**Effects of Dietary and lifestyle management on type 2 diabetes development among Ethnic minority adults living in the UK: A generational shift**

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**Introduction**

Non-communicable diseases (NCD) contribute to most health problems worldwide and are the main drivers for causing disability (Global Burden of Disease Study, 2017). An increase in disability globally was observed due to metabolic conditions such as type-2 diabetes (T2D) (Global Burden of Disease Study, 2017). Besides disability, diabetes is today also one of the top ten causes of death worldwide (Ahmed *et al.*, 2020); thus, it has become a common disease which needs health emergencies. A rapid burden of diabetes in adults is observed in the UK and the prevalence is increasing over time (Diabetes UK, 2019). The higher risk group of T2D includes ethnic populations such as South Asian or Black Afro-Caribbean people (Diabetes UK, 2019).

Jointly genetic, epigenetic, and environmental factors related to T2D (Prasad and Groop, 2015; Ahmed *et al.*, 2020; World Health Organization, 2021). Environmental means modifiable factors include dietary behaviour and physical activity (Prasad and Groop, 2015). Ethnic minorities such as South Asians genetically carry fewer β-cells, and over the life-course failure of those cells leads to diabetes (Bhopal, 2013). Thus, to reduce CVD risk and improve health in adults, prevention of T2D demands priority by enhancing a healthy diet and lifestyle globally (Hu, 2011). It is because more than half of the T2D cases are possible to prevent or delay by maintaining a healthy lifestyle and dietary habits (Diabetes UK, 2019).

In general, unhealthy dietary habits triggered the global burden of disease (GBD 2016 Risk Factors Collaborators, 2017), causing diabetes, cardiovascular disease ("CVD"), and certain cancers. Dietary habits are dynamic and are influenced by individual choice, health benefits, and culture, where the people grow and live for a long time (Pieroni *et al.*, 2007). Thus, the choice of fruits and vegetables, amount of daily consumption of those, and the cooking style differ due to acculturation and affect T2D diabetes prevention and development.

The changing pattern of such modifiable factors like dietary behaviour for different generations in ethnic populations is unclear yet in literature, particularly in the UK, as some evidence exists for the immigrant population in the US. Research in the US demonstrated that an unhealthy dietary habit such as low fruit and high fast food existed due to long-time acculturation in Latina immigrants in the USA (Kasirye *et al.*, 2005). Acculturated first-generation Chinese Americans consume more sweets, fatty foods, and soft drinks, and thus were advised to reduce such unhealthy diets; while the second generation was advised to follow a healthy lifestyle including more fruit and vegetable consumption (Lv and Cason, 2004).

The fourth prominent risk factor for mortality worldwide is deemed as sedentary activity (Ranasinghe*et al.*, 2013). A lower level of physical activity was stated by South Asians born population outside the UK (1st generation) than those born inside the UK (2nd generation). This difference can be partly explained by cultural differences (Williams *et al.*, 2011). Past studies show that North African, South Asian, African Caribbean, and Mexican immigrants in Europe are less prone to taking sufficient physical exercise due to acculturation and are more likely to be overweight and obese and developing diabetes (Gilbert and Khokhar, 2008; Gualdi-Russo *et al.*, 2014).

Socio-cultural factors influence the likelihood of becoming a smoker or drinker (Best *et al.*, 2001). Among the Indians, Pakistanis, and Black Caribbeans, smoking and alcohol drinking habits are reported more by the second generation than the first (Wang and Li, 2019). Either active or passive smoking (Zhang *et al.*, 2011) and alcohol drinking enhance the earlier onset of T2D (Johnson, Bazargan and Cherpitel, 2001).

Despite such importance, to the author's knowledge and research, no study focused on the generational effect on the onset of T2D in dietary and healthy lifestyle habits in Asian, African, and Caribbean adults living in the UK. Thus, the study aims to investigate whether these changing dietary and lifestyle habits affect the onset of T2D in terms of generations. Moreover, whether generation of Asian, African and Caribbean, living in the UK differs in terms of onset of T2D.

**Data and Methods**

***The Data***

This study incorporated longitudinal self-reported data for 3459 Asian, African and Caribbean adults aged 25+ years whose information are available in both waves, namely, wave 7 (2016) and wave 9 (2019), from Understanding Society, the UK Household Longitudinal Study. Moreover, to identify the new cases of T2D between 2016 and 2019, this study excluded respondents who had already T2D in wave 7. Thus, the analytical sample includes respondents who were free from T2D in the baseline period.

This survey was initiated to collect data using a clustered and stratified probability sampling design in 2009-2010 from 40000 households who lived in the UK and visited them with new households each year to collect updated information (Gundi Knies, 2017; Jäckle, Gaia and Baghal, 2017).

Economic and Social Council and several departments from England, Welsh, Scotland, and Ireland funded to Understanding Society (Gundi Knies, 2017). The University of Essex, the University of Warwick, and the London School of Economics lead scientific issues (Gundi Knies, 2017). This study provides data to research longitudinally in health, social life, family, education, work, and income for the UK (including ethnic) population (Gundi Knies, 2017).

# *Data analysis*

# Logistic regression was employed to quantify the risk of the onset of T2D in terms of dietary and lifestyle habits over the generations, adjusting for potential covariates. The association between generation and the development of T2D was examined. Four models were used to investigate whether this association was affected by other potential covariates by adding step by step in models as mentioned below. These models will facilitate the identification of the strong confounders. Dietary elements, such as fruit and vegetable intake were considered separately, ≤2 servings/day were set as the cut off for low intake level in the current study. The lifestyle habit elements are categorized as walked weekly and not walked weekly, smoker and non-smoker, and alcoholic and non-alcoholic individuals. The four models were:

# model 1: an unadjusted model,

# model 2: adjusted for gender, urban/rural, country of residence,

# model 3: adjusted for gender, urban/rural, country of residence, and sleep quality; and

# model 4: adjusted for gender, urban/rural, country of residence, sleep quality, high blood pressure and long-standing illness.

# The study selected a reference group of individuals to compare the results. The reference group consists of the individuals (2nd+ generation) who had the lowest level of risk in developing T2D, and the other groups are compared with that reference group (Bruemmer *et al.*, 2009). To keep all the studied independent variables free from multicollinearity variance inflation factor (VIF) was calculated and found less than 5.0. Thus, these VIF values indicated no multicollinearity among the explanatory variables and satisfied the necessary condition for using binary logistic regression (Chatterjee and Hadi, 2006).

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**Results**

**Association between generation and the development of T2D in terms of dietary and lifestyle habits**

Results indicate that a significantly higher risk of developing T2D in 1st generation than the 2nd generation respondents in those who intake two or fewer servings/d of vegetable (unadjusted model 1: OR 2⋅50; 95 % CI 1⋅38, 4⋅54), and also in those who intake more than two servings/d of vegetable (unadjusted model 1: OR 3⋅41; 95 % CI 1⋅18, 9⋅84). However, these ORs revealed that first-generation respondents who intake more vegetables had higher odds than those who intake less. Moreover, this association remained significant even after the adjustment for gender, urban/rural, country of residence in model 2 (OR 2⋅48; 95 % CI 1⋅36, 4⋅51 for veg≤2 servings/day vs OR 3⋅45; 95 % CI 1⋅20, 9⋅97 for veg>2 servings/day). The subsequent model 3- adjusted for gender, urban/rural, country of residence, and sleep quality (OR 2⋅62; 95 % CI 1⋅44, 4⋅79 for veg≤2 servings/day vs OR 3⋅60; 95 % CI 1⋅24, 10⋅47 for veg>2 servings/day) has remained significant. The fully adjusted model 4, which is adjusted for gender, urban/rural, country of residence, sleep quality, high blood pressure and long-standing illness, (OR 2⋅32; 95 % CI 1⋅27, 4⋅25 for veg≤2 servings/day vs OR 3⋅59; 95 % CI 1⋅23, 10⋅48 for veg>2 servings/day) has also remained significant. Thus, it is clear from the above results that first-generation respondents were more likely to develop T2D than the 2nd+ generations in terms of vegetable consumption.

Similarly, in the case of fruits consumption, the unadjusted model revealed that the effect of generation, which means higher risk in 1st generation than the 2nd generation, on T2D development was more pronounced in respondents who intake more than two servings/d of fruits (unadjusted model 1: OR 5⋅46; 95 % CI 1⋅66, 17⋅91) compared to 2 or less servings/d of fruits (unadjusted: OR 2⋅22; 95 % CI 1⋅22, 4⋅07) consumption. This association remained significant even after the adjustment for gender, urban/rural, country of residence in model 2 (OR 2⋅20; 95 % CI 1⋅20, 4⋅02 for veg≤2 servings/day vs OR 5⋅42; 95 % CI 1⋅65, 17⋅80 for veg>2 servings/day). Similarly, model 3 adjusted for gender, urban/rural, country of residence, and sleep quality (OR 2⋅32; 95 % CI 1⋅27, 4⋅26 for veg≤2 servings/day vs OR 5⋅72; 95 % CI 1⋅74, 18⋅83 for veg>2 servings/day) has remained significant.The fully adjusted model 4 (OR 2⋅17; 95 % CI 1⋅18, 3⋅99 for veg≤2 servings/day vs OR 5⋅11; 95 % CI 1⋅54, 16⋅91 for veg>2 servings/day) has also remained significant. Therefore, the above results demonstrate that first-generation respondents were more prone to develop T2D than the 2nd+ generations in terms of fruits consumption.

For non-smokers, higher ORs were observed for first-generation than the 2nd generation in developing T2D in unadjusted (model 1: OR 2⋅20; 95 % CI 1⋅30, 3⋅71) as well as all four adjusted models (for example, fully adjusted model 4: OR 2⋅04; 95 % CI 1⋅20, 3⋅46).

For both alcoholic and non-alcoholic respondents, higher ORs were found for the first generation than the 2nd generation in developing T2D in unadjusted and all four adjusted models. For example, it is noted from the ORs that a higher odds was observed for alcoholic (model 1: OR 2⋅74; 95 % CI 1⋅17, 6⋅41 and fully adjusted model 4: OR 2⋅80; 95 % CI 1⋅18, 6⋅62) than the non-alcoholic (model 1: OR 2⋅47; 95 % CI 1⋅21, 5⋅02 and fully adjusted model 4: OR 2⋅40; 95 % CI 1⋅17, 4⋅93) respondents.

In the case of physical activity, the generational difference is relatively high for the respondents who walked weekly that means among the respondents, who did the physical activity, first-generation respondents were significantly more likely to develop T2D than the 2nd generation, for example, (unadjusted model 1: OR 2⋅93; 95 % CI 1⋅58, 5⋅44 and fully adjusted model 4: OR 3⋅06; 95 % CI 1⋅64, 5⋅72).

The strength of the association between generation and T2D development was increased by 5.6% for veg≤2 servings/day, 4.3% for veg>2 servings/day, 5.5% for fruit≤2 servings/day, 5.5% for fruit>2 servings/day, 5.5% for non-smokers, 4.8% for the alcoholic, 8.4% for non-alcoholic respondents in model 3 by the confounding effect of sleep quality. However, the strength of the association between generation and T2D development was decreased by 11.5% for veg≤2 servings/day, 6.5% for fruit≤2 servings/day, 10.7% for fruit>2 servings/day, 11.3% for non-smokers, 7.7% for non-alcoholic respondents in model 4 by the confounding effect of high blood pressure and long-standing illness.

**Conclusion**

The current study confirms**that** first generational is more likely to develop T2D than the second+ generation in terms of dietary and lifestyle habits in Asian, African and Caribbean adults aged 25+ years. Moreover,sleep quality, high blood pressure, and long-standing illness are strong confounders since a more change was observed in the association between generation and T2D development after adjusting for these covariates.

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