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DISCOVERY SCIENTIFIC SOCIETY

# The influence of sociodemographic factors on the control of blood glucose levels among diabetic outpatients visiting various community pharmacies in Lahore

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## ABSTRACT

*Background:* Diabetes mellitus poses a significant global health challenge, necessitating effective blood glucose control to prevent complications. Sociodemographic factors influence diabetes management. *Objective:* This study aimed to identify sociodemographic determinants influencing blood glucose control in diabetic patients. *Methods:* This cross-sectional observational study determined the effect of sociodemographic determinants on the control of blood glucose levels in people with diabetes. Data has been collected through a prepared and validated data collection form. Statistical Package for Social Science (SPSS) ver. 25.0 was used to analyze the data. Multiple logistic regression was used to determine the association of these determinants with the control of blood glucose levels in patients having diabetes. *Results:* A statistically significant association was observed ($p<0.005$) between the control of blood glucose level and the gender of patients. More power was observed in female patients, 78.6% COR 2.521 (1.82-3.93). The presence of healthcare providers in the patient's family was also observed to be in significant association with the control of blood glucose level (COR = 2.122, $p<0.001$). Similarly, a robust significant association was observed in the patients of diabetes receiving three drugs combination (COR = 3.922, $p<0.001$) for the treatment, and patient education was also directly associated with the control of blood glucose level (COR = 1.599, $p<0.001$). *Conclusion:* In conclusion, the presence of hypertension as a comorbidity along

with diabetes mellitus is a crucial determinant in the present study, and a patient's adherence to following prescribed medication leads to improved blood glucose level control.

**Keywords:** Sociodemographic determinants, Hypertension, Confounders, Factors, Hypertensive Patients, Control of Hypertension.

## 1. INTRODUCTION

Diabetes presents as a chronic health condition characterized by elevated blood glucose levels and disruptions in protein and fat metabolism (Roglic, 2016). To empower individuals, mitigate immediate complications, and reduce the risk of long-term issues, continuous education and support in self-managing diabetes are imperative (American Diabetes Association Professional Practice Committee, 2024; Upadhyay & Gupta, 2023; Nordin et al., 2024). Additionally, the rising prevalence of diabetes in the Arab World can be attributed to factors such as poor dietary habits influenced by the adoption of a "Westernized diet" or inadequate nutrition, a sedentary lifestyle, and the resultant increase in overweight and obesity rates (Fleifel et al., 2023). Patients with type 1 or 2 diabetes often face complications, increasing morbidity and mortality rates. The long-term effects of diabetes can be broadly categorized into microvascular and macrovascular complications, with the former being notably more prevalent (Papatheodorou et al., 2018).

Projections indicate a substantial increase in diabetes prevalence and related outcomes in the United States between 2015 and 2030, with a projected 54% rise in the diabetic population to exceed 54.9 million individuals. Additionally, diabetes-related deaths are estimated to increase by 38% annually, reaching 385,800. In comparison the collective annual expenses for diabetes-related medical care and societal costs have been expected to surge by 53%, exceeding $622 billion (Rowley et al., 2017). Cancer and diabetes are widespread conditions with significant implications for global health. Epidemiological evidence suggests that individuals diagnosed with diabetes face an increased risk of developing various types of cancer (Vigneri et al., 2009; Srinivas et al., 2023). Factors such as population growth, aging populations, urbanization, inadequate physical activity levels, and rising obesity rates collectively contribute to the growing prevalence of diabetes mellitus (Wild et al., 2004).

Having a body mass index (BMI) above 30 kg/m2 increases the chances of developing type 2 diabetes in adults, even within the normal BMI range of 22–24 kg/m2 for men and women (Kyrou et al., 2020). The incidence of type 2 diabetes is on the rise along with the increase in obesity rates. Obesity not only heightens the risk of type 2 diabetes but also worsens its health complications and complicates its management (Maggio and Pi-Sunyer, 2003). As individuals age, the incidence of type 2 diabetes mellitus (DM2) rises (Gómez-Huelgas et al., 2018). In 2010–2011, approximately 25% of middle-aged and older rural Chinese individuals were affected by diabetes, with age, dyslipidemia, and higher body mass index associated with a greater prevalence (Wang et al., 2018). Substantial evidence suggests that the racial and ethnic backgrounds of individuals with diabetes significantly influence their clinical outcomes (Walker et al., 2016).

Studies have shown no direct correlation between the prevalence of diabetes and racial/ethnic residential segregation; however, higher levels of segregation among black individuals correlate with increased diabetes mortality rates (Kershaw and Pender, 2016). In countries with inadequate infrastructure, diabetes mellitus and its consequences stand as leading causes of morbidity and mortality. Understanding patients' views, behaviors, attitudes, family dynamics, and social networks is crucial for effectively managing diabetes mellitus (Veghari et al., 2010). The identification of diabetes risk factors is vital for prevention efforts. Well-established risk factors include obesity, dyslipidemia, hypertension, a family history of diabetes mellitus, and a sedentary lifestyle. Sociodemographic, psychological, and socioeconomic variables, such as gender, race, education, depression, and environmental factors, are believed to be associated with diabetes control and overall health outcomes (Walker et al., 2014).

Therefore, given the substantial global prevalence of Type 2 Diabetes Mellitus (T2DM), it is imperative to identify suitable medical therapies alongside flexible disease self-management strategies. Attaining an optimal level of glycosylated hemoglobin (HbA1c) signifies disease control and, consequently, the prevention of associated complications (Dupre et al., 2015). Despite increasing awareness of its challenges, the burden of inadequate glycemic control has intensified in developing countries, mainly due to limited access to affordable healthcare services (Ibrahim et al., 2021). In the outpatient setting the influence of various sociodemographic factors on blood glucose level control not has been extensively investigated in Pakistan. The current study specifically compares how different sociodemographic determinants among patients affect blood glucose level control in Lahore, Pakistan.

## 2. MATERIALS AND METHODS

A multicenter study has been conducted in Lahore, one of the prominent cities in Punjab, Pakistan. This cross-sectional observational study utilized a validated data collection tool to gather patient responses at various community pharmacies. The study spanned seven months, from December 6, 2022, to June 9, 2023. The study aimed to evaluate the impact of demographic factors on diabetes control among patients receiving antidiabetic medications from various pharmacies in Lahore. Specifically, the study investigated the impact of various demographics on the control of blood glucose levels, including the type of therapy administered (monotherapy, dual therapy, and triple therapy), and the efficacy of the prescribed drugs in regulating blood glucose levels. The required information was gathered from community pharmacies where patients obtained their medications as prescribed by physicians, with prescriptions originating from various hospitals and clinics.

The study requires a minimum sample size of 60 patients. To determine a reliable and significant value, we included a total of 147 patients. This study specifically focused on selecting prescriptions for patients who have been diagnosed with diabetes mellitus for over one year. Patients were included if they were at least 20 years old and weighed 40 kilograms or more. The study did not include pregnant women, as well as patients who chose not to participate. A comprehensive data collection form was used to gather information which includes patient demographics, social characteristics, medical and family history, symptoms, type of therapy, and medication treatment as per the National Institute for Health and Care Excellence (NICE) guidelines for blood glucose level management. The data collection process was carried out by registered pharmacists, who were the investigators involved in the study, ensuring adherence to professional standards.

Several community pharmacies were selected for inclusion in this study, and the pharmacists operating within were duly apprised of the research project. A mandatory statement and consent form were provided to all eligible pharmacies, clearly outlining the purpose of the study and the rights of participants. A mandatory statement and consent form were provided to all eligible pharmacies, clearly outlining the purpose of the study the rights of participants, and the significance and implications of the study explained to them in detail. Ethical approval for the study was obtained from the Lahore Pharmacy College, Lahore, Pakistan, with reference number (ref: ZI/06/23), ensuring compliance with ethical standards and guidelines.

Each patient included in the study had essential hypertension and a complete medication record, with their age, race, gender, family history, marital status, and past and present medical histories documented. Data collection occurred during patient interviews, with at least five prescriptions obtained from each community pharmacy. Evaluation of blood glucose level control through a glucometer-based blood glucose test conducted by the researchers on-site. Based on the reading, diabetes mellitus is classified into controlled and uncontrolled according to the American Heart Association's recommended NICE guidelines for blood glucose level management.

### Statistical analysis

The data from the experiment is displayed as mean ± standard deviation. The data was subjected to statistical analysis using the Statistical Package for the Social Sciences (SPSS) version 24.0. A significance level of $P < 0.05$ is considered statistically significant. Regression analysis is a statistical technique used to examine the relationship between a dependent variable and one or more independent variables. Regression analysis aims to create a model that explains and measures the connection between different variables. This helps in forecasting or estimating the dependent variable by analyzing the values of the independent variables. In the current study, regression analysis was used as a statistical method to analyze the data.

## 3. RESULTS

A total of 147 patients with diabetes mellitus from different community pharmacies agreed to participate in the study. The following table, Table 1, displays the socio-demographic information of the respondents. In terms of gender, a more significant number of male patients participated in this study than females. The type of therapy given to the patients was varied, and a more significant number of Oral and insulin patients were there in the present study with 78 (53.1). The demographic information of the patients is displayed in (Table 1).

The impact of different confounders is observed in the control of blood glucose levels in patients. The current study used multiple logistic regression to investigate the association between various confounders and the control of diabetes mellitus. Better control of

blood glucose levels is observed in patients without comorbidity of hypertension 56 (81.2). Patient adherence was another confounder which shows more adherence towards the given treatment to the patient, which resulted in better control of blood glucose level in a patient, which was 69 (80.2). On the other hand, patient education also has a significant impact on the management of blood glucose levels, and it was maximum in the patients who received university-level education, and it was 76.9%. The effect of different confounders is well displayed in (Table 2).

**Table 1** Represents the demographic information of the patients. (N=147)

| | |
|---|---|
| Gender | |
| Male | 77 (52.4) |
| Female | 70 (47.6) |
| Comorbidity of hypertension | |
| Yes | 78 (53.1) |
| No | 69 (46.9) |
| Insulin use | |
| Oral only | 40 (27.2) |
| Insulin only | 29 (19.7) |
| Oral and insulin | 78 (53.1) |
| Patient Adherence as prescribed | |
| Yes | 86 (58.5) |
| No | 61 (41.5) |
| Daily Exercise | |
| Yes | 66 (44.9) |
| No | 81 (55.1) |
| Number of antidiabetic drugs | |
| One drug | 28 (19.0) |
| Two drugs | 43 (29.3) |
| Three drugs | 76 (51.7) |
| Patient Education | |
| Pre-College | 71 (48.3) |
| College | 37 (25.2) |
| University | 39 (26.5) |
| Healthcare Professionals in Family | |
| Yes | 58 (39.5) |
| No | 89 (60.5) |

**Table 2** Predictors and their association with blood glycemic control (n =147).

| Variables | Blood Glycemic status (N %) | | Univariate Analysis | | Multivariate Analysis | |
|---|---|---|---|---|---|---|
| | Control | Uncontrol | COR (95% CI) | *P*-value | AOR (95% CI) | *P*-value |
| Gender | | | | | | |
| Male | 35 (45.5) | 42 (54.5) | Referent | - | Referent | - |
| Female | 55 (78.6) | 15 (21.4) | 2.521 (1.82–3.93) | <0.001 | 1.072 (1.64–2.43) | <0.001 |
| Comorbidity of hypertension | | | | | | |
| Yes | 34 (43.6) | 44 (56.4) | Referent | - | Referent | - |
| No | 56 (81.2) | 13 (18.8) | 1.875 (1.32–3.59) | <0.001 | 1.044 (0.89–1.76) | <0.001 |
| Insulin use | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| No Insulin | 26 (65.0) | 14 (35.0) | Referent | - | Referent | - |
| Insulin only | 17 (58.6) | 12 (41.4) | 1.355 (1.12–4.21) | <0.001 | 2.489 (0.22–3.89) | 0.215 |
| Oral and insulin | 47 (60.3) | 31 (39.7) | 1.491 (1.75–4.84) | <0.001 | 2.812 (1.79–3.72) | <0.001 |
| Patient Adherence as prescribed | | | | | | |
| Yes | 69 (80.2) | 17 (19.8) | Referent | - | Referent | - |
| No | 21 (34.4) | 40 (65.6) | 0.891 (0.89–3.98) | <0.001 | 3.919 (1.78–2.98) | 0.003 |
| Daily Exercise | | | | | | |
| Yes | 58 (87.9) | 8 (12.1) | Referent | - | Referent | - |
| No | 32 (39.5) | 49 (60.5) | 3.499 (1.65–5.72) | <0.001 | 3.983 (2.13–2.87) | <0.001 |
| Number of antidiabetic drugs | | | | | | |
| One drug | 14 (50.0) | 14 (50.0) | Referent | - | Referent | - |
| Two drugs | 35 (81.4) | 8 (18.6) | 3.922 (2.14–5.17) | <0.001 | 2.876 (1.33–4.90) | <0.001 |
| Three drugs | 41 (53.9) | 35 (46.1) | 4.498 (2.43–6.81) | <0.001 | 3.671 (2.12–4.78) | <0.001 |
| Patients Education | | | | | | |
| Pre-College | 35 (49.3) | 36 (50.7) | Referent | - | Referent | - |
| College | 25 (67.6) | 12 (32.4) | 2.911 (1.78–5.24) | <0.001 | 3.121 (2.99–3.83) | <0.001 |
| University | 30 (76.9) | 9 (23.1) | 1.599 (1.01–3.34) | <0.001 | 2.912 (0.98–3.11) | <0.001 |
| Healthcare Professionals in Family | | | | | | |
| Yes | 46 (79.3) | 12 (20.7) | Referent | - | Referent | - |
| No | 44 (49.4) | 45 (50.6) | 2.122 (1.99–4.32) | <0.001 | 2.799 (2.51–3.06) | 0.002 |

COD=Crude Odds Ratio, AOD=Adjusted Odds Ratio, CI=Confidence Interval

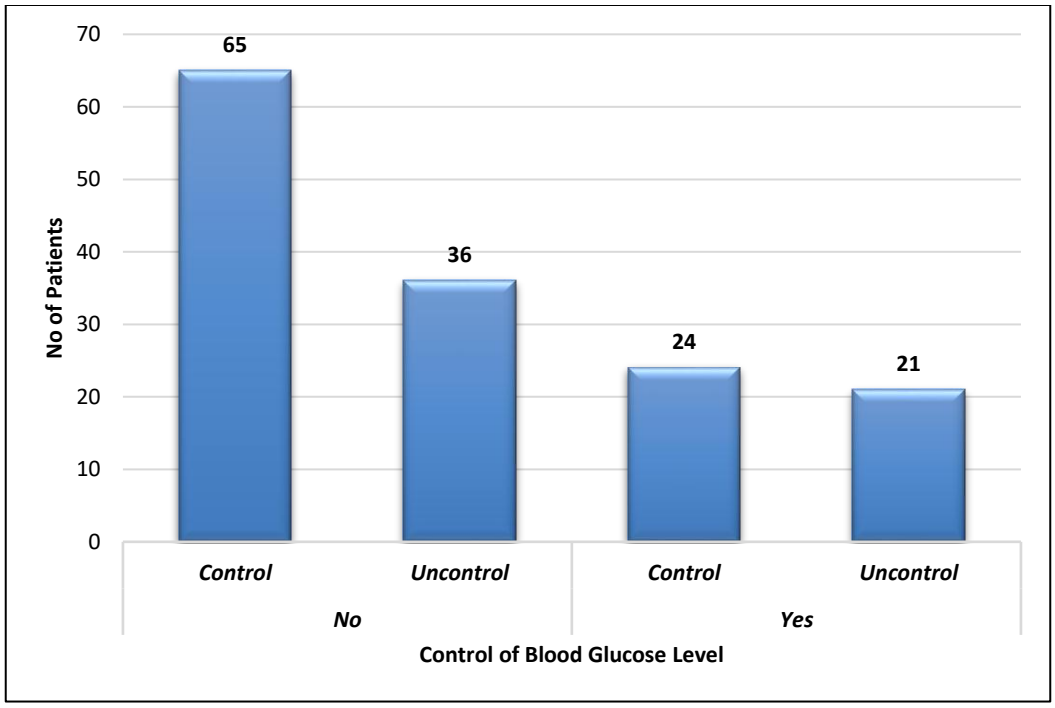


**Figure 1** Demonstrates a direct correlation between the consumption of junk food and the control of blood glucose levels. When junk food is not consumed, control of blood glucose levels improves, and vice versa.

## 4. DISCUSSION

Effective control over blood glucose levels in diabetic patients can be achieved through medication adherence, prescribed regimens, and self-care practices. Addressing the relevant contributing factors results in improved blood glucose level management. The present study thoroughly assessed the confounding variables associated with blood glycemic control. The majority of patients diagnosed with type 2 diabetes were males, comprising 52.4% of the total population. A statistically significant association was found ($p<0.001$) between the control of blood glucose level and patients' gender. According to the research, female patients showed better control than male patients, with a 78.6% COR of 2.521 (1.82-3.93). The better blood glycemic control in females may be due to their healthier dietary habits and greater attention to health. Similarly, Women generally seek medical help earlier and more frequently than men. Furthermore, it has been observed that women typically consume less alcohol, maintain a healthy diet, exercise regularly, and are more likely to follow a nutritious meal plan.

A cross-sectional study was conducted in Malaysia on 480 patients with diabetes mellitus, which presented comparable findings. The majority of the patients enrolled in the study were male (51.3%) (Iqbal et al., 2014). However, these results are in contrast to a cross-sectional descriptive study conducted on 310 diabetic patients from Ghana, West Africa, where the majority of the patients with diabetes mellitus type 2 were females i.e., 65.8% with age group 56- 65 years (Mogre et al., 2014). Similarly, a cross-sectional multi-centered study conducted in China, on 1524 diabetes mellitus type-2 patients presented the results that diabetes was comparatively more prevalent in the female population i.e., 58.2% (Liu et al., 2010). In the present study, the association of co-morbidities on glycemic control has been observed. The incidence of hypertension is associated with uncontrolled glycemic control as observed through univariate and multivariate logistic analysis.

The presence of hypertension is positively associated with uncontrolled glycemic levels in diabetes mellitus type 2 patients, with crude OR 1.875 (1.32–3.59) presenting a statistically significant association ($p<0.001$). Hypertension patients may experience insulin resistance, while chronic hypertension patients may experience Beta-cell dysfunction. High blood pressure over a long period can harm the function of pancreatic beta cells, which are responsible for producing insulin. This dysfunction can result in insufficient insulin secretion and poor blood sugar control. Both hypertension and diabetes are associated with chronic inflammation and oxidative stress. These conditions can worsen each other, leading to increased insulin resistance and poor glucose metabolism. A prospective national surveillance study conducted by the University of Manitoba in Canada presented similar results that the presence of co-morbid conditions especially hypertension is associated with enhanced risk of uncontrolled blood glucose levels and diabetes mellitus-associated complications (Amed et al., 2010).

According to an observational study conducted in the Lubuskie Voivodeship region of Poland, diabetes patients with hypertension as a co-morbidity had a higher percentage of elevated blood glucose levels - 80.5% (Bonikowska et al., 2021). The availability of healthcare providers within a family significantly influences patients' blood glycemic control. When a family member is a healthcare provider, blood glycemic control can reach up to 79%, compared to 32.1% in families without healthcare providers. A robust positive correlation was noted between blood glycemic control and the presence of a healthcare provider within the family as calculated through crude odds ratio COR = 2.122 with a statistically significant association ($p<0.001$). The presence of a healthcare provider within the family significantly influences the patient's knowledge regarding the specific disease, especially in managing the disease through medication therapy adherence, dietary modifications, and physical activity.

This cross-sectional study conducted in Kedah, Malaysia, revealed that having healthcare providers in the family led to increased knowledge of oral health and hygiene among other family members (Iqbal et al., 2020). Hence, our study findings are reinforced by existing literature, demonstrating that the presence of a healthcare provider consistently yields a positive impact on knowledge related to any given disease. According to the present study, patients who were taking a combination of three anti-diabetic drugs showed better control of their blood glucose levels in comparison to those who were taking two drugs or a single drug. On the other hand, patients taking a single anti-diabetic drug had the least control over their blood glucose levels. A strong statistically significant association was found in the patients with diabetes receiving the combination of three medications with Crude OR = 3.922 with a p-value of $p<0.001$.

The complexity of treatment for patients with high blood pressure may indeed increase when they have comorbidities compared to those without any additional health conditions. It is important to take into consideration all the factors that may affect the patient's health to provide the most effective treatment plan. Patients without comorbidities tend to have better-controlled and monitored blood

pressure as well as better blood glycemic control (Kamyshnyi et al., 2020). Patient education was also directly associated with the control of blood glucose levels (COR = 1.599, p<0.001). According to the results of the study, there is a direct correlation between the education level of diabetic patients and their glycemic control. Patients who had a university-level education showed better glycemic control, with a rate of 76.9%, compared to those with a pre-college-level education, whose rate was 49.3%. Hence, crude OR of 1.599 and presently a statistically significant association (*p<0.001*). The reason for this could be that educated patients are more likely to stick to the treatment plans prescribed by healthcare providers.

They understand the importance of consistently following medication regimens, lifestyle changes, and self-care practices. Furthermore, education enhances communication between patients and healthcare providers. Educated patients can better articulate their concerns, ask questions, and seek clarification, leading to more effective healthcare interactions. In line with the results of our study, another cross-sectional observational study conducted on 200 physician-diagnosed diabetic patients demonstrated similar results that patient education has a positive impact on disease control, presenting that patient with high education status had reduced diabetes prevalence (17.6%) as compared to patients with low education status (Mogre et al., 2014). According to a study conducted by The Ohio State University Wexner Medical Center in Columbus, United States, patients with diabetes mellitus type-2 who have completed high school or higher education levels tend to have better control of their blood sugar levels compared to those with lower levels of education (Gonzalez-Zacarias et al., 2016).

The results of our current study are consistent with those of another randomized controlled trial conducted in Canada, which demonstrated a direct relationship between patient education and disease control (Dawes et al., 2010). The present study co-related the medication therapy combination (Oral drugs only, Insulin only, and Oral drugs with Insulin) with glycemic control of diabetes mellitus type-2 patients. It has been observed that there is a positive correlation between glycemic control and the use of insulin. A statistically significant association was found (*p<0.001*) between the management of blood glucose levels and combination therapy (Oral drugs with insulin). Patients using oral medications in combination with insulin exhibited more significant blood glycemic control as compared to patients using insulin or oral drugs alone, i.e., 60.3% Crude OR 1.491(1.75–4.84).

The possible reason behind better blood glycemic control of patients using insulin could be the reason that insulin is considered the most vital item for regulating blood glucose levels by promoting glucose uptake into cells, inhibiting glucose production by the liver, and facilitating the storage or use of glucose, fatty acids, and amino acids throughout the body. Its proper function is essential for maintaining normal metabolism and preventing complications associated with elevated blood sugar levels. In a hospital-based cross-sectional study on 326 diabetes mellitus type-2 patients in Ghana, West Africa, it was observed that patients using anti-diabetic drugs or insulin alone exhibited poor glycemic control. On the other hand, patients using both anti-diabetic drugs and insulin showed comparatively better glycemic control (Alor et al., 2023).

## 5. CONCLUSION

The study participants showed poor glycemic control. Significant associations with glycemic control were found in gender, exercise, parent's education, comorbidities, number of anti-diabetic drugs, and healthcare providers in the family. Healthcare providers need to prioritize glycemic control in diabetes management. They should focus on educating and guiding patients on adhering to diabetes self-care activities to improve glycemic control.

**Limitations of the study**

This study was conducted only in selected pharmacies where a few clinics and hospital patients come for prescription refills A detailed follow-up study can be conducted to evaluate the impact of sociodemographic determinants on hypertension and type-2 diabetes patients in Pakistan.

**Authors' Contributions**

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

**Ethical Approval**

Ethical approval for the study was obtained from the Lahore Pharmacy College, Lahore, Pakistan, with reference number (ref: ZI/06/23), ensuring compliance with ethical standards and guidelines.

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**Abbreviations**

COD= Crude Odds Ratio
AOD= Adjusted Odds Ratio
95% CI= 95% Confidence Interval
SPSS = Statistical Package for the Social Sciences

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**Informed consent**

Written & Oral informed consent was obtained from individual participants included in the study.

**Conflict of interest**

The authors declare that there is no conflict of interests.

**Data and materials availability**

All data sets collected during this study are available upon reasonable request from the corresponding author.

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