High Prevalence of Type 2 Diabetes in All Ethnic Groups, Including Europeans, in a British Inner City

Relative poverty, history, inactivity, or 21st century Europe?

Lisa Riste, PhD
Farida Khan, MSC
Kennedy Cruickshank, MB, MD, FRCP

OBJECTIVE — To compare the prevalence of type 2 diabetes in white Europeans and individuals of African-Caribbean and Pakistani descent.

RESEARCH DESIGN AND METHODS — Random sampling of population-based registers in inner-city Manchester, Britain’s third most impoverished area. A total of 1,318 people (25–79 years of age) were screened (minimum response 67%), 533 individuals without known diabetes underwent 2-h glucose tolerance testing, classified by 1990 World Health Organization criteria.

RESULTS — More than 60% of individuals reported household annual income <£10,000 ($15,000) per year. Energetic physical activity was rare and obesity was common. Age-standardized (35–79 years) prevalence (mean 95% CI) of known and newly detected diabetes was 20% (17–24%) in Europeans, 22% (18–26%) in African-Caribbeans, and 33% (25–41%) in Pakistanis. Minimum prevalence (assuming all individuals not tested were normoglycemic) was 11% (8–14%), 19% (15–23%), and 32% (24–40%), respectively. Marked changes in prevalence represent only small shifts in glucose distributions. Regression models showed that greater waist girth, lower height, and older age were independently related to plasma glucose levels, as was physical activity. Substituting BMI and waist-to-hip ratio revealed their powerful contribution.

CONCLUSIONS — A surprisingly high prevalence of diabetes, despite expected increases with new lower criteria, was found in Europeans, as previously established in Caribbeans and Pakistanis. Lower height eliminated ethnic differences in regression models. History and relative poverty, which cosegregate with obesity and physical inactivity, are likely contributors. Whatever the causes, the implications for health services are alarming, although substantial preventive opportunities through small reversals of glucose distributions are the challenge.

Diabetes Care 24:1377–1383, 2001

R
ates of type 2 diabetes have been rising around the world (1,2). The increase in prevalence has accelerated due to aging population structures in developed countries and increasing obesity globally. High prevalence occurs in the Caribbean (3,4), West Africa (5,6), and among these communities in Britain (7–12), as in individuals of Indian subcontinental origin, with heterogeneity in subgroups (13). Whether these occur as a result of genetic or environmental factors remains unclear; the case against a major genetic contribution has been made elsewhere (14,15).

Poverty has been underrecognized as a contributor to prevalence of type 2 diabetes. However, in Britain, standardized mortality ratios from reported diabetes, known to be seriously underrecorded (16), correlate closely with deprivation scores and inner cities (17). Prevalence is higher in individuals exposed to more deprivation, individually and at the level of the electoral ward (18–21). Patients in more deprived areas were less likely to receive insulin therapy, and those who did receive insulin had poorer diabetes control (22).

Herein we compare the prevalence of type 2 diabetes among African-Caribbeans in inner-city Manchester (part of an international collaborative study examining nutrition and the emergence of cardiovascular disease in African origin populations) (6,23–27) with data from individuals of local European origin (aged 25–79 years) and a smaller sample of the local residents of Pakistani descent (aged 35–79 years). We examine the contribution of deprivation, measured by reported income in an area with poor socioeconomic indexes, education level, physical activity, and obesity.

RESEARCH DESIGN AND METHODS — Because no formal ethnic registers exist, population-based registers for patients aged 25–79 years held by local health centers were randomly sampled. Centers were approached within the Hulme, Moss Side, and Cheetham Hill areas of Manchester, where many African-Caribbean and Pakistani-origin people lived. Seven larger centers were recruited. The Pakistani community, more easily identifiable by name on the registers, was sampled with age restricted to 35–79 years due to needing Urdu-speaking staff (coordinated by F.K.). Up to two appointment letters were sent and were signed by the patient’s doctor to encourage attendance. Ethical approval was obtained from the local Ethics Committee. All participants provided written con-
At interview, participants were asked the ethnicity of their grandparents, requiring three sharing the same ethnic group to classify. In addition, birthplaces of grandparents and parents were ascertained. When these were unknown, participants selected their ethnic group from the Census list (28). African-Caribbean was defined as Caribbean origin and African descent. People of direct West African origin were excluded, because numbers were low and cultural and dietary habits are quite different from African-Caribbeans. Other ethnic groups were not included in regression models because of low numbers.

After completion of a questionnaire of personal and family history, carefully standardized anthropometry was performed with the patient wearing light clothing (after removing shoes). Weight was measured using calibrated scales to 0.1 kg and height was measured to 0.1 cm using a stadiometer with the head in the Frankfort plane. BMI was recorded as weight (kilograms) divided by height (meters) squared. Two waist and hip circumferences were measured using a thin metal tape to 0.1 cm. If readings differed by >0.5 cm, a third measurement was recorded and the mean of all measurements was analyzed (27).

Physical activity type, both recreational and occupational, and duration over the past week was assessed by a validated questionnaire (29) and allocated into one of five categories (light housework only to sustained vigorous activity).

Participants were asked (in Punjabi or Urdu, if necessary) whether they had ever been diagnosed as having diabetes (“sugar”). Glucose tolerance tests were performed in individuals without a previous diagnosis, randomly sampling one third of Europeans, two thirds of African-Caribbeans, and all Pakistanis. After venipuncture fasting, participants drank 75 g anhydrous glucose in 300 ml water over 2–3 min, and blood samples were collected exactly 120 min later. Plasma glucose was assayed using a standard glucose oxidase analyzer, results were clustered using World Health Organization criteria (30), with diabetes defined as having fasting blood glucose level ≥ 7.0 mmol/l and/or 2-h blood glucose level ≥ 11.1 mmol/l, or a combination of recent

### Table 1—Basic characteristics of the male and female participants aged 35–79 years

<table>
<thead>
<tr>
<th></th>
<th>European</th>
<th></th>
<th>African-Caribbean</th>
<th></th>
<th>Pakistani</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>Age (years)</td>
<td>(n = 219)</td>
<td>(n = 252)</td>
<td>(n = 131)</td>
<td>(n = 183)</td>
<td>(n = 67)</td>
<td>(n = 65)</td>
<td>(n = 502)</td>
<td>(n = 520)</td>
</tr>
<tr>
<td>Percent born in U.K.</td>
<td>65.6 (59–72)</td>
<td>73.1 (68–79)</td>
<td>3.4 (32–36)</td>
<td>31.9 (33–31–33)</td>
<td>24.6 (22–27)</td>
<td>19.3 (17–22)</td>
<td>30.8 (29–32)</td>
<td>27.7 (26–29)</td>
</tr>
<tr>
<td>Household income (%)</td>
<td>&lt;15,000 (£10,000)</td>
<td>63.5 (57–70)</td>
<td>69.3 (64–75)</td>
<td>64.6 (57–72)</td>
<td>63.1 (56–70)</td>
<td>56.3 (44–68)</td>
<td>56.3 (44–68)</td>
<td>68.9 (65–73)</td>
</tr>
<tr>
<td>Percent single</td>
<td>18.0 (13–23)</td>
<td>12.0 (8–16)</td>
<td>20.0 (14–26)</td>
<td>20.0 (14–26)</td>
<td>0</td>
<td>1.5 (0–4.5)</td>
<td>3.5 (0–4.5)</td>
<td>23.5 (20–27)</td>
</tr>
<tr>
<td>Age leaving school (years)</td>
<td>15.3 (15–15)</td>
<td>15.7 (15–16)</td>
<td>16.3 (15–18)</td>
<td>18.4 (16–21)</td>
<td>17.6 (15–20)</td>
<td>17.1 (11–23)</td>
<td>17.1 (15–23)</td>
<td>15.5 (15–16)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>170.3 (169–171)</td>
<td>159.2 (158–160)</td>
<td>171.0 (170–172)</td>
<td>160.8 (160–162)</td>
<td>168.6 (167–170)</td>
<td>156.0 (154–158)</td>
<td>158.6 (157–170)</td>
<td>159.4 (159–160)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>79.5 (78–81)</td>
<td>69.0 (67–71)</td>
<td>78.7 (77–81)</td>
<td>78.0 (76–80)</td>
<td>78.1 (75–81)</td>
<td>72.2 (69–75)</td>
<td>78.6 (77–80)</td>
<td>72.3 (71–74)</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>96.6 (95–98)</td>
<td>84.6 (83–86)</td>
<td>92.8 (91–94)</td>
<td>91.3 (89–93)</td>
<td>99.9 (98–102)</td>
<td>96.5 (94–99)</td>
<td>95.4 (94–96)</td>
<td>88.4 (87–90)</td>
</tr>
<tr>
<td>Hip (cm)</td>
<td>103.4 (102–105)</td>
<td>104.8 (103–106)</td>
<td>101.0 (100–102)</td>
<td>109.2 (107–111)</td>
<td>104.7 (102–107)</td>
<td>109.3 (107–112)</td>
<td>102.4 (102–103)</td>
<td>107.0 (106–108)</td>
</tr>
<tr>
<td>Waist-to-hip ratio</td>
<td>0.92 (0.92–0.94)</td>
<td>0.81 (0.80–0.82)</td>
<td>0.92 (0.91–0.93)</td>
<td>0.84 (0.83–0.85)</td>
<td>0.96 (0.94–0.97)</td>
<td>0.88 (0.86–0.91)</td>
<td>0.92 (0.92–0.94)</td>
<td>0.83 (0.82–0.83)</td>
</tr>
</tbody>
</table>

Data are means (95% CI).
lower fasting criteria (31) and older 2-h postglucose criteria (32).

We made vigorous efforts to contact nonattenders by telephone or by up to three visits at various times before classifying them as no longer residing in the area. Despite considerable staff time and effort to maintain representative population sampling, not all addresses could be visited.

Data were age-standardized to the 1991 combined male and female population for England and Wales (33) to provide ethnic specific prevalence, using 25–79 years of age and then 35–79 years of age, the age range of the Pakistani sample.

Variables with clearly skewed distributions were log-transformed. Multiple regression tested which factors were independently related to fasting and 2-h plasma glucose levels. Use of standardized coefficients from these allows direct comparison of the strength of association between variables.

RESULTS — Invitation letters were mailed to 3,539 individuals. Of these, 899 individuals (25%) had moved, 561 (16%) were no longer registered, 54 (1%) had died, and 7 were pregnant. Of the remaining 2,018 individuals, 355 (18%) refused screening, 345 (possibly residing at the listed addresses) did not attend more than two appointments, and 1,318 people attended (65%). To allow comparison of prevalence across all three ethnic groups, data in Tables 1 and 2 are restricted to people aged 35–79 years (n = 1,063).

Poverty indexes were prominent; >60% of participants reported annual incomes <$15,000 ($10,000) (Table 1). Pakistani men were significantly younger than European and African-Caribbean men, in whom mean ages were similar. Of the three ethnic groups, Pakistani men were the shortest and most obese, African-Caribbean men were tallest, and European men were intermediate for all factors. Both the waist and hip circumferences in African-Caribbean men were significantly smaller than in European and Pakistani men, the latter having significantly the largest waist-to-hip ratios.

Pakistani women were significantly younger (mean age 50.5 years) than European and African-Caribbean women (54.6 and 54.8 years, respectively). European and African-Caribbean women were also significantly shorter (156.0 cm) than both European (159.2 cm) and African-Caribbean (160.8 cm) women. African-Caribbean women were the most obese (mean BMI 30.2 kg/m²), although European and Pakistani women were also generally overweight (BMI >27.4 kg/m²). Waist-to-hip ratios differed significantly across the ethnic groups: they were lowest in European women (0.81), intermediate in African-Caribbean women (0.84), and highest in Pakistani women (0.88).

Of the 1,318 individuals screened, 1,063 were aged 35–79 years. A total of 124 individuals (11.7%) had existing type 2 diabetes: 6.0% of Europeans (n = 29), 17.4% of African-Caribbeans (n = 64), and 16% of Pakistanis (n = 21) (Table 2). The proportions increased rapidly with age (Fig. 1). One European participant had confirmed type 1 diabetes (not included in the prevalence data and not analyzed further).

Glucose tolerance data were obtained from 449 of these 35- to 79-year-old participants (83% of the 540 people invited). These individuals were of similar mean age (54.3 years, 95% CI 53.5–55.5) to those without glucose tolerance data, but with no previous history of diabetes (55.0 years, 54.0–56.0) and were marginally more obese (28.2 kg/m² [27.7–28.6] vs. 27.4 kg/m² [26.9–27.9]) but had similar waist-to-hip ratios (0.88 [0.87–0.88] vs. 0.87 [0.86–0.88]). The percentage of individuals who had at least one first-degree relative with diabetes was 19% (15–21%) in those with glucose tolerance data and 18% (16–23%) in those without.

The prevalence of newly detected diabetes in the 35- to 79-year-old individuals (age-standardized to the general population) differed significantly between the ethnic groups. The overall prevalence was 22.9% (95% CI 21.7–24.1) in Europeans, 26.7% (24.9–28.5) in African-Caribbeans, and 28.7% (27.1–30.4) in Pakistanis.

The differences in prevalence were most pronounced among those aged 35–44 years, where the highest prevalence was observed in Pakistani men (30.9%, 95% CI 23.9–38.2) and women (29.1%, 95% CI 22.3–36.3), which were significantly higher compared with Europeans (11.7%, 95% CI 9.0–15.3) and African-Caribbeans (16.2%, 95% CI 13.1–19.6).

The prevalence increased rapidly with age, with the highest prevalence among those aged 65–74 years in both Pakistani men (39.7%, 95% CI 32.9–46.7) and women (32.7%, 95% CI 25.5–40.0).

The prevalence was significantly lower in those with a diagnosis of type 2 diabetes (19.0%, 95% CI 16.9–21.2) compared with those without (23.1%, 95% CI 21.4–24.8) across all ethnic groups.

The prevalence among those with known diabetes was 16.2% (95% CI 14.3–18.2) in Europeans, 20.7% (18.3–23.3) in African-Caribbeans, and 22.2% (18.2–26.8) in Pakistanis, which were significantly lower compared with those with no previous history of diabetes (23.1%, 95% CI 21.4–24.8) across all ethnic groups.
High prevalence of type 2 diabetes in Britain

Finally, what matters for service provision is the combined prevalence for all diabetes (known and newly detected combined). For individuals aged 35–79 years, the prevalence was 20% (17–24%) in Europeans, 22% (18–26%) in African-Caribbeans, and 33% (25–41%) in Pakistanis, based on new 1999 criteria. Based on older criteria, the same age-adjusted prevalence was 15% (12–18%), 22% (15–23%), and 31% (23–39), respectively (32), and the sex-adjusted prevalence was 19% (16–23%), 21% (17–25%), and 24% (17–32%), respectively (31). Even minimum prevalence (assuming all individuals not tested were normoglycemic) was 11% (8–14%), 19% (15–23%), and 32% (24–40), respectively, based on the new 1999 criteria.

Figure 1—Prevalence (%) of known and newly detected type 2 diabetes using 1999 World Health Organization criteria by age and ethnic group. (Numbers in parentheses represent number of individuals screened.)

population) was high in all ethnic/sex groups, using 1999 criteria (Table 2); marked increases corresponded with age (Fig. 1). Prevalence for both older criteria illustrate which age groups are most affected by varying criteria. When 25- to 34-year-old individuals (n = 255) were included, prevalence of newly diagnosed diabetes decreased to 12.9% (9–17%) and 12.8% (9–17%) in European men and women, respectively, and decreased to 7.0% (4–10%) and 5.3% (3–8%) in African-Caribbean men and women, respectively. The distributions of fasting and 2-h blood glucose levels show how relatively small shifts lead to such high proportions of defined diabetes (Fig. 2). Sex differences were minimal.

Finally, what matters for service provision is the combined prevalence for all diabetes (known and newly detected combined). For individuals aged 35–79 years, the prevalence was 20% (17–24%) in Europeans, 22% (18–26%) in African-Caribbeans, and 33% (25–41%) in Pakistanis, based on new 1999 criteria. Based on older criteria, the same age-adjusted prevalence was 15% (12–18%), 22% (15–23%), and 31% (23–39), respectively (32), and the sex-adjusted prevalence was 19% (16–23%), 21% (17–25%), and 24% (17–32%), respectively (31). Even minimum prevalence (assuming all individuals not tested were normoglycemic) was 11% (8–14%), 19% (15–23%), and 32% (24–40), respectively, based on the new 1999 criteria.

Forward, stepwise, multiple-regression models showed several consistent independent associations with both fasting and 2-h plasma glucose levels. In descending order of impact (shown by standardized β coefficients, P values, and impact, from unstandardized coefficients, as mmol/l glucose change), in a restricted model including physical activity (n = 231), these were higher waist circumference (0.39, P < 0.001, 0.88/10 cm), lower height (0.26, P < 0.001, −0.90/10 cm), and age (0.13, P = 0.04, 0.28/10 years). Other variables were not significant (P > 0.1), so that ethnic differences in this model were entirely accounted for by lower height or greater waist and age. Substituting waist-to-hip ratio and BMI for their components included the latter (0.27, P < 0.001, 0.17 per kg/m²) but not the former (P = 0.2) and added physical activity (0.13, P = 0.04, −0.11/quintile). All significant variables contributed 13 and 22% to fasting and 2-h glucose variance; other variables, including income and education, added <1% in a forced inclusion model. The pattern was virtually identical in the fuller model (n = 374) with the omission of incomplete physical activity. Greater waist circumference (0.368, P < 0.001, 0.098/10 cm) and lower height (0.23, P < 0.001, −0.092/10 cm) predicted fasting and 2-h plasma glucose levels with European ethnicity (0.132, P = 0.007, 0.403) in the fasting and age (0.121, P = 0.027, 0.03/10 years) in the 2-h models. In log glucose models, which slightly improved the variance (17 and 25%), income became an additional if borderline contributor (0.11, P = 0.08, −0.02/$7,000).
status of many individuals could not be ascertained. Therefore, we give a minimum response for the glucose challenge but believe it to be actually closer to 75–80%.

The data illustrate the burden of type 2 diabetes across all ethnic groups in this area, to which health services must respond. To avoid inflation of these prevalences by denominator uncertainty, we also provided “minimum prevalence,” which assumes that all individuals not tested were normoglycemic. These still show mean prevalences (1999 criteria) in men and women (combined) of 11% (8–14%) in Europeans, 19% (15–23%) in African-Caribbean, and 32% (24–40%) in Pakistanis (35–79 years of age), more than twice that found in the Anglo-Saxon Ely community, in which figures were uncorrected for the 74% response (37). Even the lower 95% CIs suggest the scale of the epidemic.

However, the data also illustrate the difficulties of using fasting criteria alone for diagnosing diabetes, as reported elsewhere (38–40). A study of individuals with glycosuria undergoing glucose tolerance testing found that the impaired fasting group were phenotypically different, with fewer men, less apparent insulin resistance, and more β-cell dysfunction than the 2-h impaired group (41). Postprandial rather than fasting glucose level is also more closely associated with cardiovascular disease and death across several ethnic groups (42).

Multiple regression models showed that the most modifiable variable in predicting fasting and 2-h blood glucose was body mass, although of individual components, waist circumference and height were the most prominent.

Height is of particular importance because Pakistanis, in whom prevalence was greatest, were markedly shorter (by 2–5 cm) than other ethnic groups, and in the multiple-regression models, height virtually accounted for ethnic differences in 2-h glucose, as noted previously (8). Intergenerational increases in attained height have occurred in certain ethnic groups (43).

The basis of the diabetes epidemic in individuals of West African descent has been discussed previously (6,15) and was closely associated with increasing BMI across sites, presumably reflecting inevitable declines in physical activity with urbanization. Measurement errors caused by using only reported activity probably reduced its impact in our analysis; when physical activity has been directly measured in populations, its association with lower glucose and higher blood pressure is clear (44,45). There is overwhelming evidence that these two closely related factors, probably through habits developed during adulthood in migrating groups and perhaps intergenerationally in all groups (15,46), are the major promoters of diabetes (47,48). Therefore, public health efforts across inner cities must find solutions, which probably goes beyond health promotion trials aimed just at minor behavioral change. Such trials and other major population-directed interventions seem to not have had much impact yet (49,50). In 1998, Manchester was ranked the third most impoverished area in the U.K. (51). Although the scale of deprivation is nothing compared with current poverty in third-world cities (where undernutrition is rife but coexists with dominant obesity found here), it is salutary that 160 years ago, in a famous commentary by the owner of a cotton factory, living conditions were much worse in this very area, southwest of the city center (52). How long that historical legacy takes to eliminate is unclear, remembering that slavery was only six generations ago, and among the Pakistani women, some 30% are illiterate in their own language (15,53,54). Such is the history of Manchester and many other cities, in which newer migrants have also been relatively impoverished. Poorer socioeconomic status cosegregates with obesity, even in diabetes (21), as do physical inactivity, smoking, and low birth weight, which are all known risk factors for type 2 diabetes. These pervasive influences remain common, but whatever the origins of the high prevalence of diabetes, the implications for services are alarming.

Acknowledgments — This work was supported by grants from the North-West Regional Health Authority local scheme, the National Research & Development Cardiovascular Program (WEL16), and the European Commission (TS3*CT92 01242).

We thank the communities surveyed and all the trained field staff, particularly Caron Thomas, Judith Savage, Christine Amica, Caroline Greenwood, the late Stephen Griffiths, and also the local general practitioners and their staff. Without their persistent efforts this work could not have been completed.
High prevalence of type 2 diabetes in Britain

References


30. Riste AK: A Comparison of the Prevalence of Rheumatoid Arthritis in Caribbeans and Caucasians Living in Inner City Manchester. MSc Thesis Manchester, U.K., University of Manchester, 1992


34. von Eckardstein A, Schultze H, Assman G: Risk for diabetes mellitus in middle-aged Caucasian male participants of the PROCAM Study: implications for the definition of impaired fasting glucose by the