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## Estimating the population of young people by ethnic group in the Northern Region of England, 1971–91

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**Abstract.** We estimate the numbers of young people aged 0–24 years, resident in the Northern Region in 1971, 1981, and 1991 by ethnic group, age, sex, and birth place (inside–outside the United Kingdom). In 1991 the numbers of residents by ethnic group, age, and sex were obtained from the census and adjusted for underenumeration; the numbers born inside and outside the United Kingdom were estimated from the 1991 Census Sample of Anonymised Records (SAR). In 1981 and 1971, the numbers of UK-born residents by ethnic group, age, and sex were estimated from the proportion of UK-born residents in the relevant group in the 1991 SAR; country of birth was used as an indication of ethnicity of non-UK-born residents. The accuracy of the estimates is assessed. The methodology developed could be applied to other regions of the United Kingdom.

### Introduction

#### *What is ethnicity*

‘Ethnicity’ is a subjective concept which embodies a complex range of characteristics including culture, religion, language, and nationality (Bulmer, 1996). It implies membership of a community group and has largely replaced the earlier concept of ‘race’ (Bhopal and Rankin, 1999; Pfeffer, 1998). Evidence has accumulated to the effect that ethnicity can affect lifestyle, experiences, and life chances in many areas: income, health, housing, education, employment, experience of policing, and crime (Karn, 1997; Modood et al, 1997). Nevertheless, there is debate over many aspects of the concept: the extent to which ethnicity can define the “dynamic and shifting nature of people’s identities” (Pfeffer, 1998); the utility of a concept which obscures heterogeneity within ethnic groups, especially that defined as White; and its apparent focus on perceived victims of inequality.

#### *Recording of ethnicity in the United Kingdom*

In response to concerns not only about the size of minority ethnic groups but also about the disadvantages which they suffered, a question on ethnicity was first included in the 1991 UK Census—respondents being asked to assign themselves to specified categories (Bulmer, 1996; Peach, 1996a). This was a pragmatic compromise influenced by earlier concepts of race, which was used to identify some ethnic groups but not others. This classification has subsequently been used not only by statutory and voluntary organisations and employers monitoring discrimination, but also by researchers in health and social sciences, resulting in a much fuller picture of the characteristics of different ethnic groups (Karn, 1997; Peach, 1996b; Ratcliffe, 1996).

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Consequently, more specific quantitative information about variation between ethnic groups has been reported, for example, the incidence of and survival from cancer (Bhopal and Rankin, 1996; McKinney et al, 1999), and access to health care (Cooper et al, 1998) and education (Modood and Shiner, 1994).

*Why estimates of population by ethnicity are needed*

The accurate estimation of population by ethnic group is required for many investigations, in particular for epidemiological studies of health variations between ethnic groups, for developing policy and service provision, and for assessing the impact of these on different ethnic groups. A breakdown by age and sex of the population in each ethnic group is an essential requirement for many such assessments because, for example, disease rates, and service provision and utilisation depend on these factors. This is particularly important as the age structure of minority ethnic groups is often markedly different from that of the indigenous population, reflecting immigration of young adults of working age to the United Kingdom over a restricted time period (Peach, 1996b).

*Retrospective estimates of population by ethnicity*

Numbers of UK residents by ethnic group, age, and sex were first available from the 1991 Census; a further breakdown by place of birth is available for a 2% sample of this census population (Census Microdata Unit, 1999). The difficulty of estimating population by ethnic group for earlier decades has handicapped retrospective studies. For example, in epidemiology, Stiller et al (1991) were unable to calculate the incidence of childhood cancer by ethnic group as the relevant population data were unavailable, and so they limited their investigation to a comparison of the relative frequencies of each type of cancer. Retrospective estimates of population by ethnic group are likewise required in order to monitor changes in educational achievement and access to housing, health, and employment.

These retrospective estimates are problematic because of the lack of data on ethnicity before 1991. Although place of birth has been recorded on UK censuses since 1851, and may have corresponded closely to ethnicity in the early years of immigration, it is no longer a reliable indicator (Peach, 1996a), as substantial numbers of children of immigrants are born in the United Kingdom, but may identify with the ethnic group of their parents.

Methods have therefore been developed to estimate retrospectively the numbers of UK-born residents in each ethnic group. These were introduced by Haskey (1991) and later refined by Rees and colleagues (Peloe and Rees, 1999; Rees and Phillips, 1996). These methods are based on the proportion of those born in a specific country who are of each ethnic group, that is, the conditional probability of belonging to a particular ethnic group given country of birth. These conditional probabilities are estimated from one dataset, and then applied to the population for which ethnic-group breakdown is required. They have been variously estimated from the Labour Force Survey (a 0.3% sample of households), 1991 Census Local Base Statistics, and the Longitudinal Study (a 1% sample of population linking data from 1971, 1981, and 1991 Censuses), and have been used to estimate populations by ethnic group in boroughs, wards, county districts, and metropolitan areas (Haskey, 1991; Owen, 1996; Peloe and Rees, 1999; Rees et al, 1995).

Such population estimates have been used to investigate the incidence of childhood cancer by ethnic group in the West Midlands region of England (Powell et al, 1994) and to explore the relationship between patterns of ethnic residence and the character of social division in UK cities (Byrne, 1998).

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*Objective of current study*

The objective of this study was to estimate the number of residents in each ethnic group by age, sex, and whether they were born inside or outside the United Kingdom for young people up to the age of 24 years, in the Northern Region of England in 1971, 1981, and 1991. These population estimates were required for an investigation of whether the incidence of cancer in young people differed between ethnic groups: details of cases (including age, sex, place of birth, and ethnicity) were known from cancer-registry data for the period 1968–98, but the population denominators were unknown. Because the incidence of childhood cancer is known to vary by age and sex (Parkin et al, 1999) and to be related to migration (Dickinson and Parker, 1999; Kinlen, 1995), stratification by age, sex, place of birth, and ethnicity was required.

Estimates of ethnic-group populations by age and sex have not previously been attempted for areas within the United Kingdom. Such estimates require conditional probabilities relevant to each age group. A single conditional probability estimated from an age-aggregated population would introduce substantial error because, in all minority ethnic groups, most older people were born outside the United Kingdom and most younger people were born inside the United Kingdom—reflecting temporal waves of immigration from the 1950s onwards.

*Datasets considered for estimation of conditional probabilities*

Peloe and Rees (1999) have recently reviewed the appropriateness of various datasets in which ethnicity is linked to country of birth for the estimation of conditional probabilities to be used for such retrospective estimates of ethnic group populations. Table 5 of the *Ethnic Group and Country of Birth* report (OPCS, 1993) presents ethnicity by country of birth for England and Wales, but was inappropriate for our study of the Northern Region; both because there is geographical variation in the settlement of minority ethnic groups, and because it does not provide a breakdown by age. Table L51 of the 1991 Census Local Base statistics reports similar data for components of the Northern Region, but likewise does not provide a breakdown by age or sex. Although the estimation of conditional probabilities from a sample population has obvious disadvantages in that it introduces a range of possible error, there are only samples providing data on ethnicity by country of birth, age, and sex. Two such samples are available: the 1991 Census Sample of Anonymised Records (SAR) (2% sample) and the Longitudinal Study (1% sample). The advantage of the Longitudinal Study is that, because it tracks individuals it can allow for migration within the United Kingdom. However, for our purposes, the SAR was a better choice as it represented a larger sample. In an area such as the Northern Region, with a small minority ethnic population, the errors associated with small samples would be magnified. Because our population estimates are based on this sample, we present confidence intervals to reflect the random sampling error.

The methodology developed in the present study could be used to provide estimates of ethnic group populations by age and sex in other regions of the United Kingdom, or for different areal units or for earlier time periods.

*What debates could these estimates contribute to?*

Population estimates, both historical and contemporaneous, are required for assessment of the impact of policy initiatives on minority groups; for clarification of demographic issues, such as the relative contributions of migration and natural increase or decrease to changes in ethnic group populations; for predicting the future size of these populations, and for monitoring changes in inequality between ethnic groups. Inaccurate estimates introduce error into the estimates of the proportions disadvantaged in each ethnic group and may result in reports of apparent inequality where none exists. In the

context of child health, inequalities between ethnic groups have been reported for many important health outcomes. For example, higher rates of stillbirth, infant mortality, childhood morbidity, and some cancers have all been reported in minority ethnic groups (Bunday and Alam, 1992; Parsons et al, 1990; Powell et al, 1994; Stiller et al, 1991; Varghese et al, 1996). Accurate estimates of the numbers of young people in each ethnic group are necessary for epidemiological studies to ensure that these apparent inequalities are not an artefact and to clarify whether they are the result of components of lifestyle or of genetics subsumed in ethnic-group categorisation or of inequality in social and health-care provision. Similarly, they can be used to elucidate the factors associated with disadvantage in other areas such as education, employment opportunity, and housing.<sup>(1)</sup>

### Methods

The area considered was that defined as the Northern Region after the local government reorganisation of counties in 1974 (Local Government Act, 1972).

In the 1991 Census ethnicity was classified into ten groups: White, Black – Caribbean, Black – African, Black – Other, Indian, Pakistani, Bangladeshi, Chinese, Other groups – Asian, Other groups – other (non-Asian) (Rees et al, 1995). We grouped these into Indian, Pakistani, Bangladeshi, Chinese, White, and Other, where the Other group consisted of all the remaining ethnic groups, each of which contained few people in the Northern Region.

The methods used for estimating the numbers of residents in each group are summarised in table 1.

**Table 1.** Summary of methods used to estimate numbers of residents by ethnic group, age, sex, and place of birth (inside or outside the United Kingdom) in 1991, 1981, and 1971.

	UK-born residents	Non-UK-born residents
1991	Numbers of residents by ethnic group, age, sex from 1991 Census. Estimate proportions of residents in each cell defined by ethnic group, age, and sex, who were born inside and outside the United Kingdom from the 1991 Census Sample of Anonymised Records (SAR)	
1981	Estimate proportions of UK-born residents in each ethnic group, by age group, for those aged 10±34 years, from the 1991 SAR. Apply these proportions to 1981 Census tabulations of UK-born residents by age group and sex, for those aged 0±24 years	Census country-of-birth tables
1971	Assume all UK-born residents of Northern Region in 1981 (aged 10±34 years) were resident there in 1971 (aged 0±24 years)	Census country-of-birth tables, adjusting for parents' place of birth and change in regional boundaries

### Datasets used

*The 1991 Census LBS table L06* This table provided population by age, sex, and ethnic group.

*The 1991 Sample of Anonymised Records (2% individual SAR)* The 1991 SARs are samples of census records, suitably anonymised to avoid the identification of individuals.

<sup>(1)</sup> <http://www.cabinet-office.gov.uk/seu/2000/pat12/annex-c.htm>

Two SAR datasets are available: the 1% household SAR; and the 2% individual SAR which represents 2% of the total enumerated census population—approximately 1.1 million people. The SARs were derived from the 1991 Census 10% sample of households, which was obtained by ordering household census forms into groups of ten and selecting one form at random from each group (Dale and Marsh, 1993). The 1% household SAR was selected by ordering these households geographically by county and enumeration district (ED), grouping ten households at a time and selecting one household at random from each group. The 2% individual SAR was selected from the remaining households by stratifying individuals into groups of nine, from which two records were selected at random (individuals in communal establishments were stratified into groups of five from which one record was selected at random). Because the selection process was based on households, individuals from large households tended to be overrepresented. A comparison between the SARs and 100% census data showed that, although the 2% individual SAR did approximate to a simple random sample, clustering within households resulted in larger standard errors of estimated numbers of residents in each ethnic group (Census Microdata Unit, 1999).

We used the 2% individual SAR to estimate: (a) the numbers of residents in each ethnic group by age and sex, born inside and outside the United Kingdom, in 1991; (b) the numbers of UK-born residents in each ethnic group by age and sex, in 1971 and 1981; and (c) whether it was reasonable to assume, for 1971 and 1981 non-UK-born residents, that country of birth was an adequate surrogate for ethnic group.

*The 1981 Census country of birth statistics (OPCS, 1981, unpublished special Table DT1500U)* This unpublished table provided data concerning the population by age, sex, and country of birth. It was used both to obtain numbers of UK-born residents by age and sex, and to estimate numbers of non-UK-born residents by age, sex, and ethnic group—the assumption being that ethnicity corresponded to country of birth.

*The 1971 Census country of birth statistics (OPCS, 1971, unpublished special Table DT14)* This unpublished table provided population by age, sex, country of birth, and parents' place of birth (either both or one parent born in the British Isles, the Old, or the New Commonwealth). It was used to estimate numbers of non-UK-born residents by age, sex, and ethnic group (Indian, Pakistani, Chinese, Other, White)—it being assumed that ethnicity corresponded to country of birth. Bangladesh was part of Pakistan until it seceded in 1971, but was regarded as part of Pakistan in the 1971 UK Census and hence we were unable to estimate the Bangladeshi population separately in 1971.

*1971 Census enumeration district level data* The 1971 Census enumeration district level data on population by country of birth were supplied by the North East Regional Research Laboratory, University of Newcastle. We aggregated these data to the boundaries of the Northern Region, as defined in 1974, to estimate the population of this region in 1971.

### **Estimating ethnicity from country of birth for non-UK-born residents—1981 and 1971 Censuses**

The numbers of non-UK-born residents by ethnic group (Indian, Pakistani, Bangladeshi, Chinese, Other, White), country of birth, age, and sex were extracted from the 1991 Northern Region 2% individual SAR. These were examined for those aged 10–34 and 20–44 years in 1991, who would have been 0–24 years in 1981 and 1971, respectively. There was little difference either between these age groups or between males and females in the relationship between ethnicity and country of birth, so the sexes were aggregated and the entire group aged 10–44 years considered together (see table 2, over).

**Table 2.** Numbers of non-UK-born Northern Region residents, aged 10–44 years, of Indian, Pakistani, Bangladeshi, or Chinese ethnic group, by sex and country of birth, extracted from 1991 2% individual SAR.

Ethnicity	Country of birth	Number	% <sup>a</sup>
Indian	India	62	80.5
	Kenya	4	5.2
	Uganda	6	7.8
	Other	5	6.5
	Total	77	100.0
Pakistani	Pakistan	58	95.1
	India	1	1.6
	Uganda	1	1.6
	Other	1	1.6
	Total	61	100.0
Bangladeshi	Bangladesh	26	92.9
	India	2	7.1
	Total	28	100.0
Chinese	Hong Kong	37	77.1
	Other Asian	8	16.7
	Other	3	6.3
	Total	48	100.0

<sup>a</sup>Percentage of ethnic group born in each country.

Only 5 out of 89 Pakistani and Bangladeshi non-UK-born residents had ethnicity which was not defined by their country of birth (see table 2). Therefore for 1981 and 1971 it was assumed that among non-UK-born residents those (and only those) born in Pakistan and Bangladesh were ethnically Pakistani and Bangladeshi, respectively.

Although China was not coded as a country of birth in the SAR, 77% of non-UK-born residents of Chinese ethnic group were born in Hong Kong and, of the remainder, most were born in 'Other Asian' countries, assumed to be China. Hence, for 1981 and 1971, it was assumed that being born in Hong Kong or China defined Chinese ethnicity.

As only 15 (19%) non-UK-born Indians aged 10–44 years were born outside India (10 in East Africa and 5 in other countries) (see table 2) country of birth was used to indicate ethnicity for non-UK-born Indian residents in 1981 and 1971, as age-specific and sex-specific estimates based on the small numbers born outside India would have been subject to large sampling error.

### Estimating ethnicity for the 1971, 1981, and 1991 Censuses

#### 1991 Census

*1991 Census LBS table L06; 1991 2% individual SAR* The numbers of Northern Region residents in each ethnic group by age and sex were extracted from the 1991 Census (LBS Table L06) from the SOCPop<sup>(2)</sup> census data held at Manchester Computing Centre, in which an adjustment for underenumeration is made by applying an age, sex, ethnic group, and area-type nonresponse factor to ward-level population counts (Simpson and Middleton, 1997), [see table 3(c), over].

The numbers of UK-born and non-UK-born residents by ethnic group, age, and sex were estimated from the proportions of Indian, Pakistani, Bangladeshi, Chinese, Other, and White residents in each age group who were born inside and outside the

<sup>(2)</sup> [http://census.ac.uk/cdu/Datase/1991\\_Census\\_datasets/Area\\_Stats/Adjusted\\_data/Undercount\\_adjusted\\_census\\_data/SOCPop.htm#8](http://census.ac.uk/cdu/Datase/1991_Census_datasets/Area_Stats/Adjusted_data/Undercount_adjusted_census_data/SOCPop.htm#8)

United Kingdom in the 1991 2% individual SAR. These proportions were applied to the numbers in each ethnic group, by age and sex, extracted from the 1991 Census, resulting in the estimates shown in tables 3(a) and 3(b) and figure 1 (over) [see appendix, equation (A1)].

As these estimates were derived from a sample, they were subject to sampling error. The standard errors of the estimates, and hence their confidence intervals were calculated by means of a standard formula [see appendix, equation (A2)]. These confidence intervals increase as the number of residents in the *population* in a cell defined by ethnic group, age, and sex increases, as the number of residents in the *sample* in a cell defined by ethnic group and age decreases, and as the proportion of non-UK-born residents in the sample cell deviates further from 50%.

It was also possible to estimate the number of non-UK-born residents by ethnic group with the aid of country-of-birth tables from the 1991 Census, assuming that country of birth indicated ethnicity. For minority ethnic groups these estimates were generally within the confidence intervals reported in table 3(a), but tended to underestimate the numbers of Indian and Pakistani residents, reflecting, for example, the 19% of non-UK-born Indian residents born outside India (see table 2). In addition, the use of country of birth to define ethnicity was problematic for the White and Other ethnic groups.

### 1981 Census

#### *Ethnicity of non-UK-born residents*

*1981 Census unpublished special table DT1500U* The numbers of Northern Region residents in 1981 were extracted from table DT1500U by age, sex, and country of birth (India, Pakistan, Bangladesh, China and Hong Kong, Other, White), which was assumed to correspond to ethnic group. The Other ethnic group was assumed to correspond to people born in New Commonwealth countries (excluding India and Bangladesh), Africa, and Asia (excluding Pakistan, China, and Hong Kong). White residents were assumed to be those born in all remaining countries. This resulted in age-specific and sex-specific estimates of the numbers of non-UK-born residents in each ethnic group in 1981, as shown in table 4(a) (over) and figure 1.

A substantial number of Whites were born in India and Pakistan during the colonial era and have since returned to the United Kingdom. Hence, country of birth for non-UK-born children is not considered to be a good guide to ethnicity (Rees et al, 1995). Although the 1991 Census shows that, overall, 15% of UK residents born in India were White (Peach, 1996a), the SAR data for the Northern Region show that only 2 (3%) residents aged 0–44 years born in India were White, so this factor is unlikely to have caused any substantial error in our estimates.

The Northern Region SAR also showed that 15 (19%) non-UK-born Indian residents aged 10–44 years were born outside India (table 2). Nevertheless, we used country of birth to indicate ethnicity because of problems which would have arisen from estimates based on the small numbers in the 2% SAR. For example, in the 1991 SAR there was one female who had been born in Kenya and who was aged 30–34 years and she was of Indian ethnicity. The assumption that country of birth (for non-UK-born residents) defined ethnicity would have resulted in all females aged 20–24 years born in Kenya and living in the Northern Region in 1981 being classified as ethnically Indian. This is unlikely to be the case, as table 51 of the Local Base Statistics indicated that, aggregated over age and sex, only 17% of Northern Region residents born in East Africa were ethnically Indian. Hence the result of 100% of females aged 30–34 years of Indian ethnicity born in Kenya is likely to be due to the very small sample distorting the underlying conditional probability of ethnicity given country of birth.

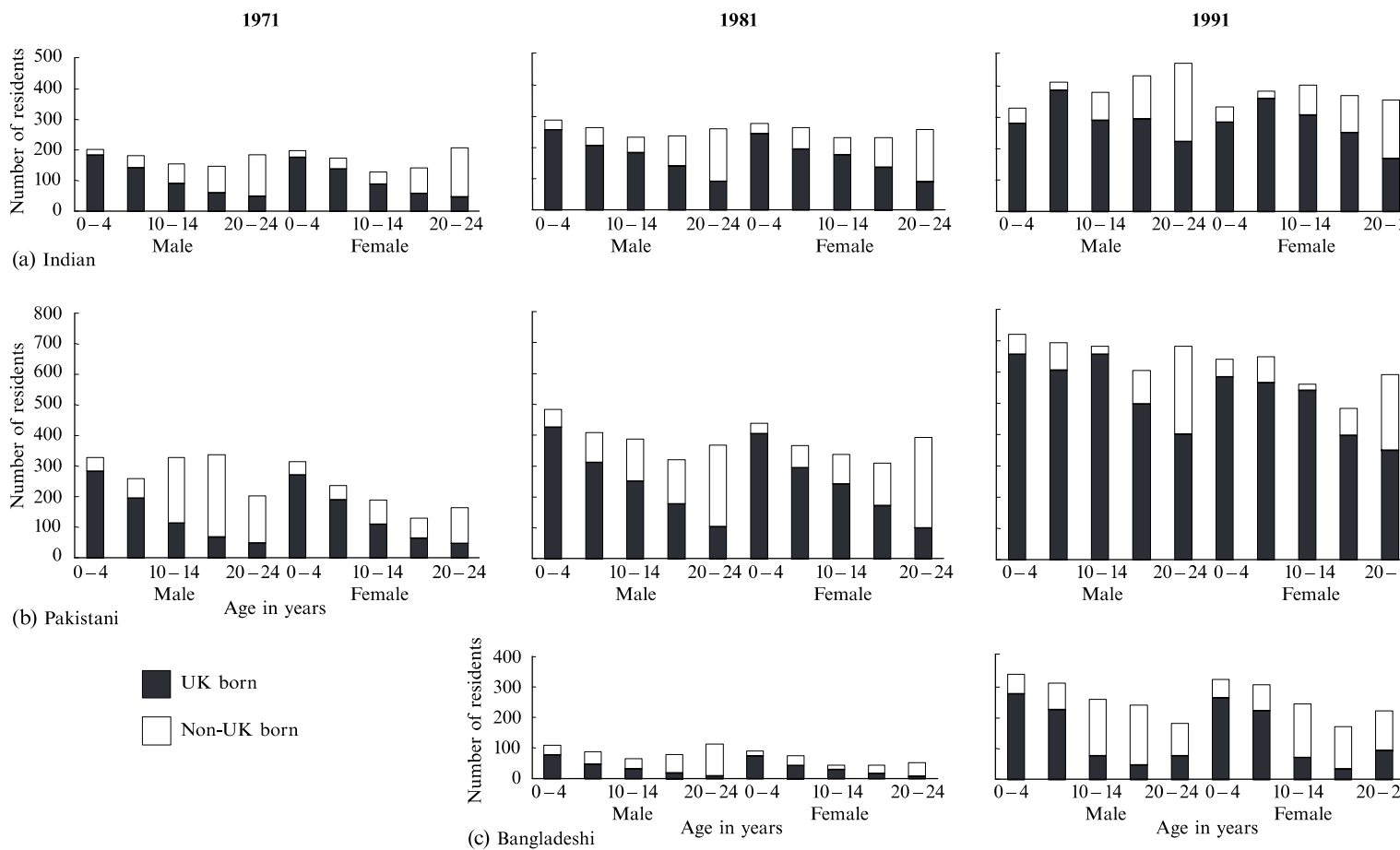
**Table 3.** Numbers (with 95% confidence intervals shown in parentheses) of Northern Region residents in 1991, by age, sex, and ethnic group.

Ethnicity	Age in years		
	0±4	5±9	10±14
<b>(a) Non-UK-born, estimated via the 2% individual SAR</b>			
<i>Males</i>			
Indian	47 (0±123)	24 (0±82)	90 (0±186)
Pakistani	62 (0±142)	87 (0±197)	24 (0±78)
Bangladeshi	62 (0±143)	86 (0±171)	182 (105±259)
Chinese	26 (0±82)	39 (0±96)	46 (0±141)
Other	163 (43±282)	335 (138±533)	76 (0±163)
White	718 (413±1022)	1 111 (726±1495)	1 073 (702±1444)
<i>Females</i>			
Indian	48 (0±125)	23 (0±77)	95 (0±197)
Pakistani	55 (0±126)	81 (0±184)	19 (0±64)
Bangladeshi	59 (0±136)	84 (0±168)	172 (99±244)
Chinese	28 (0±90)	35 (0±88)	43 (0±132)
Other	150 (40±259)	315 (130±501)	71 (0±153)
White	682 (393±972)	1 047 (685±1409)	1 017 (665±1 368)
<b>(b) UK-born, estimated via the 2% individual SAR</b>			
<i>Males</i>			
Indian	282 (206±357)	388 (330±446)	291 (194±388)
Pakistani	659 (579±739)	607 (497±718)	658 (604±712)
Bangladeshi	279 (198±360)	228 (142±314)	78 (1±155)
Chinese	156 (100±212)	174 (116±231)	183 (88±279)
Other	861 (741±980)	545 (348±742)	558 (470±645)
White	100 091 (99 786±100 396)	99 497 (99 113±99 881)	93 987 (93 616±94 358)
<i>Females</i>			
Indian	286 (209±363)	361 (307±415)	308 (205±410)
Pakistani	586 (515±658)	568 (465±671)	542 (497±587)
Bangladeshi	265 (188±341)	224 (140±308)	74 (1±146)
Chinese	171 (109±232)	158 (106±211)	171 (82±260)
Other	791 (681±900)	512 (327±698)	523 (441±604)
White	95 130 (94 841±95 420)	93 793 (93 431±94 155)	89 094 (88 743±89 446)
<b>(c) All residents</b>			
<i>Males</i>			
Indian	328	412	381
Pakistani	721	694	682
Bangladeshi	342	314	260
Chinese	182	212	229
Other	1 024	880	634
White	100 809	100 608	95 060
<i>Females</i>			
Indian	333	384	402
Pakistani	641	649	561
Bangladeshi	324	308	245
Chinese	199	194	214
Other	940	828	594
White	95 813	94 840	90 111

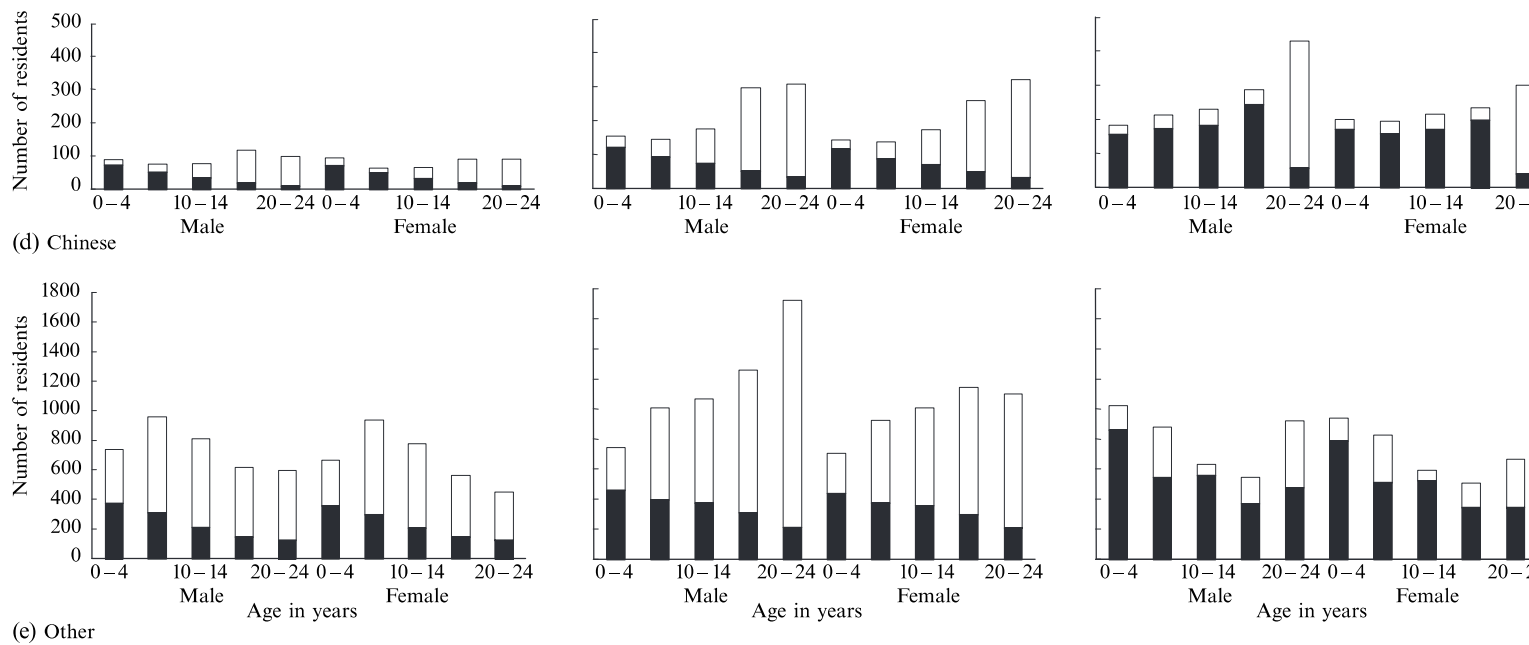


Table 3 (continued)

		Total
15±19	20±24	
138 (32±244)	249 (115±382)	548
105 (0±218)	279 (111±447)	557
193 (105±280)	105 (35±175)	628
44 (0±111)	372 (284±460)	527
174 (67±282)	444 (264±625)	1 192
2 118 (1606±2631)	2 131 (1630±2633)	7 151
117 (27±208)	187 (87±288)	470
84 (0±174)	242 (96±388)	481
137 (75±200)	127 (42±212)	579
36 (0±90)	259 (198±320)	401
162 (62±263)	322 (191±453)	1 020
2 022 (1533±2511)	2 115 (1617±2613)	6 883
295 (189±401)	224 (90±357)	1 480
500 (387±612)	403 (235±571)	2 827
48 (0±136)	79 (9±148)	712
243 (176±310)	57 (0±145)	813
371 (263±478)	476 (295±657)	2 811
98 588 (98 075±99 100)	108 555 (108 053±109 056)	500 718
251 (161±342)	169 (68±269)	1 375
399 (310±489)	350 (204±496)	2 445
34 (0±97)	95 (11±180)	692
197 (142±251)	40 (0±101)	737
345 (245±445)	345 (214±476)	2 516
94 114 (93 625±94 603)	107 726 (107 229±108 224)	479 857
432	472	2 025
605	682	3 384
241	183	1 340
287	429	1 339
545	920	4 003
100 706	110 686	507 869
369	356	1 844
484	592	2 927
172	223	1 272
232	299	1 138
507	667	3 536
96 136	109 841	486 741



**Figure 1.** Numbers of Northern Region residents by age, sex, and ethnic group in 1971, 1981, and 1991, highlighting the numbers of UK-born and non-UK-born residents.



**Figure 1 (continued).**

**Table 4.** Numbers (with 95% confidence intervals shown in parentheses) of Northern Region residents in 1981, by age, sex, and ethnic group.

Ethnicity	Age in years		
	0±4	5±9	10±14
<b>(a) Non-UK-born, as derived from Census table DT1500U</b>			
<i>Males</i>			
Indian	30	56	50
Pakistani	56	94	134
Bangladeshi	31	40	34
Chinese	31	51	100
Other	281	609	690
White	380	897	1 022
<i>Females</i>			
Indian	33	68	55
Pakistani	33	70	95
Bangladeshi	16	30	14
Chinese	26	49	101
Other	263	550	647
White	384	900	1 087
<b>(b) UK-born, as derived from Census table DT1500U and the 2% individual SAR</b>			
<i>Males</i>			
Indian	257 (204±324)	207 (163±264)	184 (137±246)
Pakistani	427 (357±511)	314 (255±386)	253 (194±329)
Bangladeshi	78 (50±122)	47 (26±86)	31 (14±70)
Chinese	118 (84±167)	88 (60±130)	72 (44±118)
Other	462 (388±550)	397 (335±472)	376 (308±458)
White	92 787 (92 643±92 917)	102 016 (101 894±102 126)	123 027 (122 896±123 142)
<i>Females</i>			
Indian	244 (194±308)	196 (154±250)	176 (131±236)
Pakistani	406 (339±486)	297 (242±365)	242 (186±315)
Bangladeshi	74 (47±116)	44 (24±81)	30 (13±67)
Chinese	113 (80±159)	84 (57±123)	69 (42±113)
Other	439 (369±523)	376 (317±447)	359 (295±438)
White	88 291 (88 154±88 415)	96 612 (96 497±96 717)	117 685 (117 559±117 795)
<b>(c) All residents, estimated by summing data above</b>			
<i>Males</i>			
Indian	287 (234±354)	263 (219±320)	234 (187±296)
Pakistani	483 (413±567)	408 (349±480)	387 (328±463)
Bangladeshi	109 (81±153)	87 (66±126)	65 (48±104)
Chinese	149 (115±198)	139 (111±181)	172 (144±218)
Other	743 (669±831)	1 006 (944±1081)	1 066 (998±1148)
White	93 167 (93 023±93 297)	102 913 (102 791±103 023)	124 049 (123 918±124 164)
<i>Females</i>			
Indian	277 (227±341)	264 (222±318)	231 (186±291)
Pakistani	439 (372±519)	367 (312±435)	337 (281±410)
Bangladeshi	90 (63±132)	74 (54±111)	44 (27±81)
Chinese	139 (106±185)	133 (106±172)	170 (143±214)
Other	702 (632±786)	926 (867±997)	1 006 (942±1085)
White	88 675 (88 538±88 799)	97 612 (97 397±97 617)	118 772 (118 646±118 882)

Table 4 (continued)

		Total
15±19	20±24	
96	167	399
143	263	690
59	103	267
244	274	700
946	1 509	4 035
985	762	4 046
94	168	418
136	291	625
26	42	128
208	288	672
843	895	3 198
1 007	863	4 241
142 (98±205)	92 (58±144)	882
178 (127±249)	104 (69±158)	1 276
18 (6±51)	9 (2±31)	183
52 (28±96)	31 (14±66)	361
310 (243±395)	213 (157±287)	1 758
129 391 (129 264±129 499)	113 325 (113 224±113 408)	560 546
138 (95±199)	89 (57±140)	843
173 (124±241)	102 (67±154)	1 220
17 (6±49)	8 (2±30)	173
50 (27±93)	30 (14±64)	346
300 (235±383)	207 (153±279)	1 681
125 450 (125 327±125 554)	110 129 (110 031±110 209)	538 167
238 (194±301)	259 (225±311)	1 281
321 (270±392)	367 (332±421)	1 966
77 (65±110)	112 (105±134)	450
296 (272±340)	305 (288±340)	1 061
1 256 (1189±1341)	1 722 (1666±1796)	5 793
130 376 (130 249±130 484)	114 087 (113 986±114 170)	564 592
232 (189±293)	257 (225±308)	1 261
309 (260±377)	393 (358±445)	1 845
43 (32±75)	50 (44±72)	301
258 (235±301)	318 (302±352)	1 018
1 143 (1078±1226)	1 102 (1048±1174)	4 879
126 457 (126 334±126 561)	110 992 (110 894±111 072)	542 508

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*Ethnicity of UK-born residents*

*1981 Census unpublished special table DT1500U; 1991 2% individual SAR* The numbers of UK-born residents in 1981 in each ethnic group by age and sex were estimated by developing methods introduced by Haskey (1991) and later refined by Owen (1996) and Rees and colleagues (Peloe and Rees, 1999; Rees and Phillips, 1996), based on the calculation of conditional probabilities of ethnic group given country of birth.

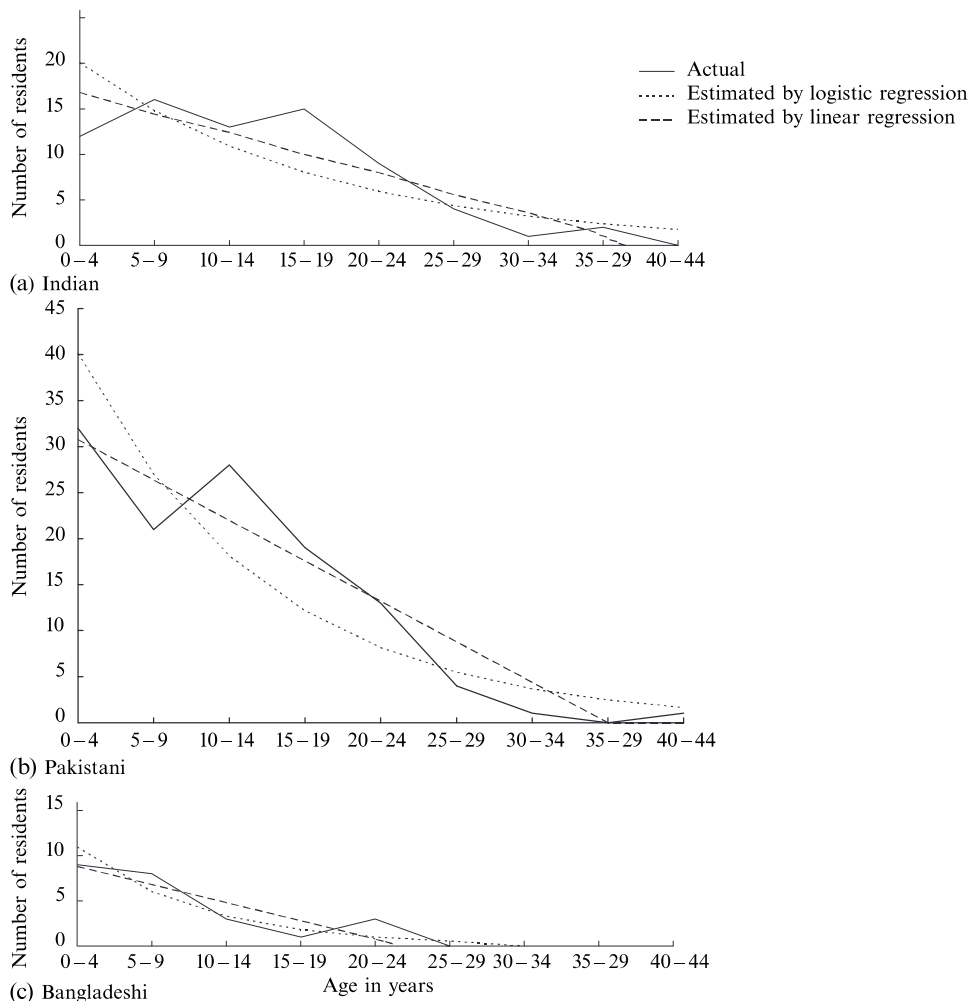
The numbers of UK-born residents in each ethnic group (Indian, Pakistani, Bangladeshi, Chinese, Other, White), by age and sex, were extracted from the 1991 Northern Region 2% individual SAR. In each of the age ranges 35–39 years and 40–44 years, one female Bangladeshi was recorded. These data were assumed to be errors and were omitted as these women would have been born in the United Kingdom before 1955, which is unlikely considering that immigration of males from Bangladesh—then East Pakistan—only began in the mid-1950s and immigration of females even later (Home Affairs Committee, 1986). Because of the small numbers in the ethnic minority groups, males and females were aggregated within age groups. To smooth out further the effects of sampling error in the SAR, logistic regression was used to relate the probability of being in a specific ethnic group, conditional on being born in the United Kingdom, to age [see appendix, equation (A3)], resulting in the estimates shown in figure 2. The estimated proportions in each ethnic group (Indian, Pakistani, Bangladeshi, Chinese, Other, and White) were applied to the numbers of boys and girls born in the United Kingdom in age groups that were 10 years younger, as recorded in the 1981 Census table DT1500U, in order to estimate the numbers in each ethnic group by age and sex in 1981 [see appendix, equation (A4)]. For example, the number of UK-born Bangladeshi boys aged 0–4 years in 1981 was estimated by multiplying the total number of UK-born boys aged 0–4 years in 1981 by the proportions of Bangladeshis among children born in the United Kingdom and aged 10–14 years in 1991.

This process resulted in age-specific and sex-specific estimates of the numbers of UK-born residents in each ethnic group in 1981, as shown in table 4(b) and figure 1.

The 95% confidence intervals for the estimated number of residents in each group were derived from the standard errors of the probabilities predicted by the logistic regression model.

These estimates of the ethnicity of UK-born residents in 1981 were based on the assumption that the proportions in each age-specific ethnic group in 1991 reflected those in the equivalent group aged 10 years younger in 1981. This involves the assumption that, within each age cohort, the proportion of migrants into and out of the region between censuses does not differ between ethnic groups. Peloe and Rees (1999), in a study of ethnic change in London boroughs, estimated proportions in each ethnic group (aggregated over all ages) from the 1981–91 Longitudinal Survey, which enabled them to allow for migration. However, for our purposes, the SAR was a better option as it represented a 2% sample compared with the 1% sample of the Longitudinal Survey. In an area such as the Northern Region, with a small number of residents from minority ethnic groups, the problems of small samples were magnified, particularly as we required population counts stratified by age and sex. Also, as our estimates were required for the Northern Region as a whole they were not affected by intraregional migration.

The 1991 SAR (which was based on a sample of households) is known to represent an overestimation of the population of Indians and Pakistanis (Census Microdata Unit, 1999), because they tend to live in large households (Ballard, 1996). Use of logistic regression to smooth out the sampling error in the SAR reduced the estimated numbers aged 10–24 years in 1991—and therefore aged 0–14 years in 1981—but increased the estimated numbers in the older age groups (see figure 2, over). Linear regression was also investigated but this resulted in erroneous estimates of numbers of



**Figure 2.** Numbers of UK-born Northern Region residents in each ethnic group in the 1991 2% individual SAR, by age group, compared with those estimated from logistic and linear regressions. The estimated numbers aged 10–34 years and 20–44 years were used to estimate the UK-born ethnic minority populations in 1981 and 1971, respectively.

Indians, Pakistanis, and Chinese in the older age groups. Logistic rather than linear regression had the further advantage that it ensured that the estimated conditional probabilities always lay within their allowed range, between 0 and 1 (Hosmer and Lemeshow, 1989).

Numbers of all residents, by age, sex, and ethnic group, were obtained by summing those for UK-born and non-UK-born residents [see table 4(c) and figure 1].

### 1971 Census

The 1981 and 1991 Census data refer to the Northern Region as defined after the local government reorganisation of counties in 1974 (Local Government Act, 1972), whereas the 1971 Census data refer to the pre-1974 North Region. After the 1974 boundary changes the Northern Region gained the Furness area of Lancashire but lost much of Yorkshire North Riding to the Yorkshire and Humberside Region, resulting in a population decrease of approximately 150 000 residents compared with the 1971 Census (DoE, 1972).

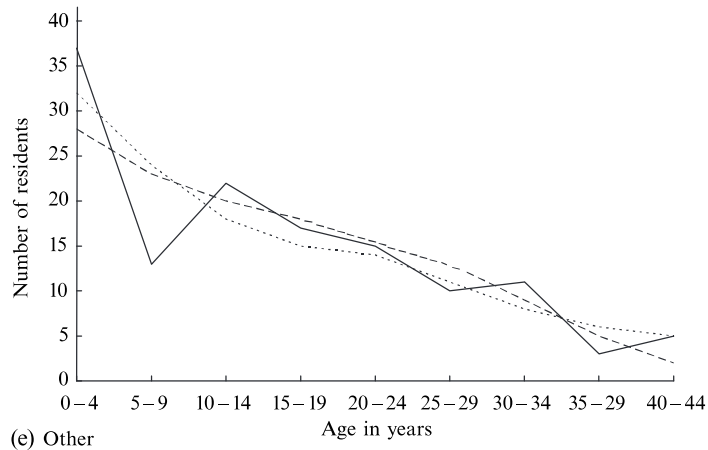
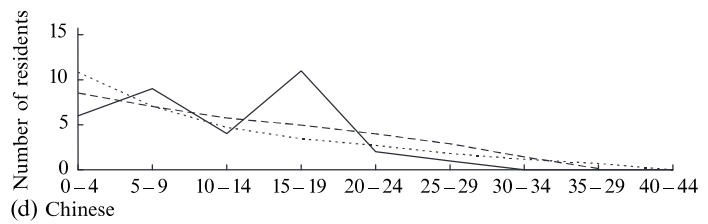


Figure 2 (continued).

Table 5. Total number of residents by country of birth for the pre-1974 North Region (data extracted from 1971 Census table DT14) and post-1974 Northern Region (data extracted from 1971 Census ED-level data, table 8).

Country of birth	North Region		Northern Region	
	male	female	male	female
India	2 770	2 145	2 415	1 855
Pakistan	1 990	905	1 886	840
China	245	185	±	±
United Kingdom	1 574 365	1 656 565	1 466 758	1 547 051

Note: Neither Hong Kong nor China were listed as countries of birth in the 1971 Census ED-level data.

The population of the Northern Region in 1971, by country of birth, was obtained by aggregating ED-level data for the 1971 Census. Table 5 compares the 1971 population of the pre-1974 North and post-1974 Northern Regions.

#### *Ethnicity of non-UK-born residents*

*1971 Census country of birth unpublished special table DT14; 1971 Census ED-level data*

The numbers of North Region residents in 1971 were extracted from table DT14 by age, sex, and country of birth (India, Pakistan, China and Hong Kong). As in 1981, the Other and White ethnic groups were defined by country of birth, although the tabulations by country were different in each census. Residents born in India and Pakistan whose parents were not born in the New Commonwealth were assumed to be White in order to minimise the numbers of Whites being counted as ethnically Indian or

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Pakistani. Residents born in China and Hong Kong whose parents were born in the United Kingdom were likewise counted as White.

To allow for the 1974 boundary changes, the numbers of 1971 residents born in India and Pakistan, in each age-specific and sex-specific group, were scaled by the ratio of the total number of such residents in the Northern Region compared with the North Region; the numbers of all other non-UK-born 1971 residents were scaled by the ratio of the total populations of these regions.

This process resulted in age-specific and sex-specific estimates of the numbers of non-UK-born residents in each ethnic group in 1971 as shown in table 6(a) and figure 1.

#### *Ethnicity of UK-born residents*

*1991 2% individual SAR; 1981 Census unpublished special table DT1500U.* It was assumed that all UK-born residents in the Northern Region in 1981 had been resident there in 1971. Therefore the estimated numbers of residents by age, sex, and ethnic group, shown in table 4(b), were assumed to be the numbers of residents in a similar group aged 10 years younger in 1971, [see table 6(b) and figure 1]; 95% confidence intervals were similarly obtained.

In this, migration into or out of the Northern Region was not taken into account and hence there may be an overestimation of the numbers of residents in minority ethnic groups, as immigration to the United Kingdom in the 1960s and 1970s was predominantly to London, the Midlands, the North West and Yorkshire, followed by dispersal to other areas, particularly of the more mobile Indian and Pakistani communities (Eade et al, 1996; Robinson, 1996a).

It was not possible to estimate the number of residents in 1971 by applying conditional probabilities from the 1991 SAR to the UK-born population by age and sex in 1971 as these data were not available for the Northern Region because of boundary changes. However, the estimated total numbers of 0–24-year-old residents in the Northern Region were similar to numbers in the North Region, scaled by the ratio of the total populations of these regions.

Numbers of all residents by age, sex, and ethnic group, were obtained by summing those for UK-born and non-UK-born residents [see table 6(c), figure 1].

## **Conclusions**

### **Accuracy of estimates**

Estimates of the numbers of residents in 1991 in each ethnic group, by age, and sex, are likely to be reasonably accurate. The main source of error was underenumeration, which was a particularly significant problem in the 1991 Census, especially within ethnic minorities (Peach, 1996a). However, the best available methods have been used to adjust for this. On the other hand, there is substantial uncertainty in the numbers within each subgroup (defined by ethnic group, age, and sex) who were born inside and outside the United Kingdom.

Estimates of the UK-born population in minority ethnic groups in 1981 were difficult to arrive at as no question on ethnicity or parents' place of birth was included in the 1981 Census. The uncertainty in the estimates is reflected in the wide confidence intervals. The assumption of no difference between ethnic groups in the proportion of migrants within each age cohort, may not be valid because of outward migration of White residents and inward migration of people from minority ethnic groups after dispersal from major centres, and we may therefore have tended to underestimate the population in minority ethnic groups. For non-UK-born residents, the use of place of birth as a surrogate for ethnicity may have resulted in an underestimation of the Indian population, although data from the SAR indicated that most Indians born outside India were over 15 years old.



**Table 6.** Numbers (with 95% confidence intervals shown in parentheses) of Northern Region residents in 1971, by age, sex, and ethnic group.

Ethnicity	Age in years		
	0±4	5±9	10±14
(a) Non-UK-born, as derived from census table DT14 (numbers scaled to allow for 1974 boundary changes)			
<i>Males</i>			
Indian	17	39	61
Pakistani	43	62	213
Chinese	14	23	42
Other	363	647	600
White	926	1280	996
<i>Females</i>			
Indian	22	35	39
Pakistani	42	46	79
Chinese	23	14	33
Other	308	635	570
White	897	1252	934
(b) UK-born, estimated with the assumption that UK-born people resident in the Northern Region in 1981 had also been resident in the region in 1971			
<i>Males</i>			
Indian	184 (137±246)	142 (98±205)	92 (58±144)
Pakistani	253 (194±329)	178 (127±249)	104 (69±158)
Bangladeshi	31 (14±70)	18 (6±51)	9 (2±31)
Chinese	72 (44±118)	52 (28±96)	31 (14±66)
Other	376 (308±458)	310 (243±395)	213 (157±287)
White	123027 (122896±123142)	129391 (129264±129499)	113325 (113224±113408)
<i>Females</i>			
Indian	176 (131±236)	138 (95±199)	89 (57±140)
Pakistani	242 (186±315)	173 (124±241)	102 (67±154)
Bangladeshi	30 (13±67)	17 (6±49)	8 (2±30)
Chinese	69 (42±113)	50 (27±93)	30 (14±64)
Other	359 (295±438)	300 (235±383)	207 (153±279)
White	117685 (117559±117795)	125450 (125327±125554)	110129 (110031±110209)
(c) All residents, estimated by summing data above			
<i>Males</i>			
Indian	201 (154±263)	181 (137±244)	153 (119±205)
Pakistani	327 (251±442)	258 (195±362)	326 (284±402)
Chinese	86 (58±132)	75 (51±119)	73 (56±108)
Other	739 (671±821)	957 (890±1042)	813 (757±887)
White	123953 (123822±124068)	130671 (130544±130779)	114321 (114220±114404)
<i>Females</i>			
Indian	198 (153±258)	173 (130±234)	128 (96±179)
Pakistani	314 (241±424)	236 (176±336)	189 (148±263)
Chinese	92 (65±136)	64 (41±107)	63 (47±97)
Other	667 (603±746)	935 (870±1018)	777 (723±849)
White	118582 (118456±118692)	126702 (126579±126806)	111063 (110965±111143)

Table 6 (continued)

		Total
15±19	20±24	
87	135	339
270	152	740
98	88	265
470	470	2550
992	1257	5451
82	160	338
65	116	348
70	79	219
416	322	2251
901	1266	5250
60 (35±104)	49 (26±93)	526
62 (38±103)	46 (26±82)	643
4 (1±19)	3 (0±15)	64
19 (7±47)	14 (5±41)	188
149 (104±214)	128 (84±197)	1176
101200 (101121±101263)	110970 (110895±111026)	577913
59 (34±102)	48 (25±91)	509
61 (37±100)	45 (25±80)	623
4 (1±19)	2 (0±15)	62
18 (7±46)	14 (5±40)	181
146 (101±210)	126 (82±193)	1138
98996 (98918±99056)	108747 (108674±108803)	561007
147 (122±191)	184 (161±228)	866
336 (309±392)	201 (178±249)	1448
117 (105±145)	102 (93±129)	453
619 (574±684)	598 (554±667)	3726
102192 (102113±102255)	112227 (112152±112283)	583364
141 (116±184)	208 (185±251)	848
130 (103±184)	163 (141±211)	1032
88 (77±116)	93 (84±119)	400
562 (517±626)	448 (404±515)	3389
99897 (99819±99957)	110013 (109940±110069)	566257

The estimated numbers of UK-born ethnic minority residents in 1971 are based on similar methods to the 1981 estimates, and so are subject to similar percentage error. However, as parents' place of birth was recorded in the 1971 Census, it was possible to refine estimates of ethnicity based on place of birth for non-UK-born residents by omitting those born in Asia who were likely to be ethnically White. Hence the 1971 estimates for non-UK-born residents are likely to be more accurate than those for 1981.

The numbers of residents in each subgroup, defined by ethnic group, age, sex, and place of birth (inside–outside the United Kingdom) were checked for consistency between 1971, 1981, and 1991. There was an apparent overestimation of the numbers in the Other group of non-UK-born residents in 1981 [see figure 1(e) and tables 3(a), 4(a), and 6(a)]. Complementing this overestimation was an apparent underestimation of the numbers of non-UK-born Whites in 1981, which were consistently much lower than those in the corresponding group who were 10 years older in 1991 and, in most instances, also lower than those in the corresponding group who were 10 years younger in 1971. These discrepancies suggest that a substantial number of non-UK-born Whites may have been erroneously classified as being in the Other ethnic group in 1981, particularly because the countries of birth tabulated in the 1971 and 1981 Censuses were different and hence these ethnic groups could not be defined in exactly the same way for 1971 and 1981.

#### **Change in numbers of young people in each ethnic group, 1971–91**

The estimated White population of the Northern Region, aged 0–24 years, fell steadily from 1149 621 in 1971 to 1107 100 in 1981, and to 994 610 in 1991—decreases of 4% and 10% respectively. The decline between 1971 and 1981 is the result of a large decrease in the birth rate during this period, which fell from 16.7 per 1000 population in 1971 to 12.8 per 1000 population in 1981, and also to migration out of the Northern Region (CSO, 1992). The large decline between 1981 and 1991 occurred despite a small increase in the birth rate of 0.5% (CSO, 1992). Regional statistics show that the total population of the Northern Region fell by 1% between 1981 and 1991, largely as a result of outwards migration (CSO, 1994).

In contrast, the estimated ethnic minority Asian population (Indian, Pakistani, Bangladeshi, Chinese), aged 0–24 years, trebled between 1971 and 1991. The Bangladeshi population showed the most rapid increase, nearly quadrupling between 1981 and 1991. The Pakistani and Chinese populations increased by a factor of over two and a half; the Pakistani population increased by over 60% both during 1971–81 and during 1981–91 but the Chinese increased mostly during 1971 and 1981. The Indian population increased steadily, approximately doubling between 1971 and 1991.

In each minority ethnic group, the number of young people born in the United Kingdom increased much more than the number born abroad. The numbers of Chinese and Pakistani young people born in the United Kingdom in 1991 were about 4 times the numbers in 1971; the corresponding factor for Indians was between 2 and 3. The number of Bangladeshi young people born in the United Kingdom in 1991 was roughly 4 times that in 1981. This group could not be estimated separately from the Pakistani group in 1971, but probably included few children as there was no substantial emigration from Bangladesh to the United Kingdom before the late 1950s (Home Affairs Committee, 1986). These increases in the UK-born ethnic minority population reflect the high fertility, young age structure, and early age of childbearing among these groups (Ballard, 1996; Cheng, 1996; Eade et al, 1996; Robinson, 1996b).

The numbers of ethnic minority young people born abroad increased by over two thirds between 1971 and 1981, but remained at much the same level in the following decade. Between 1981 and 1991, the numbers of non-UK-born Pakistani and Chinese

young people decreased by approximately a fifth and a third, respectively, but these decreases were balanced by increases in other ethnic groups: the number of non-UK-born Indian young people increased by approximately one quarter and the number of non-UK-born Bangladeshi young people more than doubled.

In all ethnic groups, most young people living in the Northern Region in 1991 were born here, the exceptions being (a) Bangladeshis aged 10–24 years and (b) Chinese aged 20–24 years, reflecting the later immigration of these groups to the United Kingdom (Cheng, 1996; Home Affairs Committee, 1986).

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**Appendix**

**Estimation of population by means of conditional probabilities**

**1991 UK-born and non-UK-born residents**

The numbers of UK-born and non-UK-born residents in each cell (specified by ethnic group, age, and sex) in 1991 were estimated from

$$\hat{N}_{91}(i, j, k, l) \hat{=} N_{91}(i, j, k)p_{91}(l|j, j), \tag{A1}$$

where  
*i* is the ethnic group,  
*j* is the age group,  
*k* is the sex,  
*l*  $\hat{=} 1$  UK-born, *l*  $\hat{=} 2$  non-UK-born,  
*N*<sub>91</sub>(*i, j, k*) is the number of residents in a cell (specified by ethnic group, age, and sex), extracted from 1991 Census,  
*p*<sub>91</sub>(*l|j, j*) is the probability of being UK-born or non-UK-born, conditional on ethnic group and age, extracted from 1991 SAR,  
 $\hat{N}_{91}(i, j, k, l)$  is the estimated number of residents in a cell (specified by ethnic group, age, sex, and birthplace).

The standard error of the estimates was calculated with the following formula (Census Microdata Unit, 1999):

$$SE \hat{=} dN_{91}(i, j, k) \sqrt{\frac{p_{91}(1|j, j) \hat{=} p_{91}(2|j, j)}{n_{91}(i, j)}}, \tag{A2}$$

where  
*N*<sub>91</sub>(*i, j, k*) is the number of residents in a cell (specified by ethnic group, age, and sex), extracted from 1991 Census,  
*n*<sub>91</sub>(*i, j*) is the number of residents in a cell (specified by ethnic group and age), extracted from 1991 SAR,  
*d* is a design factor specific to each ethnic group, which allows for clustering of the sample, *d*  $\hat{=} 1.26, 1.20, 1.04, 1.19, 1.08, 1.15$  for Indian, Pakistani, Bangladeshi, Chinese, Other, and White ethnic groups, respectively.  
Hence, 95% confidence intervals were estimated. For the Other group, which was an aggregation of a number of ethnic groups, *d* was taken to be the average of the design factors for these ethnic groups.

**1981 UK-born residents**

The numbers of residents in each cell (specified by ethnic group, age, and sex) in 1981 were estimated as follows.

The numbers of UK-born residents in each ethnic group, by age, were extracted from the 1991 SAR. To smooth out the effects of sampling error in the SAR, logistic regression was used to relate ethnicity to age:

$$\text{logit} \hat{=} p_{91}(i|j, l \hat{=} 1) \hat{=} a_i \hat{=} \sum_{m=2}^J b_{ijm} x_{jm}, \tag{A3}$$

where  
*p*<sub>91</sub>(*i|j, l*  $\hat{=} 1$ ) is the probability of being in ethnic group *i*, conditional on age group and being UK-born,  
*a*<sub>*i*</sub> *b*<sub>*ijm*</sub> are parameters to be estimated,  
*J* is the total number of age groups,  
*x*<sub>*jm*</sub> is a dummy variable indicating age group such that *x*<sub>*jm*</sub>  $\hat{=} 1$ , if *m*  $\hat{=} j$  and *m*  $> 1$ , and *x*<sub>*jm*</sub>  $\hat{=} 0$  otherwise.

The estimated conditional probabilities  $\hat{p}_{91}(ijj, l \neq 1)$  were then applied to the numbers of boys and girls born in the United Kingdom in age groups that were 10 years younger, as recorded in the 1981 Census table DT1500U, in order to estimate the numbers in each ethnic group by age and sex in 1981, using

$$\hat{N}_{81}(\tilde{O}, j^0, k, j, l \neq 1) = N_{81}(\tilde{Q}^0, k, j, l \neq 1) \hat{p}_{91}(\tilde{O}, j, l \neq 1) \quad (\text{A4})$$

where

$\hat{N}_{81}(\tilde{O}, j^0, k, j, l \neq 1)$  is the estimated number of residents in a cell (specified by ethnic group, age, and sex, conditional on being UK-born),

$N_{81}(\tilde{Q}^0, k, j, l \neq 1)$  is the number of residents in a cell (specified by age and sex, conditional on being UK-born), extracted from 1981 Census,

$j^0$  refers to the age group 10 years younger than age group  $j$ .