

## Data Management and Analysis Group

# Transgenerational Ethnicity



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## Transgenerational Ethnicity: How the ethnicity of an infant compares with that of its parents

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### **2001 Census**

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### **Front Page**

The population pyramid presented on the front cover of this *Briefing* is for the Mixed: White and Black Caribbean population of London, 2001 Census.

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## Executive Summary

2001 Census Commissioned Table CO200 provides a unique insight into the relationships between the ethnicities of mothers, fathers and their infant children in London.

In previous ethnic group projections carried out by the GLA it has been impossible to accurately estimate age-specific fertility rates of women in each ethnic group and it has also not been possible to model the ethnicities of their babies. This data from the 2001 Census opens up the possibility of calculating both these aspects of fertility with confidence.

Table CO200 includes data on the family relationships for only 91 per cent of the infants resident in private households. The main reasons for incomplete data are thought to be due to the inability to discern a relationship with the biological mother in the household. This could be because the infant lives with an adult other than their mother, for example a step-parent or grandparent. However, the main reason a relationship could not be established with the infant and its mother is thought to be in the case of large households. At the Census, households with more than five members would have needed to complete a continuation form. There was no relationship question on the continuation form. Therefore if the infant was on this continuation form and the mother on the original Census form, it would not be possible to discern a relationship between mother and infant and therefore the processing of these forms would indicate a household with an infant present but no mother.

For 76 per cent of the infants for whom data is available about their mothers there is also information on the ethnicity of the father. In the remaining 24 per cent of cases either the father was not identified as being usually resident in the household or his ethnicity was not known.

Twenty-one per cent of infants in London do not share their ethnicity with their mother.

While fewer than 20 per cent of infants to South Asian (Indian, Pakistani and Bangladeshi) women do not share their mothers' ethnicity, the equivalent for Black Caribbean and Other Black women is 30 per cent and 40 per cent respectively.

Six per cent of infants to White British mothers have mixed ethnicity.

Forty-one per cent of infants with White Other mothers are categorised as White British.

Black Caribbean and Black Other women have a higher likelihood that their children are categorised as Mixed or in a different Black ethnic group than their own.

True age-specific fertility rates are not possible because there are no data sources that give ethnicity of births and ethnicity of mothers. However the shapes of the 'fertility' curves have been calculated from these data and can be compared with results from using Health Episode Statistics to properly scale the rates up.

The data have been used to create a model that will be used in future GLA ethnic group population projections to estimate the babies' ethnicities from knowledge of the fertility rates of women in each ethnic group and the likelihood of the ethnicity of the fathers.

The key variables identified are:

- Age-specific fertility rates of women by age and ethnic group – London wide
- Probability that the father will be of a particular ethnic group given the age, ethnicity and area of residence of the mother – local (ie borough) level
- Probability that the child will then be of a particular ethnicity – London wide

## Introduction

The aim of this *Briefing* is to present analysis of a commissioned table from the 2001 Census (CO200) in order to better understand the processes leading to how the ethnicity of a child differs from that of its parents, particularly from its mother. The knowledge gained of the processes involved – the probability of a woman of a given age and ethnicity having a child, the ‘selection’ of the father’s ethnicity and the resulting ethnicity of the child – will then be incorporated in a modelling exercise in order to improve the fertility component of the GLA ethnic group population projections model. The *Briefing* describes the modelling process.

The population universe of table CO200 is infants (children under 1 year old) in private households where the mother is present. The table shows:

- The ethnicity of the infant
- The age group and ethnicity of the mother, and
- The ethnicity of the father, if he is present and if his ethnicity is known.

The table contains data for the following groupings of boroughs:

- Central London
- Rest of Inner London
- Outer London
- Greater London

However, this *Briefing* concentrates on results for London as a whole.

The three main variables, ethnicity of infant, mother and father, are available for all 16 ethnic categories from the 2001 Census.

The data and analysis presented here assume a biological link between infants and mothers as well as infants and fathers. This may not be true in all cases as some step-parents may have been represented as parents and some infants are likely to have been adopted. However, this is the only working assumption that can be made.

## **Background: Fertility in the GLA Ethnic Group Population Projections Model**

The birth registration system in England and Wales does not collect information on the ethnicity of the infant or that of either parent, although, following consultation, there are proposals from ONS that these data should in future be collected on a voluntary basis. Without reliable statistics on the ethnicities of births and of parents, reliably projecting fertility in an ethnic group demographic model is extremely difficult.

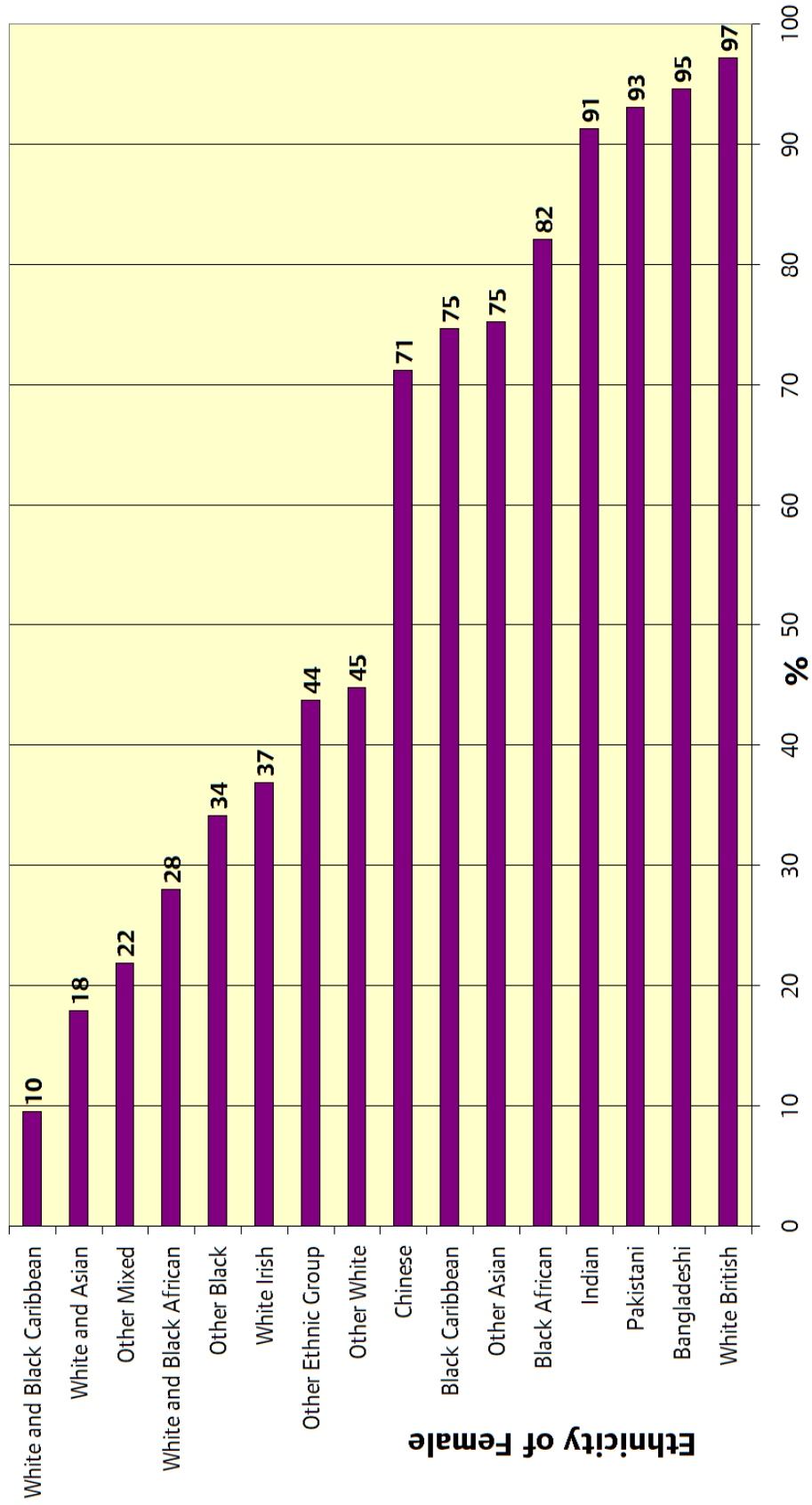
In ethnic group population projections for London based upon the 1991 Census, ethnic category proxies for ethnicity have been used. Birth registrations collect information on the country of birth of the mother. By allocating countries to particular ethnic categories, allowing for the knowledge that many younger women in all ethnic groups will have been born in the UK, and assuming that the ethnicity of an infant is the same as its mother, it was possible to create age-specific fertility rates and therefore project births to women of particular ethnic groups. However, as increasing proportions of successive generations of the ethnic minority populations are born in the UK, the use of country of birth as an ethnicity proxy is increasingly defective. It was also apparent that for some ethnic groups the age structure of the population meant that many of the children categorised as, for example, Black Other, must have had mothers in other groups, presumably Black Caribbean, Black African or White.

The assumption that an infant has the same ethnicity as its mother is an increasingly flawed assumption. Within the UK mixed partnerships are more prevalent in London, given the high ethnic diversity. Recognition of this fact resulted in the inclusion of four mixed ethnic categories in the 2001 Census.

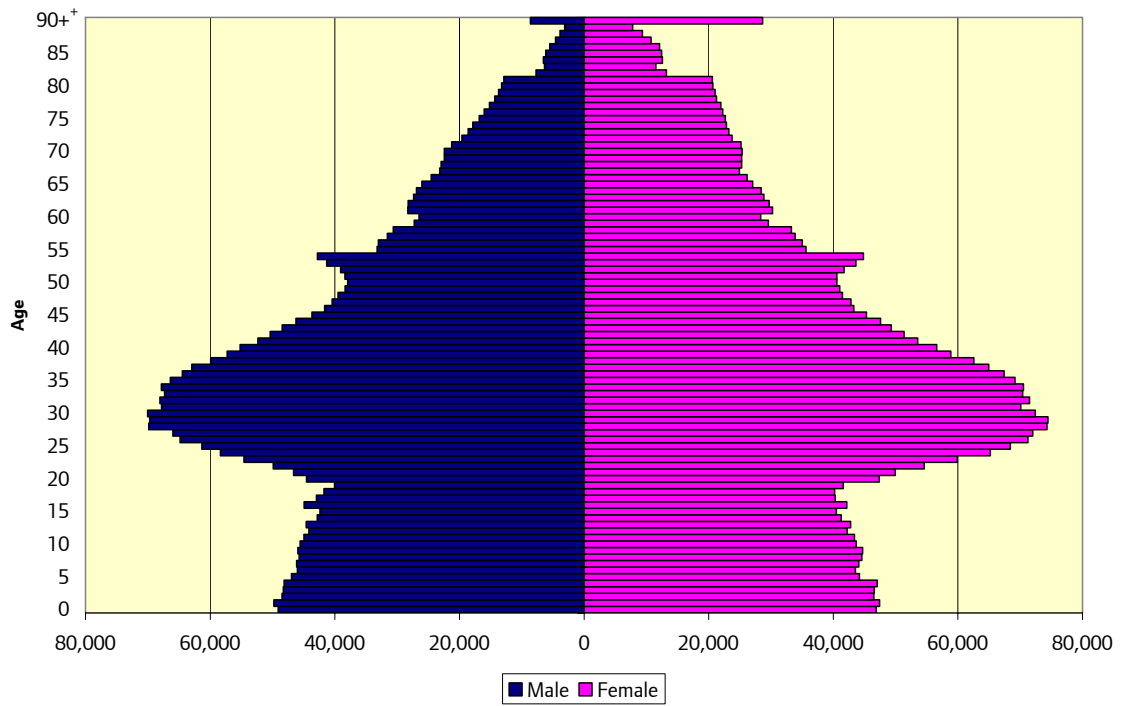
Chart 1 shows for England and Wales the proportions of women in an ethnic group who are married to males of the same ethnic group. There is no ethnic group that only chooses partners from the same ethnic group. The results range from as little as 10 per cent of all Mixed: White and Black Caribbean women marrying men of the same ethnic group to 97 per cent for the White British population. The population pyramids show the age structure of the 2001 Census ethnic category Mixed: White and Black Caribbean compared with that of the Greater London.



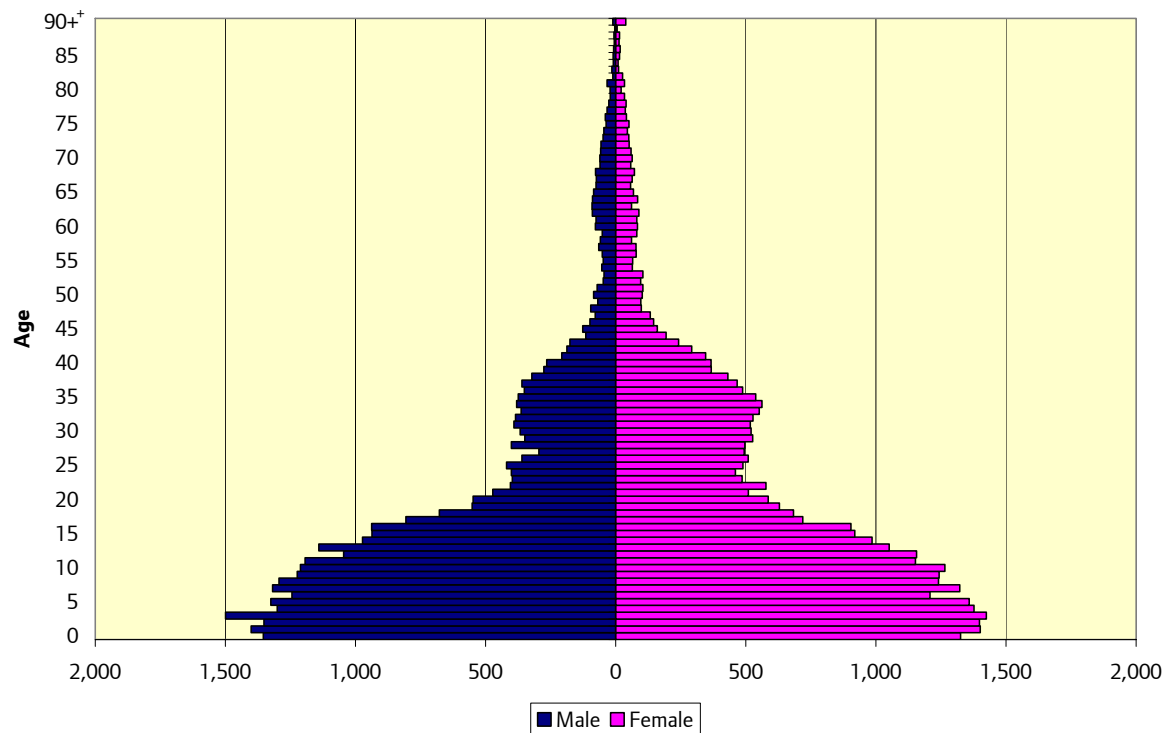
**Chart 1: Proportion of Females married to Males of the same ethnic group**



**Chart 2: Population Pyramid  
All Persons, Greater London  
2001 Census**



**Chart 3: Population Pyramid  
Mixed: White and Black Caribbean, Greater London,  
2001 Census**



The bulge at the base of the population pyramid for the Mixed: White and Black Caribbean population represents a very large number of young people in this group. Under the assumption that the infants (under 1 years old) share the same ethnic group as their mothers, the large numbers of infants would be attributed to the 15-44 year old women in the same population pyramid as their mothers. This would result in an unreasonably high general fertility rate (births per thousand women) of over 140 compared to just 54 in the total population of London.

The large representation of young people in the Mixed: White and Black Caribbean ethnic group is clearly a result of mixed unions. In these cases, by the very nature of mixed ethnicity, the ethnicity of the mother (presumably mostly either White or Black Caribbean) will be different from that of the infant (Mixed: White and Black Caribbean). The women to whom these infants should be 'attributed' are present in another ethnic group and therefore not represented in this population pyramid.

Table CO200 presents the first opportunity for researchers to analyse the dynamic nature of ethnic change between generations. The analysis will help understanding of the extent and likelihood of mixed partnerships as well as assist in improving the fertility components of the ethnic group population projections model. The data in CO200 will be able to:

- Confirm the basic age structure of fertility curves for each ethnic group, and
- Disaggregate the projected births to a woman aged x belonging to a particular ethnic group into the various potential ethnic groups of the child.

The later will be based upon:

- Knowledge of the likely ethnic group of the child's father, and
- Knowledge of the likely ethnicity of the child given the ethnicities of each of the parents.

## Data Issues

The GLA originally requested CO200 at borough level but were denied this request since ONS deemed this level of detail breached disclosure control.

The data set relates to **87,406** infants (children aged under 1), however there were:

- **104,160** births in London in the year before the Census,
- **97,137** infants in the mid-2001 population estimates published by ONS
- **95,970** infants in the 2001 Census, **95,714** of whom were present in private households

Of the 87,406 infants in table CO200, **66,597** had a father present and his ethnicity was known.

There are, therefore, 8,308 (2001 Census figure for infants in private households minus total infants from CO200) infants not represented in table CO200.

It is assumed that there is a biological link between infant and mother as well as infant and father. The 2001 Census form asked a question on the relationships between individuals in the same household. Therefore it would be expected that all mother/father, son/daughter relationships would be included in CO200. It is also possible that adoptions, where the relationships are also legally recognised as mother/father, son/daughter are also included. Step-relationships should not be included in CO200, but if a true stepmother, or stepfather, were recorded on the census form as a mother, or father, then that case would be included in the data. These differences may account for an element of the missing 8,308 infants.

It is understood that the main reason is the inability to discern a relationship with the biological mother in a large household. Families with more than five members would have needed to complete a Census continuation form. There was no relationship question on the continuation form therefore if the infant was on this continuation form and the mother on the original Census form (or vice versa), it would not be possible to discern a relationship between mother and infant and therefore the processing of such forms would indicate a household with an infant present but no mother.

CO200 is an extremely large and sparse data set. With 16 ethnic groups for each of the three individuals, six age groups for mothers and a category if the father is not present or his ethnicity is unknown, the total number of cells amounts to 26,112. Hence the average cell size is a little more than 3.

It has been decided to concentrate the main analyse of the data for the ten ethnic group categories proposed for the GLA ethnic group population projections. This reduces the number of cells in the table to a much more manageable 6,600 and increases the average cell size to 13. This reduction still leaves many cells having been adjusted by ONS to show 0 or 3. While many of these would be 'true' values, particularly the 0s, a significant proportion would have been 'true' 1s or 2s.

In the next section some initial remarks are addressed to an analysis of CO200 for all sixteen groups. Table 1 shows the ten categories as amalgamations of the 16 2001 Census categories. More information on this is available from the authors.

**Table 1**

<u>2001 Census Ethnic Group Categories</u>	<u>GLA EGPP Categories</u>
<p>White British White Irish White Other</p>	<p>White</p>
<p>Black or Black British: Caribbean</p>	<p>Black Carribbean</p>
<p>Black or Black British: African</p>	<p>Black African</p>
<p>Black or Black British: Other Mixed: White and Black Caribbean Mixed: White and Black African</p>	<p>Black Other</p>
<p>Asian or Asian British: Indian</p>	<p>Indian</p>
<p>Asian or Asian British: Pakistani</p>	<p>Pakistani</p>
<p>Asian or Asian British: Bangladeshi</p>	<p>Bangladesh</p>
<p>Asian or Asian British: Other Asian Mixed: White and Asian</p>	<p>Other Asian</p>
<p>Chinese</p>	<p>Chinese</p>
<p>Other Ethnic Group Mixed: Other Mixed</p>	<p>Other Ethnic Group</p>

## Initial Results

Before looking at the results specific to the ten groups used in the projection model, it is valuable to establish the basic statistics for all 16 ethnic groups. Table 2 shows the percentage distribution of the ethnicities of children in relation to that of their mothers. Overall 78.7 per cent of children share their mother's ethnicity, with a range up to 91.7 per cent for White British mothers. However in six groups: White Irish, White Other and the four Mixed categories, less than half of the children share their mother's ethnicity. In all groups other than the White Irish the 'same' ethnicity is the most common outcome, but for the Irish the majority of infants are defined as White British (52.7 per cent).

**Table 2: Distribution (%) of Child's Ethnicity by Mother's Ethnicity**

Ethnicity of Mother:	Ethnicity of Child:							
	Births	Same	White	Mixed	South Asian	Black	Chinese	Other
<b>Total</b>	87,406	78.7	9.4	7.7	0.9	2.5	0.1	0.8
<b>British</b>	45,003	91.7	1.7	5.8	0.3	0.4	0.0	0.2
<b>Irish</b>	2,296	32.1	58.7	7.6	0.3	0.5	0.3	0.5
<b>Other White</b>	10,118	44.6	41.8	10.2	0.6	1.7	0.1	1.1
<b>White and Black Caribbean</b>	785	41.1	16.4	18.1	1.1	23.2	0.0	0.0
<b>White and Black African</b>	542	39.1	21.2	16.6	0.6	20.3	0.0	2.2
<b>White and Asian</b>	626	44.2	32.6	14.5	4.3	0.0	0.0	4.3
<b>Other Mixed</b>	681	47.7	32.6	8.1	1.8	7.2	0.9	1.8
<b>Indian</b>	4,610	83.4	2.9	7.5	2.8	0.6	0.2	2.7
<b>Pakistani</b>	2,287	82.8	3.6	5.1	3.6	0.5	0.3	4.0
<b>Bangladeshi</b>	2,630	88.4	3.5	3.2	2.6	0.2	0.1	2.0
<b>Other Asian</b>	1,919	70.3	9.2	10.6	6.1	2.0	0.0	1.8
<b>Black Caribbean</b>	4,481	69.7	3.2	12.1	0.7	13.7	0.1	0.5
<b>Black African</b>	7,872	83.6	2.7	4.8	0.7	7.7	0.0	0.5
<b>Other Black</b>	729	59.1	5.6	18.4	0.8	15.6	0.0	0.4
<b>Chinese</b>	941	65.6	6.0	24.0	0.6	1.0	0.0	2.9
<b>Other Ethnic Group</b>	1,886	51.5	14.4	24.9	1.4	2.8	2.1	2.9

Other features of this table (and the more detailed statistics that lie behind it) are that:

- White British mothers have 5.8 per cent of their children categorised as Mixed
- Other White mothers have 41.3 per cent of their children categorised as White British
- Children of women of Mixed ethnicity have the broadest range of ethnicities, with over 20 per cent of children of Mixed White/Black women being classed in the Black groups
- 32.6 per cent of children of both Mixed White/Asian and Other Mixed women are classed as White
- More than 80 per cent of children of South Asian women share their mothers' ethnicities
- Black Caribbean and Other Black women have a high likelihood that their children are classed as Mixed or in a different Black group

A major finding is that over 21 per cent of London's infants do not share their mother's ethnicity. Looking at the ethnicities of known fathers helps to establish some more background to the study.

Taken at face value Table 3 shows that nearly 24 per cent of London's infant children were either not living with their father, or the father's ethnicity was not known. This proportion rises to over 50 per cent in the cases where the mother is Mixed White/Black Caribbean, Black Caribbean or Black Other. While Black Caribbean women were mothers to nearly 4,500 infants, only 2,000 Black Caribbean men were identified as fathers. The ratio of known fathers to mothers by ethnic group in this dataset is 76 per cent overall with most groups between 72 per cent (Other Mixed) and 89 per cent (Other White). The exceptions are Black Other (34 per cent), Mixed White/Black Caribbean (40 per cent), Black Caribbean (44 per cent), Black African (56 per cent) and Mixed White/Black African (62 per cent). This means that in drawing inferences about the ethnicity of children based upon known partnerships and known outcomes of such partnerships, particular attention must be made to the higher proportions of missing information for Black and Mixed White/Black fathers.

For most mothers where the ethnicity of the father is known it is the same, but this does not hold true for six groups: White Irish, Other Black and the Mixed groups. More than 50 per cent of the fathers of children born to White Irish, Mixed White/Black Caribbean and Mixed White/Asian women were in other White groups – nearly all being White British. The fathers of children born to Other Black women were fairly evenly spread amongst Other Black, White and Black Caribbean/Black African groups.

Table 4 considers the reduced set of ten ethnic groups. It shows that at least 50 per cent of the infants to each ethnic group of mothers have the same ethnicity as the mother. The White, South Asian and Black African ethnic groups show an excess of 80 per cent of infants and mothers sharing the same ethnic group. In aggregating the number of ethnic groups the main analytical challenges have been reduced to:

- Allocating infants to the White group from the Other Asian, Other Black and Other groups,
- Distributing births between the three Black groups, and
- General allocations to the Other Asian and Other groups.

**Table 3: Distribution (%) of Known Father's Ethnicity by Mother's Ethnicity**

Ethnicity of Mother:	Births	Ethnicity of Known Father:					(Other) (Other) Black	(Other) (Other) Chinese	(Other) (Other) Other
		Unknown Father (%)	Same	White	Mixed	S Asian			
<b>Total</b>	66,597	23.8	78.1	14.6	1.9	1.5	2.1	0.5	1.5
<b>British</b>	36,435	19.0	84.1	10.4	1.6	0.9	1.3	0.5	1.2
<b>Irish</b>	1,868	18.6	36.9	55.7	1.3	1.3	2.8	0.8	1.3
<b>Other White</b>	7,718	23.7	66.4	26.4	2.3	1.1	1.8	0.4	1.7
<b>White and Black Caribbean</b>	276	64.8	8.3	65.6	9.8	2.2	13.0	0.0	1.1
<b>White and Black African</b>	339	37.5	36.0	34.2	8.8	0.9	19.2	0.0	0.9
<b>White and Asian</b>	453	27.6	30.0	53.2	2.0	8.8	0.7	0.7	4.6
<b>Other Mixed</b>	446	34.5	27.1	48.4	4.0	4.0	6.1	1.3	9.0
<b>Indian</b>	3,957	14.2	87.8	7.8	0.6	1.7	0.5	0.4	1.3
<b>Pakistani</b>	1,960	14.3	83.3	6.5	1.6	5.1	1.4	0.2	2.0
<b>Bangladeshi</b>	2,048	22.1	94.1	1.8	0.4	1.8	0.4	0.0	1.4
<b>Other Asian</b>	1,799	6.3	76.0	9.1	1.7	9.4	1.3	0.3	2.2
<b>Black Caribbean</b>	2,174	51.5	58.3	26.0	5.6	1.6	6.1	0.7	1.7
<b>Black African</b>	4,786	39.2	81.9	9.2	2.0	0.6	5.8	0.1	0.3
<b>Other Black</b>	269	63.1	29.4	29.7	6.7	0.0	30.9	0.0	3.3
<b>Chinese</b>	646	31.3	78.6	11.9	1.9	0.9	0.5	0.0	6.2
<b>Other Ethnic Group</b>	1,423	24.5	67.3	22.7	2.5	2.5	1.1	0.8	3.1



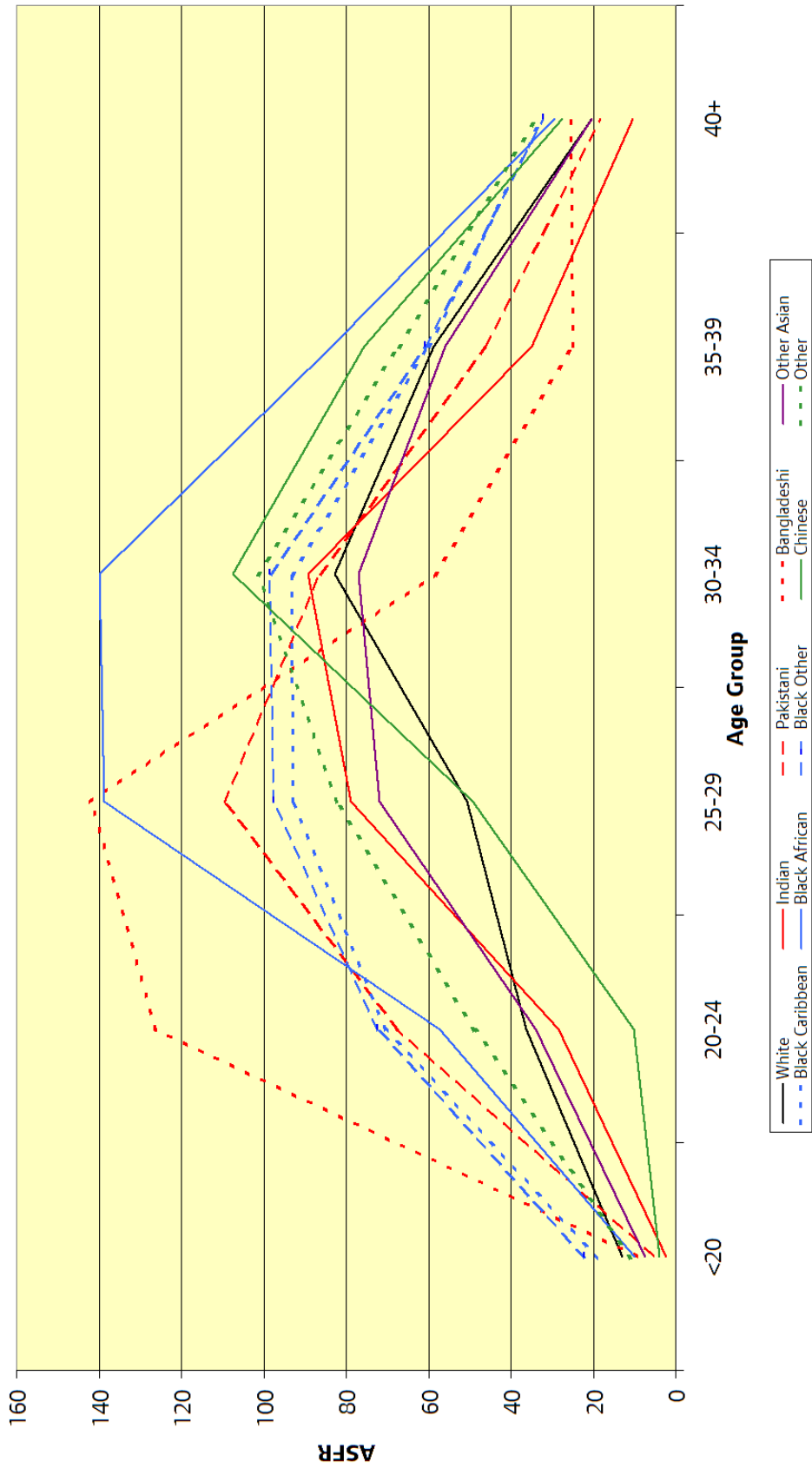
**Table 4: Distribution (%) of Child's Ethnicity by Mother's Ethnicity (10 Groups)**

Ethnicity of Mother:	Ethnicity of Child:											
	Births	Same	White	Indian	Pakistani	Bangladeshi	Other Asian	Black Caribbean	Black African	Other Black	Chinese	Other
White	57,417	92.0	-	0.1	0.1	0.1	1.6	0.1	0.4	4.0	0.0	1.5
Indian	4,610	83.4	2.9	-	2.3	0.5	8.4	0.4	0.2	0.3	0.2	1.5
Pakistani	2,287	82.8	3.6	2.8	-	0.9	7.2	0.3	0.3	0.8	0.3	1.2
Bangladeshi	2,630	88.4	3.5	1.5	1.1	-	3.0	0.0	0.2	0.3	0.1	1.8
Other Asian	2,545	68.7	14.9	2.6	1.8	1.3	-	0.5	0.9	1.7	0.0	7.6
Black Caribbean	4,481	69.7	3.2	0.5	0.1	0.1	0.7	-	5.6	18.1	0.1	1.9
Black African	7,872	83.6	2.7	0.2	0.2	0.3	0.7	1.9	-	9.8	0.0	0.6
Other Black	2,056	54.8	13.9	0.4	0.1	0.3	1.6	8.8	8.1	-	0.0	12.0
Chinese	941	65.6	6.0	0.0	0.3	0.3	6.3	0.6	0.0	0.6	-	20.3
Other	2,567	59.9	19.2	0.8	0.6	0.1	11.9	1.2	1.3	3.2	1.8	-

The reduction of the dataset to ten groups has the merit of conflating the White groups and therefore eliminating the need to consider and model the many transgenerational ethnicity changes contained therein. Many of these changes, which would have been entirely discretionary for the parent filling in the Census form, would probably not have been a concern for parents until the Census form was in front of them. The amalgamation of the relatively small numbers of births to women belonging to Mixed groups into the 'appropriate' Other groups has the merit of having to deal rather less with small numbers in the modelling process. While the choice of amalgamation is pragmatic it does reflect those groups into which many children of mothers in the Mixed groups are categorised.

A spin-off from the data in CO200 is that it is possible to calculate pseudo age-specific 'fertility' rates for each of the ethnic groups as the number of infants can be used as a surrogate for 'births' to mothers by ethnicity and five-year age groups. The calculation will be deficient due to the number of infants being only about 85 per cent of the actual births and all mothers would be an average of half a year older than when their baby was born. It is also necessary to assume that there would be an equal likelihood of the reduction to 85 per cent of births across all ages and ethnic groups. Despite these shortfalls, the advantage of making the calculation is to get confirmation of the relative shapes and levels of the age-specific fertility curves that had previously been calculated using Hospital Episode Statistics (HES) data. See *DMAG Briefing 2004/24 Fertility of Ethnic Groups in London, 2002/03*. Chart 4 shows these rates, which do broadly confirm the main differentials found using HES data: the high rates, particularly in the 20s, for Bangladeshi women, the high rates at late 20s and 30s for Black African women.

**Chart 4: Age Specific 'Fertility' Rates**



## Main Results

The following results all relate to the reduced set of ten ethnic groups and also only to Greater London. While the CO200 data show the distributions of the births in the three borough groups it has been decided to restrict this *Briefing* to dealing with the pan-London situation and leave the grouped data to assist in the final modelling.

Overall 65 per cent of infants in the data set shared their ethnicity with both parents. Chart 5 shows the range from 3.3 per cent for all Black Other infants compared with over 80 per cent for all White infants.

The ethnic group categories with the smallest correlations between the ethnicity of the infant and the ethnicities of the parents are the following categories:

- Black African
- Black Caribbean
- Black Other
- Other Asian
- Other

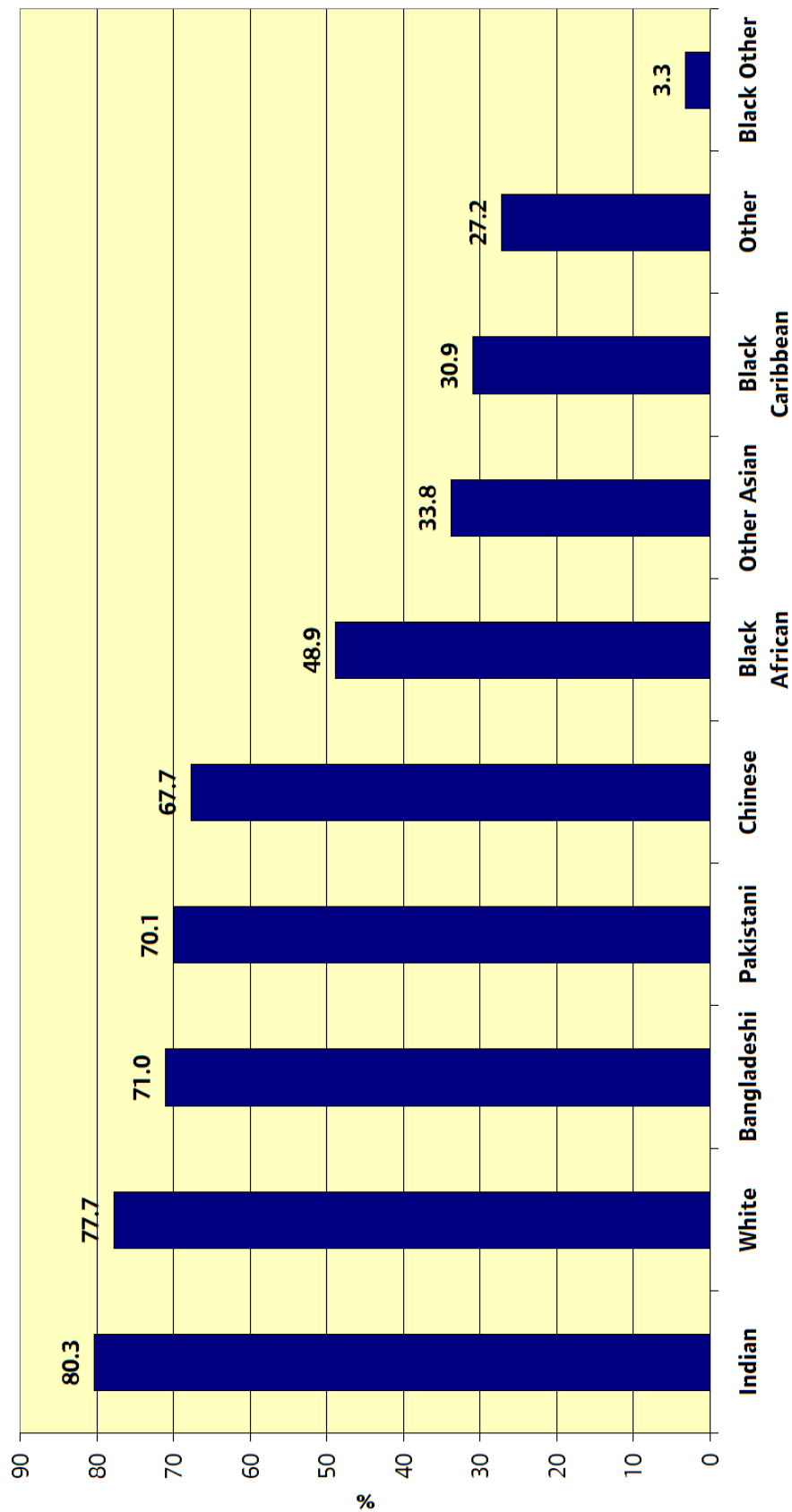
However three of the South Asian groups show a strong correlation between the ethnicity of children and their parents; 80 per cent of all Indian infants, 71 per cent of all Bangladeshi infants and 70 per cent of all Pakistani infants share their ethnicity with both parents.

There is, however, a closer relationship between the ethnicity of infant and the ethnicity of mother. Chart 6 shows the proportions of those infants of a particular ethnic group who share their ethnicity with their mother.

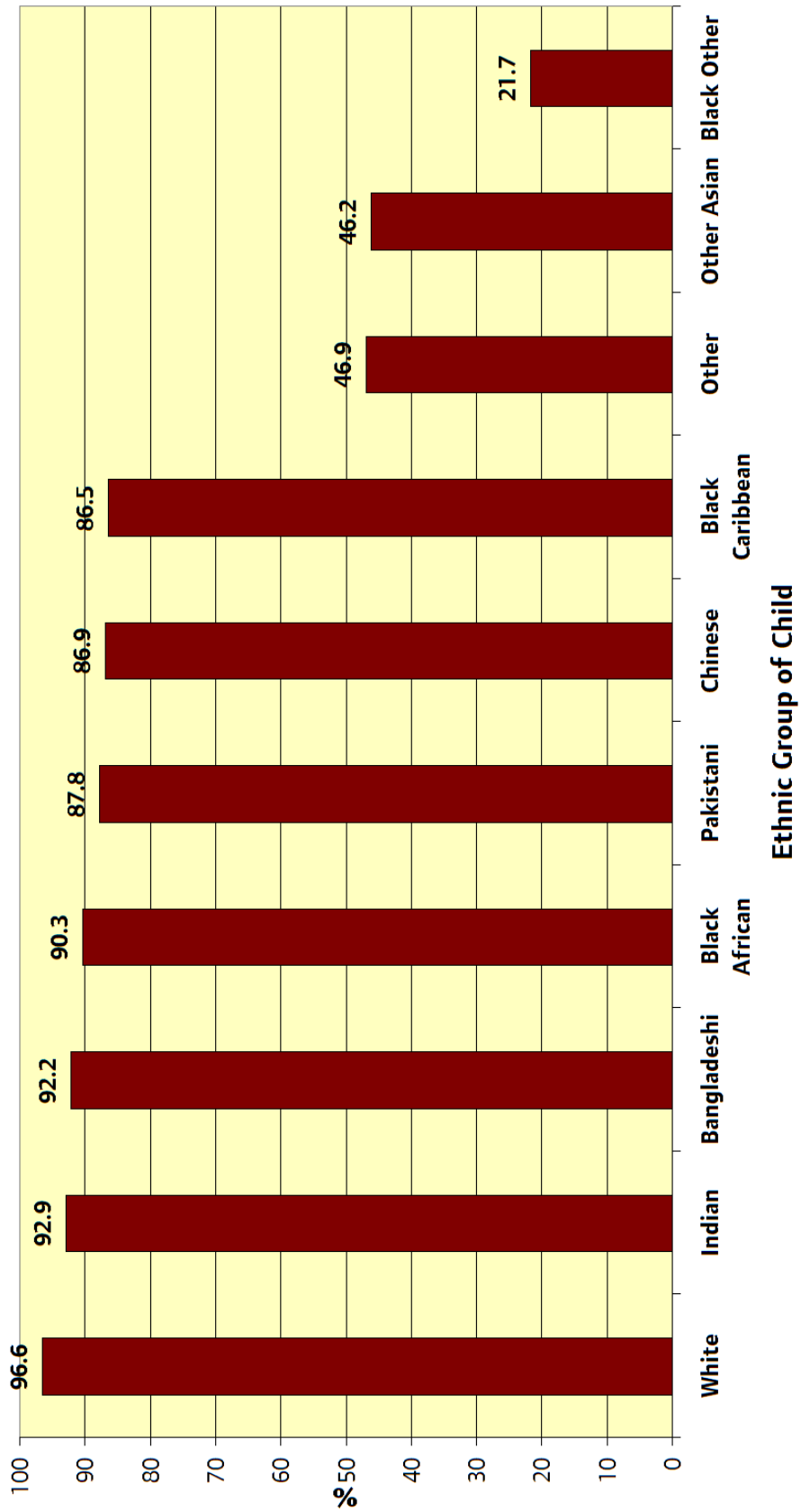
The Other groups (Black Other, Other Asian and Other ethnic group) show noticeably different correlations from those of the other seven ethnic categories. Only 22 per cent of infants in the Black Other group have a mother who is also Black Other, for Other Asian and Other the figures are 46 per cent and 47 per cent respectively. However the remaining seven groups range from 87 per cent (Black Caribbean) to the highest value for infants and mothers who are White, 97 per cent.

In this analysis the Other ethnic groups contain Mixed categories from the 2001 Census (see Table 1). The Black Other group contains the two mixed ethnic categories; Mixed: White and Black Caribbean and Mixed: White and Black African. It would be reasonable to expect a lower correlation between the ethnicity of infants and the ethnicity of the mother for these mixed groups because for infants with mixed ethnicity it is highly likely that their mothers will not be in the same ethnic group. The four subsumed mixed ethnic group categories will be partly responsible for the lower correlations for those categories into which they were subsumed.

**Chart 5: Mother, Father and Child have the same ethnicity**



**Chart 6: Proportion of Infants with same ethnic group as their Mother**



However when analysing the ethnicity of infants relative to mothers, the data show a slightly different picture. Chart 6 shows the proportion of children who have a different ethnicity from the mother as a proportion of all infants to women of that ethnic group.

Chart 7 shows the proportion of infants who have a different ethnic group to their mother. Some 45 per cent of all babies to Black Other women are not categorised as Black Other. However for White women only eight per cent of all infants are not White.

There is a strong correlation between the ethnicity of the infant and that of its mother. However the correlation between infants and their fathers is not as strong. Chart 8 shows what proportion of children share their ethnicity with their fathers.

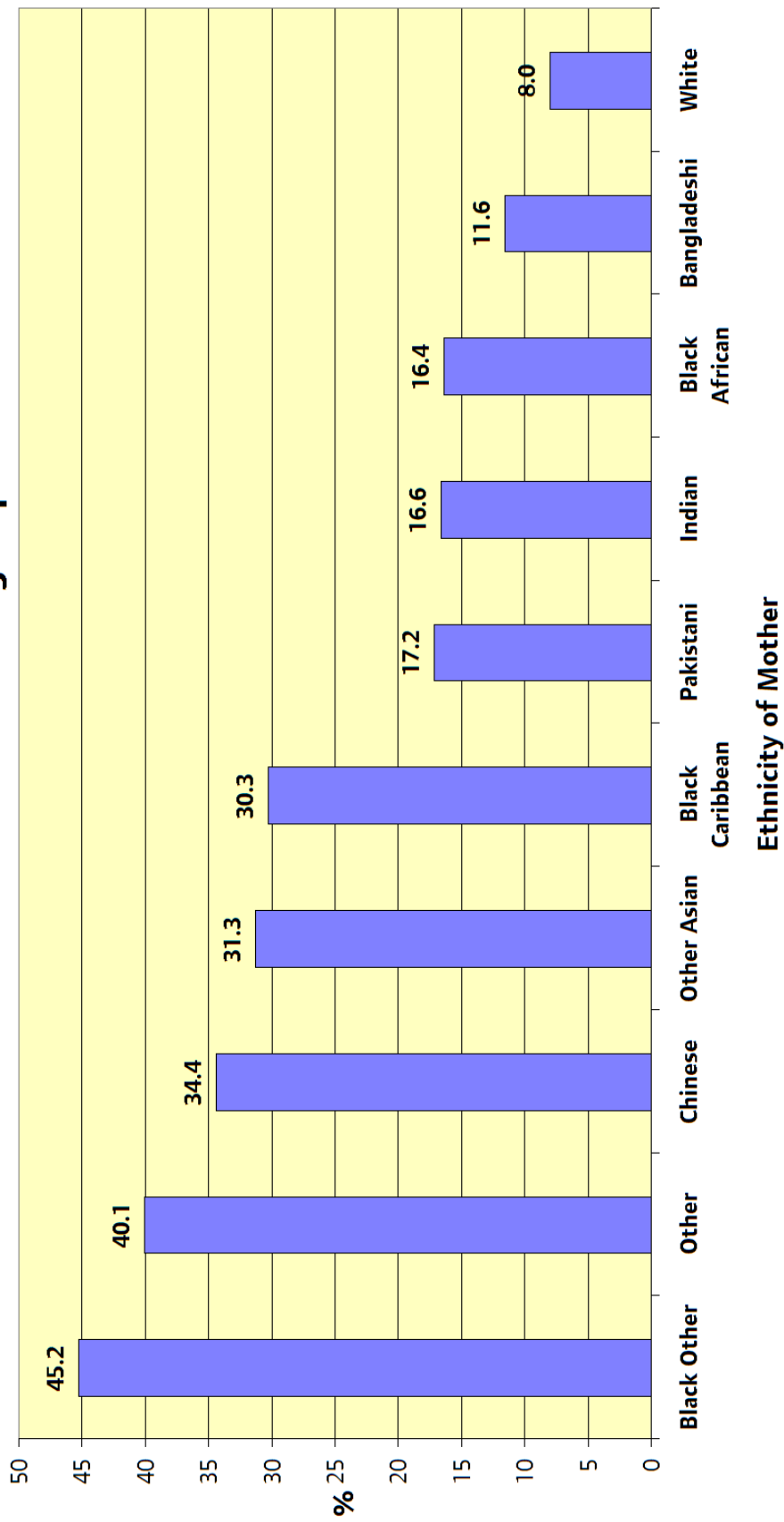
The highest correlation is for Indian infants where 82 per cent have Indian fathers. The lowest is for Black Other infants, where less than 9 per cent of infants share their ethnic group with their father.

These data, however, only include data on fathers where their ethnicity is known. Chart 9 shows the proportion of infants where the father is not present or his ethnicity not known. Twenty-three per cent of infants in the London data set are in a situation where the father is either not present or his ethnicity is unknown.

Of all infants to Black Other mothers and Black Caribbean mothers, 56 per cent do not have the father present or his ethnicity is unknown. For Black African mothers the figure is 44 per cent. However, for the remaining seven ethnic groups all have values below 22 per cent (Bangladeshi) with the lowest 12 per cent (Indian).

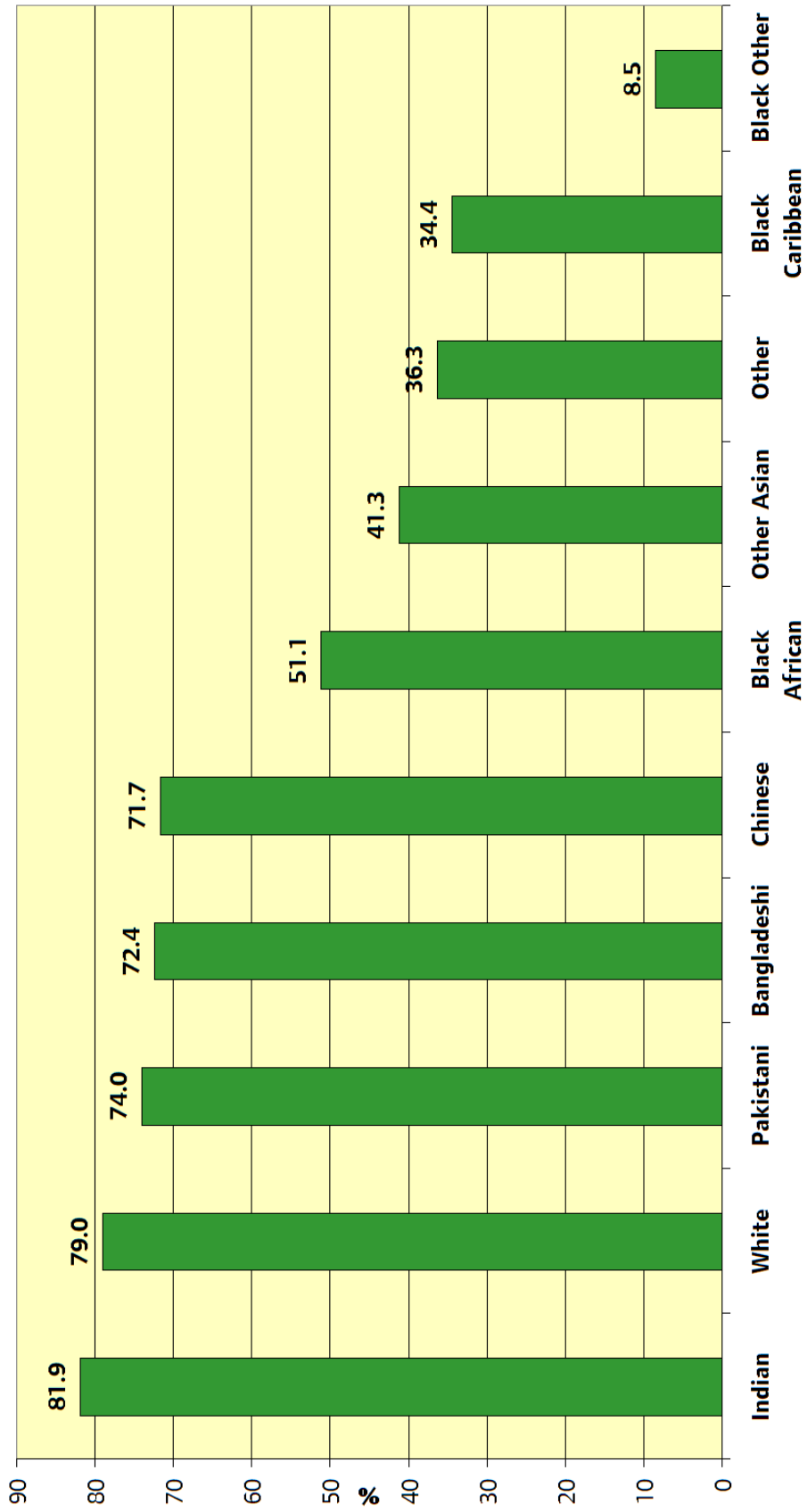
Chart 10 shows the ethnicity of infants as a proportion of all infants to parents of that ethnicity. For example White infants represent 90 per cent of all infants born to White parents. However Black Other infants number 2,660 and infants to Black Other parents number 1,600, hence the higher proportional value of 165 per cent. This is primarily because Black Other is an aggregation of two mixed groups that contain a large number of infants who are not likely to share their ethnicity with their parents.

**Chart 7: Proportion of all infants to women of ethnic group x who are of a different ethnic group**

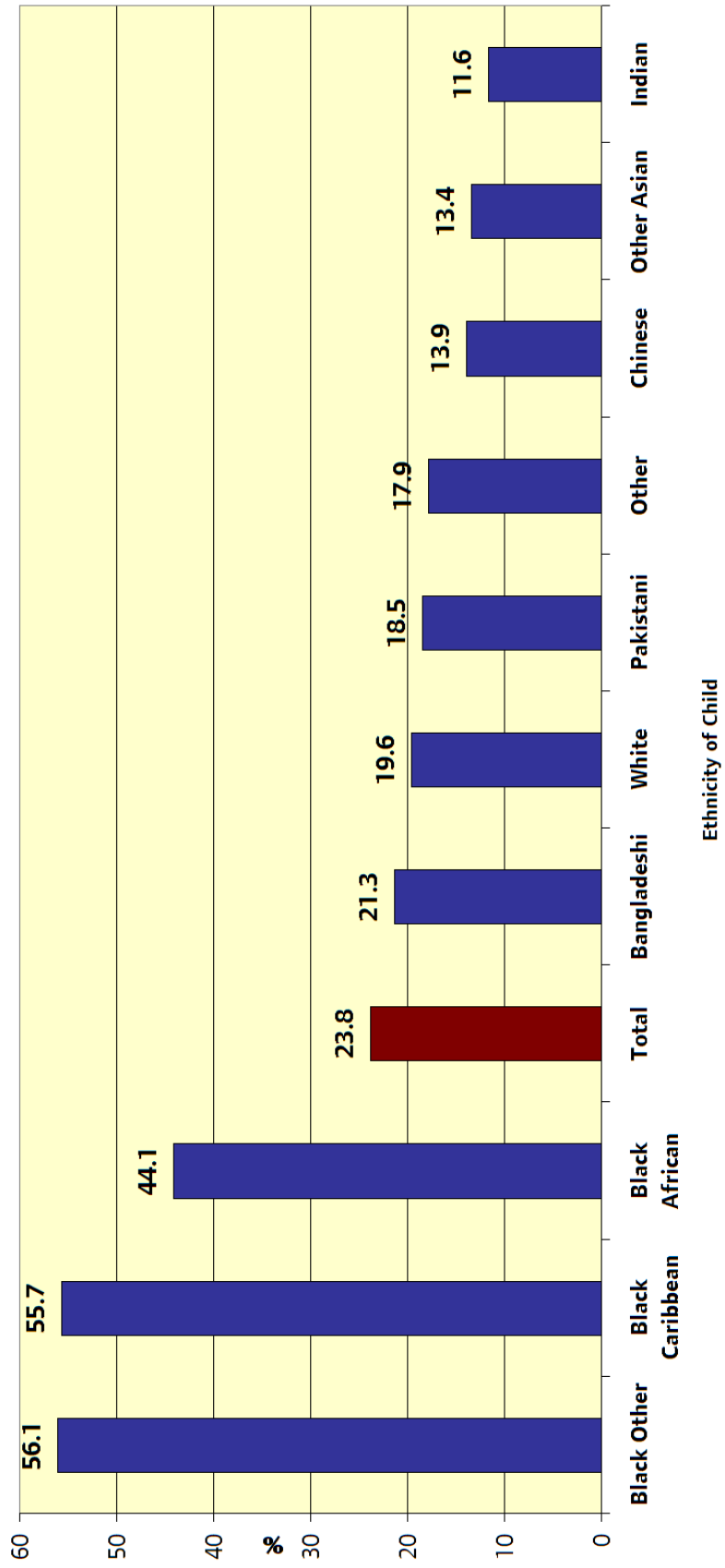




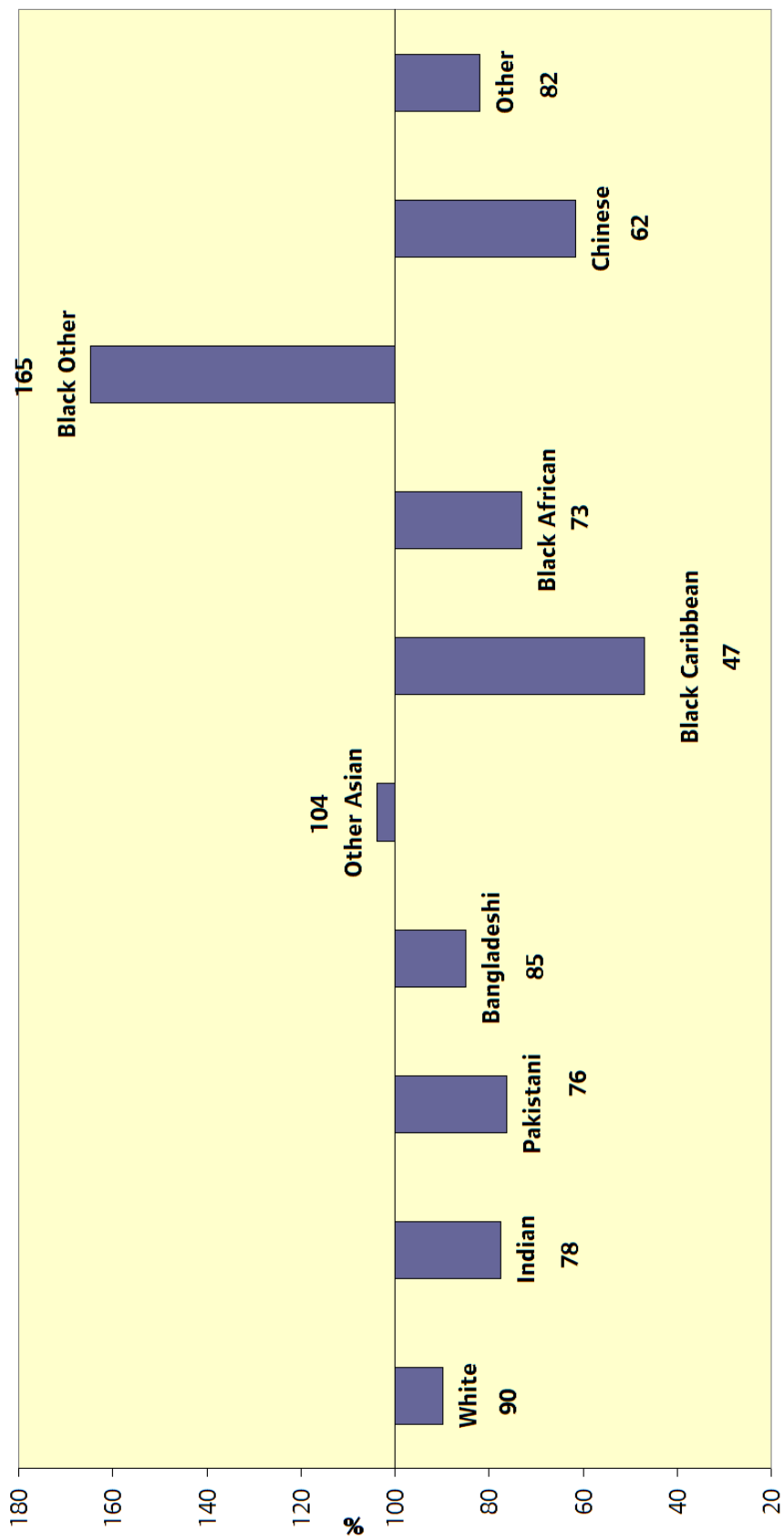
**Chart 8: Father and Child have same ethnicity**



**Chart 9: Proportion of all births where Father not present/ethnicity known**



**Chart 10: Ethnicity of Infants as proportion of all infants to parents of that ethnicity**



## Implementation in Fertility Modelling

Modelling fertility in a standard 'all population' projection model is quite straightforward. The model requires an estimate of the population of women, by age, at risk of having a child ( $P_w(x, A)$ ) together with an estimate of the relevant age-specific fertility rate ( $f(x, A)$ ):

$$B(x, A) = P_w(x, A) * f(x, A) \quad \text{for all women aged } x$$

This produces an estimate of births by age of mother.

Extending this simple model to ethnic groups initially produces the following:

$$B(x, e_1) = P_w(x, e_1) * f(x, e_1) \quad \text{for women aged } x \text{ in ethnic group } e_1$$

This produces an estimate of births by ages of mothers belonging to each ethnic group.

However the model also needs to know the distribution of these births into their own ethnic groups:

$$B(x, e_1, e_2) = P_w(x, e_1) * f(x, e_1) * T(x, e_1, e_2)$$

Where:

$T(x, e_1, e_2)$  is the probability that a birth to a women aged  $x$  belonging to ethnic group  $e_1$  will itself be ascribed to ethnic group  $e_2$ .

Then:

$$B(x, A, e_2) = \sum_{e_1} ( P_w(x, e_1) * f(x, e_1) * T(x, e_1, e_2) )$$

represents all births to all mothers aged  $x$  for which the child belongs to ethnic group  $e_2$ , and:

$$B(e_2) = \sum_x \sum_{e_1} ( ( P_w(x, e_1) * f(x, e_1) * T(x, e_1, e_2) ) )$$

represents all births for which the child belongs to ethnic group  $e_2$ .

In this process estimates of  $P_w(x, e_1)$  and  $f(x, e_1)$  are quite straightforward. The main problem is estimating  $T(x, e_1, e_2)$ . The data contained in table CO200 offers a direct estimate of this three-way matrix for births in the year before the 2001 Census. This is a static matrix that may be a good estimator for a few years but which does not help to explain the dynamic situation in which the ethnic characteristics of the pool of men available to father a child is itself changing through time.

The value of CO200 is that it gives, first, the distribution of fathers' ethnicities according to the ethnicity of the mother and, second, the probability of the child's ethnicity given the age and ethnicity of mother and the ethnicity of the father. Therefore this can be expressed as:

$$T(x, e_1, e_2) = M(e_3 / x, e_1) * C(e_2 / x, e_1, e_3)$$

Where:

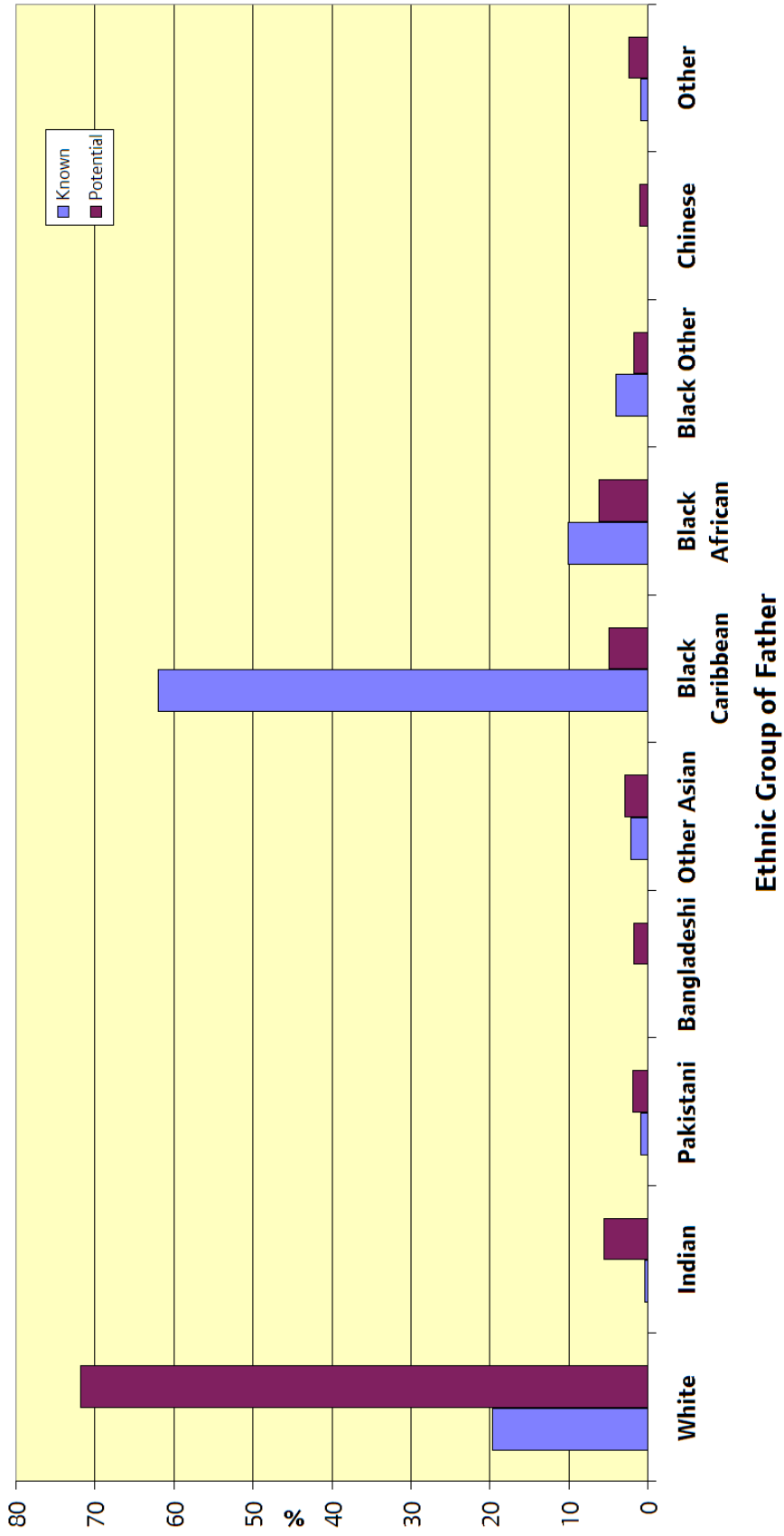
$M(e_3 / x, e_1)$  is the probability that the father of child borne by a woman aged  $x$  belonging to ethnic group  $e_1$  will belong to ethnic group  $e_3$  and  $C(e_2 / x, e_1, e_3)$  is the probability that the child will belong to ethnic group  $e_2$ .

It is possible to establish the values of both  $M$  and  $C$  from the subset of births for which the father's ethnicity is known. The values of  $C$  are likely to be stable, both through time and for different areas, but  $M$  is likely to change as the characteristics of the male population also changes, through time and by area. It is therefore necessary to deconstruct  $M$  given the present structure of the pool of potential fathers and the likelihood of particular partnerships forming.

It is first necessary to define the pool of potential fathers. The following example is based upon using the population of London as the limits of the pool for practical reasons. Firstly, it is easy to manipulate Census statistics for a common area of residence of the mothers and the potential fathers and, secondly, the application within the ethnic group projection model for London will also require limiting to the same population of London residents. Data for mothers is broken down into the following age groups <20, 20-24, 25-29, 30-34, 35-39, and 40 plus. The ages of the fathers are unknown. It may be practically assumed that the fathers are drawn principally from the same age groups as the mothers or, more reasonably, from a slightly wider group. In the example presented here it is assumed that Black Caribbean women aged 30-34 will draw partners, or their children's fathers, from the pool of men aged 30-39 resident in the same area. Chart 11 shows the distribution of the pool of potential fathers and compares them to the actual known fathers.

This clearly shows that although over 70 per cent of the pool is formed of White males these only appeared to make up 20 per cent of the fathers. There is, naturally, a very strong bias towards Black Caribbean males, while Black African and Black Other males are also relatively overrepresented as fathers.

**Chart 11: EG of Known Fathers and Potential Fathers  
(Black Caribbean Women aged 30-34)**



Converting these data to odds ratios, as in Chart 12, shows how particular the selection of partners/fathers is. Note that the data did not reveal any Bangladeshi or Chinese fathers of Black Caribbean women's children hence odds ratio values of zero for these ethnic groups.

Using the odds ratios (R) and the distribution of the pool of males enables the expression for M to be rewritten, as follows:

$$M(e_3/x, e_1) = (P_{M, x, e1}(X, e_3) / P_{M, x, e1}(X, A)) * R_{x, e1}(e_3)$$

Where:

$P_{M, x, e1}(X, e_3)$  is the male population in the wider age group X (associated with x) in the ethnic group  $e_3$ , and:

$R_{x, e1}(e_3)$  is the odds ratio for males of ethnic group  $e_3$  who are the fathers of children borne by women of age x and ethnic group  $e_1$ .

Therefore:

$$B(e_2) = \sum_x \sum_{e1} ((P_w(x, e_1) * f(x, e_1) * ((P_{M, x, e1}(X, e_3) / P_{M, x, e1}(X, A)) * R_{x, e1}(e_3)) * C(e_2/x, e_1, e_3))$$

We now have an expression to test in which the data from CO200 has been converted to the 'constant' expressions R and C and with the ability to pick up dynamic change in the population from the populations of males and females found within the projection process.

**Chart 12: Odds Ratios by EG of Potential Fathers  
(Black Caribbean Women aged 30-34)**

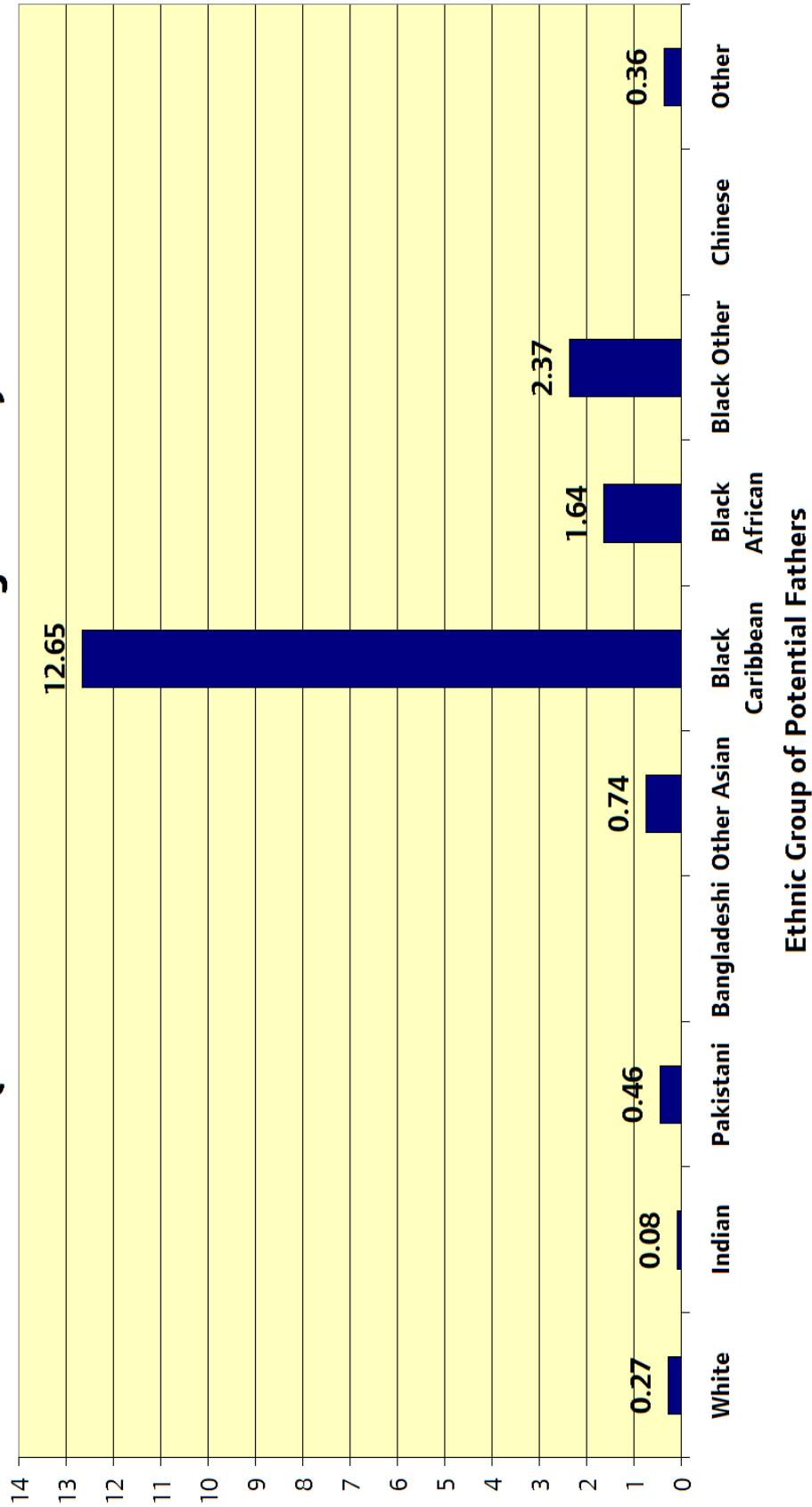
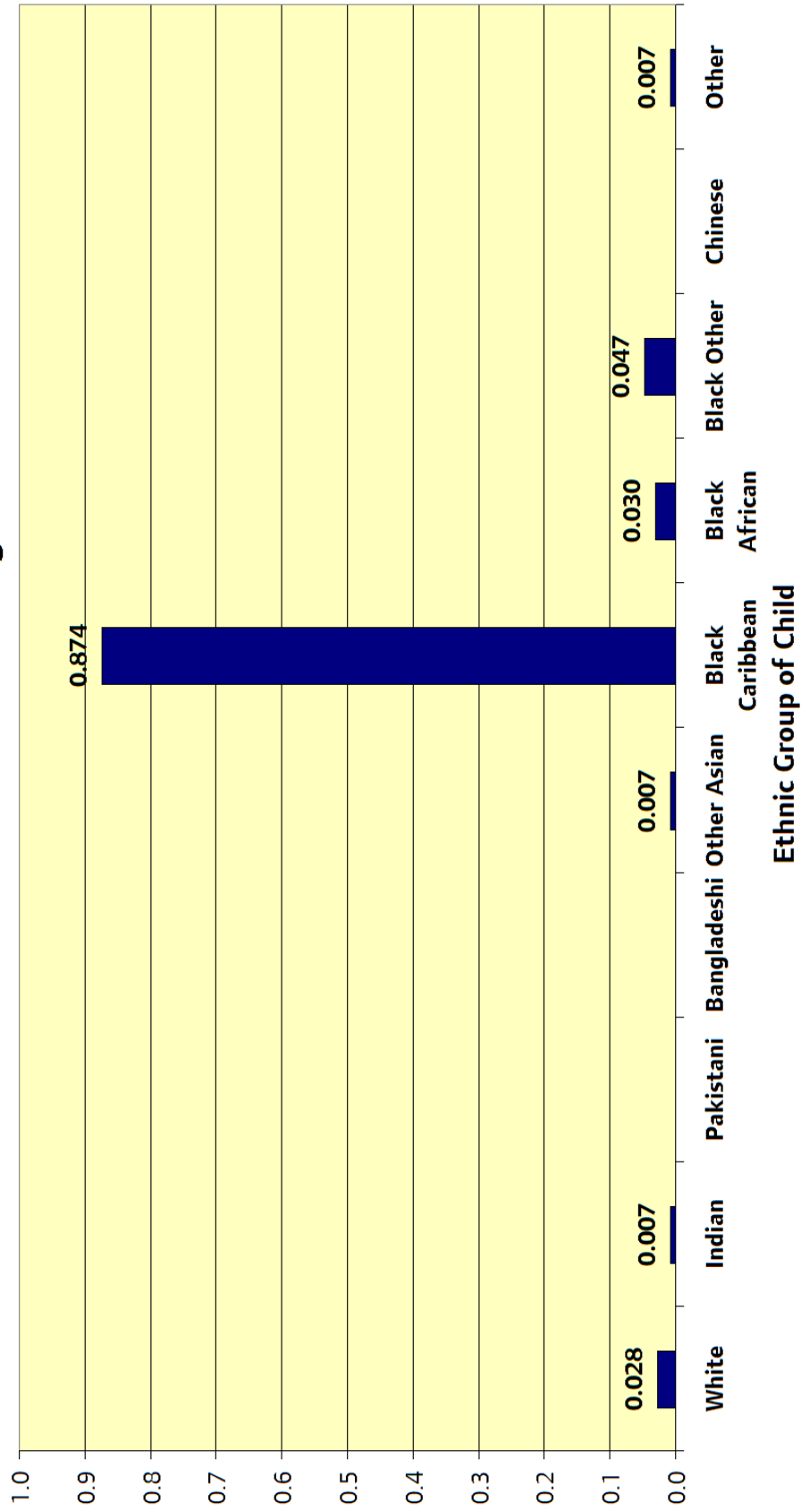


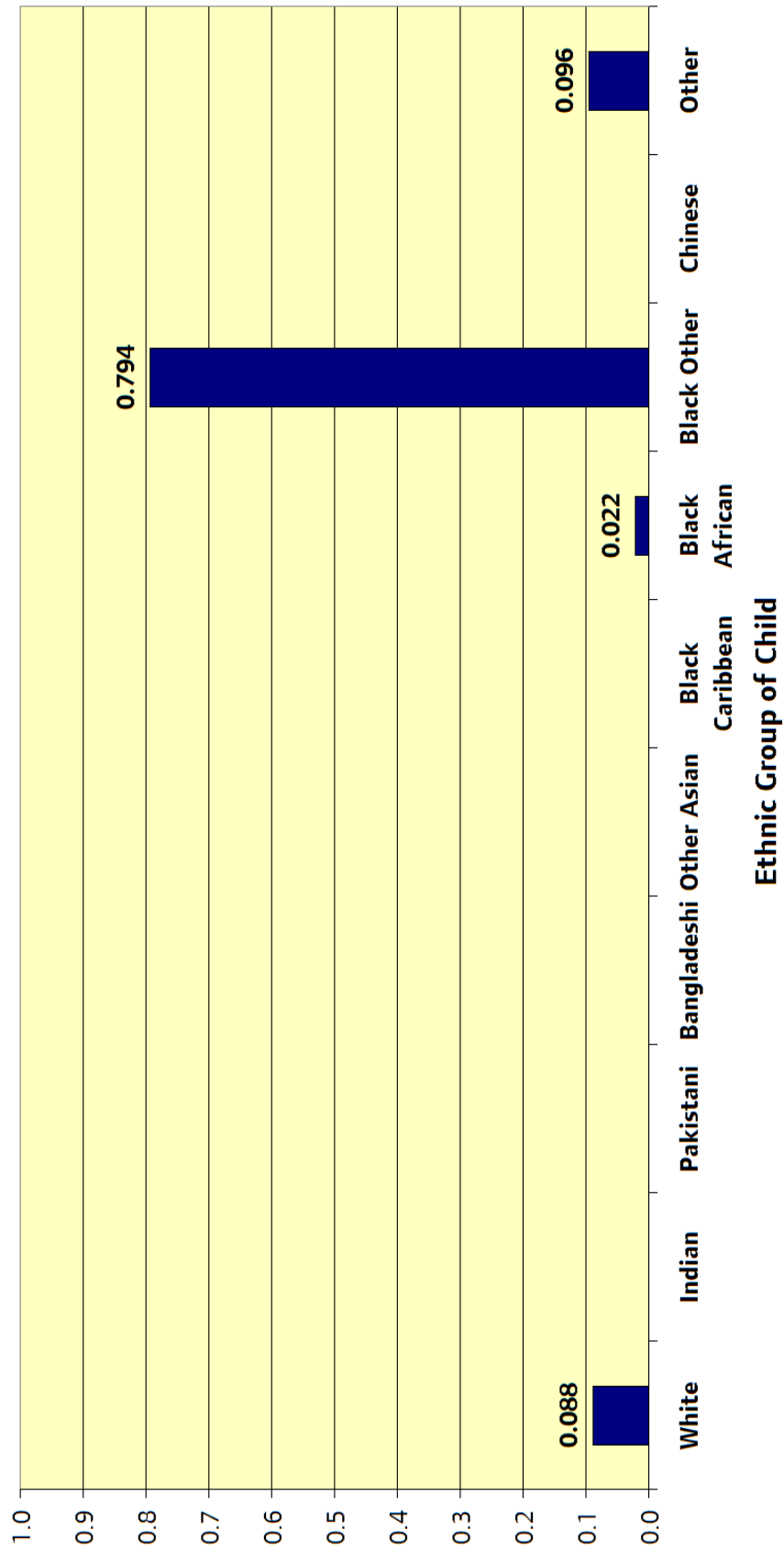


Chart 11 showed the distribution of the known fathers of babies borne to Black Caribbean woman aged 30-34. Three ethnic groups dominate this distribution: Black Caribbean (62 per cent), White (20 per cent) and Black African (10 per cent). The ethnicities of the resulting infants are shown in Charts 13, 14 and 15. While nearly 90 per cent of the babies with Black Caribbean fathers are, unsurprisingly, categorised as Black Caribbean and 80 per cent of those with a White father are categorised as Black Other, the children with Black African fathers are divided amongst the three Black ethnic groups with over half being Black Other.

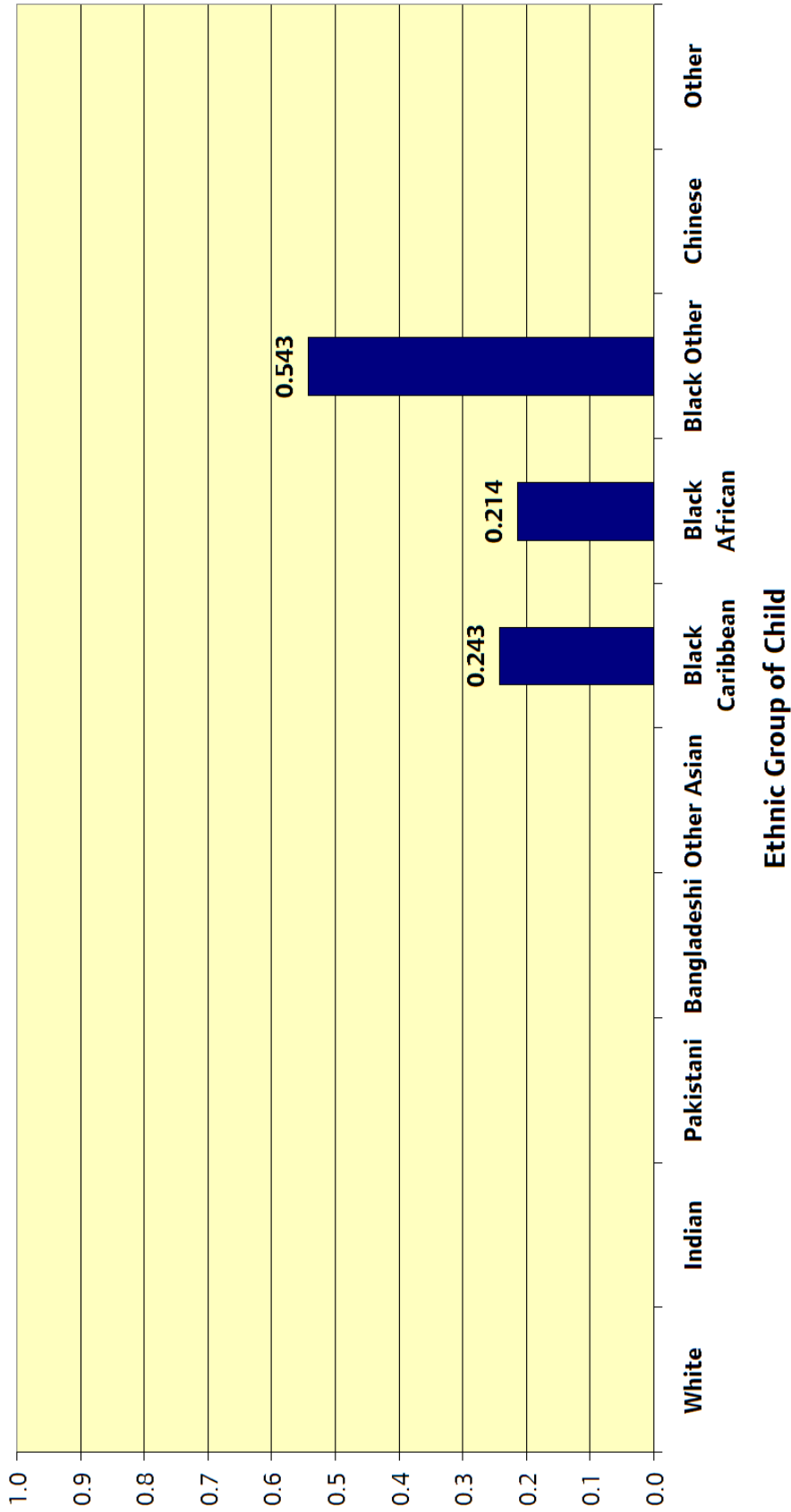
**Chart 13: Probability of EG of Child given Black Caribbean Father and Black Caribbean Mother aged 30-34**



**Chart 14: Probability of EG of Child given White Father and Black Caribbean Mother aged 30-34**



**Chart 15: Probability of EG of Child given Black African Father and Black Caribbean Mother aged 30-34**



The matrices C should capture these distributions and enable the total distribution of the babies' ethnicities to be calculated once the likely range of ethnicities is known.

When this method was tested it was found that the distribution of the babies differed from the known distribution as follows:

- Black Caribbean: 802 rather than 925
- Black Other: 342 rather than 246
- Other: 42 rather than 30
- All other groups within 5 of known totals

This clearly implies that the assumption that unknown fathers are the same ethnicity as known fathers to be faulty. This was actually expected given the relatively low numbers of known Black Caribbean fathers. To gain an adequate correction it was necessary to develop a methodology to allocate an ethnic group to fathers whose ethnicity was unknown.

For a mother of a given age and ethnic group the population of known fathers is used to give initial odds. These odds are then used to predict how births would be distributed across each ethnic group. The total number of infants born is known and defined subtotals are taken to be the number of infants in each of the ten ethnic groups. If the predictions agreed with the known subtotals then the proportions of unknown fathers in each ethnic group are the same as for known fathers. However, if when the odds are applied there is a large difference in each subtotal then the unknown fathers cannot be distributed similarly and hence the odds ratios need to be adjusted.

Using Microsoft Excel's Solver (an optimising function) the difference between the known and predicted subtotals can be minimised (optimised). The sum of the absolute values of the predicted subtotals less the actual subtotals for each ethnic group is taken for a measure of the difference.

This difference is optimised by changing the odds ratios. Solver requires a set of constraints to satisfy before optimising:

- All odds must be greater than zero.
- The total number of predicted infants must equal the known total.
- The number of infants belonging to ethnic group A with a father known to belong to ethnic group Y must not decrease.

Solver then performs many iterations of its built-in algorithm until it converges to an optimal solution in which all constraints are satisfied. It may be necessary to run Solver a few times with different initial odds to ensure that a final solution really is optimal.

This correction effectively adjusts the odds ratios to take account of the infants where the ethnicity of the father is not known. The Appendix shows the odds ratios calculated for all age groups of females and all ten ethnic groups.

There are cases when Solver can't reduce the difference between the predicted and actual subtotals. Taking Black Caribbean mothers aged 20-24 as an example.

**Table 5: Infants to Black Caribbean Mother Aged 20-24**

Ethnic Group of Father	Ethnic Group of Infant										Total
	White	Indian	Pakistani	Bangladeshi	Other Asian	Black Caribbean	Black African	Black Other	Chinese	Other	
White	0	0	0	0	0	6	0	9	0	0	15
Indian	0	0	0	0	3	0	0	0	0	0	3
Pakistani	0	0	0	0	3	0	0	0	0	0	3
Bangladeshi	0	0	0	0	0	0	0	0	0	0	0
Other Asian	0	0	0	0	0	0	0	0	0	0	0
Black Caribbean	0	3	0	0	0	74	4	0	0	0	81
Black African	0	0	0	0	0	7	3	12	0	0	22
Black Other	3	0	0	0	0	3	0	7	0	0	13
Chinese	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0
Not Known	6	3	0	3	3	363	20	84	0	18	500
<b>Total</b>	<b>9</b>	<b>6</b>	<b>0</b>	<b>3</b>	<b>9</b>	<b>453</b>	<b>27</b>	<b>112</b>	<b>0</b>	<b>18</b>	<b>637</b>

There are 637 infants to Black Caribbean mothers aged 20-24. For 500 (78%) of these infants the ethnicity of the father is not known.

This in itself is not a problem for Solver. The difficulty arises when it becomes clear from table 5 that the ethnicity of the father is not known for any of the 18 infants in the Other ethnic group. In this case there is no way of knowing the probability of an infant with a Black Caribbean mother and a father of ethnic group A being classified as Other. Note this probability was derived from the fathers whose ethnicity was known and assumed to remain constant when all fathers are considered.

If the probability of an infant being classified Other cannot be derived even when the ethnicities of both parents are known then for practical reasons the probability has to be treated as being zero. Therefore Solver cannot assign any infants to the Other group. The constraint of the predicted total equalling the known total then forces the 18 infants who should be in the Other group to be allocated elsewhere. Therefore the difference between the predicted and actual subtotals is automatically going to be at least twice 18 or 36.

There are many instances of this problem. In particular there are many cases where the total number of children belonging to an ethnic group is three and ethnicity is not known for any of the fathers. These may not be 'true' threes due to disclosure control but they are treated as such. This error is generally small compared to the total number of births. Most significant are the large numbers of unknown fathers for mothers aged under 20 in the Black African, Black Caribbean, Black Other and Other Asian ethnic groups. To improve accuracy in these cases it is necessary to subsume the under 20 population into the 20-24 population.

The expression for births may be amended as follows:

$$B(e_2) = \sum_x \sum_{e_1} ( ( P_w(x, e_1) * f(x, e_1) * ((P_{M, x, e_1}(X, e_3) / P_{M, x, e_1}(X, A)) * RR_{x, e_1}(e_3)) * C(e_2 / x, e_1, e_3) ) )$$

Where RR are the original odds ratios R adjusted to better reflect the missing ethnicities of some fathers.

It is proposed to calculate the matrices RR and C for each age group (6) and ethnic group (10) of mother. The age-specific fertility rates, f, will also be calculated using the 2001 Census data from table CO200 together with previously calculated rates using Health Episode Statistics.

## Appendix : Odds Ratios

### White mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	1.308	1.251	1.253	1.298	1.301	1.243
Indian	0.000	0.051	0.085	0.124	0.121	0.048
Pakistani	0.000	0.138	0.157	0.123	0.180	0.000
Bangladeshi	0.174	0.090	0.054	0.040	0.000	0.000
Other Asian	1.289	0.191	0.202	0.276	0.314	0.422
Black Caribbean	0.383	0.896	0.584	0.382	0.306	0.295
Black African	0.816	0.744	0.383	0.182	0.233	0.628
Black Other	0.810	1.216	0.894	0.421	0.471	1.335
Chinese	0.000	0.084	0.115	0.159	0.206	0.084
Other	0.817	0.265	0.500	0.476	0.499	1.051

### Indian mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	0.000	0.063	0.032	0.131	0.210	0.214
Indian	9.258	12.553	15.605	14.804	12.503	10.927
Pakistani	0.000	1.326	1.023	0.892	1.089	1.091
Bangladeshi	3.824	0.224	0.750	0.343	0.000	0.000
Other Asian	3.548	1.243	0.724	0.925	1.490	0.000
Black Caribbean	0.000	0.363	0.000	0.147	0.269	0.367
Black African	0.000	0.602	0.073	0.252	0.000	0.000
Black Other	0.000	0.000	0.150	0.106	0.000	0.000
Chinese	0.000	0.000	0.000	0.191	0.000	0.000
Other	0.000	0.000	0.667	0.303	0.000	0.000

### Pakistani mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	0.000	0.008	0.023	0.117	0.127	0.296
Indian	0.000	0.269	0.472	0.368	1.046	0.792
Pakistani	25.754	35.202	40.101	44.004	47.927	36.681
Bangladeshi	2.256	0.730	0.000	0.376	0.000	0.000
Other Asian	0.000	2.280	0.484	1.447	0.915	2.743
Black Caribbean	0.000	0.000	0.541	0.000	0.000	0.000
Black African	0.000	0.000	0.213	0.127	0.000	0.000
Black Other	4.146	0.000	0.000	0.000	0.000	0.000
Chinese	0.000	0.000	2.868	0.000	0.000	0.000
Other	0.000	0.000	0.312	0.245	0.578	0.000

### Bangladeshi mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	0.100	0.028	0.028	0.036	0.037	0.000
Indian	0.000	0.143	0.220	0.184	0.000	0.000
Pakistani	2.060	0.340	0.318	0.671	0.000	5.292
Bangladeshi	23.708	37.604	45.476	53.415	61.752	61.051
Other Asian	0.000	0.792	0.156	0.985	0.000	0.000
Black Caribbean	0.000	0.000	0.000	0.000	0.000	0.000
Black African	0.000	0.000	0.144	0.000	0.000	0.000
Black Other	0.000	0.000	0.000	0.000	0.000	0.000
Chinese	0.000	0.000	0.000	0.000	0.000	0.000
Other	2.206	0.314	0.120	0.338	1.198	1.230



### Other Asian mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	0.081	0.242	0.139	0.290	0.349	0.315
Indian	0.000	0.145	0.348	0.358	0.289	0.882
Pakistani	0.000	2.961	0.753	1.130	2.148	0.000
Bangladeshi	0.000	1.046	0.886	0.582	0.000	0.000
Other Asian	25.974	19.482	25.032	23.004	20.689	21.335
Black Caribbean	0.000	0.000	0.119	0.562	0.457	1.515
Black African	0.000	0.000	0.000	0.061	0.174	0.000
Black Other	0.000	0.000	1.167	0.870	0.940	0.000
Chinese	0.000	0.000	0.612	0.000	0.000	0.000
Other	0.000	2.834	1.798	0.903	2.784	0.942

### Black Caribbean mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	0.050	0.137	0.136	0.172	0.178	0.128
Indian	0.000	0.142	0.064	0.041	0.094	0.000
Pakistani	0.000	0.253	0.000	0.239	0.266	0.000
Bangladeshi	0.000	0.000	0.000	0.000	0.000	0.000
Other Asian	0.000	0.000	0.239	0.415	0.282	0.000
Black Caribbean	8.239	22.028	23.097	15.304	12.722	16.189
Black African	2.713	2.812	1.554	1.222	1.674	1.510
Black Other	0.000	4.791	1.195	1.498	1.955	7.860
Chinese	0.000	0.000	0.000	0.000	1.320	0.000
Other	15.321	0.000	0.000	0.310	0.752	1.000

### Black African mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	0.000	0.188	0.062	0.042	0.044	0.097
Indian	0.000	0.000	0.051	0.000	0.000	0.000
Pakistani	0.000	0.000	0.202	0.000	0.290	0.000
Bangladeshi	0.000	0.000	0.394	1.126	0.302	0.000
Other Asian	0.000	0.000	0.000	0.000	0.000	0.000
Black Caribbean	0.000	0.000	0.543	0.454	0.728	0.407
Black African	14.868	18.032	16.927	14.052	14.711	17.420
Black Other	4.212	1.449	1.368	2.303	1.484	3.459
Chinese	0.000	0.000	0.000	0.000	0.000	0.000
Other	0.000	0.000	0.162	1.023	0.378	0.000

### Black Other mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	0.345	0.111	0.287	0.461	0.363	0.628
Indian	0.216	0.000	0.000	0.097	0.000	0.000
Pakistani	0.000	0.287	0.299	0.000	0.636	0.000
Bangladeshi	0.000	0.000	0.718	0.000	0.000	0.000
Other Asian	0.000	0.000	0.578	0.185	0.000	0.000
Black Caribbean	1.168	7.361	5.274	5.200	3.557	3.100
Black African	4.125	1.842	1.681	2.268	2.670	5.363
Black Other	15.556	32.923	30.173	15.000	24.280	8.041
Chinese	0.000	0.000	0.000	0.000	0.000	0.000
Other	0.000	0.566	0.711	0.355	0.000	2.383

## Chinese mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	0.000	0.275	0.234	0.395	0.540	0.411
Indian	0.000	1.356	0.000	0.391	0.210	0.000
Pakistani	0.000	0.000	0.000	0.000	0.873	0.000
Bangladeshi	0.000	0.000	0.000	0.000	0.000	0.000
Other Asian	0.000	0.000	0.000	0.637	0.508	0.000
Black Caribbean	10.405	2.317	0.685	0.151	0.240	0.000
Black African	0.000	0.000	0.596	0.000	0.000	0.000
Black Other	0.000	0.000	0.000	0.000	0.000	0.000
Chinese	28.645	34.048	66.355	68.569	50.956	53.783
Other	0.000	2.914	1.284	0.338	0.650	2.301

## Other mother

Ethnicity of father	Age of mother					
	<20	20-24	25-29	30-34	35-39	40+
White	0.065	0.278	0.335	0.469	0.659	0.449
Indian	0.000	0.134	0.085	0.129	0.199	0.216
Pakistani	0.000	1.140	1.116	0.000	0.000	0.000
Bangladeshi	0.000	0.000	1.844	0.000	0.402	1.111
Other Asian	0.000	0.805	0.446	1.087	1.213	0.662
Black Caribbean	7.515	1.140	0.268	0.283	0.284	0.430
Black African	0.000	1.500	0.000	0.200	0.347	0.000
Black Other	1.382	3.467	3.327	0.703	0.000	18.164
Chinese	0.000	0.000	3.381	2.800	1.956	0.000
Other	20.158	22.500	23.914	23.580	18.732	19.254

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DMAG 2005/20	Benefits 1: Income Support	Lovedeep Vaid

A full list of the 2004 DMAG Briefings is available to internal customers through the GLA Intranet; otherwise please contact Jackie Maguire who can also provide a CD containing PDF versions of the Briefings or hard copies, [jackie.maguire@london.gov.uk](mailto:jackie.maguire@london.gov.uk).

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