

Inequalities in type 2 diabetes incidence in a multiethnic population: a cohort study investigating the impact of ethnicity, migration and mental health comorbidities

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Electronic supplementary materials (ESM)

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ESM Table 1. Clinical codes (UK Read Codes) for the extraction of clinical mental health diagnoses.

Term	Read Code
Type 1 Diabetes	C10E%
Type 2 Diabetes	C10F%, C109%
HBA _{1c}	42W5 (IFFC), 42W4 (DCCT)
Fasting plasma glucose	44g1
Secondary Diabetes	C10H%, C10B, C10N%, C10G%
Other types of diabetes	C10A, C10C, C10D, C1A%, C10M%, C326%, A3A2, PH3y5, M212, C135, PKyP, Q441, C10FS, C150%, C3500, C10N1, C370%, PKyF, C1zy4, PH3yA, PKy93, PKy1
Pancreatic disease/surgery	J670%, J671%, J6710, J6711, J67y6, 9b8G
Diabetes in pregnancy	L1808, L1809
Diabetes emergencies	C10EM, C109K
Severe mental illness: Psychosis, schizophrenia, bipolar affective disease codes	E10..%, E110..%, E111..%, E1124, E1134, E114.- E117z, E11y.% (excluding E11y2), E11z., E11z0, E11zz, E12..%, E13..% (excluding E135.), E2122, Eu2..%, Eu30..%, Eu31..%, Eu323, Eu328, Eu333, Eu32A, Eu329
Depression	E0013, E0021, E112..%, E113..%, E118., E11y2, E11z2, E130., E135., E2003, E291., E2B., E2B1., Eu204, Eu251, Eu32.% (excluding Eu32A, Eu32B, Eu329), Eu33..%, Eu341, Eu412
Anxiety	E200%
Polycystic ovarian syndrome	C165
Chronic kidney disease	1Z10.00, 1Z17.00, 1Z17.11, 1Z18.00, 1Z11.00, 1Z19.00, 1Z19.11, 1Z1A.00, 1Z1A.11, 1Z12.00, 1Z15.00, 1Z16.00, 1Z1B.00, 1Z1B.11, 1Z1C.00, 1Z1C.11, 1Z1D.00, 1Z1D.11, 1Z1E.00, 1Z1E.11, 1Z1F.00, 1Z1F.11, 1Z1G.00, 1Z13.00, 1Z1H.00, 1Z1J.00, 1Z1J.11, 1Z14.00, 1Z1K.00, 1Z1L.00, 1Z1L.11
Diabetic Retinopathy	2BBF.00, F420.00, F420z00, 2BBP.00, 2BBQ.00, F420000, 2BBR.00, 2BBS.00, F420200, F420500, F420600, F420800, 2BBT.00, 2BBV.00, 2BBø.00, F420100, F420700, 2BBk.00, 2BBI.00, 7276.
Diabetic neuropathy	C106.00, C106.11, C106.12, C106.13, C106000, C106100, C106y00, C106z00, C108200, C108211, C108212, C108B00, C108C00, C108J00, C108J11, C108J12, C109200, C109211, C109212, C109A00, C109A11, C109B00, C109B11, C109H00, C109H11, C109H12, C10E200, C10EB00, C10EC00, C10EC11, C10EJ00, C10EQ00, C10F200, C10F211, C10FA00,

	C10FA11, C10FB00, C10FB11, C10FH00, C10FR00, F171100, F345000, F35z000, F372.00, F372.11, F372.12, F372000, F372100, F372200, F381300, F381311, F3y0.00, M271100, N030100
Amputation	2G42. , 2G44. , 2G46., 2G43. , 2G45. , 2G47
Other eye complications	C105.00, C105000, C105100, C105y00, C105z00, C108100, C108F00, C108F11, C109100, C109111, C109112, C109E00, C109E11, C109E12, C10E100, C10E112, C10EF00, C10F100, C10FE00, C10FE11, F464000, 2BBL.00, 2BBW.00, 2BBX.00, C10EP00, C10EP11, C10FQ00, F420300, F420400
Diabetic foot ulcer	2G5L, 2G55, 2G5H, 2G54
Ischaemic Heart Disease\Coronary Heart Disease	G3, G30%, G31%, G32, G33%, G34%, G35%, G38%, G39%, G3y%, G3z, Gyu3%
Atrial fibrillation & flutter	G573%
Heart failure	G58..% , G1yz1 , 662f.-662i.
Stroke/Transient Ischemic Attack	G61%, G63y0,G63y1, G64%, G66%, G6760, G6W, G6X, Gyu62, Gyu63, Gyu64, Gyu65,Gyu66, Gyu6F, Gyu6G, ZV12D, Fyu55, G65%
Hypertension	G2, G20%, G24%, G25%, G26, G28, G2y, G2z, Gyu2, Gyu20
Peripheral vascular disease	G7310, G732, G7320, G7321, G7322, G7323, G7324, G733, G734, G735, G73y, G73y0, G73y1, G73z, G73z0, G73zz
Peripheral arterial disease	G73, G734, G73y, G73z%, Gyu74,
Abdominal aortic aneurysm	G71%
Myocardial infarction	G30%, G310%
Angina stable	G33%
Angina unstable	G311%

Other atherosclerotic disease	F421100, F421112, G342.00, G5y2.00, G70..00, G70..11, G70y.00, G70z.00
Cardiac valve disorders	791..00, 7910., 7910.11, 7910.12, 7910000, 7910100, 7910200, 7910211, 7910212, 7910213, 7910214, 7910300, 7910400, 7910y00, 7910z00, 7911., 7911.11, 7911.12, 7911000, 7911100, 7911200, 7911300, 7911400, 7911y00, 7911z00, 7912., 7912.11, 7912.12, 7912000, 7912100, 7912200, 7912300, 7912y00, 7912z00, 7913., 7913.11, 7913.12, 7913000, 7913100, 7913200, 7913300, 7913400, 7913y00, 7913z00, 7914., 7914.11, 7914000, 7914100, 7914200, 7914211, 7914212, 7914300, 7914400, 7914y00, 7914z00, 7915., 7915000, 7915100, 7915200, 7915300, 7915y00, 7916.11, 7916000, 7916100, 7916200, 7916300, 7916z11, 7917.11, 7917000, 7917100, 7917300, 7918000, 7919.11, 7919000, 7919100, 7919300, 7919400, 791A200, 791A300, A932.11, G11..00, G11..11, G110.00, G110.11, G111.00, G111.11, G111.12, G112.00, G112.12, G112.13, G113.00, G114.00, G11z.00, G12..00, G120.00, G121.00, G121.11, G121.12, G122.00, G12z.00, G13..00, G130.00, G131.00, G131.13, G131.14, G132.00, G132.12, G132.13, G133.00, G133.11, G133.12, G13y.00, G13z.00, G140.00, G140000, G140100, G140111, G140112, G140200, G14021X, G14021Y, G140300, G140400, G140412, G140413, G140500, G140514, G140z00, G141.00, G141000, G141100, G141z00, G54..11, G540.00, G540.12, G540.14, G540.15, G540.16, G540000, G540100, G540200, G540300, G540z00, G541.00, G541000, G541011, G541012, G541100, G541200, G541211, G541212, G541300, G541400, G541500, G541600, G541z00, G542.00, G542000, G542011, G542012, G542100, G542200, G542X00, G542z00, G543.00, G543000, G543011, G543012, G543100, G543200, G543213, G543215, G543300, G543311, G543400, G543z00, G544.00, G544000, G544100, G544200, G544X00, G54z000, G54z013, G54z014, G54z100, G54z500, Gyu1000, Gyu1100, Gyu5500, Gyu5600, Gyu5800, Gyu5A00, P602.00, P602z00, P61..00, P611.00, P62..00, P63..00, P64..00, P640.00, P641.00, P64z.00, P65..00, P650.00, P66..00, P6W..00, P6X..00, P6y0.00, P6y2.00, P712.13, P722400
Venous thromboembolism	G801.00, G801.12, G801600, G801700, G801B00, G801C00, G801E00, G801F00, G801z00, F05..00, F051.00, F051z00, F053.00, F053000, F053100, F05z.00, G676.00, G801.11, G801.13, G801D00, G80y.11, G80y400, G80y500, G80y600, G80y700, G80y800, G81..00, G820.00, G820.11, G822.00, G822000, Gyu8000, J420200, L413.00, L413.11, L413000, L413100, L413z00, L414.00, L414.11, L414000, L414200, L414z00, SP12200, 7A09300, 7A09311, 7A0A100, G401.00, G401.12, G401000, G401100, L096400, L43..00, L43..11, L430.00,

	L431.00, L431100, L432.00, L43z.00, L43z100, L43z400, L43zz00
Cardiomyopathy	G551.00, G554300, Gyu5M00

ESM Table 2. Defining categories for ethnicity variable in this study

<i>Collected data</i>	<i>Grouping for this study</i>	<i>included/ excluded</i>
<i>African</i>	Black African	included
<i>Any other ethnic group</i>	Other Ethnic Group	excluded
<i>Arab</i>	Other Ethnic Group	excluded
<i>Bangladeshi</i>	South Asian	included
<i>British</i>	White British	included
<i>Caribbean</i>	Black Caribbean	included
<i>Chinese</i>	Asian Other	excluded
<i>Gypsy or Irish Traveller</i>	White Other	included
<i>Indian</i>	South Asian	included
<i>Irish</i>	White Other	included
<i>Not Stated/Refused</i>	NA	excluded
<i>Other Asian</i>	Asian Other	excluded
<i>Other Black</i>	Black Caribbean	included
<i>Other Mixed</i>	Other Ethnic Group	excluded
<i>Other White</i>	White Other	included
<i>Pakistani</i>	South Asian	included
<i>Unknown</i>	NA	excluded
<i>White and Asian</i>	South Asian	included
<i>White and Black African</i>	Black African	included
<i>White and Black Caribbean</i>	Black Caribbean	included

ESM Table 3. Missing values

	<i>Missing %, All</i>	<i>Missing %, SMI</i>
Age	0	0
Physical and Mental Health Comorbidities⁽¹⁾	0	0
Deprivation index	2.7%	3.3%
Migrant (Country of birth not GBR)	34.9%	31.3%
Ethnicity	0	0
Language	16.2%	14.1%
Baseline BMI	57.2%	43.6%
Baseline HBA_{1c}	89.6%	80.6%
Any value during observation BMI ⁽²⁾	30.5%	8.9%
Any value during observation HBA_{1c} ⁽²⁾	57.5%	25.8%

⁽¹⁾ Comorbidities are all physical and mental health diagnoses that were established from the clinical codes. As the assumption that a diagnosis is present if diagnosed and vice versa, no missing values are generated. Note, 0 missingness rather reflects this assumption and does not exclude from biases in the data from undiagnosed or uncoded conditions, or errors in EHR.

⁽²⁾ Refers to the percentages of participants for whom no measurements were available at any point during the 7 years of observation.

ESM Table 4. Study population by ethnicity, SMI and Birth Country

<i>Ethnicity</i>	Migrant or non-Migrant (Country of Birth Not GBR)	<i>ALL</i>		<i>SMI</i>		<i>non-SMI</i>	
		<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
<i>Black African</i>	Non-migrant	4100	15.5%	172	27.9%	3928	15.2%
<i>Black African</i>	Migrant	22,402	84.5%	444	72.1%	21,958	84.8%
<i>Black African</i>	No record	13,549		214		13,335	
<i>Black Caribbean</i>	Non-migrant	11,820	52.0%	569	62.1%	11,251	51.6%
<i>Black Caribbean</i>	Migrant	10,892	48.0%	347	37.9%	10,545	48.4%
<i>Black Caribbean</i>	No record	15,438		446		14,992	
<i>South Asian</i>	Non-migrant	2777	31.3%	57	43.5%	2720	31.1%
<i>South Asian</i>	Migrant	6103	68.7%	74	56.5%	6029	68.9%
<i>South Asian</i>	No record	4497		55		4442	
<i>White British</i>	Non-migrant	74,551	91.3%	1206	92.6%	73,345	91.3%
<i>White British</i>	Migrant	7087	8.7%	97	7.4%	6990	8.7%
<i>White British</i>	No record	54,615		706		53,909	
<i>White Other</i>	Non-migrant	7582	9.3%	155	22.2%	7427	9.2%
<i>White Other</i>	Migrant	73,710	90.7%	542	77.8%	73,168	90.8%
<i>White Other</i>	No record	30,392		248		30,144	

ESM Table 5. Estimated coefficients of the CoxPH models (Model 1, Model 2, Model 3) for the outcome of Type 2 Diabetes Mellitus (T2DM) incidence.

<i>Variable Name</i>	<i>Model*</i>	<i>complete cases</i>	<i>imputed</i>
		<i>HR (95% CI), p-value</i>	<i>HR (95% CI), p-value</i>
<i>Age (per 10y)</i>	1	1.74(1.67,1.8); $p<0.001$	1.74(1.67,1.8); $p<0.001$
<i>Sex</i>	1	0.92(0.88,0.96); $p<0.001$	0.92(0.88,0.96); $p<0.001$
<i>Black African</i>	1	3.29(3.11,3.49); $p<0.001$	3.29(3.11,3.49); $p<0.001$
<i>Black Caribbean</i>	1	2.92(2.76,3.09); $p<0.001$	2.92(2.76,3.09); $p<0.001$
<i>South Asian</i>	1	3.83(3.53,4.16); $p<0.001$	3.83(3.53,4.16); $p<0.001$
<i>White Other</i>	1	1.12(1.05,1.2); $p<0.001$	1.12(1.05,1.2); $p<0.001$
<i>Age (per 10y)</i>	2	1.76(1.69,1.85); $p<0.001$	1.73(1.67,1.8); $p<0.001$
<i>Sex</i>	2	0.91(0.87,0.96); $p<0.001$	0.92(0.88,0.95); $p<0.001$
<i>Black African</i>	2	2.93(2.66,3.23); $p<0.001$	2.81(2.63,3.01); $p<0.001$
<i>Black Caribbean</i>	2	2.70(2.48,2.94); $p<0.001$	2.63(2.47,2.8); $p<0.001$
<i>South Asian</i>	2	3.37(3.3,3.78); $p<0.001$	3.34(3.06,3.65); $p<0.001$
<i>White Other</i>	2	1.01(0.92,1.11); $p=0.8399$	0.96(0.9,1.04); $p=0.3145$
<i>Migrant (Born outside of UK)</i>	2	1.23(1.14,1.32); $p<0.001$	1.33(1.24,1.42); $p<0.001$
<i>Age (per 10y)</i>	3	1.63(1.52,1.76); $p<0.001$	1.53(1.47,1.58); $p<0.001$
<i>Sex</i>	3	0.72(0.67,0.78); $p<0.001$	0.82(0.79,0.86); $p<0.001$
<i>Black African</i>	3	2.08(1.78,2.43); $p<0.001$	2.20(2.05,2.36); $p<0.001$
<i>Black Caribbean</i>	3	2.04(1.77,2.34); $p<0.001$	2.13(1.99,2.27); $p<0.001$
<i>South Asian</i>	3	3.97(3.31,4.77); $p<0.001$	3.50(3.19,3.83); $p<0.001$
<i>White Other</i>	3	1.01(0.87,1.18); $p=0.8992$	0.96(0.89,1.04); $p=0.3288$
<i>Migrant (Born outside of UK)</i>	3	1.25(1.11,1.41); $p<0.001$	1.29(1.2,1.38); $p<0.001$
<i>Area-level deprivation (decile)</i>	3	0.94(0.92,0.97); $p<0.001$	0.94(0.93,0.96); $p<0.001$
<i>Depression & Anxiety</i>	3	1.17(1.02,1.34); $p=0.0204$	1.15(1.07,1.24); $p<0.001$
<i>SMI - Severe Mental Illness</i>	3	1.65(1.42,1.92); $p<0.001$	1.84(1.67,2.03); $p<0.001$
<i>BMI (per 5 units)</i>	3	1.60(1.56,1.65); $p<0.001$	1.58(1.55,1.61); $p<0.001$
<i>Family history of diabetes</i>	3	2.25(1.51,3.36); $p<0.001$	3.01(2.44,3.72); $p<0.001$
<i>Hypertension</i>	3	1.51(1.38,1.66); $p<0.001$	1.47(1.4,1.55); $p<0.001$
<i>Macro-vascular comorbidity</i>	3	1.09(1.04,1.15); $p<0.001$	1.12(1.09,1.16); $p<0.001$
<i>South Asian x SMI cross-term</i>	3	0.57(0.29,1.14); $p=0.1084$	0.56(0.34,0.91); $p=0.019$

*Model 1: age, sex, ethnicity. Model 1 had no missing values; therefore, the results are identical.

Model 2: age, sex, ethnicity, migration status

Model 3: age, sex, ethnicity, migration status, physical (BMI, number of macro-vascular diseases, hypertension) and mental health comorbidities (depression and anxiety, severe mental illness), and area-level deprivation.

ESM Table 6. Estimated hazard ratios for T2DM incidence by ethnic group, migration status and SMI diagnosis.

The hazard ratios are with respect to White British, non-migrant, non-SMI group. These are HRs adjusted for age, sex, area-level deprivation, BMI, number of macro-vascular diseases, hypertension, depression and anxiety.

	<i>White British</i>	<i>White Other</i>	<i>Black African</i>	<i>Black Caribbean</i>	<i>South Asian</i>
Model 3 (fully adjusted)	HR (95% CI), p-value	HR (95% CI), p-value	HR (95% CI), p-value	HR (95% CI), p-value	HR (95% CI), p-value
Non-Migrant (non-SMI)	1 (baseline)	0.96(0.89, 1.04); P= 0.3381	2.2(2.05, 2.36); p<0.001	2.13(1.99, 2.27); p<0.001	3.5(3.19, 3.84); p<0.001
Non-Migrant & SMI	1.84(1.67, 2.03); p<0.001	1.78(1.57, 2.01); p<0.001	4.05(3.6, 4.56); p<0.001	3.92(3.5, 4.39); p<0.001	3.61(2.23, 5.86); p<0.001
Migrant (non-SMI)	1.29(1.2, 1.38); p<0.001	1.24(1.15, 1.33); p<0.001	2.83(2.64, 3.04); p<0.001	2.74(2.54, 2.95); p<0.001	4.51(4.08, 4.98); p<0.001
Migrant & SMI	2.37(2.1, 2.69); p<0.001	2.29(2.02, 2.59); p<0.001	5.22(4.62, 5.9); p<0.001	5.05(4.47, 5.7); p<0.001	4.65(2.86, 7.58); p<0.001
HR for SMI vs non-SMI within ethnic group	1.84(1.67, 2.03); p<0.001	1.84(1.67, 2.03); p<0.001	1.84(1.67, 2.03); p<0.001	1.84(1.67, 2.03); p<0.001	1.03(0.63, 1.68); p=0.8959

ESM Table 7. Share of participants by the duration of available medical history by migration status.

Share of participants by the duration of available medical history

	Born in UK	Migrant	All
≤ 2 years	40.80%	48.90%	48.60%
2 to 5 years	15.00%	18.60%	12.70%
>5 years	44.20%	32.50%	38.70%
total	100.00%	100.00%	100.00%
≤ 5 years	55.80%	67.50%	61.30%
> 5 years	44.20%	32.50%	38.70%
total	100.00%	100.00%	100.00%