Study Of The Isonimic Method To Estimate Consanguinity In Population Of Northern Morocco

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Abstract: the purpose of this study was to estimate the rate of consanguinity and to determine the inbreeding coefficient by means of the analysis of isonymy in the population of Northern Morocco. The study involved a sample of 1586 individuals. These individuals belong ancestrally and linguistically to the population of northern Morocco. Results show that the inbreeding coefficient calculated through the isonymy is (0.0276031), almost twice the coefficient calculated through the relationship (0.0148253). The marriage with the father's brother's daughter (FFP) is the most contracted among the group of isonymous couples with a percentage of 89.16%. In the group of non-isonymous couples, we note that all first cousin links are present without any preference to a given link.

Index Terms: Isonimy, consanguinity, inbreeding coefficient, northern Morocco.

1. INTRODUCTION

Isonimy is a method that reveals higher rates than those calculated using the coefficient of apparent inbreeding [1,2]. Surnames can give information about the migratory history of families, and are commonly used in the study of the genetic structure of human populations [3] and population dynamics [4]. The use of surnames to measure inbreeding was ignored before. There have been studies that have found the link between family names and consanguineous marriages [4], and that surnames could be used to calculate the degree of inbreeding of populations [5]. But we had to wait until 1965, thanks to the studies conducted by Crow and Mange. They have elaborated a standard method to evaluate the consanguinity of a population through a mathematical model developed by the two authors and published for the first time during that year (1965). The surnames were finally used in the study of the genetic structure of human populations. To apply this method, the transmission of surnames must be continuous and without spelling modification or full name change. Other factors may cause deviation from the transmission path of surnames such as adoption. Some types of marriages may prevent the use of the isonomic method as the most incestuous marriage form between brother and sister, while marriages between cousins may give a good estimation of the degree of consanguinity. These unions must be random and without preference or prohibition of a particular type [6]. The isonomic method can look for any resemblance between names by analyzing the history of each family surname in the old archives. This method allows the analysis of ancient genealogies, to find the origins, and links the different branches belonging genealogy studied [7]. This method involves the most profound genealogies, and the oldest unions, changes in surnames becomes weaker towards the older families [8,9].

Family names, as they are transmitted by patrilineal line, appear as genetic markers linked to the Y chromosome [10] [11] [12]. These surnames can give information about the migratory history of families, and are commonly used in the study of the genetic structure of human populations [13], and population dynamics [4].

From a genetic point of view, we can consider the family name as a “gene” that segregates over generations, or as if it was an allele and calculates its frequency. Admittedly, it does not affect public health, but it can undergo mutations, such as changes or graphic errors that are passed down to the offspring. It is also subject to genetic drift, which can cause the disappearance of some names or increase of others. It is also subject to migration because the patronymic moves with its carrier.

2 METHODOLOGY:

The study involved a sample of 1586 couples with informed consent. These individuals belong ancestrally and linguistically to the northern region of Morocco. The socio- anthropological approach was used during sampling to apply specific methods of data collection. However, extensive investigations were carried out to have a large database using a previously prepared survey to answer the following questions:

- Age, sex, birthplace, family name, health problems of volunteer’s couple, his parents and grandparents.
- Relationships of couples belonging to three generations: volunteer’s couple, his parents and grandparents.

1- Calculation of Inbreeding Coefficient:

The inbreeding coefficient ($C_a$) is determined by the average of inbreeding coefficients of all couples constituting the studied sample according to the following formula:

$$C_a = \sum_{i=1}^{n} \frac{n}{P_i F_i}$$

$C_a$ is the summation of the proportion of all individuals $P_i$ in each consanguineous union category $F_i$.

The following formula is used to determine the general inbreeding coefficient for the entire population and for all consanguineous unions [14] [15].
\[ Ca = \frac{1}{9} f_{DFC} + \frac{1}{16} f_{FC} + \frac{1}{32} f_{FCR} + \frac{1}{64} f_{SC} + C_{NR} f_{NR} \]

Where:
\[ F_{NR} = -\frac{1}{8} f_{DFC} + \frac{1}{16} f_{FC} + \frac{1}{32} f_{FCR} + \frac{1}{64} f_{SC} \]
\[ n_{DFC} + n_{FC} + n_{FCR} + n_{SC} \]

\( F_{NR} \) represents the inbreeding coefficient of undefined relationships.

\( f_{DFC}, f_{FC}, f_{FCR}, f_{SC} \) are respectively the frequencies of the unions between: first cousins (FC), second cousins (SC), first cousin once-removed (FCR), double first cousins (DFC), and undefined relationship (NR).

The coefficient of consanguinity is calculated according to two methods: the "paths" method, considered the most used, it consists in determining each of the possible paths from the father to the mother going through a common ancestor [16] [17].

**Inbreeding coefficient of double first cousins (DFC):**

\[ F_{DFC} = \frac{1}{2}(5+1) (1+F_A) + \frac{1}{2}(5+1) (1+F_B) + \frac{1}{2}(5+1) (1+F_C) + \frac{1}{2}(5+1) (1+F_D) = 1/8 \]

**Inbreeding coefficient of first cousins (FC):**

\[ F_{FC} = 1/2(4+1) (1+F_A) + 1/2(4+1) (1+F_B) = 1/16 \]

**Inbreeding coefficient of second cousin (SC):**

\[ F_{SC} = 1/2(6+1) (1+F_A) + 1/2(6+1) (1+F_B) = 1/64 \]

**Inbreeding coefficient of first cousin once-removed (FCR):**

\[ F_{FCR} = 1/2(5+1) (1+F_A) + 1/2(5+1) (1+F_B) = 1/32 \]

**2. Coefficient of Inbreeding by Isonomy:**

The isonymic method considers the family name as a gene, and both couples must have the same surname derived from a common ancestor.

The relationship between the coefficient of inbreeding F and the probability of isonymy P has been established by Crow, J. F. and Mange, A. P. [1]:

\[ F = \frac{P}{4} \]

P: Isonymous couples / Total number of marriages;
F: Coefficient of consanguinity by isonymy.

3 RESULTS AND DISCUSSION:
The percentage of consanguineous couples is 24.78%, this figure is close to the national average 22.79% [18], this percentage is close to that recorded in the region of Doukkala 26.3% [19], however it is lower compared to the percentage denoted in the population of Fritissa of the Middle Atlas (30.32%) [20]. But it is higher compared to that recorded in the 20.06% Gharb population [21] [22]. See table (1). The estimate of inbreeding by isonymy reveals rates, 3 to 4 times higher than those calculated from the inbreeding coefficient [1]. This is due to the ability of the isonomic method to look for any similarity of names and to detect distant consanguinity [23]. See table (2).

In this study, the inbreeding coefficient calculated through the isonymy is (0.0276031), almost twice the coefficient calculated through the relationship (0.0148253), these results are consistent with those found in Morocco in the region of Tétouan et Médiq-Fnideq population [24], in Gharb-Chrarda-Beni Hssen Population [25] and in the Middle Atlas population [26].

Table (3) shows that the marriage with the father’s brother’s daughter (FFP) is the most contracted in the group of isonymous couples with a percentage of 89.16%. In the group of non-ismonymous couples, we note that all first cousin links are present without any preference to a given link.

### Table 1: Calculating inbreeding coefficient through relationship, and the inbreeding coefficient through isonomy

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Coefficient of inbreeding</th>
<th>Number of individuals</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>First cousins</td>
<td>1/8</td>
<td>0.125</td>
<td>1</td>
</tr>
<tr>
<td>Second cousins</td>
<td>1/64</td>
<td>0.01562</td>
<td>5</td>
</tr>
<tr>
<td>First cousin once-removed</td>
<td>1/32</td>
<td>0.03125</td>
<td>8</td>
</tr>
<tr>
<td>Double first cousins</td>
<td>1/16</td>
<td>0.0625</td>
<td>144</td>
</tr>
<tr>
<td>Undefined relationship</td>
<td></td>
<td>235</td>
<td>14.82</td>
</tr>
<tr>
<td>No relationship</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Inbreeding coefficient (Ca)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inbreeding coefficient by isonomy (F)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 2: Distribution of the different consanguinity links in isonymous and non-isonymous groups

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Isonymous couples (n)</th>
<th>Non isonymous couples (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First cousins</td>
<td>83</td>
<td>65</td>
</tr>
<tr>
<td>Second cousins</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>First cousin once-removed</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Double first cousins</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Undefined relationship</td>
<td>75</td>
<td>143</td>
</tr>
<tr>
<td>No relationship</td>
<td>1</td>
<td>1204</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>1425</td>
</tr>
<tr>
<td>Consanguineous %</td>
<td>99.38</td>
<td>15.50</td>
</tr>
</tbody>
</table>

### Table 3: Distribution of the different first cousin links in the isonymous and non-isonymous groups.

Several factors may cause the total deviation of the path of transmission of surnames. According to historical data from the northern region of Morocco, the colonial period and independence played an important role in the choice of family name. Registration in the civil state was reserved for French and foreigners residing in Morocco, following independence in 1956, the Civil Status were extended to all the liberated parts of Moroccan territory [27]. In that time, the registration of surnames was at its beginning, it was made on local criteria and not ancestral for many reasons. These conditions lead us
to ask the question about the real branches of the old genealogies, and about the reliability of the attribution of surnames. Therefore, the family name is considered as a blind gene that is transmitted to the last generations without any estimate of the possibility of kinship.

5 CONCLUSION
Consanguineous marriage is commonly practiced in Arab families to avoid conflict, preserve property, and strengthen family relationships. It is deduced that this particular union is done more between cousins, especially with the father's brother's daughter (FFP) since the ancestors of the couples bore the same family name. Consequently, this behavior contributes to the impoverishment of the genetic heritage and to the increase of homogeneity within the populations.

6 REFERENCES
Tétouan et M’diq-Fnideq (Maroc).

