DOI:
10.1111/dme.13895

Document Version
Peer reviewed version

Ethnicity and type 2 diabetes in the UK

Louise M. Goff, PhD RD

Diabetes Research Group, Departments of Diabetes and Nutritional Sciences, King's College London, Franklin-Wilkins Building, Room 3.87, Stamford Street, London, SE1 9NH, UK.

T: +44 (0)20 7848 6111; E: louise.goff@kcl.ac.uk

Novelty statement

The prevalence of type 2 diabetes (T2DM) is alarmingly high among ethnic minority groups in the United Kingdom (UK), about 3-5 times higher than White-British population. Particularly striking is the earlier onset of T2DM, which occurs some 10-12 years younger, with a significant proportion of cases being diagnosed before the age of 40 years.

A wealth of literature exists aiming to understand how genetic, physiological, socio-economic and lifestyle factors contribute to ethnic inequalities in T2DM. Much of this evidence is drawn from the United States of America; the current review focuses on the UK context, in which there are distinctions in the demographic, social and healthcare system factors that contribute to the presentation and outcomes of T2DM.

This review highlights a number of ways in which ethnicity impacts on the pathophysiology, presentation, complications and management of T2DM. Importantly it draws upon evidence from UK cohorts and recognises distinctions between UK cohorts and those residing in other regions. The focus on the UK context aims to provide practitioners with a greater understanding of T2DM in ethnic minority groups.

Abstract

Type 2 diabetes (T2DM) is a major UK public health priority. Among ethnic minority communities the prevalence is alarmingly high, about 3-5 times higher than White-British population. Particularly striking is the earlier onset of T2DM, which occurs some 10-12 years younger, with a significant proportion of cases being diagnosed before the age of 40 years. This review focuses on the UK context and T2DM in adult populations, exploring the available evidence regarding the complex interplay of biological, lifestyle, social, clinical and healthcare system factors that are known to drive these disparities.

Introduction

It is well documented that ethnic minority groups in the United Kingdom (UK) and worldwide suffer disproportionately from diabetes compared to non-minority populations (1, 2). This review will focus on type 2 diabetes (T2DM) as it is the burden of this disease that is most evident amongst ethnic minority populations, and it will focus on the UK context in which demographic, social and healthcare system factors contribute to the presentation and outcomes of T2DM being distinct to that of other regions.

Ethnic Diversity in the United Kingdom

The UK population is recognised for its growing diversity. In the most recent Census of England and Wales 14% of the population identified as from an ethnic minority background (Figure 1); whilst these figures are lower in Scotland (4%) and Northern Ireland (1.8%) all regions have seen significant growth of their minority communities over the last two decades. Half of the total minority population are of South Asian descent (Indian, Pakistani, Bangladeshi, or other Asian origin), around 25% are of Black, African, Caribbean or other Black descent, and there are smaller communities of Arab and other ethnic backgrounds (3). Growth in the diversity of the UK population is relatively recent compared to other regions, beginning mainly in response post-second world war appeals to citizens of Europe and the Commonwealth regions to move to the UK to assist with gaps in its labour market, including its public services such as the newly created National Health Service. This led to a large influx of labour in the 1950s from a number of European nations (e.g. Hungary, Italy, Ireland and Poland) as well the Commonwealth nations of India, Pakistan and the Caribbean islands, particularly Jamaica. The symbolic starting point of mass migration from the Caribbean was the journey of almost 500 West Indians on the SS *Empire Windrush* from Kingston, Jamaica in June 1948. From the Indian subcontinent, the majority of immigrants arrived in Britain during the 1950s and 1960s and included Hindus from the Gujarat region of western India, Sikhs from the eastern Punjab region, and Muslims both from the west part of Pakistan and from East Pakistan (now Bangladesh). Migrants from the African continent form another significant proportion of the UK population; often from Commonwealth countries, such as Nigeria, Ghana and Kenya, the majority of migration from these countries has tended to be more recent, peaking around the 1980s and often in response to economic downturn post-

independence. Asylum from civil unrest is another driver of recent migration to the UK from countries such as Somalia. Migrants from African nations currently form the largest growing ethnic minority group in the UK population, whilst growth of other ethnic minority populations is slowing (3).

Ethnicity is a complex multidimensional construct that groups people who identify with each other through shared cultural traditions. Membership of an ethnic group tends to be defined by shared cultural heritage, ancestry, language, history, diet, religion or physical appearance (4). Ethnicity, therefore, should be self-defined, allowing the individual to assert their identity, although it is often established or confirmed through information on parental and grandparental origin (5). The term 'ethnic minority group' has traditionally described migrant communities, i.e. people with a different birth country to that in which they reside. However, it is now recognised that classifying ethnicity according to country of birth is inappropriate in many regions of the world where communities of 2nd and 3rd generation migrants live, and as such new terminologies, which capture ancestry rather than place of birth have been introduced e.g. Black-British and Asian-American. It is important to distinguish ethnicity from race or racial background, which is a cruder/simpler construct that uses physical traits, such as skin colour, to group people.

Diabetes in Ethnic Minority Groups – the scale of the problem

Diabetes is a major UK public health priority. Currently in the UK, 5.6% of the population or 3.7 million individuals have diagnosed diabetes but the true prevalence is thought to be nearer 7.4% when undiagnosed individuals are taken in to account (6). Among ethnic minority groups the prevalence is alarmingly high, about three to five times higher (Figure 2). Modelling of data from the London 'SABRE' multi-ethnic cohort estimates that by age 80 years, 40-50% of South Asian and African-Caribbean men and women will have T2DM, at least twice the proportion of their age-matched White-European counterparts (7). Particularly striking is the earlier onset of T2DM; a recent analysis of UK primary care data showed the age of diagnosis to be 10-12 years younger on average in South Asians (46 ± 12 years) and Black African/Caribbeans (48 ± 12 years) compared to White-Europeans (58 ± 12 years) (8). Furthermore, a significantly greater proportion of people from ethnic minority backgrounds develop T2DM before the age of 40 years compared to White-Europeans (Figure 3) (8). The significant

variability in diabetes prevalence within a given ethnic group between different environments (for example, indigenous *versus* diasporic communities) provides evidence that these disparities are driven by a complex interplay of biological, lifestyle, social, clinical and healthcare system factors.

While this review will focus on adult T2DM, it is important to recognise that childhood T2DM is significantly more prevalent among children and adolescents from ethnic minority groups than children of White-European ancestry. The US SEARCH for Diabetes in Youth study, which recently reported a 30.5% increase in T2DM amongst 10-19 year olds between 2001 and 2009, shows the disproportionate burden of T2DM among children from ethnic minority groups, with an estimated prevalence of 1.20 per 1000 among American-Indian youth and 1.06 per 1000 among Black African-American youth compared to 0.17 per 1000 among White-American youth (9). In the UK it is estimated that South Asian children are 14 times more likely to develop T2DM than White-European children (10), which may be driven by higher body fat and central fat accumulation (11).

Risk factors and aetiology of diabetes in ethnic minority groups

Recognition of ethnic patterns of disease has led to extensive research investigating the roles of genetic, social and lifestyle factors in these inequalities.

The contribution that genetic factors make to ethnic inequalities in T2DM is unclear. The majority of studies, focused on common variants, suggest there is no ethnic variation in the genetic architecture that confers an increased T2DM risk, however, large-scale genetic studies in non-White European populations are lacking (2, 12).

Epidemiological evidence and migration studies that recognise different rates of disease within an ethnic group living in different environments or countries demonstrates the influence of non-genetic factors e.g. prevalence of T2DM is around 2% among Asian-Indians living in rural areas of India compared to around 8% among Asian-Indians living in urban India, and Asian-Indians living in the UK or other westernised countries, have about four times higher prevalence (13, 14). The comparison in populations of African ancestry is even more striking as it is estimated that African-Americans have a

prevalence of T2DM at least 12 times greater than that observed among indigenous African-Blacks (15-18).

Obesity represents one of the strongest contributors to the development of T2DM; around 90% of adults with T2DM are overweight or obese, and T2DM is five times more prevalent amongst adults with an obese body mass index (BMI) compared to those with a healthy weight (19). In the UK around 60% of adults are overweight or obese (BMI ≥25 kg/m^2) and 25% are obese (BMI ≥30 kg/m^2) (20). In some ethnic groups obesity rates are high, for example Black African/Caribbean women, but in others e.g. Black African/Caribbean men, the rates are no different to White-Europeans or the general population (Figure 4) (1). Recently a number of UK-based multi-ethnic cohort studies have identified that ethnic minority groups experience a higher risk of T2DM at lower levels of obesity than White-Europeans (8, 21, 22). Modelling of UK Biobank data have demonstrated that T2DM prevalence in South Asian groups with a BMI of 22 kg/m^2 is equivalent to T2DM prevalence in White groups with a BMI of 30 kg/m^2; while in Black African/Caribbean groups the equivalent BMI is 26 kg/m^2, and in Chinese women and men it is 24 and 26 kg/m^2, respectively (21). Data from The Health Improvement Network (THIN), a UK longitudinal general practice dataset, demonstrates that South Asians and Black African/Caribbeans have significantly higher probability of developing T2DM in the normal and overweight BMI categories, compared to White-Europeans and significantly more South Asians (38%) develop T2DM at a BMI below 30 kg/m^2 than White-Europeans (26%) and Black African/Caribbeans (29%) (8). Emerging evidence from the Child Heart and Health Study in England (CHASE), in which ethnic patterns in adiposity have been assessed in UK South Asian, Black African/Caribbean and White-European ethnicity, has shown higher levels of adiposity at any given BMI among South Asian children and lower or similar among Black African/Caribbean children compared to White-Europeans. These data suggest that BMI systematically underestimates adiposity in South Asians (23) and helps to explain why T2DM occurs at lower BMI cut-offs in South Asian communities. Drawn together this evidence suggests that conventional clinical definitions for obesity, that are derived from populations of White European descent (BMI ≥30 kg/m^2; waist circumference ≥88 cm in women and ≥102 cm in men), may not be appropriate for screening diabetes risk in non-white groups. In response the World Health

Organisation (WHO) and International Diabetes Federation (IDF) have proposed Asian specific thresholds in which overweight is defined as a BMI >23 kg/m^2 and obesity >27.5 kg/m^2, with waist circumference cut-offs of 80 cm for Asian women and 90 cm for Asian men (24, 25), although there is concern that these may be too conservative and lower cut-offs should be introduced (26). Currently there is insufficient data to derive specific cut-offs for Black African/Caribbean men and women, therefore European thresholds remain in use with these communities.

Ethnic differences in the pathophysiology of diabetes

The main pathophysiological processes underlying T2DM development are well documented and focus on the role of obesity, visceral and ectopic fat accumulation, insulin resistance and insulin secretory failure (27). Originally insulin resistance was proposed as the principal abnormality, attributed to visceral fat accumulation and the resultant flow of free fatty acids into the portal vein and deposition of hepatic fat. Insulin resistance would subsequently lead to compensatory insulin hypersecretion to maintain normoglycaemia. At the point of 'beta-cell exhaustion' or 'burn-out', where the beta-cells are unable to secrete sufficient insulin, the state of frank hyperglycaemia develops. It is now understood that there is a heterogeneity in the relationship between insulin sensitivity and insulin secretion, in that glucose tolerance can be maintained even in the presence of severe insulin resistance if the beta-cell secretory capacity is able to balance the degree of insulin resistance. Conversely, an individual may become hyperglycaemic with a relatively low level of insulin resistance if they have a low beta-cell secretory capacity.

There is a wealth of research investigating ethnic differences in the pathophysiology of T2DM. There is much debate as to whether the predominant mechanism in the development of T2DM differs according to ethnicity; much of the uncertainty comes from the contrast between methods used to measure these processes in large scale cohort/epidemiological studies compared to those used in detailed mechanistic investigations. In the UK SABRE cohort beta-cell function was lowest among Black African/Caribbean participants while South Asians showed more adverse measures of insulin resistance and higher calculated beta-cell function (7). While there is extensive evidence coming both from large-scale epidemiological studies and smaller detailed mechanistic investigations demonstrating

greater insulin resistance among South Asian populations compared to White-Europeans (28-35), there is also evidence that suggests South Asian populations are not characterised by more severe insulin resistance (36) and that progression of T2DM is more strongly linked to susceptibility of the beta-cells than insulin resistance (37-39). Detailed physiological studies in Black populations have also focused on the role of inadequate beta-cell function in the development of T2DM. An exaggerated insulin response to glucose stimulation in Blacks compared to other ethnic groups has been consistently reported, which is recognised to be driven by a combination of higher insulin secretion and lower hepatic insulin clearance (40, 41). Recent evidence has shown that by the point of frank T2DM there are greater failures in beta-cell insulin secretory capacity in Blacks but that these are still compensated for by reduced hepatic insulin clearance (42). It is important to note that there is a lack of longitudinal data in this field, therefore, it is still not possible to draw clear conclusions.

Insulin resistance is closely associated with occurrence of the Metabolic Syndrome, defined as a clustering of metabolic derangements including abdominal obesity, dyslipidaemia (raised triglyceride and low high-density lipoprotein (HDL) concentrations), hypertension and dysglycaemia (25), which is known to increase the risk of T2DM and cardiovascular disease (43, 44). South Asian populations are recognised to exhibit many features of Metabolic Syndrome in the prediabetic and diabetic state, particularly central obesity and dyslipidaemia (45), however Black African/Caribbean populations have a distinct phenotype in which there is marked hypertension (46) but in the absence of dyslipidaemia or central obesity (47-49). These ethnic patterns in cardiometabolic risk are evident in early life, for example dyslipidaemia was found to be most prevalent among South Asian, and least prevalent among Black African/Caribbean children in the CHASE study (50).

Increasing body fat content is linearly related to insulin resistance (51-54), however, it is now accepted that fat distribution, particularly abdominal/visceral fat, is a more sensitive predictor of insulin sensitivity than body mass index (BMI). Consistently in the literature South Asians are reported to have higher amounts of body fat for a given BMI and a higher risk of developing central obesity compared to White-Europeans despite similar or smaller body mass index values (55, 56). Evidence suggests that South Asians may be more prone to visceral fat deposition than White-Europeans or African-ancestry

groups, who develop less visceral obesity for a similar BMI (57), although the evidence for this is not always consistent (58) with the suggestion that visceral accumulation is more evident in men (59). There is a lot of interest in visceral fat in Black populations, who despite exhibiting markedly greater insulin resistance than White-Europeans have significantly less visceral fat (60). These differences are apparent as early as childhood/adolescence, indicating that these differences manifest early in life (61). While increased adiposity, particularly visceral adiposity, is a strong determinant of insulin resistance, this may not be as important in the development of T2DM in Black populations as it is in other ethnic groups (62).

Ectopic fat, defined as the deposition of triglycerides within cells of non-adipose tissue, is believed to be integral to the development of T2DM by causing metabolic disturbances in the organ/tissue it resides in (63). Visceral, liver and pancreatic fat are important ectopic depots. Ethnic specific patterns of ectopic fat have not been well investigated. In European populations liver fat has been shown to consistently correlate with measures of insulin resistance. South Asian populations have consistently been shown to exhibit elevated liver fat (59, 64) but there is a paucity of data regarding pancreatic lipid. In Black populations the majority of studies have been conducted in adolescent cohorts, with a focus on obese populations without diabetes (65, 66). Visceral fat, liver and pancreatic fat have been reported to be lower in Black populations compared to their White counterparts (65, 67). In a review of ethnic differences in the prevalence of non-alcoholic fatty liver disease (NAFLD), Pan *et al.* found several studies consistently reporting a significantly lower prevalence of NAFLD in Black compared to White populations (68). However, there is evidence that Black populations may be more sensitive to the negative effects of liver fat accumulation (65). In adults contradictory findings have been reported; liver fat has been found to be inversely associated with hepatic insulin sensitivity in Black but not White women (69), however, the opposite was found in Black *versus* White men where liver fat was inversely associated with hepatic insulin sensitivity in White but not Black men (70). This suggests that not only are there ethnic disparities but there are gender differences in the role of ectopic fat in the pathophysiology of T2DM within the Black ethnic groups where further research is required. Overall, studies of ectopic fat accumulation show that these features identify a subset of individuals at increased

risk of T2DM and CVD, although these relationships are affected by ethnicity. Data across different ethnicities highlight differences in the pathogenesis of insulin resistance.

Glycaemic control, diabetes complications and mortality

Hyperglycaemia is an important risk factor for the development of diabetic microvascular complications (71); HbA1c has been established as a sensitive marker of glycaemic control and microvascular risk. However there is concern over the use of HbA1c both for monitoring glycaemic control and in the diagnosis of diabetes in some ethnic groups because higher HbA1c values, in the region of 0.4%, have been consistently reported, particularly among Black African/Caribbeans, at all levels of glycaemia (72, 73). In the recent South London Diabetes Study, HbA1c was significantly higher in Black African/Caribbean people with newly diagnosed T2DM compared to White-Europeans (74). Paul *et al.* (2017) also recognised significantly higher HbA1c, and a greater proportion of people with HbA1c ≥ 58 mmol/mol, among Black African-Caribbean participants compared to South Asians or White-Europeans (8). In a longitudinal analysis of 24,111 adults from inner London, ethnicity was independently associated with HbA1c, and both South Asian and Black African/Caribbean adults demonstrated worse glycaemic control despite more intensive management (75). Ethnic differences in HbA1c are proposed to be, at least in part, due to non-glycaemic factors such as variation in glycation rates and erythrocyte membrane permeability to glucose (76). However, glycated albumin and frutosamine, which are less affected by non-glycaemic factors, have been shown to also be higher in non-White European groups (72), suggesting real differences in glycaemic control and an important contributor to the development of complications and poor outcomes for these ethnic groups. Currently ethnic-specific HbA1c criteria are not in use, however, a growing body of evidence suggests that diagnostic and monitoring cut-points should be used with caution in non-White European groups, as misdiagnosis is significantly more common than in White populations (76).

Whether ethnic differences in mortality and rates of microvascular and macrovascular complications exist in diabetes has been addressed in a number of large cohorts, for example the UKPDS (77, 78) and the Southall Diabetes Study (79, 80). In their systematic review of 51 studies Lanting *et al.* (81) described distinct differences in the conclusions drawn from US and UK based studies. In the US rates

of mortality and risk of lower limb amputation, retinopathy, nephropathy and end stage renal disease are consistently higher amongst non-White European ethnic groups. However, in the UK this is not the case, compared to White-Europeans, Black African/Caribbean and South Asians have been found to have lower risks of lower limb amputation (82, 83), equal rates of retinopathy in Black African/Caribbean (79) and lower rates in South Asians (84), lower rates of cardiovascular complications in Black African/Caribbean and lower or equal rates in South Asians (79, 84). It is only nephropathy and end stage renal disease for which the rates are worse in South Asians (84, 85) but equal in Black African/Caribbeans (79). Although there are cultural differences between ethnic groups living in the US and the UK, these differences in mortality and morbidity cannot be attributed to genetic differences, and much more likely point towards differences in healthcare systems, access and quality of care (81). More recently ethnic differences in diabetes complications have been investigated using data from the UK THIN database (86). At diagnosis the rates of comorbidities were 30% in White-Europeans compared with 11% of African-Caribbeans and South Asians (86). Clear distinctions in the incidence of chronic kidney disease (CKD) have been found, which is higher in White-Europeans than both Black African-Caribbeans and South Asians (86). Ethnic differences in the incidence of major cardiovascular diseases are also apparent; coronary heart disease (CHD) is highest among South Asians, while Black African-Caribbeans experience significantly lower rates of CHD compared to White-Europeans and South Asians, but rates of stroke do not differ by ethnicity (86, 87). Detailed investigations in the SABRE cohort are providing evidence for the mechanisms which may underlie these ethnic patterns in cardiovascular diseases. For example, arterial stiffness has recently been reported to be more favourable among Black compared to South Asians, which may explain some of the relative protection from coronary heart disease experienced by UK Black African/Caribbean groups (88). In a focus on CHD among South Asians Park *et al.* recently reported the detrimental impact of hyperglycaemia on left ventricular failure in South Asians that is not seen in White-Europeans (89).

Healthcare access and engagement

Cultural barriers to accessing healthcare make an important contribution to ethnic inequalities in diabetes. Linguistic and cultural differences, poor health literacy, low socioeconomic position and their

migrant status (90) often result in people from non-White European ethnic backgrounds having poorer diabetes knowledge and worse diabetes control (81). The UK National Service Framework for Diabetes recognises that diabetes services must be equitable to meet the needs of the population and to narrow the inequalities gap for groups with the poorest outcomes (91). The recent Department of Health (DH) strategy for the management of long-term conditions highlights the need to promote patient involvement and self-management (92) and the National Institute for Health and Care Excellence (NICE) recommends self-management education is accessible for all people with diabetes, taking into account culture and ethnicity (93). In pursuit of this diabetes services principally aim to deliver patient-centred care that is responsive to individual culture, lifestyle and religion, which will empower and enable people to self-manage their diabetes through support and education (91). However, evidence from the Healthcare Commission suggests that people from non-White European ethnic backgrounds are more likely to report not having the opportunity to attend an education course, suggesting that access issues are impacting on these groups disproportionately (94). Poor access to healthcare is a significant issue for non-White European ethnic groups (90); the DH report *'No patient left behind'* was commissioned in response to findings that people from non-White European ethnic backgrounds find it more difficult to access primary care services than White populations and their healthcare needs are not met by current services (95).

Self-management programmes and diet/lifestyle advice, which form the cornerstone of diabetes care, are less effective in people from non-White European ethnic backgrounds (96). This is often attributed to a lack of cultural competency amongst healthcare practitioners, and a failure to account for cultural beliefs and practices in generic education programmes (97). Culturally tailored advice and education programmes that are respectful of, and responsive to, the health beliefs, practices, cultural and linguistic needs of diverse people have been developed to overcome issues relating to healthcare access in people from non-White European ethnic backgrounds, and have been shown to bring about positive health outcomes (97). Furthermore ensuring cultural competency of healthcare professionals, such that they understand and can address the customs, beliefs and values of people from different cultural

backgrounds is proposed as a principal way to address ethnic inequalities in diabetes and its management (98).

Health behaviour contributors to ethnic disparities in diabetes

It is recognised that among any ethnic group there is huge diversity in terms of health beliefs and behaviours and 'culture' is an ever-changing concept; this is particularly true among different generations of migrant groups, who may undergo significant acculturation. However, a wealth of evidence exists which describes distinct cultural beliefs and behaviours that exist amongst non-White European ethnic groups and can act as barriers to healthful self-management practices. Consideration of these is important when delivering education programmes and promoting self-management practices amongst these patient groups. In South Asian communities language and communication discordance is often focused on as a significant barrier to receiving and understanding diabetes education. However, there are a number of deeper cultural structures, which may act as stronger barriers, and may not receive enough focus. Themes reported in the literature include, for example, a strong preference for traditional remedies and folk medicine, and a concern over the long-term safety of conventional medicines; beliefs that management should be left to qualified health professionals, a reliance on physician-led advice and a reluctance to partake in self-management; fatalist beliefs and the view that diabetes is not something to be concerned about, or it is inevitable, due to its widespread nature; risk being attributed to external influences e.g. stress, heredity, 'the will of God/Allah' for which the person with diabetes has a lack of control; beliefs that excess weight indicates good health; social responsibilities to maintain a traditional diet and misconceptions about the principles of the 'diabetic diet'; a lack of gender specific exercise facilities, a fear of injury or worsening health with exercise, and exercising being seen as a selfish activity that detracts from family commitments (99-102). These beliefs may be more relevant among older generations, those who are less acculturated, or those who associate more closely to traditional cultural practices.

In African-Caribbean communities, where language discordance may not be a prominent barrier to receiving health education, important cultural beliefs and behaviours are still recognised that should be considered. Themes reported in the literature include, for example, a strong distrust of medical advice

and a desire for natural, non-pharmacological therapies (103). Healthcare professionals are perceived commonly as lacking cultural understanding (104) and their advice lacking cultural relevance (105) or being poorly adapted to cultural needs (103). In addition, specific barriers associated with applying dietary advice to cultural foods consumed at home, an acceptance of larger body sizes and a lack of cultural salience of engagement in moderate or vigorous physical activity can limit positive health behaviours (106). Again, there may be generational differences in these beliefs and practices that have yet to be recognised in the literature.

Diabetes health education that has been culturally-tailored or is culturally appropriate brings about significantly greater improvements in glycaemic control, diabetes knowledge and self-efficacy than conventional education (107). However, it is noteworthy that very few culturally-tailored programmes have been evaluated in the UK. Only four out of the 33 trials included in the recent Cochrane review were UK-based, and they all focused on South Asian communities using linguistic adaptations (108-111). Effective methods of culturally tailoring have been identified in a recent systematic review (112) and include:

- Bilingual/bicultural professional educators or lay educators providing the education
- Teaching/counselling about dietary change by modifying ethnic foods and recipes
- Teaching/counselling of activity change using culturally appropriate activities e.g. dancing and walking
- Delivery of intervention in preferred language, including all materials
- Attendance by family members to elicit home-based support
- Use of visual aids to tailor to low-literacy needs

Diabetes Prevention

Diabetes prevention, targeting specific ethnic groups, has been evaluated in large scale trials and shown to be effective in indigenous communities in India (113, 114) and China (115). Definitive trials of T2DM prevention focusing on high-risk *migrant* populations have yet to be conducted; instead smaller scale studies have focused on prevention indirectly through weight loss rather than incident diabetes.

Achievement of weight loss amongst non-White European ethnic groups is noted as particularly challenging; a range of cultural beliefs and practices relating to body size and weight often act as barriers to behaviour change (116). For example, African-Americans participating in the Diabetes Prevention Programme and other weight loss trials achieve approximately half the magnitude of weight loss than that achieved by White-Americans (116, 117). While in a large scale trial of UK South Asians the authors noted that weight loss, although significant, was relatively modest (118), and another trial failed to achieve significant results (119). Understanding how to effectively engage high risk groups, such as ethnic minority communities, in health promotion interventions has been receiving increasing attention in recent years as tackling health inequalities has become a public health priority. Community engagement approaches have advanced as a promising strategy, the evidence for which has been comprehensively reviewed by O'Mara-Eves *et al.* (120). Community engagement methods are defined as 'involving communities in decision-making and in the planning, design, governance and delivery of services' (120). Community engagement approaches can take many forms including service user networks, volunteering or interventions delivered by trained peers. In their review O'Mara-Eves *et al.* concluded that there is strong evidence that community engagement interventions have a positive impact on health behaviours, health consequences, self-efficacy and perceived social support outcomes across a range of conditions and should therefore be incorporated into public health intervention design (120). It is acknowledged, however, that there is little data on the cost effectiveness of such strategies as they have rarely been evaluated against standard models of care. One example of this approach that has been evaluated in diabetes prevention is working in partnership with community organisations such as churches and faith-based institutions, which can overcome issues of distrust associated with healthcare settings. Faith-based diabetes prevention programmes have been evaluated in the USA and demonstrated significant improvements in weight, BMI, fasting glucose and healthy nutrition and activity behaviours (121, 122) but these approaches have yet to be trialled in the UK in which the role churches and faith institutions play in society is different to the US.

Conclusion

T2DM is a major public health priority, currently affecting over 3 million individuals in the UK. Non-White European ethnic groups are disproportionately burdened by T2DM; prevalence is alarmingly high, and it is diagnosed some 10-12 years earlier than in White-Europeans. These disparities are driven by a complex interplay of biological, lifestyle, social, clinical and health system factors. Tackling ethnic inequalities in diabetes requires cultural competency among healthcare professionals and culturally-sensitive interventions that are tailored to the health beliefs and practices of these cultural groups.

FIGURE LEGENDS

Figure 1. Ethnic groups, England and Wales Census 2011. Reproduced from Office for National Statistics.

Figure 2. Doctor-diagnosed type 2 diabetes among ethnic minority groups in England & Wales. Reproduced from Health Survey for England focus on ethnic minority health, 2004.

Figure 3. Age distribution of people with type 2 diabetes in White-European, African-Caribbean and South Asian ethnic groups in the UK. Reproduced from Paul SK et al. Diabetes, Obesity & Metabolism. 2017;19(7):1014-23.

Figure 4. Prevalence of obesity amongst ethnic groups in England and Wales. Reproduced from Health Survey for England focus on ethnic minority health, 2004.

REFERENCES

1. Becker E, Boreham R, Chaudhury M, Craig R, Deverill C, Doyle M, et al. Health Survey for England 2004. The health of minority ethnic groups. London: Joint Health Surveys Unit, National Centre for Social Research, Department of Epidemiology and Public Health at the Royal Free and University College Medical School; 2006.
2. Golden SH, Brown A, Cauley JA, Chin MH, Gary-Webb TL, Kim C, et al. Health disparities in endocrine disorders: biological, clinical, and nonclinical factors--an Endocrine Society scientific statement. The Journal of clinical endocrinology and metabolism. 2012;97(9):E1579-639.
3. ONS. Census data 2011. 2011.
4. Williams DR. Race and health: basic questions, emerging directions. Ann Epidemiol. 1997;7(5):322-33.
5. Oldroyd J, Banerjee M, Heald A, Cruickshank K. Diabetes and ethnic minorities. Postgraduate medical journal. 2005;81(958):486-90.
6. Diabetes UK. Annual Diabetes Prevalence Figures. Position Statement. 2017.
7. Tillin T, Hughes AD, Godsland IF, Whincup P, Forouhi NG, Welsh P, et al. Insulin resistance and truncal obesity as important determinants of the greater incidence of diabetes in Indian Asians and African Caribbeans compared with Europeans: the Southall And Brent REvisited (SABRE) cohort. Diabetes Care. 2013;36(2):383-93.
8. Paul SK, Owusu Adjah ES, Samanta M, Patel K, Bellary S, Hanif W, et al. Comparison of body mass index at diagnosis of diabetes in a multi-ethnic population: A case-control study with matched non-diabetic controls. Diabetes, obesity & metabolism. 2017;19(7):1014-23.
9. Dabelea D, Mayer-Davis EJ, Saydah S, Imperatore G, Linder B, Divers J, et al. Prevalence of type 1 and type 2 diabetes among children and adolescents from 2001 to 2009. JAMA. 2014;311(17):1778-86.
10. Ehtisham S, Kirk J, McEvilly A, Shaw N, Jones S, Rose S, et al. Prevalence of type 2 diabetes in children in Birmingham. BMJ. 2001;322(7299):1428.
11. Ehtisham S, Crabtree N, Clark P, Shaw N, Barrett T. Ethnic differences in insulin resistance and body composition in United Kingdom adolescents. The Journal of clinical endocrinology and metabolism. 2005;90(7):3963-9.
12. McCarthy MI. Genomics, type 2 diabetes, and obesity. The New England journal of medicine. 2010;363(24):2339-50.
13. Mckeigue PM, Miller GJ, Marmot MG. Coronary Heart-Disease in South Asians Overseas - a Review. J Clin Epidemiol. 1989;42(7):597-609.
14. Ramachandran A, Snehalatha C, Dharmaraj D, Viswanathan M. Prevalence of Glucose-Intolerance in Asian Indians - Urban-Rural Difference and Significance of Upper-Body Adiposity. Diabetes care. 1992;15(10):1348-55.
15. Carter JS, Pugh JA, Monterrosa A. Non-insulin-dependent diabetes mellitus in minorities in the United States. Ann Intern Med. 1996;125(3):221-32.
16. Erasmus RT, Fakeye T, Olukoga O, Okesina AB, Ebomoyi E, Adeleye M, et al. Prevalence of Diabetes-Mellitus in a Nigerian Population. T Roy Soc Trop Med H. 1989;83(3):417-8.
17. Harris MI, Flegal KM, Cowie CC, Eberhardt MS, Goldstein DE, Little RR, et al. Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults. The Third National Health and Nutrition Examination Survey, 1988-1994. Diabetes Care. 1998;21(4):518-24.
18. Rotimi CN, Cooper RS, Okosun IS, Olatunbosun ST, Bella AF, Wilks R, et al. Prevalence of diabetes and impaired glucose tolerance in Nigerians, Jamaicans and US blacks. Ethnicity & disease. 1999;9(2):190-200.
19. Abdullah A, Peeters A, de Courten M, Stoelwinder J. The magnitude of association between overweight and obesity and the risk of diabetes: a meta-analysis of prospective cohort studies. Diabetes research and clinical practice. 2010;89(3):309-19.
20. Public Health England. Adult obesity and type 2 diabetes 2014.

21. Ntuk UE, Gill JM, Mackay DF, Sattar N, Pell JP. Ethnic-specific obesity cutoffs for diabetes risk: cross-sectional study of 490,288 UK biobank participants. Diabetes Care. 2014;37(9):2500-7.
22. Tillin T, Sattar N, Godsland IF, Hughes AD, Chaturvedi N, Forouhi NG. Ethnicity-specific obesity cut-points in the development of Type 2 diabetes - a prospective study including three ethnic groups in the United Kingdom. Diabetic medicine : a journal of the British Diabetic Association. 2015;32(2):226-34.
23. Nightingale CM, Rudnicka AR, Owen CG, Cook DG, Whincup PH. Patterns of body size and adiposity among UK children of South Asian, black African-Caribbean and white European origin: Child Heart And health Study in England (CHASE Study). International journal of epidemiology. 2011;40(1):33-44.
24. Expert Consultation WHO. Appropriate body mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004;363:157-63.
25. International Diabetes Federation. The IDF consensus worldwide definition of the metabolic syndrome. 2005.
26. Misra A, Chowbey P, Makkar BM, Vikram NK, Wasir JS, Chadha D, et al. Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management. J Assoc Physicians India. 2009;57:163-70.
27. Defronzo RA. Banting Lecture. From the triumvirate to the ominous octet: a new paradigm for the treatment of type 2 diabetes mellitus. Diabetes. 2009;58(4):773-95.
28. Forouhi NG, Jenkinson G, Thomas EL, Mullick S, Mierisova S, Bhonsle U, et al. Relation of triglyceride stores in skeletal muscle cells to central obesity and insulin sensitivity in European and South Asian men. Diabetologia. 1999;42(8):932-5.
29. Geragotou T, Jainandunsing S, Ozcan B, de Rooij FW, Kokkinos A, Tentolouris N, et al. The Relationship of Metabolic Syndrome Traits with Beta-Cell Function and Insulin Sensitivity by Oral Minimal Model Assessment in South Asian and European Families Residing in the Netherlands. J Diabetes Res. 2016;2016:9286303.
30. Hall LM, Moran CN, Milne GR, Wilson J, MacFarlane NG, Forouhi NG, et al. Fat oxidation, fitness and skeletal muscle expression of oxidative/lipid metabolism genes in South Asians: implications for insulin resistance? PloS one. 2010;5(12):e14197.
31. Chandalia M, Abate N, Garg A, Stray-Gundersen J, Grundy SM. Relationship between generalized and upper body obesity to insulin resistance in Asian Indian men. The Journal of clinical endocrinology and metabolism. 1999;84(7):2329-35.
32. Whincup PH, Gilg JA, Papacosta O, Seymour C, Miller GJ, Alberti KG, et al. Early evidence of ethnic differences in cardiovascular risk: cross sectional comparison of British South Asian and white children. BMJ. 2002;324(7338):635.
33. Whincup PH, Gilg JA, Owen CG, Odoki K, Alberti KG, Cook DG. British South Asians aged 13-16 years have higher fasting glucose and insulin levels than Europeans. Diabetic medicine : a journal of the British Diabetic Association. 2005;22(9):1275-7.
34. Raji A, Seely EW, Arky RA, Simonson DC. Body fat distribution and insulin resistance in healthy Asian Indians and Caucasians. The Journal of clinical endocrinology and metabolism. 2001;86(11):5366-71.
35. Hulman A, Simmons RK, Brunner EJ, Witte DR, Faerch K, Vistisen D, et al. Trajectories of glycaemia, insulin sensitivity and insulin secretion in South Asian and white individuals before diagnosis of type 2 diabetes: a longitudinal analysis from the Whitehall II cohort study. Diabetologia. 2017;60(7):1252-60.
36. Gujral UP, Mohan V, Pradeepa R, Deepa M, Anjana RM, Mehta NK, et al. Ethnic Variations in Diabetes and Prediabetes Prevalence and the roles of Insulin Resistance and beta-cell Function: The CARRS and NHANES Studies. J Clin Transl Endocrinol. 2016;4:19-27.

37. Gujral UP, Narayan KM, Kahn SE, Kanaya AM. The relative associations of beta-cell function and insulin sensitivity with glycemic status and incident glycemic progression in migrant Asian Indians in the United States: the MASALA study. Journal of diabetes and its complications. 2014;28(1):45-50.
38. Staimez LR, Weber MB, Ranjani H, Ali MK, Echouffo-Tcheugui JB, Phillips LS, et al. Evidence of reduced beta-cell function in Asian Indians with mild dysglycemia. Diabetes Care. 2013;36(9):2772-8.
39. Mohan V, Amutha A, Ranjani H, Unnikrishnan R, Datta M, Anjana RM, et al. Associations of beta-cell function and insulin resistance with youth-onset type 2 diabetes and prediabetes among Asian Indians. Diabetes technology & therapeutics. 2013;15(4):315-22.
40. Goran MI, Bergman RN, Cruz ML, Watanabe R. Insulin resistance and associated compensatory responses in african-american and Hispanic children. Diabetes Care. 2002;25(12):2184-90.
41. Hannon TS, Bacha F, Lin Y, Arslanian SA. Hyperinsulinemia in African-American adolescents compared with their American white peers despite similar insulin sensitivity: a reflection of upregulated beta-cell function? Diabetes Care. 2008;31(7):1445-7.
42. Mohandas C, Bonadonna R, Shojee-Moradie F, Jackson N, Boselli L, Alberti K, et al. Ethnic differences in insulin secretory function between black African and white European men with early type 2 diabetes. Diabetes, obesity & metabolism. 2018;20(7):1678-87.
43. Reaven GM. Syndrome X: 6 years later. Journal of internal medicine Supplement. 1994;736:13-22.
44. Reaven GM. Pathophysiology of insulin resistance in human disease. Physiological reviews. 1995;75(3):473-86.
45. Patel SA, Shivashankar R, Ali MK, Anjana RM, Deepa M, Kapoor D, et al. Is the "South Asian Phenotype" Unique to South Asians?: Comparing Cardiometabolic Risk Factors in the CARRS and NHANES Studies. Glob Heart. 2016;11(1):89-96 e3.
46. Chaturvedi N, McKeigue PM, Marmot MG. Resting and ambulatory blood pressure differences in Afro-Caribbeans and Europeans. Hypertension. 1993;22(1):90-6.
47. Zoratti R, Godsland IF, Chaturvedi N, Crook D, Stevenson JC, McKeigue PM. Relation of plasma lipids to insulin resistance, nonesterified fatty acid levels, and body fat in men from three ethnic groups: relevance to variation in risk of diabetes and coronary disease. Metabolism. 2000;49(2):245-52.
48. Chaturvedi N, McKeigue PM, Marmot MG. Relationship of glucose intolerance to coronary risk in Afro-Caribbeans compared with Europeans. Diabetologia. 1994;37(8):765-72.
49. Hakim O, Charles-Edwards G, Whitcher B, Shuaib H, Goff LM. Associations between regional and whole-body fat and insulin sensitivity in type 2 diabetic men of White and Black ethnicity. Proc Nutr Soc. 2017;76((OCE4)):1.
50. Whincup PH, Nightingale CM, Owen CG, Rudnicka AR, Gibb I, McKay CM, et al. Early emergence of ethnic differences in type 2 diabetes precursors in the UK: the Child Heart and Health Study in England (CHASE Study). PLoS Med. 2010;7(4):e1000263.
51. Abate N, Garg A, Peshock RM, Stray-Gundersen J, Grundy SM. Relationships of generalized and regional adiposity to insulin sensitivity in men. The Journal of clinical investigation. 1995;96(1):88-98.
52. Goodpaster BH, Thaete FL, Simoneau JA, Kelley DE. Subcutaneous abdominal fat and thigh muscle composition predict insulin sensitivity independently of visceral fat. Diabetes. 1997;46(10):1579-85.
53. Karter AJ, Mayer-Davis EJ, Selby JV, D'Agostino RB, Jr., Haffner SM, Sholinsky P, et al. Insulin sensitivity and abdominal obesity in African-American, Hispanic, and non-Hispanic white men and women. The Insulin Resistance and Atherosclerosis Study. Diabetes. 1996;45(11):1547-55.
54. Bello O, Ladwa M, Marathe CS, Mohandas C, Amiel SA. The impact of ethnicity on the association between insulin sensitivity and adiposity measures in Black African and White European men with normal glucose tolerance and type 2 diabetes. Diabetic Medicine. 2018;35:1.

55. Scott WR, Zhang W, Loh M, Tan ST, Lehne B, Afzal U, et al. Investigation of Genetic Variation Underlying Central Obesity amongst South Asians. PloS one. 2016;11(5):e0155478.
56. Misra A, Khurana L. Obesity-related non-communicable diseases: South Asians vs White Caucasians. Int J Obes (Lond). 2011;35(2):167-87.
57. Karastergiou K. The Interplay Between Sex, Ethnicity, and Adipose Tissue Characteristics. Curr Obes Rep. 2015;4(2):269-78.
58. Shah AD, Kandula NR, Lin F, Allison MA, Carr J, Herrington D, et al. Less favorable body composition and adipokines in South Asians compared with other US ethnic groups: results from the MASALA and MESA studies. Int J Obes (Lond). 2016;40(4):639-45.
59. Shah A, Hernandez A, Mathur D, Budoff MJ, Kanaya AM. Adipokines and body fat composition in South Asians: results of the Metabolic Syndrome and Atherosclerosis in South Asians Living in America (MASALA) study. Int J Obes (Lond). 2011.
60. Lovejoy JC, de la Bretonne JA, Klemperer M, Tulley R. Abdominal fat distribution and metabolic risk factors: effects of race. Metabolism. 1996;45(9):1119-24.
61. Gower BA, Nagy TR, Goran MI. Visceral fat, insulin sensitivity, and lipids in prepubertal children. Diabetes. 1999;48(8):1515-21.
62. Goedecke JH, Mtintsilana A, Dlamini SN, Kengne AP. Type 2 diabetes mellitus in African women. Diabetes research and clinical practice. 2017;123:87-96.
63. Gastaldelli A, Basta G. Ectopic fat and cardiovascular disease: what is the link? Nutrition, metabolism, and cardiovascular diseases : NMCD. 2010;20(7):481-90.
64. Anand SS, Tarnopolsky MA, Rashid S, Schulze KM, Desai D, Mente A, et al. Adipocyte hypertrophy, fatty liver and metabolic risk factors in South Asians: the Molecular Study of Health and Risk in Ethnic Groups (mol-SHARE). PloS one. 2011;6(7):e22112.
65. Alderete T, Toledo-Corral C, Goran M. Metabolic Basis of Ethnic Differences in Diabetes Risk in Overweight and Obese Youth. Current diabetes reports. 2014;14(2):455.
66. Goedecke JH, Mtintsilana A, Dlamini SN, Kengne AP. Type 2 diabetes mellitus in African women. Diabetes Research and Clinical Practice. 2017;123:87-96.
67. Szczepaniak LS, Victor RG, Mathur R, Nelson MD, Szczepaniak EW, Tyer N, et al. Pancreatic steatosis and its relationship to beta-cell dysfunction in humans: racial and ethnic variations. Diabetes care. 2012;35(11):2377-83.
68. Pan JJ, Fallon MB. Gender and racial differences in nonalcoholic fatty liver disease. World Journal of Hepatology. 2014;6(5):274-83.
69. Goedecke JH, Keswell D, Weinreich C, Fan J, Hauksson J, Victor H, et al. Ethnic differences in hepatic and systemic insulin sensitivity and their associated determinants in obese black and white South African women. Diabetologia. 2015;58(11):2647-52.
70. Hakim O, Billoo Z, Sunderland A, Charles-Edwards G, Whitcher B, Shuaib H, et al. Associations between ectopic fat and hepatic and adipose tissue insulin sensitivity in men of White European and Black West African ethnicity with type 2 diabetes. Diabetic medicine : a journal of the British Diabetic Association. 2018;35(Suppl 1):1.
71. UKPDS Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet. 1998;352(September 12):17.
72. Selvin E, Brancati FL. A conundrum addressed: the prognostic value of HbA1c. Nat Rev Endocrinol. 2011;7(1):c1; author reply c2.
73. Kirk JK, D'Agostino RB, Jr., Bell RA, Passmore LV, Bonds DE, Karter AJ, et al. Disparities in HbA1c levels between African-American and non-Hispanic white adults with diabetes: a meta-analysis. Diabetes Care. 2006;29(9):2130-6.
74. Winkley K, Thomas SM, Sivaprasad S, Chamley M, Stahl D, Ismail K, et al. The clinical characteristics at diagnosis of type 2 diabetes in a multi-ethnic population: the South London Diabetes cohort (SOUL-D). Diabetologia. 2013;56(6):1272-81.

75. James GD, Baker P, Badrick E, Mathur R, Hull S, Robson J. Ethnic and social disparity in glycaemic control in type 2 diabetes; cohort study in general practice 2004-9. J R Soc Med. 2012;105(7):300-8.
76. Dagogo-Jack S. Pitfalls in the use of HbA(1)(c) as a diagnostic test: the ethnic conundrum. Nat Rev Endocrinol. 2010;6(10):589-93.
77. Davis TM, Coleman RL, Holman RR, Group U. Ethnicity and long-term vascular outcomes in Type 2 diabetes: a prospective observational study (UKPDS 83). Diabetic medicine : a journal of the British Diabetic Association. 2014;31(2):200-7.
78. UKPDS Group. Ethnicity and cardiovascular disease. The incidence of myocardial infarction in white, South Asian, and Afro-Caribbean patients with type 2 diabetes (U.K. Prospective Diabetes Study 32). Diabetes Care. 1998;21(8):1271-7.
79. Chaturvedi N, Jarrett J, Morrish N, Keen H, Fuller JH. Differences in mortality and morbidity in African Caribbean and European people with non-insulin dependent diabetes mellitus: results of 20 year follow up of a London cohort of a multinational study. BMJ. 1996;313(7061):848-52.
80. Mather HM, Chaturvedi N, Kehely AM. Comparison of prevalence and risk factors for microalbuminuria in South Asians and Europeans with type 2 diabetes mellitus. Diabetic medicine : a journal of the British Diabetic Association. 1998;15(8):672-7.
81. Lanting LC, Joung IM, Mackenbach JP, Lamberts SW, Bootsma AH. Ethnic differences in mortality, end-stage complications, and quality of care among diabetic patients: a review. Diabetes Care. 2005;28(9):2280-8.
82. Leggetter S, Chaturvedi N, Fuller JH, Edmonds ME. Ethnicity and risk of diabetes-related lower extremity amputation: a population-based, case-control study of African Caribbeans and Europeans in the United kingdom. Arch Intern Med. 2002;162(1):73-8.
83. Gujral JS, McNally PG, O'Malley BP, Burden AC. Ethnic differences in the incidence of lower extremity amputation secondary to diabetes mellitus. Diabetic medicine : a journal of the British Diabetic Association. 1993;10(3):271-4.
84. Samanta A, Burden AC, Jagger C. A comparison of the clinical features and vascular complications of diabetes between migrant Asians and Caucasians in Leicester, U.K. Diabetes research and clinical practice. 1991;14(3):205-13.
85. Burden AC, McNally PG, Feehally J, Walls J. Increased incidence of end-stage renal failure secondary to diabetes mellitus in Asian ethnic groups in the United Kingdom. Diabetic medicine : a journal of the British Diabetic Association. 1992;9(7):641-5.
86. Owusu Adjah ES, Bellary S, Hanif W, Patel K, Khunti K, Paul SK. Prevalence and incidence of complications at diagnosis of T2DM and during follow-up by BMI and ethnicity: a matched case-control analysis. Cardiovasc Diabetol. 2018;17(1):70.
87. Tillin T, Hughes AD, Mayet J, Whincup P, Sattar N, Forouhi NG, et al. The relationship between metabolic risk factors and incident cardiovascular disease in Europeans, South Asians, and African Caribbeans: SABRE (Southall and Brent Revisited) -- a prospective population-based study. Journal of the American College of Cardiology. 2013;61(17):1777-86.
88. Park CM, Tillin T, March K, Jones S, Whincup PH, Mayet J, et al. Adverse effect of diabetes and hyperglycaemia on arterial stiffness in Europeans, South Asians, and African Caribbeans in the SABRE study. Journal of hypertension. 2016;34(2):282-9.
89. Park CM, Tillin T, March K, Ghosh AK, Jones S, Wright A, et al. Hyperglycemia has a greater impact on left ventricle function in South Asians than in Europeans. Diabetes Care. 2014;37(4):1124-31.
90. Wilson C, Alam R, Latif S, Knighting K, Williamson S, Beaver K. Patient access to healthcare services and optimisation of self-management for ethnic minority populations living with diabetes: a systematic review. Health & social care in the community. 2012;20(1):1-19.
91. Department of Health. National Service Framework for Diabetes Standards. London, UK: Department of Health; 2001.

92. Department of Health. Improving quality of life for people with long term conditions. London, UK: Department of Health; 2013.
93. The National Collaborating Centre for Chronic Conditions. Type 2 diabetes. National clinical guideline for management in primary and secondary care (update). 2008.
94. Healthcare Commission. Managing diabetes: improving services for people with diabetes. 2007.
95. Lakhani M. No patient left behind: how can we ensure world class primary care for black and minority ethnic people? London: Department of Health; 2008.
96. Coonrod BA, Betschart J, Harris MI. Frequency and determinants of diabetes patient education among adults in the U.S. population. Diabetes Care. 1994;17(8):852-8.
97. Creamer J, Attridge M, Ramsden M, Cannings-John R, Hawthorne K. Culturally appropriate health education for Type 2 diabetes in ethnic minority groups: an updated Cochrane Review of randomized controlled trials. Diabetic medicine : a journal of the British Diabetic Association. 2016;33(2):169-83.
98. The Office of Minority Health. What is cultural competency. In: Sciences USDoHaH, editor. 2013.
99. Ludwig AF, Cox P, Ellahi B. Social and cultural construction of obesity among Pakistani Muslim women in North West England. Public Health Nutr. 2011;14(10):1842-50.
100. Sriskantharajah J, Kai J. Promoting physical activity among South Asian women with coronary heart disease and diabetes: what might help? Family practice. 2007;24(1):71-6.
101. Sohal T, Sohal P, King-Shier KM, Khan NA. Barriers and Facilitators for Type-2 Diabetes Management in South Asians: A Systematic Review. PloS one. 2015;10(9):e0136202.
102. Grace C, Begum R, Subhani S, Kopelman P, Greenhalgh T. Prevention of type 2 diabetes in British Bangladeshis: qualitative study of community, religious, and professional perspectives. BMJ. 2008;337:a1931.
103. Brown K, Avis M, Hubbard M. Health beliefs of African-Caribbean people with type 2 diabetes: a qualitative study. The British journal of general practice : the journal of the Royal College of General Practitioners. 2007;57(539):461-9.
104. Sarkar U, Piette JD, Gonzales R, Lessler D, Chew LD, Reilly B, et al. Preferences for self-management support: findings from a survey of diabetes patients in safety-net health systems. Patient education and counseling. 2008;70(1):102-10.
105. Stone MA. Making education in diabetes culturally appropriate for patients. Practice Nursing. 2006;17(12):5.
106. Moore AP, Stanton-Fay S, Rivas CA, Goff LM. Co-design of a theoretically based diabetes self-management education and support programme for UK African and Caribbean patients with type 2 diabetes: Healthy Eating & Active Lifestyles for Diabetes (HEAL-D). Diabetic Medicine. 2018;35(Suppl 1):1.
107. Attridge M, Creamer J, Ramsden M, Cannings-John R, Hawthorne K. Culturally appropriate health education for people in ethnic minority groups with type 2 diabetes mellitus. The Cochrane database of systematic reviews. 2014(9):CD006424.
108. Baradaran HR, Knill-Jones RP, Wallia S, Rodgers A. A controlled trial of the effectiveness of a diabetes education programme in a multi-ethnic community in Glasgow [ISRCTN28317455]. BMC public health. 2006;6:134.
109. O'Hare JP, Raymond NT, Mughal S, Dodd L, Hanif W, Ahmad Y, et al. Evaluation of delivery of enhanced diabetes care to patients of South Asian ethnicity: the United Kingdom Asian Diabetes Study (UKADS). Diabetic medicine : a journal of the British Diabetic Association. 2004;21(12):1357-65.
110. Bellary S, O'Hare JP, Raymond NT, Gumber A, Mughal S, Szczepura A, et al. Enhanced diabetes care to patients of south Asian ethnic origin (the United Kingdom Asian Diabetes Study): a cluster randomised controlled trial. Lancet. 2008;371(9626):1769-76.

111. Hawthorne K, Tomlinson S. One-to-one teaching with pictures--flashcard health education for British Asians with diabetes. The British journal of general practice : the journal of the Royal College of General Practitioners. 1997;47(418):301-4.
112. Nam S, Janson SL, Stotts NA, Chesla C, Kroon L. Effect of culturally tailored diabetes education in ethnic minorities with type 2 diabetes: a meta-analysis. J Cardiovasc Nurs. 2012;27(6):505-18.
113. Ramachandran A, Snehalatha C, Mary S, Mukesh B, Bhaskar AD, Vijay V, et al. The Indian Diabetes Prevention Programme shows that lifestyle modification and metformin prevent type 2 diabetes in Asian Indian subjects with impaired glucose tolerance (IDPP-1). Diabetologia. 2006;49(2):289-97.
114. Ram J, Selvam S, Snehalatha C, Nanditha A, Simon M, Shetty AS, et al. Improvement in diet habits, independent of physical activity helps to reduce incident diabetes among prediabetic Asian Indian men. Diabetes research and clinical practice. 2014;106(3):491-5.
115. Pan XR, Li GW, Hu YH, Wang JX, Yang WY, An ZX, et al. Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance. The Da Qing IGT and Diabetes Study. Diabetes Care. 1997;20(4):537-44.
116. Wingo BC, Carson TL, Ard J. Differences in weight loss and health outcomes among African Americans and whites in multicentre trials. Obesity reviews : an official journal of the International Association for the Study of Obesity. 2014;15 Suppl 4:46-61.
117. Samuel-Hodge CD, Johnson CM, Braxton DF, Lackey M. Effectiveness of Diabetes Prevention Program translations among African Americans. Obesity reviews : an official journal of the International Association for the Study of Obesity. 2014;15 Suppl 4:107-24.
118. Bhopal RS, Douglas A, Wallia S, Forbes JF, Lean ME, Gill JM, et al. Effect of a lifestyle intervention on weight change in south Asian individuals in the UK at high risk of type 2 diabetes: a family-cluster randomised controlled trial. Lancet Diabetes Endocrinol. 2014;2(3):218-27.
119. Admiraal WM, Vlaar EM, Nierkens V, Holleman F, Middelkoop BJ, Stronks K, et al. Intensive lifestyle intervention in general practice to prevent type 2 diabetes among 18 to 60-year-old South Asians: 1-year effects on the weight status and metabolic profile of participants in a randomized controlled trial. PloS one. 2013;8(7):e68605.
120. O'Mara-Eves A, Brunton G, McDaid D, Oliver S, Kavanagh J, Jamal F, et al. Community engagement to reduce inequalities in health: a systematic review, meta-analysis and economic analysis. Public Health Res. 2013;1(4).
121. Gutierrez J, Devia C, Weiss L, Chantarat T, Ruddock C, Linnell J, et al. Health, community, and spirituality: evaluation of a multicultural faith-based diabetes prevention program. The Diabetes educator. 2014;40(2):214-22.
122. Boltri JM, Davis-Smith M, Okosun IS, Seale JP, Foster B. Translation of the National Institutes of Health Diabetes Prevention Program in African American churches. Journal of the National Medical Association. 2011;103(3):194-202.