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Men across a range of ethnicities have a higher prevalence of diabetes: findings from a cross-sectional study of 500 000 UK Biobank participants

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What's new?

- This study provides data on sex differences in diabetes prevalence across different ethnicities in UK Biobank, a cohort study with around 500 000 participants.
- Crude diabetes prevalence was higher in men than in women across all four major ethnicities. Our results have been standardized for age, BMI, socio-economic status, and lifestyle. Significant sex differences in diabetes prevalence persisted in white (men 6.0% vs. women 3.6%) ($P < 0.0001$), South Asian (21.0% vs. 13.8%) ($P < 0.0001$) and black (13.3% vs. 9.7%) ($P < 0.0001$) ethnicities, though there was a non-significant difference between Chinese men and women (7.1% vs. 5.5%, $P = 0.211$).
- This work shows that within UK Biobank men are at higher risk of diabetes than women.

Abstract

Aims: Studies show that white men have a higher prevalence of Type 2 diabetes mellitus than women at a given age and BMI, but equivalent standardized data for other ethnic groups in the UK are sparse.

Methods: This cross-sectional study analysed UK Biobank data from 489 079 participants to compare the prevalence of diabetes mellitus across four major ethnic groups including: 471 700 (96.4%) white, 7871 (1.6%) South Asian, 7974 (1.6%) black and 1534 (0.3%)

Chinese participants, before and after standardizing for age, socio-economic status (SES), BMI and lifestyle factors including physical activity, TV viewing, fruit and vegetable intake, processed meat, red meat, oily fish, alcohol intake and smoking. A subgroup analysis of South Asians was also undertaken.

Results: Crude diabetes prevalence was higher in men across all four ethnicities. After standardizing for age, SES, BMI and lifestyle factors, a significant sex difference in diabetes prevalence persisted in white (men 6.0% vs. women 3.6%), South Asian (21.0% vs. 13.8%) and black individuals (13.3% vs. 9.7%) ($P < 0.0001$); there was a non-significant difference between Chinese men and women (7.1% vs. 5.5%) ($P = 0.211$). Sex differences persisted across South Asian subgroups.

Conclusions: Men across a range of major ethnic groups including white, South Asian and black, have a higher prevalence of diabetes compared with women of similar age, BMI, SES and lifestyle in the UK.

<H1>Introduction

The global diabetes prevalence in adults has increased in the past 30 years, more than doubling in men from 4.3% in 1980 to 9.0% in 2014. Men have been shown to have higher age-standardized diabetes prevalences in a number of countries [1]. However, there is limited research regarding whether this sex difference occurs across different ethnic groups within the UK and whether it persists after consideration of important differences in BMI, socio-economic status (SES) and lifestyle factors between ethnicities.

Using UK Biobank, we investigated whether the prevalence of diabetes differed in men and women across four major ethnic groups: South Asian, black, Chinese and white, after standardizing for age, BMI, SES and lifestyle factors. We also investigated whether this sex

difference occurred across South Asian subgroups including Indian, Pakistani and Bangladeshi participants.

<H1>Methods

This cross-sectional study used baseline data from UK Biobank, a large, population-based cohort study set up to study lifestyle, environmental and genetic determinants of a range of adulthood diseases [2]. Between April 2007 and December 2010, UK Biobank recruited 502 682 participants (5.5% response rate) aged 40–69 years. Overall, participation rates were higher in women (6.4%) than men (5.1%), older age groups (9% in those aged ≥ 60 years and 3% in those aged 40–44 years), and in less socio-economically deprived areas (8.3% in those from the least deprived areas vs. 3.1% among those from the most deprived areas) [3]. Baseline information was collected via questionnaires and physical measurements.

Diabetes was based on self-report of a physician diagnosis. Participants classified themselves into 1 of 16 ethnic groups consistent with the UK Office of National Statistics Census categories. This study was restricted to participants who belonged to one of the following: white, Indian, Pakistani, Bangladeshi, black African, black Caribbean or Chinese. To maximize statistical power, Indian, Pakistani and Bangladeshi participants were analysed collectively as South Asian, and black African and black Caribbean participants were grouped together as black for the main analysis. SES was measured using the Townsend deprivation score, an area of residence-based index of material deprivation derived from census information on housing, employment, social class and car availability [4]. Lifestyle factors including physical activity, TV viewing, fruit and vegetable intake, processed meat, red meat, oily fish, alcohol intake and smoking were collated into a modified lifestyle score with 0–1 associated with the highest risk and a score of 8–9 the lowest risk. A collective risk

score was chosen as lifestyle factors do not occur in isolation and all-cause mortality increases with the number of risk factors present [5].

Of the 489 079 eligible participants: 471 700 (96.4%) were white, 7871 (1.6%) South Asian, 7974 (1.6%) black and 1534 (0.3%) Chinese. We measured crude diabetes prevalence in men and women in each ethnic group. Diabetes prevalence was stratified by ethnic group then standardized by age, SES, BMI and lifestyle factors using the Stata 14 command 'dstdize' with corresponding 95% confidence intervals (95% CI). Because of differences in characteristics within the South Asian population, a subgroup analysis was also performed. Finally, sensitivity analysis was performed excluding individuals with probable Type 1 diabetes by removing those diagnosed with diabetes aged ≤ 30 years [6].

<H1>Results

Of the 502 682 UK Biobank participants, 489 079 people of relevant ethnic backgrounds were included in the analysis. Baseline participant characteristics are outlined in Table 1. Median age was higher in white participants (58 years). Median BMI in black women was 1.7 kg/m^2 higher than in black men (29.7 vs. 28.0 kg/m^2 respectively). Subgroup analysis revealed that Pakistani and Bangladeshi women had higher BMIs than their male counterparts (Table 2). Conversely, median BMI in Chinese men was 1.8 kg/m^2 higher than in their female counterparts (24.8 vs. 23.0 kg/m^2 respectively). Over 60% of black participants were in the lowest socio-economic quintile.

Overall crude diabetes prevalence was 6.9% in men and 3.7% in women. After standardizing for age, SES, BMI and lifestyle factors, this difference remained with a diabetes prevalence of 6.4% in men and 3.9% in women ($P < 0.0001$) (Table 3, Fig. 1). Sensitivity analysis with exclusion of those diagnosed with diabetes aged ≤ 30 years confirmed similar findings (Table 3).

The crude prevalence of diabetes was higher in men than women in all ethnic groups. After standardizing for age, SES, BMI and lifestyle factors, the standardized diabetes prevalence (with 95% CI) was: 6.0% (5.9%, 6.1%) white men vs. 3.6% (3.5%, 3.7%) white women ($P < 0.0001$); 21.0% (19.7%, 22.2%) South Asian men vs. 13.8% (12.7%, 15.0%) South Asian women ($P < 0.0001$); 13.3% (12.1%, 14.5%) black men vs. 9.7% (8.8%, 10.6%) black women ($P < 0.0001$); and 7.1% (5.1%, 9.1%) Chinese men vs. 5.5% (4.0%, 7.0%) Chinese women ($P = 0.211$) (Table 3 and Fig. 1). Sex differences persisted after excluding those with likely Type 1 diabetes (Table 3). Subgroup analysis in South Asian participants also revealed persistent sex differences in diabetes prevalence after standardization, with the highest prevalence in Bangladeshi, followed by Pakistani, then Indian individuals (Table 4 and Fig. 1).

<H1>Discussion

This study confirms men across a range of major ethnic groups including white, South Asian, and black, have a higher prevalence of diabetes compared with women of similar age, BMI, SES and lifestyle in the UK. This difference persisted across South Asian subgroups and after excluding those with probable Type 1 diabetes.

A study of 276 837 people with newly diagnosed diabetes in two Canadian provinces revealed that South Asian, white and Chinese men had higher diabetes incidences than women following age standardization [7]. However, this study did not standardize for BMI or SES or lifestyle factors, nor did it include black ethnicities and so our study has specific strengths beyond existing relevant literature.

The SABRE study compared diabetes prevalence in European, Indian Asian and African Caribbean participants aged 40–69 years. Although South Asian men had higher diabetes prevalence than South Asian women (22% vs. 17%), African Caribbean women had higher diabetes prevalence compared with men (21% vs. 18%). However, the sample size was far

smaller than the current study (801 in SABRE vs. 7974 African Caribbean participants in the current study). The SABRE study also did not adjust for BMI which was 3 kg/m^2 greater in African Caribbean women than men (29.4 vs. 26.4 kg/m^2) [8].

Previous studies from our group have shown that white men develop diabetes at lower BMI levels than women. This may relate to men without diabetes being more insulin resistant than women of a comparable BMI, due to men's lower subcutaneous stores and more rapid visceral and ectopic fat accumulation with weight gain [9].

Nordström examined the association of visceral fat with plasma glucose and Type 2 diabetes prevalence in 1393 elderly northern European participants. Type 2 diabetes was more prevalent in men than women (14.6% vs. 9.1%; odds ratio (OR), 1.72). Interestingly, after adjusting for visceral fat, the prevalence of Type 2 diabetes was similar in men and women, suggesting that differences in visceral fat may contribute to sex differences in diabetes prevalence [10]. Given that visceral fat levels correlate strongly with liver and pancreatic fat, ectopic rather than visceral fat differences may explain the greater diabetes risk in men.

Mechanisms to explain sex differences in diabetes prevalence may also include hormonal influences, including a fall in oestrogen levels and increased androgen predominance seen with the menopause [11,12].

The current study showed a non-significant sex difference in diabetes prevalence among Chinese individuals, likely due to fewer participants in this group. However, a large study of 46 239 Chinese adults showed that age-standardized prevalences of total diabetes were 10.6% among men and 8.8% among women [13].

Are there any clinical implications of our findings? Men are at higher risk of diabetes across a range of ethnicities, as well as higher mortality risks for any given BMI compared with women [14]. However, men engage less in lifestyle changes, with twice as many women as men enrolling in a recent weight management trial [15]. These data suggest more should be

done to encourage and motivate men to undertake lifestyle changes to moderate their adiposity-associated risks. Of interest, a male-specific weight control intervention delivered in conjunction with football clubs was successful in helping men achieve meaningful weight loss [16], and such work is now extending to other European countries. Couple-based interventions may also prove useful as spousal diabetes history can increase the risk of diabetes by 26% [17].

We attempted to ensure the majority with Type 1 diabetes were not included in the sensitivity analysis by excluding those with an age at diagnosis of diabetes of ≤ 30 years [6]. However, we acknowledge that this exclusion may misclassify some. Nevertheless, as > 90% of individuals are likely to have Type 2 diabetes, and with little evidence for sex difference in prevalence of Type 1 diabetes by ethnicity, we believe our results are reflective of true patterns. We acknowledge that diabetes was self-reported; however, we note recent findings that only 0.001% of people with diabetes were missed on comparing with primary care reports [18]. Participation rates in UK Biobank were low (5.5% overall response rate), with more women, older and more affluent individuals participating [3]. Response rate by ethnicity was not available. We therefore note UK Biobank participants are not representative of the general population and so cannot be used to provide representative disease prevalence and incidence rates. However, valid assessment of exposure–disease relationships are still generalizable and do not require participants to be representative of the population at large [19]. Standardization of age, BMI, SES and lifestyle factors also allows us to be more confident that the sex differences are likely robust and not necessarily unique to the population examined. Finally, although recent data suggest women in UK Biobank are more active than men, the 4% higher levels in women are simply too small to account for sex difference in diabetes prevalence. [20]

In conclusion, this study confirms the sex difference in diabetes prevalence across white, South Asian and black ethnic groups, but not Chinese individuals in UK Biobank, with men being at higher risk for any given age and BMI than women. We suggest more work is needed to increase physician and public awareness of men's greater diabetes risk, to better educate, target and motivate men at elevated risk to lifestyle changes.

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Competing interests

None declared.

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FIGURE 1 Author to supply caption

Table 1 Characteristics of study participants by ethnic group and sex

	Women				Men			
	White (n = 257 027)	South Asian (n = 3660)	Black (n = 4614)	Chinese (n = 965)	White (n = 214 673)	South Asian (n = 4211)	Black (n = 3360)	Chinese (n = 569)
Age, years; median (IQR)	58 (50–63)	53 (46–60)	51 (46–58)	52 (46–58)	58 (51–64)	53 (46–61)	50 (45–58)	51 (45–59)
BMI, kg/m^2; median (IQR)	26.1 (23.4–29.6)	26.8 (24.1–30.2)	29.7 (26.1–33.7)	23.0 (20.9–25.4)	27.3 (25.0–30.1)	26.6 (24.4–29.2)	28.0 (25.6–30.6)	24.8 (23.0–27.0)
Diabetes, n (%)	8881 (3.5)	523 (14.3)	479 (10.4)	48 (5.0)	14 049 (6.5)	889 (21.1)	431 (12.8)	44 (7.7)
Deprivation, n (%)								
1 (least)	53 241 (20.7)	372 (10.2)	131 (2.8)	148 (15.4)	44,933 (21.0)	382 (9.1)	93 (2.8)	84 (14.8)
2	52 082 (20.7)	358 (9.8)	209 (4.5)	144 (15.0)	44,200 (20.6)	402 (9.6)	152 (4.5)	97 (17.1)
3	53 197 (20.7)	579 (15.8)	391 (8.5)	157 (16.3)	43,292 (20.2)	635 (15.1)	261 (7.8)	80 (14.1)
4	51 385 (20.0)	1117 (30.6)	974 (21.1)	256 (26.6)	41,631 (19.4)	1169 (27.8)	690 (20.6)	145 (25.6)
5 (most)	45 818 (17.9)	1229 (33.6)	2904 (63.0)	257 (26.7)	40,356 (18.8)	1619 (38.5)	2149 (64.3)	161 (28.4)
Lifestyle score, n (%)								
0–1	116 (0.1)	0	0	1 (0.1)	567 (0.3)	2 (0.1)	17 (0.5)	1 (0.2)
2–3	5844 (2.3)	32 (0.9)	137 (3.1)	15 (1.6)	13 748 (6.5)	160 (4.0)	265 (8.3)	33 (5.9)
4–5	55 398 (21.8)	628 (17.8)	1090 (24.9)	229 (24.3)	71 091 (33.4)	1146 (28.5)	1186 (37.1)	206 (36.8)
6–7	132 354 (52.1)	2130 (60.4)	2163 (49.5)	488 (51.9)	97 903 (46.0)	2077 (51.6)	1341 (42.0)	255 (45.5)
8–9	60 363 (23.8)	737 (20.9)	980 (22.4)	208 (22.1)	29 337 (13.8)	643 (16.0)	384 (12.0)	65 (11.6)

$P < 0.0001$ for all variables. IQR, inter-quartile range.
Lifestyle score: 0–1 (highest risk), 2–3 (medium–high risk), 4–5 (medium risk), 6–7 (medium-low risk), 8–9 (lowest risk).

Table 2. Characteristics of South Asian participants

	Women			Men		
	Indian (n = 2892)	Pakistani (n = 694)	Bangladeshi (n = 74)	Indian (n = 2961)	Pakistani (n = 1090)	Bangladeshi (n = 160)
Age, years; median (IQR)	53 (47–60)	50 (44–57)	50 (44–59)	55 (47–62)	50 (44–57)	46 (42–54)
BMI, kg/m^2; median (IQR)	26.4 (23.9–29.7)	28.5 (25.6–32.1)	29.7(26.1–33.7)	26.3 (24.2–28.9)	27.3 (25.1–30.1)	25.8 (23.8–27.7)
Diabetes, n (%)	373 (12.9)	130 (18.7)	20 (27.0)	577 (19.5)	265 (24.3)	47 (29.4)
Deprivation, n (%)						
1 (least)	310 (10.7)	59 (8.5)	3 (4.1)	316 (10.7)	62 (5.7)	4 (2.5)
2	307 (10.6)	48 (6.9)	3 (4.1)	314 (10.6)	82 (7.5)	6 (3.8)
3	481 (16.7)	88 (12.7)	10 (13.5)	499 (16.9)	120 (11.0)	16 (10.0)
4	939 (32.5)	156 (22.5)	22 (29.7)	905 (30.6)	238 (21.9)	26 (16.3)
5 (most)	851 (29.5)	342 (49.4)	36 (48.7)	924 (31.2)	587 (53.9)	108 (67.5)
Lifestyle score, n (%)						
0–1	0	0	0	2 (0.1)	0	0
2–3	18 (0.6)	13 (1.9)	1 (1.5)	88 (3.1)	62 (6.0)	10 (6.7)
4–5	452 (16.2)	164 (24.5)	12 (18.2)	749 (26.3)	347 (33.8)	50 (33.3)
6–7	1,692 (60.6)	396 (59.2)	42 (63.6)	1,516 (53.2)	493 (48.0)	68 (45.3)
8–9	630 (22.6)	96 (14.4)	11 (16.7)	496 (17.4)	125 (12.2)	22 (14.7)

IQR, inter-quartile range.
Lifestyle score: 0–1 (highest risk), 2–3 (medium-high risk), 4–5 (medium risk), 6–7 (medium-low risk), 8–9 (lowest risk).

Table 3. Crude and standardized prevalence of diabetes mellitus according to ethnicity and sex

	Crude prevalence (%)[a]	Prevalence standardized by age (%)	Prevalence standardized by age and SES (%)	Prevalence standardized by age, SES, and BMI (%)	Prevalence standardized by age, SES, BMI, and lifestyle score (%)[b]	Prevalence standardized by age, SES, BMI, and lifestyle score (excluding Type 1 diabetes) (%)[c]
			White			
Men (*n* = 214 673)	6.5 (6.4, 6.6)	6.5 (6.4, 6.6)	6.5 (6.3, 6.6)	6.2 (6.1, 6.3)	6.0 (5.9, 6.1)	6.0 (5.9, 6.1)
Women (*n* = 257 027)	3.5 (3.4, 3.5)	3.5 (3.4, 3.6)	3.5 (3.4, 3.6)	3.6 (3.5, 3.7)	3.6 (3.5, 3.7)	3.3 (3.2, 3.4)
			South Asian			
Men (*n* = 4211)	21.1 (19.9, 22.3)	20.9 (19.7, 22.1)	20.9 (19.7, 22.0)	21.2 (20.0, 22.5)	21.0 (19.7, 22.2)	19.5 (18.3, 20.8)
Women (*n* = 3660)	14.3 (13.2, 15.4)	14.5 (13.3, 15.6)	14.5 (13.2, 15.8)	13.9 (12.8, 15.0)	13.8 (12.7, 15.0)	12.8 (11.7, 13.9)
			Black			
Men (*n* = 3360)	12.8 (11.7, 14.0)	12.9 (11.8, 14.0)	12.9 (11.8, 14.0)	13.5 (12.4, 14.7)	13.3 (12.1, 14.5)	12.3 (11.1, 13.5)
Women (*n* = 4614)	10.4 (9.5, 11.3)	10.4 (9.5, 11.2)	10.4 (9.5, 11.2)	9.9 (9.1, 10.8)	9.7 (8.8, 10.6)	8.9 (8.0, 9.7)
			Chinese			
Men (*n* = 569)	7.7 (5.5, 9.9)	7.6 (5.4, 9.7)	7.7 (5.5, 9.9)	6.9 (5.0, 8.9)	7.1 (5.1, 9.1)	6.4 (4.4, 8.3)
Women (*n* = 965)	5.0 (3.6, 6.3)	5.1 (3.7, 6.5)	5.0 (3.7, 6.4)	5.5 (4.0, 7.0)	5.5 (4.0, 7.0)	5.1 (3.6, 6.6)
			Overall			
Men (*n* = 223 113)	6.9 (6.8, 7.0)	6.8 (6.7, 6.9)	6.8 (6.7, 6.9)	6.5 (6.4, 6.6)	6.4 (6.3, 6.5)	6.2 (6.1, 6.3)
Women (*n* = 266 266)	3.7 (3.7, 3.8)	3.8 (3.7, 3.8)	3.8 (3.7, 3.8)	3.9 (3.8, 3.9)	3.9 (3.8, 3.9)	3.6 (3.6, 3.7)

SES, socio-economic status.
[a] Values in parentheses are 95% confidence intervals.

[b] Lifestyle factors include physical activity, TV-viewing, fruit and vegetable intake, processed meat, red meat, oily fish, alcohol intake and smoking.
[c] After exclusion of those diagnosed with diabetes aged ≤ 30 years, there were: 256 215 White women, 3605 South Asian women, 4570 Black women, 962 Chinese women, 213 483 White men, 4128 South Asian men, 3315 Black men and 564 Chinese men.
SES, socio-economic status.

Table 4. Crude and standardized prevalence of diabetes mellitus in South Asian participants

	Crude prevalence (%)[a]	Prevalence standardized by age (%)	Prevalence standardized by age and SES (%)	Prevalence standardized by age, SES and BMI (%)	Prevalence standardized by age, SES, BMI and lifestyle score (%)[b]	Prevalence standardized by age, SES, BMI and lifestyle score (excluding Type 1 diabetes) (%)[c]
			Indian			
Men (*n* = 2961)	24.3 (21.8, 26.9)	19.1 (17.8, 20.5)	19.1 (17.7, 20.5)	19.3 (17.9, 20.7)	18.8 (17.4, 20.2)	17.7 (16.2, 19.1)
Women (*n* = 2892)	18.7 (15.8, 21.6)	13.2 (11.9, 14.4)	13.2 (11.9, 14.4)	12.6 (11.4, 13.8)	12.5 (11.3, 13.8)	11.6 (10.4, 12.8)
			Pakistani			
Men (*n* = 1090)	24.3 (21.8, 26.9)	23.9 (21.5, 26.3)	23.8 (21.4, 26.2)	24.8 (22.4, 27.3)	25.4 (22.9, 28.0)	23.4 (20.8, 25.9)
Women (*n* = 694)	18.7 (15.8, 21.6)	19.3 (16.5, 22.2)	19.5 (16.7, 22.4)	18.6 (15.9, 21.4)	18.7 (15.8, 21.5)	17.2 (14.4, 20.0)
			Bangladeshi			
Men (*n* = 160)	29.3 (22.3, 36.4)	30.6 (23.7, 37.4)	30.5 (23.7, 37.3)	30.7 (23.9, 37.6)	30.5 (23.5, 37.5)	28.7 (21.9, 35.6)
Women (*n* = 74)	27.0 (16.9, 37.1)	24.8 (15.7, 33.9)	24.9 (15.8, 34.0)	24.4 (15.3, 33.6)	22.3 (13.3, 31.3)	19.2 (10.5, 28.0)

[a] Values in parentheses are 95% confidence intervals.
[b] Lifestyle factors include physical activity, TV-viewing, fruit and vegetable intake, processed meat, red meat, oily fish, alcohol intake and smoking.
[c] After exclusion of those diagnosed with diabetes aged ≤ 30 years, there were: 5403 Indian, 1612 Pakistani and 203 Bangladeshi participants.