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Poverty, and the Global Prevalence of Diabetes Mellitus

Innocent Chanza[1], Ian Shaw[2] and Gary Adams[1*]

[1]Faculty of Medicine and Health Sciences, School of Health Sciences, University of Nottingham, Nottingham, UK

[2]School of Sociology and Social Policy, University of Nottingham, Nottingham, UK

[*]**Corresponding author:** Adams G, Faculty of Medicine and Health Sciences, School of Health Sciences, University of Nottingham, C Floor, South Block Link, Queen's Medical Centre, Nottingham, NG7 2RD, UK, Tel: +44 (0) 115 82 30901; E-mail: Gary.Adams@nottingham.ac.uk

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Abstract

Introduction: Race, ethnicity and lifestyle have been regarded as the main predisposing factors affecting illness and this is also the case with regards the global prevalence of DM. However, recent studies have indicated that poverty as the primary factor affecting DM both in the UK and the rest of the world. The aim of the review was to examine systematically the literature reporting on the impact of poverty, low income and deprivation in order to assist health care, EBP and policy makers to diabetes and the many complications that ensue.

Method: Seven electronic databases, CINHAL, Medline, AMED, Ovid, PubMed, Embase and PsycINFO, were systematically searched for the most appropriate studies to be included. Articles were identified using Critical Appraisal Skills Programme (CASP) for eligibility of the 11 papers. Key words were used to search the database. A PRISMA-based systematic review was utilised to identify studies. A thematic approach was undertaken to analyse the results.

Results and Discussion: Four major themes were identified from the 11 studies; 1) Neighbourhood deprivation affects DM prevalence, 2) Socioeconomic status affects quality of DM self-care and health care, 3) Leisure and SES affect DM prevalence, 4) Poor background affects DM in adulthood.

Conclusion: The key factors impacting on the Global Prevalence of Diabetes Mellitus are also key factors influencing wider global health inequalities. This suggests that one way to reduce incidence of Diabetes Mellitus is to reduce inequalities in health.

Keywords: ***Diabetes mellitus; Poverty; Global prevalence of DM***

1. Introduction

Diabetes mellitus (DM) is one of the most common chronic non-communicable diseases (NCD) in the world and its prevalence continues to grow due to changing lifestyles with reduced physical activity and increased obesity [1,2]. According to the World Health Organisation (WHO) [3], DM is the sixth highest cause of deaths in the world causing 1.6 million deaths in 2015 (NICE, [4]). Currently, type 2 DM (T2DM) is a leading cause of severe morbidities and disabilities which includes blindness, chronic

renal impairment, cardiovascular events, and lower limb amputation. In their study of 91 countries on DM prevalence, Shaw, Sicree and Zimmet [2] projected that by 2030 there will be 439 million adults living with DM, while T2DM is expected to be the primary cause of death predominantly due to its rapid rise in middle-income and low-income countries.

In addition, many studies explored factors that affected this prevalence. Thibault et al. [5], Bernabé-Ortiz et al., [6], Wangdi and Jamtsho [7], investigated obesity, hypertension, prediabetes, alcohol consumption, immigration and urbanization as predisposing factors. Singal and Ayoola [8] noted age, hypertension and chronic liver disease, particularly cirrhosis, affected DM prevalence. Siegel et al. [9], Kolb and Martin [10], Reis et al. [11] and Mutyambizi [12] attributed lifestyle as a major factor that affected the prevalence of DM while Hu [13] explored diet, lifestyle and genes as factors affecting prevalence of DM.

Although Spanakis and Golden [14], Chow et al. [15], Chang et al. [16] and Lopez et al. [17] examined race and ethnicity as a major factor and new research has revealed that low income were the main risks of developing DM rather than lack of physical activity, ethnicity and heredity [18], there has been minimal investigations into poverty.

Approximately 1.2 billion people in the world live in extreme poverty (less than one dollar per day) (OECD/WHO (DAC Guidelines and Reference Series), 2003) and although WHO attempts to ensure that the health perspective is reflected in poverty reduction strategies, medium term expenditure frameworks, and help to develop sector-wide approaches, poverty still impacts on health.

The aim in this paper is to establish the impact of poverty, low income and deprivation on the global prevalence of DM.

2. Methodology

2.1 Search strategy

Seven electronic databases, CINHAL, Medline, AMED, Ovid, PubMed, Embase and PsycINFO, were systematically conducted to discover the review papers using Boolean operators ‘AND’ and ‘OR’ with keywords. Combining two words using ‘AND’ raised articles that mentioned both words while ‘OR’ widened the search and realised more articles that mentioned either subject. Filters such as article types, text availability, language, age, sex and journal categories were also used to refine the search. The same search keyword, Boolean operators and filters were used in each database to ensure a uniform systematic search for each database and retrieval of the same papers if replicated.

Articles were identified using Critical Appraisal Skills Programme (CASP) for eligibility of the 11 papers. A PRISMA-based systematic review was utilised to identify studies. A thematic approach was undertaken to analyse the results.

2.2 Inclusion and exclusion criteria

Adults aged 18 and over were identified as the population while under 18s were excluded. As a requirement for a systematic review, primary research studies were included while secondary research studies were excluded. To increase the credibility, validity and reliability of the review peer reviewed and less than 5 years old studies were used [19]. Quantitative studies were included while qualitative papers were excluded for consistency, precision, reliability and generalizability [20].

2.3 Search result

The systematic search for studies through the databases literature produced 1655 articles. 127 studies were identified after duplicates were removed when titles were scanned. The titles and abstracts of the 127 records retrieved, 65 studies were excluded for not covering the topic. The 60 papers were further screened for eligibility. 49 full-text articles were excluded as they were not in line with the research question. 11 papers met the final quantitative inclusion for the review (FIG. 1).

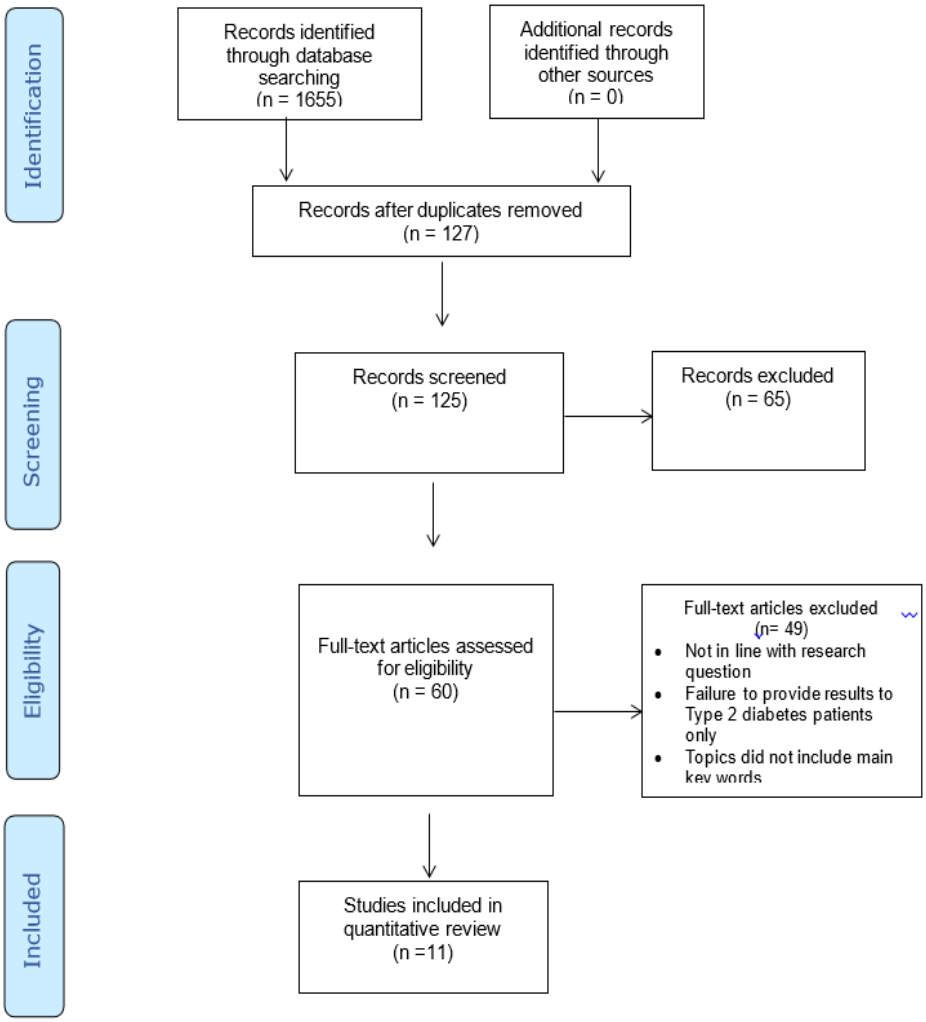

FIG 1. **Prisma Flow Diagram to Illustrate Studies Included in Review.**

3. Results and Discussion

Four major themes that linked DM to poverty. The key themes identified in the papers were:

i. Neighborhood deprivation affects DM prevalence,
ii. Socioeconomic status affects quality of DM self-care and health care,
iii. Leisure and SES affect DM prevalence,
iv. Poor background affects DM in adulthood (TABLE 1).

This should not be surprising as they are also the major global factors in illness and in health inequalities [1].

TABLE 1. **Representing the Number of Studies Included.**

Study Number	Author and Year	Country of study	Aim	Sample	Methods	Results
1	Sheets L, Petroski GF, Jaddoo J, et al. [21]	USA	To evaluate the neighbourhood socio-economic disadvantage, as a factor in DM prevalence	Study population comprised 4,770, 65 years or older and enrolled in Medicare.	The findings of the study show the power of the Area Deprivation Index (ADI) to quantify neighbourhood socio-economic deprivation into a single index in predicting the NCDs prevalence.	• Results indicate that DM prevalence was lowest in the least disadvantaged quintile of neighbourhoods after adjusting for age, gender, and race/ethnicity. • DM prevalence varies by ethnicity, disparities are more strongly associated with socio-economic status than with race or ethnicity. • Most deprived suffer a disproportionate share of the burden of DM and children who live in poverty are more likely to develop T2DM and more likely to die from it earlier. • The percent of patients with diabetes mellitus (DM) within each ADI quintile clearly shows a positive but non-linear association of increasing DM prevalence (ranging from less than 25% to more than 35% in the study population) with increasing ADI (i.e., increasing neighbourhood deprivation).
2	Conway et al. [22]	USA	To investigate health disparities in diabetes and other non-communicable diseases low-income racially diverse southern US cohorts.	24,000 black and 14,064 white adults aged 40-79	Community Prospective Cohort Study - An ongoing Southern Community Cohort Study (SCCS) in the	Study undertaken in Community Health Centres (CHCs), • Rates of obesity-associated diabetes were exceptionally high in this low-income adult population. • Lower levels of education and income was the reason to marked

					deprived areas of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia.	increases in the incidence and prevalence of DM. • Only after median 4.5-year follow-up period, nearly 12% of blacks and 6% of whites overall, 20% and 17% respectively who were morbidly obese (BMI_40 kg/m^2) developed adult onset DM requiring medication treatment. • Diabetes risk rose with increasing BMI, but the trends differed between blacks and whites (p interaction <.0001). Adjusted ORs (CIs) for diabetes among those with BMI 40 vs 20-25 kg/m^2 were 11.9 (8.4-16.8) for whites and 4.0 (3.3-4.8) for blacks. • Diabetes prevalence was two-fold higher among black than white of normal BMI however racial difference became attenuated as BMI rose with risk
3	Zhang Z, Chen X, and Gong W. [23]	China, Zhejiang Provincial Centre	To examine the relationship between the prevalence of T2DM and neighbourhood deprivation.	1,299 out of 1,531 sub-districts of 54 million people.	T2DM data (2012–2016) in the study were obtained from a population-based DM registry system maintained by Zhejiang Provincial Centre for Disease Control and Prevention.	The study used a composite neighbouring deprivation index based on integrating remote sensing data and socio-economic statistical data with the help of spatial analysis to quantify the spatial pattern of T2DM prevalence and NDI at the township level. • Spatial analysis showed that the prevalence of T2DM hot spots were in urban centres while the cold spots were in the rural areas of (Hangzhou city) and western and south-western regions of Zhejiang.

						• Type 2 diabetes mellitus incidence (Moran's I: 0.531, P <0.001) and Neighbourhood Deprivation Index (Moran's I: 0.772, P <0.001) showed positive statistically significant global Moran's I index values, showing a tendency towards clustering. • T2DM hot spots of the less deprived areas to be located in urban centres while the cold spots of the deprived were clustered in the rural areas of western and south western regions of Zhejiang. • Association between neighbourhood deprivation and T2DM justifying the growing consensus that socio-economic characteristics of an area could have an impact on the health of the residents.
4	Fleetcroft, R., Miqdad A., Shehzad, A., and Cookson, R. [24]	United Kingdom	To quantify trends in socio-economic inequality and DM outcomes.	32 482 LSOAs (Lower Layer Super Output Areas)	Community prospective cohort study. Three indicators linking diabetes outcomes to socio-economic inequality • glycaemic control • preventable emergency hospitalisation for diabetes; • amenable mortality from	2.7 million adults in the UK had a diagnosis of diabetes in 2013 and 90% of these diagnoses were T2DM. • T2DM is socially patterned, with prevalence being 50% higher in the quintile of the population with the greatest levels of deprivation compared with the quintile of least deprivation. • Diabetes-related amenable mortality rates decreased at a faster rate in neighbourhoods of greatest deprivation than in areas of least deprivation between 2004/2005 and 2011/2012

					diabetes related causes.	• In 2004/2005, there were substantial socio-economic gradients in both amenable mortality and preventable hospitalisation for diabetes and a smaller socio-economic gradient in glycaemic control with outcomes less favourable in neighbourhoods of greater deprivation. • By 2011/2012, substantial inequalities still remained and were associated with a deficit of 1.90 percentage points (95% confidence interval [CI] =1.74 to 2.06) in diabetes-related primary care quality, 22 189 (95% CI =21 498 to 22 881) DM outcomes unchanged- SII (0.04, 95% confidence interval [CI] = –0.43 to 0.52). • During the study, Emergency hospitalisation connected to DM complications rose in deprived areas.
5	Compean Ortiz et al. [25]	USA	To examine self-care behaviour and their relationship to glycaemic control in low-income Mexican adults with T2DM.	135 patients	Empirical Quantitative Longitudinal study, which examined self-care behaviours and their relationship to glycaemic control in low-income Mexican adults with T2DM in South-eastern	The findings were based on the healthy eating, exercise, medication and blood glucose monitoring in low-income adults with T2DM and the relationship to glycaemic control (HbA1c and fasting blood glucose) and cardiovascular risk factors (total cholesterol, low-density lipoprotein [LDL], high-density lipoprotein [HDL], and triglycerides. • Findings show all the patients demonstrated poor glycaemic control, with glycated haemoglobin >7%. Self-care

					Tamaulipas, México.	behaviours were associated with fasting blood glucose (rs =.223, p =.005). • Findings show medication management was influenced by cognitive performance, F (1, 130) =4.49, p =.036, and depression, F (1, 130) =8.22, p =.005. Dietary behaviours were influenced by previous diabetes education, F (1, 130) =6.73, p =.011. - Findings indicate that education and cognitive behavioural interventions in Spanish for Mexican adults with type 2 diabetes are urgently needed. • Variables that significantly influenced self-care in diet and medications were cognitive performance (MMSE), depression, and previous education on diabetes. • Linked to low-income and low educational levels.
6	Hazriani et al. [26]	Malaysia	To assess the prevalence of hypertension, DM and hypercholesterolemia among adults, in relation to economic status.	330 adults (133 males, 197 females)	A cross-sectional study. Stratified random sampling method was used to recruit the respondents. Participants were: 87% were living below the Poverty with median per capita household	Newly diagnosed cases of hypercholesterolemia was 40.6%, diabetes T2DM was 5.8%, and hypertension was 24.5%. • High numbers of adults from the hardcore poor did not have blood pressure, blood sugar and cholesterol checked in the 12 months preceding the study p <0.01). • High numbers of adults from the hardcore poor were represented in undiagnosed hypertension and uncontrolled blood pressure

					income of RM83.33/month (USD20/month).	among those diagnosed (p =0.013). • Among diabetic adults from the hardcore poor, the undiagnosed fasting blood glucose was 11.2 ± 4.5 compared to 5.1 ± 0.6 mmol/L for diagnosed diabetic adults (p <0.001). • Cholesterol and LDL cholesterol values were higher in the undiagnosed hardcore poor than in diagnosed adults (p <0.001). • Many people in this rural coastal community were unaware that they had high cholesterol level (40.6%) and elevated blood pressure (24.5%). • Household income were mostly below Poverty Line Income for households in rural Sabah of RM1, 180/month [18]; 14.2% were poor (household income RM761-1180/month) and 72.4% were hardcore poor (household income =RM760/month).
7	Funakoshi, M, Azami Y, Matsumoto H, Ikota A, Ito K, Okimoto H, et al. [27]	Japan	To assess the socio-economic status and T2DM complications among young adult patients in Japan	782 outpatients with type 2 diabetes (525 males, 257 females), aged 20-40 years	96-member hospitals and clinics of the Japan Federation of Democratic Medical Institutions. The study examined the link between socio-economic status (SES) [educational	The prevalence of type 2 diabetic retinopathy was 23.2%, while that of nephropathy was 8.9%. The odds of having retinopathy were higher among junior high school graduates (OR 1.91, 95% CI 1.09-3.34), patients receiving public assistance (OR 2.19, 95% CI 1.20-3.95), and patients with irregular (OR 1.72, 95% CI 1.03-2.86) or no employment (OR 2.23, 95%CI 1.36-3.68), compared to those with a higher SES, even after covariate adjustment (e.g., age, gender, body mass index). Similarly,

					level, income, type of public healthcare insurance and employment status] and T2DM complications [retinopathy and nephropathy] using a multivariate logistic regression analysis.	the odds of having nephropathy were higher among patients with middle (OR 3.61, 95% CI 1.69-8.27) or low-income levels (OR 2.53, 95% CI 1.11-6.07), even after covariate adjustment. • Findings show low SES was associated with a greater likelihood of T2DM complications in young adults. • Findings suggest the necessity of health policies that mitigate socio-economic disparity and thereby reduce the prevalence of diabetic complications. • Most of the participants had a lower SES than the national average. • 44.6% of the total sample was obese. The findings show the relationship between SES with DM risk factors and inhabitancy status. • Findings show a higher prevalence of alcohol drinking among those with regular employment while smoking was higher among those with low education levels and regular workers.
8	Carrillo-Vega MF, Albavera-Hernández C, Ramírez-Aldana R, García-Peña C. [28]	México	To analyse whether the presence of social disadvantages in childhood and in the present affects the presence of diabetes in older adults	8,848 individuals	Study based on longitudinal data from the third and fourth Mexican Health and Aging Study (MHAS) waves (2012 and 2015).	Findings suggested that childhood social disadvantages can be a determinant for the presence of NCDs in adulthood. • Predictor variable “no shoes during childhood” was statistically significant in the model incident versus no diabetes group.

						• Hypertension and body mass index (BMI) were the most relevant covariates as they were statistically significant in the three groups (PG, IG and NDG) • Most of the participants were women and percentages range from 54.46% in the NDG to 62.01% in the PG. • Percentage of individuals reporting bad self-perception of economic status was higher in the PG (80.82%) followed by the IG (75.96%). • Obesity was higher in the IG (24.84 and 36.60%), followed by the PG (24.07 and 33.11%). • Social disadvantages that start from childhood and continue into the later stages in life may be linked to the presence T2DM.
9	Glover, C., Wang, Y., Fogelfeld, L. and Lynch, E. [29]	United States of America	To understand relationships between DSQOL (diabetes- specific quality of life) and demographics, clinical markers, psychosocial factors, and stress in African Americans.	211 African Americans	A randomized controlled trial. Participants were 211 African Americans with uncontrolled T2DM enrolled in the Lifestyle Improvement through Food and Exercise (LIFE) study.	Demographics such as lower income, lack of education, being female, married or living with a partner have an influence with poorer DSQOL. • Findings suggest that treating low- income African Americans with uncontrolled T2DM should include not only a focus on T2DM- related clinical markers such as HbA1c level but an assessment and understanding of stress and depression, as these are potentially modifiable determinants of DSQOL. • Stress management interventions may improve DSQOL in high-risk patient populations

						• Patient-centred care for low-income African Americans with uncontrolled T2DM should include stress- reduction strategies in order to improve DSQOL. • Stress among the poor significantly affected the quality of self-diabetes care than the poverty itself.
10	Medina, C, Janssen, I., Barquera , S., Bautista-Arredondo, S., González, M. and González, M. [30]	Mexico	To examine the relationship between total, leisure and occupational moderate-to-vigorous physical activity (MVPA) and prevalence of type II diabetes (T2DM) and hypertension in the Mexico City low income areas.	2282 Men and women	A prospective cohort study from 1989 to 2009 in adults living in six low-income neighbourhoods in Mexico City. Data obtained from Mexico City Diabetes. Physical examinations and questionnaires over 20 years on BMI, blood glucose. Lifestyle, alcohol, smoking and physical activities and cause of deaths.	Study conducted from 1989 to 2009 among 2282 men and non-pregnant women living in six low-income neighbourhoods in Mexico. • 70% of the cohort was classified within the lowest educational level. • Link between the rate of physical activity and the prevalence of hypertension and T2DM. • Work identified as the main source of physical activity among the adults in the poor neighbourhoods of Mexico City. • Study found link between leisure, occupational and total METs/min/week MVPA (moderate-to-vigorous physical activity) and the risk of T2DM and hypertension in a sample of low-income adults residing in Mexico City. • Adults in low- and middle-income countries accumulate more MVPA during work and less MVPA during leisure time. Less MVPA during leisure time in low income areas increases

						the prevalence of hypertension and T2DM. • Not accumulating MVPA during leisure time was associated with a 30% increased risk of T2DM and hypertension.
11	Mohamed, S., Mwangi, M., Mutua, M., Kibachio, J., Hussein, A., Ndegwa, K., Owondo, S., Asiki, G., and Kyobutungi, C. [31]	Kenya	To find out the prevalence, awareness, treatment and control of diabetes and the factors that affect the prevalence of condition.	6000 households randomly selected from a national sample STEPs survey of adults aged 18–69 years were used	Data obtained from 2015 Kenya STEPs survey, first national household survey on NCD risk factors. - Data was collected in all 47 counties in Kenya between April and June 2015.	prevalence NCDs and T2DM was exacerbated by poverty and no education. • 46% of respondents were aged 18-29 years of which 51% were females with no schooling and were unemployed living in the rural areas belonging in the poorest wealth quantile. • Prevalence of pre-diabetes was higher in respondents living in urban areas (3.5%) than rural areas (2.7%). This was also higher among females (3.3%) compared to males (2.8%). The condition was again higher in the richest wealth quintile (4.9%) compared to poorest quintile (3.3%) although not statistically significant. • Prevalence of diabetes was high in respondents living in urban areas (3.4%) compared to those rural areas (1.9%). The prevalence was also high among the respondents in the 4th richest wealth quintile and 5th richest wealth quintile (5.2%) compared to respondents in the poorest wealth quintile (1.6%). • Education level was the only factor linked to pre-diabetes.

						• Results also show that diabetes treatment levels are low. Only 21.3% of the patients with diabetes reported that they were on treatment while only 41% among those who were aware of their diagnosis were on treatment. The low levels of awareness of having diabetes is likely to contribute to low levels of treatment. • Women compared to men were more likely to have abdominal obesity (50.2% vs. 12.1%), BMI ≥ 25 kg/m^2 and high total cholesterol levels (9.8% vs. 4.6%).

4. Description of the Included Studies

Eleven quantitative primary research studies were included. Of the 11 papers, there were 5 cohort studies, 2 longitudinal studies, 2 cross sectional studies, 1 WHO STEPwise survey and 1 randomized controlled trial. The studies were all published in English between 2016 - 2019. The studies were conducted in community and health centres. Study quality assessment was done using the CASP tool. The assessment revealed the papers were of medium to good quality thus justifying applicability of the findings to practice. Two of the studies were conducted in America, two in Mexico, one in Africa, one Malaysia, one in China, one in United Kingdom and one in Japan. The studies were conducted in developed countries, medium developing countries as well as third world countries to give a wide picture on the analysis of link between DM and poverty at different levels and setting. For a description for results of the included studies.

The papers utilised a world accepted criteria deprivation level index (DPI) to classify low income households or the deprived in developed countries and third world countries. The studies also used an international accepted criterion to describe levels of education and literacy levels. The studies ranged from three months to two years while one study followed the participants for a period of twenty years with planned follow-ups and for those participants who died death certificates were obtained to verify cause of death. The findings have been presented according to the themes of the papers.

4.1 Theme 1: Neighbourhood deprivation affects DM prevalence

The first theme that neighbourhood deprivation affects DM prevalence was significantly proved by four out of the eleven studies in the review. Neighbourhood deprivation is also a known factor in poor ill health generally [32]. The findings of the four papers showed that there is a link between neighbourhood deprivation and DM prevalence.

Sheets et al. [21] evaluated the neighbourhood socio-economic disadvantage as a factor affecting DM in deprived areas in USA and concluded that neighbourhood deprivation increased DM prevalence. Their findings are consistent with (Conway et al. [22]) who conducted a study in deprived areas of South USA to investigate health disparities in DM and other NCDs. Conway et al. [22] concluded that deprived areas were more prone to lack of education, low income and obesity which increased the DM prevalence. (Fleetcroft et al., [24]) quantified trends in socio-economic inequality and DM outcomes using LSOAs in UK using NHS interventions and concluded that neighbourhood deprivation increases DM prevalence agreeing with findings (Conway et al. [22]) and Sheets, L et al. [21]. However, Zhang et al. [23] findings were different to the other three papers.

Zhang et al. [23] studied the relationship between the prevalence of T2DM and neighbourhood deprivation in China, Zhejiang Province and the findings showed high prevalence of T2DM in higher in affluent areas than the deprived areas across the study period. Conway et al. [22]; Sheets et al. [21] and Fleetcroft et al., [24] did their study in USA and UK respectively which are developed countries while (Zhang et al. [23]) conducted their study in a developing province of China where food is readily available for the affluent not the deprived which explains and justifies the different findings.

Sheet et al. [21] revealed an important finding that although DM prevalence is mainly associated with race and ethnicity, but DM prevalence is strongly associated with SES. Conway et al. [22] supports (Sheet et al. [21]) with their findings that DM prevalence was twice higher among black than white of normal BMI however racial difference became attenuated as BMI rose with risk more significantly associated with low income. Grundmann et al. [33] study in Germany to analyse the association between area deprivation and the prevalence of T2DM confirmed that there a positive association of area deprivation with T2DM and obesity. Grundmann et al. [33] concluded that it is important to focus on preventive efforts on very deprived communities.

Bilal et al. [34] study on deprived areas and DM prevalence in Spain also found an association between the level of area deprivation and DM prevalence. Jacobs et al. [35] analysis of regional deprivation to T2DM in Germany revealed an association of T2DM to regional deprivation. Jacobs et al. [35] findings showed T2DM prevalence as twice high in most deprived areas compared to least compared areas. Hill et al. [36] study in Australia on disparity of health care among communities of different SES confirmed that there is a significant link between high DM prevalence and deprived areas.

Furthermore, Matthew et al. [37] study in New Zealand on locality deprivation and DM prevalence found that area deprivation is positively related to diabetes incidence. Matthew et al. [37] also found that deprived areas near less deprived areas have low prevalence of DM as they benefit from the resources and better health care of the less deprived area. These findings can change the outlook of health care which place more emphasis on race and ethnicity as the main cause of DM prevalence rather than socio economic status.

Conway et al. [22] enhanced their study reliability by using a large cohort sample composed of deprived black and white Americans while their findings drawn from systematic detailed data on several potential DM risk factors, however, their reliance on self-report on DM among the participants could have affected their findings. Nevertheless, Conway et al. [22] findings are important as they showed that low-income deprived areas of USA are prone to obesity, lower levels of education while increasing DM prevalence. Fleetcroft et al. [24] also used a large sample and 8 years of data, including outcome data on virtually all

individuals with DM in England which strengthened the reliability and validity of their study, although their findings were limited to the period of this study.

Furthermore, Fleetcroft et al., [24] used both absolute and relative inequality measures based on the entire socio-economic gradient of all 32 482 LSOAs in England to successfully link DM prevalence and deprivation. Sheet et al. [21] study sample of over 65 years old adults concentrated only one centre questioned its reliability and generalisability while the relatively small sample also affected the statistical inferences of the findings. The importance of (Zhang et al., [23]) findings was that they successfully analysed a large bulk of data to determine the prevalence of DM in affluent areas and deprived areas although they did not highlight the criteria they came up to identify the data for the study.

4.2 Theme 2: Socio-economic status affecting health care and DM self-care

The second theme, SES affecting health care and DM self-care was covered by 5 of the 11 studies. Again this is a known factor in both self-care and health care [38,39]. Compean et al. [25]; Hazriani et al. [26]; Glover et al. [29] Funakoshi et al. [27] and Mohamed et al. [31] linked low SES to poor DM self-care and healthcare.

Compean et al. [25] examined self-care in low income Mexican patients and concluded that T2DM prevalence was exacerbated by poor glycaemic control and DM self-care in low income earners in Mexico. Compean et al. [25] findings agreed with Hazriani et al. [26] who conducted a CSS in Sabah in Malaysia to assess the relationship between SES and DM prevalence among adults. Hazriani et al. [26] found that among poor rural areas had high DM prevalence urban areas due to lack of income and access to health clinics. Funakoshi et al. [27] added weight to the findings of the Compean et al. [25] and Hazriani et al. [26] in their study which assessed the link between SES and T2DM complications among young adult patients in Japan concluded that low SES was significantly associated with a greater likelihood of T2DM complications in young adults. Glover et al. [29] conducted an RCT in USA to understand relationships between DSQOL with stress and depression.

Glover et al. [29] found that that there was a significant relationship between depression among the poor and poorer DSQOL. Glover et al. [29] findings which linked depression among the poor as affecting DM quality of life were in tandem with the findings of Compean et al. [25]; Hazriani et al. [26]; Glover et al. [29] Funakoshi et al. [27] and Mohamed et al. [31] although Glover et al. [29] measured an aspect of depression among the poor affecting their DSQOL.

Mohamed et al. [31] conducted a STEPS survey in Kenya to examine the factors that affect DM prevalence. Mohamed et al. [31] findings echoed the other studies when they concluded that DM patients in the poorest households failed to achieve glycaemic control due to lack of access to treatment. Mohamed et al. [31] other interesting finding which was co-herent with (Zhang et al. [23]) (theme 1) was that DM prevalence was higher among the rich in urban areas compared to the rural poor in Kenya. The findings of Mohamed et al. [31] also revealed high DM prevalence in urban areas than in the rural areas.

This could be the case because Mohamed et al. [31] and Zhang et al. [23] conducted their studies in developing countries where DM is regarded as the disease of the affluent where the poor are more worried about malnutrition due to lack of food. Animaw and Seyoum [40] in their study in Ethiopia to assess DM prevalence in rural areas support Mohamed et al. [31] and (Zhang et al. [23]) that in poor countries there is high DM preva-lence among relatively rich urban dwellers than poor rural dwellers. Animaw

and Seyoum [40] recommended further studies in poor countries to identify what causes the urban dwellers to have a higher risk of DM other than the feeding habit. Msyamboza et al. [41] in WHO STEPwise study on DM prevalence in Malawi pointed out that DM previously considered as a disease of the western world or the affluent urban affluent is increasingly becoming a significant cause of morbidity and mortality in sub-Saharan Africa.

Several studies have supported the findings of Compean et al. [25]; Hazriani et al. [26]; Glover et al. [29] Funakoshi et al. [27] and Mohamed et al. [31]. Vest et al. [42] study on DM self-management in deprived areas of New York USA agreed with Compean et al. [25] in their findings that poor DM self-management was directly linked to low income. Van Olmen et al. [43] study in Cambodia, DR Congo and Philippines to improve access and quality of DM care for people in third world countries revealed that poor DM self-care and lack of access to good healthcare was associated with low SES. Van Olmen et al. [43] suggested that DM programmes among poor people could help improve their DM self-care. Shrivastava et al. [44] study agreed with Funakoshi et al. [27] on the role of DM self-care and management and suggested increased role of clinicians in promoting DM self-care to avert any long-term complications suffered among the deprived.

The studies had several strengths and weaknesses. Hazriani et al. [26] recommended further studies in changes in food habits among rural poor communities that affect their DM risks and identifying risk factors for DM in rural areas of poor countries, added strength to their study. Compean et al. [25] study's reliability was limited by their small sample however their study provides valuable information for DM health care providers in México. The reliability of Mohamed et al. [31] findings could not be questioned due to their use of a large national sample that was representative nationally however, the validity of their findings could have been compromised by the incorrect estimates due to reliance on self-reported physical activity, dietary data and social behaviours. Glover et al. [29] findings could not be very reliable due to the small sample size and lacked a comparison group while the measured DSQOL stress measures among the poor were not T2DM- specific.

4.3 Theme 3: Socioeconomic Status (SES) and leisure time affects DM prevalence

The third theme which linked leisure and SES as affecting DM prevalence had one study, though this is also a known factor in health inequalities [45]. Medina et al. [30] examined the relationship between leisure and occupational (MVPA) and T2DM in low-income workers in Mexico City. The findings of Medina et al. [30] revealed the link be-tween lack of exercise among low-income workers after work and the high T2DM prevalence among low-income workers.

One study supported Medina et al. [30] findings that leisure and SES as affect DM prevalence. Kim et al. [46] findings on the impact of SES on health behaviours in Korea revealed that that people with low income do not engage in physical exercise which turn to in-crease DM prevalence among them.

The strength in the findings of Medina et al. [30] lies in the fact that the study was conduct-ed for 20 years following the 2282 participants in an area where T2DM is high in Mexico.

In summary, Medina et al. [30] were able to successfully analyse and link the association between leisure, occupation, life style and high DM prevalence among low-income workers.

4.4 Theme 4: Poor background affects DM in adulthood

Carrillo-Vega et al. [28] analysed whether the presence of social disadvantages such as not having shoes in childhood affected DM prevalence in adulthood in Mexico. Carrillo-Vega et al. [28] findings concluded that social disadvantages during childhood increased the likelihood of DM prevalence in adulthood. Again this is a known factor in health inequalities [1]

Carrillo-Vega et al. [28] findings were supported by several papers. Sahoo et al. [47] study on child obesity revealed that obesity common among children from low income neighbourhood who feed on junk food affect their DM out comes in adulthood. Levine [48] study of poverty and obesity in USA linked obesity in childhood to poverty in developed nations which leads to DM in adulthood.

Although the validity of Carrillo-Vega et al. [28] study cannot be challenged as the used a large sample 8,848 in a LS but its reliability could be questioned if the study could produce the same results if replicated in another area. Carrillo-Vega et al. [28] failed to give a scientific evidence of their study linking between lack of no shoes in childhood and DM although this could be a factor to determine future poverty and DM.

In summary, Carrillo-Vega et al. [28] successfully revealed that lack of shoes in childhood increased the likelihood of developing DM in adulthood.

5. Conclusion

The aim of the review was to examine the impact of poverty on the prevalence of DM so that global policy makers and health systems could come up with effective ways to deal with problems that affect high prevalence of DM among the deprived.

Of the eleven studies systematically retrieved and critically appraised, four themes were identified;

i. Neighbourhood deprivation affects DM prevalence,
ii. Socio-economic status affects health care and DM self-care,
iii. Leisure and Socio-economic status affect DM prevalence and
iv. Poor background affects DM in adulthood.

The findings in all the themes linked poverty high DM prevalence. As these are also key factors in determining health inequalities, as support of inequality reduction programs should also serve to reduce these factors in diabetes.

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