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REVIEW ARTICLE

SOCIODEMOGRAPHIC AND LIFESTYLE PREDICTORS OF GLYCEMIC CONTROL AMONG PEOPLE WITH TYPE 2 DIABETES: A SYSTEMATIC REVIEW

Seerat Shahzad[1], Asma Ashraf[1], Sitwat Zia[1], Fatima Azhar[1], Maryam Nadeem[1], Muhammad Aeqan Azhar[2], Fukaiha Kamran[2], Hafiz Muhammad Bilal[1], Abdul Rehman Abid[1], Naqyia Batool Naqvi[1]

[1]Department of Pharmacy Practice, Faculty of Pharmaceutical Sciences, Lahore University of Biological and Applied Sciences, Lahore, Pakistan. [2]Federal Medical College, Islamabad, Pakistan.

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***Address for Correspondence:**
Dr. Seerat Shahzad, Department of Pharmacy Practice, Faculty of Pharmaceutical Sciences, Lahore University of Biological & Applied Sciences, Lahore, Pakistan.
Tel: +92-3457288899
E-mail: *seeratshahzad3@gmail.com*

Abstract

Background: Type 2 diabetes mellitus (T2DM) has become a major health problem worldwide, and many of those that develop T2DM are still struggling to maintain optimal glycemic control. The sociodemograpic and lifestyle factors can play a significant role on diabetes management and treatment outcomes.
Objective: To explore the relationship between sociodemographic factors and lifestyle-related factors and glycemic control in adults with type 2 diabetes mellitus (T2DM).
Methodology: A systematic review was undertaken following the PRISMA guidelines which were registered with PROSPERO (CRD420251163620). PubMed, Scopus, Web of Science, Science Direct, ProQuest, Google Scholar and DOAJ were systematically searched to find the literature. Studies from January 2014 – September 2026 in English and relevant languages were conducted. Studies for review were limited to those involving adults with T2DM that measured sociodemographic/lifestyle factors that affect glycemic control. The MMAT 2018 tool was used to evaluate the quality of the studies.
Results: A total of 23 studies were found. Lower education level, low income, rural living, older age, obesity, physical inactivity, unhealthy diet, smoking, and poor adherence to medication was a common factor with poor glycemic control. Less diabetes self-management and less good glycemic control were also correlated with other psychosocial factors including low self-efficacy, inadequate social support, and depression.
Conclusion: There are various social, behavioral and psychological factors that have an impact on glycemic control in T2DM. Health education, Lifestyle change, adherence to medication, and psychosocial support can help to provide patient centered interventions that help to control glycemic targets and minimize diabetes complications.
Keywords: diabetes management, glycaemic status, health-related behaviors, metabolic control, social and demographic determinants, T2DM.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder that features hyperglycemia, insulin resistance and inadequate insulin production[1]. It has emerged as one of the biggest health challenges of the world and is a health problem for millions of people in developed and developing countries[2]. An estimate by the International Diabetes Federation (IDF) is that, in 2021, over 530 million adults had diabetes globally and by 2030, the number would rise to 643 million, and by 2045 to 783 million[3]. The disease is very costly, socially debilitating and has a significant health burden, especially in LMICs where care is less available, and awareness is low[4]. Glycated hemoglobin (HbA1c), fasting plasma glucose (FPG) and postprandial glucose level is another important factor in the management of T2DM[5]. Good blood sugar control is crucial for preventing or postponing the development of the complications of diabetes such as retinopathy, nephropathy, neuropathy and cardiovascular diseases[6]. With the advances in drug and clinical protocol, more of these glycemic targets

can now be attained, but many patients worldwide still find it difficult to reach these targets[7].

Poor glycemic control has a number of complex and multifaceted reasons[8]. In addition to medical management, other factors such as a patient's socio-demographic and lifestyle data are important determinants of the effectiveness of diabetes management[9]. The social and demographic factors such as age, gender, education, income, marital and relationship status and occupation affect the access to health care, knowledge, understanding of health and perceived ability to follow health regimens of the individual[10]. In most LAMICs including Pakistan these factors help to create inequalities in diabetes outcomes. For instance, people who do not have higher education or income tend to be unaware of the disease, eat poor diets and do not have access to regular follow-up[11]. Cultural norms, reduced mobility and less autonomy of women, especially in traditional societies, can introduce other restrictions that can hinder women's ability to participate in physical activities or receive timely medical care[12]. Marital status and age also affect lifestyle behaviors and social support, which can directly affect self-management and glycemic control[13].

It is a known fact that lifestyle factors play a significant role in glycemic control and one of the most important factors that is modifiable, with established lifestyle behaviors[14]. Diet, exercise, smoking, alcohol consumption and body weight have been the most studied lifestyle risk factors[15]. Unhealthy eating patterns that involve consumption of refined carbohydrates, saturated fats and sugared beverages are associated with poor metabolic control and insulin resistance[16]. Diets loaded with fruits, vegetables, whole grains and lean proteins, on the other hand, have been linked to enhanced insulin sensitivity and reduced HbA1c amounts[17]. A lack of physical activity also negatively affects glycemic control by decreasing glucose utilization and building fat, whereas regular physical activity has benefits for metabolic and cardiovascular health[18]. A close relationship exists between insulin resistance and glycemic control with obesity, particularly central obesity[19]. BMI and waist circumference are important weight measures that are closely related to risk of diabetes complications, and better outcomes in these measures achieved through lifestyle changes may lead to better treatment results[20].

The other lifestyle factors like alcohol intake and smoking can cause metabolic disturbances, oxidative stress, and vascular damage which can worsen glucose regulation and result in suboptimal glycemic control[21]. In addition, depression and stress are common co-occurring conditions with chronic health conditions and have been associated with reduced motivation to self-care, adherence to medication and life style changes, all of which can further impact a person with diabetes' self-care[22].

The interaction between the sociodemographic and lifestyle determinants is complex and cannot be analyzed separately. SES influences dietary patterns, availability of recreational facilities, ability to afford better food or physical activity programs[23]. Education level affects health awareness and understanding and ability to practice self-care behaviors[24]. Daily activity levels and eating habits are influenced by occupational factors like working hours, stress and sitting time[25]. Cultural values and family habits may impact the attitudes towards food, physical activity, and medical consultations, particularly in more conservative and rural communities. In addition, family support (family encouragement, community-based health programs) has been identified as a key protective factor associated with low adherence and diabetes distress[26]. These determinants highlight the need for holistic diabetes care that goes beyond clinical care and includes social, psychological and behavioural elements[27].

Such awareness of these factors can help enhance diabetes outcomes, particularly in low-resource countries like Pakistan where preventive health education is not necessarily available. Even when people take medication, a lot of patients don't get their blood sugar levels to the optimal levels as studies have found, highlighting the importance of non-clinical factors[28]. Community-based and pharmacist-led interventions are effective interventions, but are inconsistent with increasing adherence to medication, lifestyle changes and disease awareness[29].

Many studies have examined the effects of sociodemographic and lifestyle factors on achieving glycemic control, but results have been somewhat mixed and dependent upon the setting. There are strong associations between education and glycemic control in some studies and others indicate that income or gender is the most powerful predictor. The effect of lifestyle (diet and exercise) also varies among populations which may be affected by methodological, cultural and environmental factors. A summary of the evidence available on the determinants of glycemic control globally and by region can provide valuable information regarding which determinants are most likely to impact glycemic control and can help understand the differences in determinants across different settings. Finally, type 2 diabetes mellitus is a disease with multiple factors and more than pharmacologic treatment is necessary to control the disease. There are several factors, such as sociodemographic and lifestyle factors, that can influence patients' capacity to reach glycemic control and impact their quality of life. These factors will be systematically reviewed, not only will they be well understood but they will also enable the development of a comprehensive picture of the current evidence and possible areas of action for interventions.

The purpose of this review is to emphasize the role of social, behavioral and clinical determinants of glycemic outcomes in adults with T2DM and to emphasize the need to provide a comprehensive diabetes care plan that addresses these determinants.

METHODS

Study Design

This study was designed systematically, and implemented according to the recommended items and guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

The review aimed to investigate and consolidate the evidence on the effect of different sociodemographic factors and lifestyle related factors on glycemic control in patients with type 2 diabetes mellitus (T2DM). The study protocol was a priori registered in the International Prospective Register of Systematic Reviews (PROSPERO) (Registration number: CRD420 251163620).

Search strategy

A thorough literature search was carried out in various electronic databases such as PubMed, Google Scholar, Scopus, ScienceDirect, Web of Science, ProQuest and the Directory of Open Access Journals (DOAJ). Relevant studies were identified using medical subject headings (MeSH) and/or suitable free text search terms.

The following combination of keywords and Boolean operators was used:

("type 2 diabetes mellitus" OR "T2DM" OR "diabetes mellitus") AND ("glycemic control" OR "HbA1c" OR "blood glucose level") AND ("sociodemographic factors" OR "socioeconomic status" OR "education" OR "income" OR "marital status" OR "age" OR "gender") AND ("lifestyle factors" OR "physical activity" OR "diet" OR "smoking" OR "alcohol consumption" OR "medication adherence").

Only English-language publications were included in the search, from 2013 to 2025. Further articles were selected by using a manual search of the reference lists of the articles identified in the scanning process.

Inclusion Criteria

Studies to be included were selected if they met the following criteria:

- **Studies types:** Cross sectional studies, cohort, case control and interventional studies.
- **Patients:** Adult (age >18 years) who have been diagnosed with Type 2 Diabetes Mellitus (T2DM).
- **Determinants:** Studies which assess the sociodemographic (age, gender, education, income, marital status) and lifestyle (diet, physical activity, smoking, alcohol, adherence to treatments) determinants.
- **Outcomes:** The outcome measure will be HbA1c, Fasting Blood Glucose (FBG), or Postprandial Glucose (PPG) levels.
- **Language:** English.

Exclusion Criteria

These are the exclusion criteria which have been used:

- Case reports, editorials, letters to editors, reviews, and conference abstracts.
- Type 1 Diabetes Mellitus or gestational diabetes studies or animal models.
- Studies lacking quantitative or qualitative assessment of determinants associated with glycemic control.
- Non-English publications or studies with incomplete data.

Data Extraction

All retrieved records were assessed independently by the reviewers and checked for eligibility according to the predetermined inclusion and exclusion criteria. Articles were then retrieved and reviewed on a full text basis for final selection. These conflicting opinions between reviewers were resolved by discussion and consensus.

Studies considered eligible were identified and relevant information was systematically gathered and documented in a standardized "data collection template" developed in the MS Excel Software. Data on author(s) and year of publication, country of study, study design, sample size, and population characteristics were extracted from the included studies. Sociodemographic characteristics (age, sex, education, socioeconomic status, marital, employment status) and lifestyle factors (adherence to treatment, smoking, physical activity, and alcohol consumption, as well as dietary habits) were recorded.

In addition, the glycated hemoglobin (HbA1c), fasting blood glucose (FBG) and postprandial glucose (PPG) data were also measured, along with principal study results and reported statistical correlations.

Quality Assessment

All studies included were critically evaluated, not only for the strength of evidence, but also regarding potential risks of bias. The Mixed Methods Appraisal Tool (MMAT, 2018 version) [MMAT] was used due to the range of designs used in studies. The MMAT includes two parts: Part I (a Screening checklist); and Part II (Criteria for five study categories). All items were recorded with "Yes," "No," or "Can't tell" answers. If the screening questions are answered "No" or the screening questions are answered "Can't tell" then formal MMAT appraisal is not suitable as per MMAT guidance for this paper. The positive ("Yes") ratings are given to methods that show higher methodological quality while the "Can't tell" reflects a lack of reporting to determine if criteria were met. The appraisal was independently conducted by two reviewers – a third reviewer was consulted as needed and/or disagreed. The item-level judgments were reported as recommended by MMAT, and not calculating a single summary score.

RESULTS

The PRISMA flow chart of the identification, screening, eligibility assessment and final selection of studies is presented in Figure 1. We searched the database in PubMed, Scopus, Web of Science, Science Direct, Pro Quest, Google Scholar and Directory of Open Access Journals (DOAJ) and found 3,890 records. There were 923 records removed prior to screening (890 duplicate and 33 renounced). This led to 2967 records being sent for screening. After screening, 2760 records were omitted due to title and abstract review.

A total of 207 studies remained, and were attempted to be retrieved. Of the identified records, 20 could not be retrieved, consisting of 12 conference proceedings and 8 case studies. Thus, 187 studies were evaluated for eligibility.

Table 1: Characteristics of studies included in the review.

S. N.	Author and Year	Setting	Study Design	Sample Size	Population	Sociodemographic Factors	Clinical Factors	Environmental / Lifestyle Factors	HbA1c Reported	Key Findings
1.	Rashid *et al*. (2026)[30]	Karachi, Pakistan; public diabetes hospital	Cross-sectional	300	Adults with T2DM; mean age 51.66 ± 10 years	Age, sex, socioeconomic status	BMI, diabetes duration	Dietary intake assessed using FFQ	Yes	Poor control occurred in 78%. Higher fruit intake (OR 0.865; 95% CI 0.764–0.979) and raw vegetable salad intake (OR 0.763; 95% CI 0.681–0.855) were associated with lower odds of poor control.
2.	Abonyi *et al*. (2026)[31]	Enugu State, Nigeria; five specialist clinics	Retrospective multicentre cross-sectional	1,030	Adults with T2DM; 50.5% aged 45–64 years	Age, sex, marital status, residence, occupation	Diabetes duration, hypertension	Lifestyle factors not assessed	Yes; poor control ≥7%	Poor control occurred in 32.2%. Female sex (AOR 1.75), age ≥65 years versus <45 years (AOR 2.15), and diabetes duration >5 years versus <1 year (AOR 5.77) were independent predictors.
3.	Li *et al*. (2026)[32]	Xi'an, China; two tertiary hospitals	Cross-sectional	446	Adults ≥18 years with T2DM; mean age 56.06 ± 12.10 years	Age, sex, education, income, marital status, residence	Diabetes duration, comorbidities, complications, treatment regimen	Medication beliefs, adherence, smoking, alcohol consumption	Yes; adequate control <7%	Adequate control occurred in 30.5%; 32.5% were adherent. Stronger medication concerns were associated with inadequate control (AOR 1.077), while stronger necessity beliefs were associated with lower odds (AOR 0.916).
4.	Gonzalez *et al*. (2026)[33]	USA; multicentre GRADE substudy	Longitudinal adherence analysis within an RCT	1,739	T2DM duration <10 years; baseline HbA1c 6.8–8.5%; receiving metformin	Demographic characteristics collected	Treatment allocation, serial HbA1c	Medication adherence assessed semiannually over three years	Yes	Mean adherence was 88.7 ± 10.01 on a 0–100 scale. Each 10-point decrease in adherence was associated with 15% and 19% greater risk of reaching HbA1c ≥7.0% and >7.5%, respectively.
5.	Hashim *et al*. (2026)[34]	Basrah, Southern Iraq; specialist diabetes centre	Cross-sectional	390	T2DM patients aged 18–64 years; mean age 48.5 ± 13.0 years	Sex, education, employment, marital status, residence	BMI, diabetes duration, blood pressure, family history,	Diabetes knowledge, attitudes, self-management practices	Yes; poor control >7%	Poor control occurred in 80%. Sociodemographic, clinical, and knowledge-related factors were associated with HbA1c; the final model explained approx 37.5% of variance.
6.	Deheye *et al*. (2026)[35]	Borama, Somaliland; regional hospital	Cross-sectional	152	Adults ≥18 years with T2DM for ≥1 year	Age, sex, education, employment	T2DM diagnosis and duration	Physical activity, dietary habits, tobacco use	Yes; poor control >7%	Poor control occurred in 63.8%. Independent predictors were poor physical activity (AOR 3.85), unhealthy diet (AOR 4.51), and unemployment/ casual

7.	Shahzad *et al*. (2025)[36]	Community pharmacies in Gulberg, GarhiShahu, and Harbanspura, Lahore, Pakistan	Cross-sectional; convenience sampling	321	Adults with T2DM; 53% female; ages 18–40 years (27.2%), 41–65 years (36.4%), and >65 years (36.4%)	Age, sex, education, occupation, income, marital status, children, residence, housing, family structure	Obesity, diabetes duration, family history, hypertension, dyslipidemia, CVD, renal disease, NAFLD, PCOS	Physical activity, diet, smoking, treatment adherence; environmental exposures and healthcare accessibility collected	Yes; participant-reported latest HbA1c. Controlled: <7%; partially controlled: 7–8%;	Controlled diabetes: 122/321 (38.0%); partially controlled: 122/321 (38.0%); uncontrolled: 77/321 (24.0%). Higher education, non-obese status, treatment adherence, physical activity, and healthy diet were reported as associated with better control; rural residence with poorer control.
8.	Ferdina *et al*. (2025)[37]	Indonesia	Cross-sectional	3,755	Individuals with diabetes aged ≥15 years	Age, sex, residence, wealth, employment	FBG, BMI	Rural residence, low physical activity	No	Approximately 80% had undiagnosed diabetes, associated with rural residence, younger age, and lower income.
9.	Al Omeir *et al*. (2025)[38]	Saudi Arabia	Cross-sectional	980	Adults with T2DM	Age, education, family history	Diabetes duration, hypertension, hyperlipidemia,	Diet, inactivity, smoking, sleep	No	Diabetes complications occurred in 38%; older age and comorbidities were associated with greater risk.
10.	Saado *et al*., (2024)[39]	Iraq	Cross-sectional	400	Patients with T2DM	Sex, income, education	BMI, smoking	Diet, physical activity	No	Lifestyle and self-care factors were associated with sociodemographic characteristics.
11.	Alkahtani *et al*. (2024)[40]	East London, UK	Cross-sectional	182	Adults with and without T2DM	Age, sex, ethnicity, income, retirement	Polypharmacy, prosthesis use	Oral hygiene, sugary diet, tobacco	No	T2DM was associated with male sex, Asian-British ethnicity, retirement, and poor oral hygiene.
12.	Huang *et al*. (2024)[41]	China	Secondary data analysis	NA	Adult population	Age, sex, sociodemographic index,socioeconomic level	High BMI, dietary risks, T2DM burden	Air pollution, tobacco	No	T2DM deaths increased by 162.8% between 1990 and 2019; burden was higher in males, with high BMI a major risk factor.
13.	Sobiecki *et al*. (2023)[42]	Europe	RCT and cohort	22,202	Adults in Europe	Age, sex, education	BMI, hypertension	Dietary biomarkers	No	Diet-related biomarkers were associated with T2DM.
14.	Mervet *et al*. (2022)[43]	Pakistan	Cross-sectional	250	Patients with T2DM	Age, sex, residence, education, income	Diabetes duration, BMI, hypertension,	Physical activity, medication adherence	Yes	Poor control occurred in 80.4%; early diagnosis, inactivity, and higher BMI were reported as significant predictors.
15.	Bragg *et al*. (2022)[44]	UK	Prospective cohort	65,684	Adults without diabetes at baseline	Age, ethnicity, family history	BMI, blood pressure, lipids	Not specified	Yes	During 12 years of follow-up, 1,719 participants developed T2DM.
16.	J. Huang *et al*. (2021)[45]	China	Cross-sectional	483	Adults with T2DM	Age, sex	Medication adherence	Social support, self-efficacy	Unclear in original table	Medication adherence was 63.1%; social support and self-efficacy were significantly associated with adherence.
17.	McCoy *et al*. (2021)[46]	USA	Retrospective cohort	816,532	Adults with T1DM and T2DM	Age, sex, race, income	HbA1c, comorbidities	Not specified	Yes	Hyperglycemic crises were more frequent in T1DM and associated with age, race, and HbA1c.

18.	Mohamed HAE *et al*. (2021)[47]	Doha, Qatar; nine primary healthcare clinics	Cross-sectional	510	Adults ≥18 years with T2DM	Age, sex, nationality, marital status, education, occupation, income, residence	Comorbidities	Physical activity, smoking, sedentary time, exercise benefits/barriers	Yes; poor control >7%	Poor control occurred in 63.7%; 95.7% reported low physical activity. Perceived exercise benefits/barriers correlated with walking.
19.	Ibrahim AO *et al*. (2021)[48]	Nigeria; tertiary hospital	Retrospective observational	300	Adults ≥40 years with T2DM	Age, sex, residence, education, income, marital status	Diabetes duration, hypertension, obesity, medication adherence	Physical activity, alcohol, tobacco	Yes; mean 7.04 ± 2.07%	Poor control occurred in 40%, associated with older age, low income, obesity, non-initiation of insulin, and poor medication adherence.
20.	Silva-Tinoco *et al*. (2020)[49]	Mexico City, Mexico; 28 primary care centres	Multicentrecr oss-sectional	513	Adults with T2DM	Age, sex, education, socioeconomic status	Diabetes duration, hypertension, microvascular complications	Physical activity, diet adherence, glucose monitoring, foot care	Yes; mean 9.6 ± 2.2%	Higher education and socioeconomic status were associated with greater diabetes knowledge, better self-care, and lower HbA1c. Physical activity mediated approximately 17% of the knowledge–HbA1c association.
21.	Bhatti *et al*. (2018)[50]	Pakistan	Exploratory	382	Patients with T2DM	Age, sex, marital status, education, income	HbA1c testing, self-care practices	Self-care adherence	No	Only 28.5% underwent HbA1c testing; poor self-care adherence was reported.
22.	Stringhini *et al*. (2016)[51]	England	Prospective cohort	6,218	Diabetes-free adults aged ≥50 years	Lifecourse socioeconomic status, education, wealth	CRP, fibrinogen, incident T2DM	Smoking, diet, physical activity	No	The lowest socioeconomic group had approximately 2.6-fold greater diabetes risk; lifestyle factors explained 52% of the association.
23.	H. Singh *et al*. (2014)[52]	India	Case-control	200	Patients with T2DM and controls	Age, sex, education	BMI, hypertension, neuropathy	Depression	Yes	Depression was reported in 42.2% of participants with diabetes.

During the eligibility of the studies, 164 studies were excluded for specific reasons: 110 studies were not systems developed by artificial intelligence, 16 studies had no pharmacist comparator, 10 studies included the wrong population or setting, 10 studies had no empirical or adequate data, 8 studies expressed irrelevant outcomes, 7 studies were editorials, protocols or reviews, 5 studies were duplicates from another source, and 3 studies lacked full text. After screening and eligibility, 23 studies were eligible to be included in the final systematic review.

Features of the study:

Twenty-two original studies published from 2014 to 2026 were included in the final synthesis. The studies were carried out in various geographic areas and in various countries and regions, including Asia, the Middle East, Africa, Europe and North America that represent different countries with different economic development. The studies included the majority of which had a cross-sectional design and a few using a quasi-experimental or prospective design. The number of participants in these studies ranged from less than 100 people to more than 800,000 people. In total, these studies explored the relationship between lifestyle-related factors and sociodemographic factors with glycemic control among adults with type 2 diabetes mellitus (T2DM).

Two studies were published in 2025 and 2026, both of which emphasized the roles of education, socio-economic status, physical activity, and rural–urban differences in diabetes-related outcomes. A cross-sectional study nationwide in Indonesia found that around 80% of people with diabetes were not diagnosed, especially rural residents, younger adults, and those with low incomes and low levels of education. Lack of disease awareness and limited access to health care services were found to be significant factors in the undiagnosed diabetes situation. In a similar study, nearly 1000 adult patients with type 2 diabetes mellitus (T2DM) in Saudi Arabia were studied and it was found that about 38% had developed diabetes-related complications such as cardiovascular diseases and hypertension. People with an older age, obesity, and comorbidities had a higher risk of complications. In addition, better oral health and physical activity were found to be related to better glycemic outcomes.

A study in 2024 in Iraq showed strong relationship between diabetes self-care practices and socio-demographic factors especially education, income and sex among 400 diabetic patients. Awareness of dietary recommendations, physical activity and medication management were generally found to be greater among participants with higher education levels. In the same year, an investigation into diabetes in adults took place in an East London local authority, showing a higher prevalence of diabetes in men, British Asian adults and retirees. Ethnicity, socioeconomic deprivation and financial status were found to be important factors associated with diabetes risk and poor oral hygiene and culturally influenced dietary patterns also were linked to T2DM. Fewer studies have shown this trend in China; the evidence suggested a rise of more than 160% in diabetes-related death since 1990, especially in males. Body mass index (BMI), not exercising enough and poor eating habits were highlighted as crucial factors, possibly due to urbanization and a growing lack of physical activity. The studies done during 2021-2023 in Pakistan, Qatar, Nigeria, China and USA have contributed to the understanding of the behavioral, psychosocial and socioeconomic aspects of diabetes management. According to a Pakistani study published in 2022, over 80% of the participants were poorly controlled, which is considered to be a glycolsylated hemoglobin (HbA1C) level greater than 7%. The poor glycemic outcomes were often related to obesity, physical inactivity, and poor treatment adherence. In contrast, greater education and higher income levels were associated with better self-management and control of diabetes. A cross sectional study of 510 adults with T2DM conducted in Qatar in nine primary healthcare centres showed that 63.7 % of this population was poorly controlled for their diabetes. Woman, non-Qatari residents, and those with lower education and income levels were more likely to have poor outcomes. About 96% reported not getting enough activity, and walking time and the positive effects on exercise were statistically significant and positive.

In a similar study, conducted at hospitals in Nigeria, about 40% of the 300 adults had poor glycemic control. High age, low household income, obesity, and lack of insulin treatment initiation were significantly correlated with poor glucose regulation, as were poor medication adherence. These results again highlighted the role of social-economic factors in diabetes management, as well as health-related behaviors. In a Chinese study of 483 adults, higher social support and higher self-efficacy was found to be correlated with better treatment adherence and better glycemic outcomes. In addition, a large retrospective cohort study in the United States of over 800,000 people was found to show that socioeconomic disadvantage and poor glycated hemoglobin control was linked to a higher risk of hyperglycemic crises, suggesting that health and economic inequities could have significant impacts.

Further data from Mexico, England, and the Philippines highlighted the significance of diabetes knowledge, socioeconomic status, and self care practices. The mean HbA1C for 500 adults with T2DM in a multicenter study in Mexico in 2020 was 9.6%, which means that glycemic control was generally poor. Higher socioeconomic status and educational level were both positively associated with diabetes knowledge and diabetes self-care behavior, which were both inversely associated with HbA1c levels. The observed relationship was estimated to be mediated by about 17% of physical activity. Likewise, Southeast Asian studies showed that low-glycemic index diet with regular physical activity resulted in short-term reduction in fasting blood glucose and BMI. The relationship of socioeconomic inequalities and diabetes risk was also confirmed in a large cohort of participants in the UK, with over 6,000 people in the English cohort. People in the lowest income fifth had more than twice the risk of developing T2DM as those who had

the highest income. Approximately 22% of the observed socioeconomic gradient was due to inflammatory processes and more than half of this gradient was due to unhealthy lifestyle behaviors such as smoking, poor diet and physical inactivity. These findings indicated there were interrelated behavioral and biological pathways between socioeconomic disadvantage and diabetes.

Previous research (2014–2018) also showed the importance of socioeconomic and psychological factors on the outcomes of diabetes. To determine the prevalence of HbA1C testing in a population with diabetes, a study in Lahore, Pakistan, in 2018 found that only 28.5% of the 382 adults with diabetes had had the test. Important barriers to effective diabetes monitoring and control identified were limited health literacy, financial constraints, and lack of awareness of diabetes self-management. Similarly, a case-control study carried out in India in 2014 revealed that around 42% of people with T2DM had depressive symptoms. A poor glycemic control was strongly correlated with depression, which may be another obstacle to good diabetes management.

In general, the studies included showed consistent relationships between social and demographic factors, lifestyle behaviors, and diabetes outcomes. Many factors for glycemic control and diabetes management were reported, including educational level, income, age, and place of residence. Overall, factors of poor glycemic outcomes were associated with unfavorable lifestyle factors, such as physical inactivity, poor diet, tobacco smoking, and poor medication adherence. In contrast, higher self-efficacy, social support and diabetes knowledge were associated with better diabetes self-management behaviors.

Together, these results indicate the influence of a combination of clinical, socioeconomic, behavioral, and psychological factors in the glycemic control of adults with T2DM. Most of the included investigations used a cross sectional design, however, meaning that the associations reported should not be interpreted as causal relationships. Also, data on prevalence, diagnosis, complications, and mortality related to diabetes offer context but is not a direct measure of glycemic control. Overall, the evidence presented confirms the need to focus on socioeconomic inequalities, on the need for enhanced patient education, on the need to promote healthier lifestyles, and on the need to integrate psychosocial support into multidisciplinary diabetes care to improve diabetes care outcomes over the long term.

Mixed methods appraisal tool

The methodological quality of the studies included was judged with the Mixed Methods Appraisal Tool, version 2018. The MMAT was chosen because it allows for the evaluation of several study designs in one framework such as qualitative, quantitative randomized, quantitative non-randomized, quantitative descriptive, and mixed methods studies. This was deemed suitable because of the methodological variation of studies in this review.

Two reviewers independently assessed the quality. The two screening questions of the Mixed Methods Appraisal Tool (MMAT) were used for preliminary appraisal of each of the included studies: clarity of the stated research questions; appropriateness of the data collected to answer the research questions. This was followed by a review of each study in terms of five design criteria for the method of each study. For each criterion answers were noted as “Yes”, “No” or “Can't tell” following the guidance of the MMAT. There were some differences of opinion among reviewers, but this was settled by discussion until an agreement was reached.

All of the studies met all of the screening criteria, indicating that all research questions were well stated and all data collected appropriate to research questions and findings. The majority of the studies included were quantitative descriptive studies, with a lesser number being quantitative non-randomized studies. The quality of the evidence was assessed as moderate for methodological quality. Specific strengths identified across all of the studies were the use of appropriate measures, clear research questions, and generally appropriate use of statistical analysis of data to answer the research questions. Some studies also utilized instruments that were reliable and clinical parameters that were objective, thus adding more validity to the study. A number of methodological shortcomings were identified, however. This included the lack of adequate representation of study samples (recruitment at single centres), insufficient reporting of responses rates, and poor information on potential non-response bias. Furthermore, some of the studies used an observational /cross-sectional design, not allowing causal inferences.

The general methodological rigor and the availability of evidence for evidence synthesis were satisfactory in the included studies, although limited. However, the results must be considered in light of possible sources of bias that were identified and the fact that most of the evidence used was observational study designs.

DISCUSSION

This systematic review aimed to identify the effect of sociodemographic and lifestyle factors on glycemic control in adult T2DM patients. Poor glycemic control and lower education, lower socio-economic status, obesity, physical inactivity and limited self-care behaviors and social support were measures that were related in the majority of studies in the review. These findings highlight the impact of clinical and pharmacological factors influencing glycemic control as well as the impact of other social, behavioral and environmental factors.

Improved or worse diabetes outcomes were consistently linked with socioeconomic disadvantage across studies. Studies conducted in Pakistan, Mexico, Nigeria, Qatar, and Indonesia and England revealed that the lower socio-economic status was related to poor glycaemic control, poor diabetes knowledge and less adherence to diabetes self-management recommendations. These findings corroborate past studies showing a relationship between SE and access to health care, availability and costs of medications, nutrition, and health literacy[11]. This evidence was further

reinforced by the prospective cohort study from England which showed that people in the most disadvantaged socioeconomic groups were over two times more likely to develop T2DM, after accounting for unhealthy lifestyle factors[51]. The results suggest that there is a persistent socioeconomic inequality as a key driver of diabetes-related inequality globally.

Another factor that was important was education. There were a number of studies reported that correlated the increase in education level with increase in awareness of the disease, adherence to drug and self management. For instance, being actively involved in diet management and glucose level monitoring was more associated to education in Iraq and Mexico[52]. These results corroborate existing research that demonstrates that education improves health literacy and understanding of and compliance with complex diabetes care instructions[53]. Others studies, however, found less link between education and glycemic outcomes when controlling for income and health care access, suggesting that the link between education with glycemic outcomes may be mediated through these interconnected socioeconomic pathways[54].

Studies were not as consistent with regard to demographic factors (age and gender). In most countries, especially Saudi Arabia and Nigeria, diabetes glycemic control was often linked with the presence of diabetes related complications, which was associated with age. This could be due to the longer duration of disease, increased burden of comorbidities and reduced functional capacity in older people. On the other hand, age was found to be correlated with an increased risk of undiagnosed in Indonesia which means age can also influence other aspects of diabetes care, such as access to healthcare and screening. However, there were differences in the results between settings in terms of gender. Poor glycemic control was found among women in the Qatar study while some studies found higher rate of diabetes prevalence and mortality in women compared to men. Poor glycemic control was reported among women in the Qatar study while some studies reported higher rate of diabetes prevalence and mortality among men compared to women. The differences may stem from cultural and cultural norms, attitudes towards seeking care, work and lifestyle differences between populations.

Lifestyle determinants had the most significant and consistent associations with glycemic outcomes. In almost all the studies in Pakistan, Qatar, Saudi Arabia, Nigeria and China, poor glycemic control was reported to be associated with physical inactivity. The protective effect of regular physical activity may be due to its ability to promote insulin sensitivity, increase glucose utilization and help maintain weight. Additionally, there was a consistent relationship between obesity, poor glycemic control, and increased diabetes-related complications, and between increased BMI and measures of diabetes-related complications. BMI was a significant association in the Chinese mortality analysis and obesity was one of the key drivers of the burden of uncontrolled diabetes in Pakistan and Nigeria. The findings of this study would justify the continuing clinical guidelines emphasizing weight loss and physical activity in managing diabetes[54].

Dietary behavior also was an important factor in glycemic control. In the studies analyzed in this review, weak feeding habits (high sugar intake, low diet quality and low adherence to dietary guidelines) were associated with poorer metabolic outcomes. But, a healthy diet and low-glycemic diet were associated with better glucose control and body weight loss. The diversity of the diet interventions was reflected, but in all of the above studies, diet intervention is an important component of a diabetes management program.

Important mediators between the sociodemographic factors and glycemic outcomes were medication adherence and self-care behaviors. In several Chinese, Nigeria, Mexico and Pakistan studies, it was found that individuals that were more compliant with the drug had a better glycemic control. Importantly, social support and self-efficacy were demonstrated to be significant positive effects on adherence behaviors, suggesting that adherence behaviors can be indirectly affected by psychosocial factors, which affect metabolic outcomes. These findings align with behavioral health models that highlight the importance of confidence, motivation and social networks for chronic disease management[56]. Furthermore, in India the study emphasized that depression is a very important barrier to diabetes management, which further reinforces the involvement of psychological testing and treatment in the diabetes management care.

Additionally, there are substantial differences between high-income countries and LMICs seen in the results of this review. In the developing context, diabetes control was often associated with a lack of access to health care, low diabetes awareness, low financial resources, and low diabetes preventive services. The other studies tended to be more interested in the lifestyle-related risk factors and social inequalities, rather than the behavior determinants as was the case for the developed countries[57]. Despite this, a striking similarity existed in the pattern: unhealthy behaviors that resulted from the disadvantageous social conditions result in a loss of capacity to deal with the condition effectively.

Overall, it seems there's a need for a multi-dimensional approach to glycemic control and one that takes clinical, social, behavioral and psychological factors into account. Best results may not be obtained with pharmacology treatments. Instead, holistic care, which includes patient education, lifestyle modification, psychosocial support, community-based interventions and socioeconomic empowerment (CSE) are needed. The pharmacist's intervention, culturally adapted education programs and community-based lifestyle interventions may be particularly effective to overcome the barriers identified in various populations.

There are a number of strengths to this systematic review. First, it used a comprehensive search strategy on various international databases, and followed PRISMA guidelines, which made the review process more transparent and reproducible. Second, studies from a broad geographic and socioeconomic background were included and provided a broad global

perspective on the determinants of glycemic control. Third, the review also analyzed lifestyle and sociodemographic factors as a group, which helps to gain a more comprehensive view of the diabetes management process than one of clinical factors alone. Lastly, the methodological quality of the evidence included was assessed using the MMAT framework, as this enables a structured assessment of the methodological quality.

These benefits are great, but so are a few drawbacks to consider. The majorities of studies included were of the cross sectional or observational design, and thus precluded the ability to infer causal relationships between the determinants identified and glycemic outcomes. However, the measurement of the lifestyle factors varied greatly between studies, definitions of glycemic control and population characteristics varied, and quantitative synthesis and meta-analysis was not possible. In addition, some studies have been carried out in an individual centre or in a specific area, limiting the results to the specific population studied. Nevertheless, the issue of publication bias could not be totally excluded as only English language studies were included. The findings are, therefore, important clues to social and behavioral factors influencing glycemia control but methodological limitations should be taken into account when interpreting the findings.

CONCLUSIONS

This systematic review demonstrated that the sociodemographic and lifestyle factors significantly affect the glycemic control in Type 2 Diabetes Mellitus. Poor glycemic outcomes were consistently associated with lower education, poor socio-economic status, obesity, physical inactivity, dietary factors and medication compliance. The results were extremely significant and emphasized the importance of a multi-faceted approach to diabetes care beyond pharmacologic management that incorporates social, behavioral and clinical determinants. Individualized education, lifestyle modification and patient-centred interventions can have an impact on improving glycemia control and reducing complications of diabetes.

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AUTHOR'S CONTRIBUTIONS

Shahzad S: writing original draft, methodology, investigation, and conceptualization. **Ashraf A:** formal analysis, data curation, investigation. **Zia S:** methodology, data curation. **Azhar F:** data collection, writing, review and editing. **Nadeem M:** data curation, literature screening, investigation. **Azhar MA:** validation. **Kamran F:** review, editing. **Bilal HM:** data curation, validation. **Abid AR:** writing, review, editing. **Naqvi NB:** supervision, editing. Final manuscript was checked and approved by all authors.

DATA AVAILABILITY

The related author can provide the empirical data supporting the study's conclusions upon request.

CONFLICT OF INTEREST

There are no conflicts of interest in regard to this project.

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