperature and wiped with lintless cloth) were dipped in 70 percent methanol and 1 to 2 drops of the cell suspension were dropped onto the slide using a Pasteur pipette. The slide was quickly passed through a flame to ignite the methanol. After the flame burned out, the remaining drops of water were blown off the slide. The slides were placed in a slide box and refrigerated until they could be viewed, at which time the slides were stained with Giemsa stain. The slides were stained by placing them in a Petri dish and covering them with staining solution (for 10-15 minutes) prepared by diluting 1ml of Bacto-Giemsa Stain (Difco) stock solution with 20ml of distilled water. The slides were viewed under oil-immersion (970X) and the number of chromosomes in each separate chromosomal spread was counted.
CHAPTER III

RESULTS

A total of 23 basketball teams or 270 players visited the UW-O campus during the Winter 1975 semester, including UW-O varsity and freshmen teams. Seventeen of these teams (74 percent) agreed to participate in the study. There were 199 players on these teams and 184 (93 percent) allowed buccal smears to be taken. Eighteen additional varsity basketball players at UW-O, who at the time were ineligible to play due to injuries, academic reasons (or had not graduated within four years), were included in the study.

Approximately half of the cells viewed from each person contained at least one fluorescent Y body which is in close agreement to Welch and Lee\textsuperscript{52} who found the frequency around 67 percent in cells from adult populations. The rest of the cells showed no fluorescent body either because the cells did not stain properly for unknown reasons or the Y body was entirely lost in the presence of many bacteria. The Y body was clearly distinguishable from bacterial cells. Bobrow et al.\textsuperscript{53} noted a paranucleolar positioning of human Y chromosomes in interphase nuclei, but this researcher noted slightly more Y bodies near the nuclear membrane than the center of the cell.
Tishler et al.\textsuperscript{54} found no evidence for the Y chromosome to be associated specifically with either the membrane or nucleolus. In this study it was found that the Y bodies varied in size and brightness between individuals as was reported by Robinson\textsuperscript{40}.

One possible explanation for varied regions of fluorescence of human chromosomes using acridines as a fluorescent stain is that an electron exchange occurs between quanine and acridine, quenching some of the fluorescence in quanine-cytosine regions of DNA whereas adenine-thymine regions have one less hydrogen bond per base pair for electron exchange resulting in greater fluorescence. This theory is also supported by the observation that the banding pattern obtained by the use of fluorescence-labelled antiadenosine antibodies\textsuperscript{55} is generally equivalent to the pattern obtained by quinacrine staining. The only well-proven function of the Y chromosome is in sex determination and these genes are probably localized in the nonfluorescent area. The intensely fluorescent distal part of the Y chromosome is constitutive hetero-chromatin material\textsuperscript{53} which is compact, granular-appearing chromatin material in which little nucleic acid synthesis occurs. The procedure used to identify this region involves denaturing and reannealing DNA and is thought to demonstrate highly repetitive sequences apparently many of which contain an abundance of A-T base pairs.
After examination of the 202 slides, 52 (28 percent) of the slides were not of sufficient quality to distinguish the subject as a 46,XY or a 47,XY. There were a total of 150 basketball players' karyotypes distinguished, of which 20 (13 percent) were Negro. Previous reports have indicated that the prevalence of 47,XY males in populations of Negroes is significantly lower than their prevalence in Caucasian populations.

The average height of the 150 players was 74.6 inches with a standard deviation of 2.7 inches, a median of 75 inches, a mode of 75 inches and a range of 68 to 83 inches. The average height of a general population of American males is approximately 70 inches according to Clark. Baker et al. found the average height of 23 47,XY males to be 75.4 inches which falls near the median and mode of the present sample of basketball players.

Of the 150 slides examined three were found to have approximately 25 percent of their cells with two fluorescing Y bodies. One additional slide was found with 50-60 percent of the cells containing two Y bodies. In order to confirm their genotypes, these four subjects were karyotyped using cultured leukocytes. One of the males was unavailable for a blood sample. Two of the subjects with 25 percent double Y bodies appeared to be 46,XY after counts were made of at least fifteen chromosomal spreads from each person. Examination of chromosomal spreads from the male showing
50-60 percent double Y bodies confirmed that he possessed 47 chromosomes. The 47,XY was Caucasian and 77 inches tall.
CHAPTER IV

DISCUSSION

The 47,XY Y subject identified in this study was Caucasian, 77 inches tall and, at the time of screening, a college senior. He later graduated from a small private college with a major in sociology. The subject's family lived in a low socioeconomic community. Borgaonkar\(^3\) cited, in his review of family and social class factors of XYYs, that the majority identified were from lower social classes.

A very evident phenotypic feature of the subject was severe scarring acne over his face, shoulders and back. The finding of severe acne in a 47,XY Y male supports Voorhees\(^{30,31}\) hypothesis that acne may be a more prevalent phenotypic feature of an XYY karyotype than either height or aggression.

Borgaonkar\(^3\) states that males with an extra Y chromosome are, on the average, taller than XY males. He reported the average height of 117 adult XYY males as approximately 74 inches. The present study consisted of adult males who averaged 75 inches in height. If XYY males are taller, on the average, than XY males than you might expect to find them more frequently in tall populations of males, such as basketball teams. The present research identified a tall
XYY but the prevalence rate for XYYs among basketball players was not significantly different than their incidence in the newborn population. In light of the results of this research project it cannot be stated that 47,XYY males are found more frequently among above-average height persons in the particular sample used for this study.

Studies have shown that aggressive behavior constituted one of the major personality factors indicative of an individual likely to persist in sports and become a successful athlete. If there is any validity to the assumption that certain 47,XYY males are prone to aggressive behavior, then such individuals would be expected to be found in competitive sports where a marked degree of aggressiveness is usually present. Athletic competition is a more socially accepted mode of relieving aggressive tendencies than that of aggression taken out against property as was exhibited by XYYs found in penal institutions. The present research identified one 47,XYY male in a population of 150 basketball players which is not significant in light of the true incidence rate for 47,XYY males as one in 1000 newborn males. The possibility exists that sports other than basketball (i.e. football) may provide a significant difference in the prevalence for XYYs. High school, college and especially professional sports may all possess varying prevalence rates for XYY males. Furthermore, similar screenings might be attempted to identify XYY males in other
aggressive populations since Kessler and Moos\textsuperscript{25} have identified several types of aggression: predatory, inter-male, irritable, fear-induced, territorial, maternal and instrumental.

The fact that the population of this study consisted entirely of collegiate males indicates that all those screened were at least high school graduates and of at least normal intelligence. Owen\textsuperscript{22} reported a 47,XYY with an IQ between 120-129 and notes that it is likely that all ranges of IQ scores are possible in 47,XYY males. Therefore, the fact that the population consisted of persons near the middle and high range of the intellectual pool should not have been a factor altering the prevalence of 47,XYYs among college men versus the general population. No studies have been reported on the prevalence of XYY males in a random sample of college males. The 47,XYY identified in this study successfully completed college.

Studies\textsuperscript{7,8} have shown a racial differential in the incidence of XYYs. Goodman \textit{et al.}\textsuperscript{29} in 1968 examined the chromosomes of 36 basketball players of which 5 (14 percent) were Negro. The present study consisted of 150 basketball players with 20 (13 percent) being Negro. Approximately the same proportion of Negro to Caucasian players existed in the two studies along with similar height distributions. Goodman's players averaged 76 inches with a range of 71 to 82 inches while the present study population averaged 75
inches with a range of 68 to 83 inches. Apparently Goodman's total population was too small to detect any 47,XYY males. Even if the 20 black players were excluded from the study due to a racial bias in the frequency of 47,XYY males in Negro populations, the results still would not be significantly different from the incidence rate for 47,XYYs in the newborn population.

The 47,XYY male was not informed of the findings of this study in accordance with the suggestions of Kivowitz and Beckman and King. Due to the concern on the part of the researcher for anonymity on the part of the 47,XYY male, no physiological or psychological studies were done. The excessive amount of attention that would follow any further tests performed on the XYY subject would have increased significantly his chances of gaining knowledge of the conclusions. Without telling him the reasons for further tests would have resulted in the subject participating without his informed consent. In view of the widespread uncertainties associated with the XYY phenotype the researcher did not deem the risks involved warranted further testing.
LITERATURE CITED


