

Glycosylated Haemoglobin Test (HbA_{1c}) health literacy associates with diabetic disease control assessed in an outpatient podiatry practice

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Key words

- Glycosylated haemoglobin test
- HbA_{1c}
- Health literacy
- Population statistics
- Diabetes

Article points

1. High prevalence of diabetes makes health literacy with respect to the HbA_{1c} test a significant public health issue.
2. The data point to a gap in health literacy and opportunity for intervention, as only 64.6% of patients with diabetes in this population knew their most recent HbA_{1c}%.
3. There is a benefit in measured HbA_{1c}% for patients who know their own most recent value as compared with those who do not.

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Background: The glycosylated hemoglobin test (HbA_{1c}) is used as a measurement of diabetes control that captures cumulative effect of elevated blood glucose over 3 months. Elevated HbA_{1c} is indicative of worse blood glucose control and has been associated with cardiovascular disease, nephropathy, neuropathy, and retinopathy. Reduction in HbA_{1c} by <1% can decrease 5-year mortality rates by 50%. However, HbA_{1c} is less intuitive than fingerstick point-of-care glucose measurements. This observational study aims to determine the level of awareness patients with diabetes have about HbA_{1c} and how it relates to observed HbA_{1c} value. **Methods:** At a New York City tertiary care hospital-based outpatient podiatry practice, incoming patients with diabetes were surveyed about their HbA_{1c} knowledge over a 3-month period, and observed HbA_{1c} levels were compared between patients with disparate levels of HbA_{1c} health literacy. **Results:** In 165 patients, HbA_{1c} knowledge was categorised into three groups: (1) knows HbA_{1c} value ($n=106$); (2) knows about HbA_{1c} but does not know most recent personal value ($n=27$); and (3) does not understand HbA_{1c} ($n=32$). Mean HbA_{1c} levels between the three groups were not significantly different by three-way Kruskal-Wallis test (P -value=.06); However, the difference comparing patients who knew their most recent HbA_{1c}% (mean 6.86%) versus patients who did not (mean 7.46%) was significant (Wilcoxon P -value=.01). **Conclusions:** This data suggest that there is a benefit in measured HbA_{1c}% for patients who know their own most recent value as compared with those who do not, but not in patients who only understand HbA_{1c} values in general. In addition, the data points to a gap in health literacy and opportunity for intervention, as only 64.6% of patients with diabetes knew their most recent HbA_{1c}%. High prevalence of diabetes makes health literacy with respect to the HbA_{1c} test a national concern with significant public health implications.

D iabetes, a disease of chronically elevated blood sugar, is a large and ever-growing public health concern, affecting approximately 34.1 million adults in the United States, or 13% of the United States population over 18 years old (Centers for Disease Control and Prevention [CDC], 2020). Diabetes can be managed through diet and pharmacological interventions, leading to improved clinical outcomes. In patients with controlled diabetes, there is a reduction in

major macrovascular and microvascular events (ADVANCE Collaborative Group, 2008). This underscores the importance of maintaining diabetic control of blood glucose levels over time.

Hyperglycaemia is an important risk factor for long-term complications of diabetes (Laasko and Cederberg, 2012). Hyperglycaemia is characteristic of uncontrolled diabetes, and can result in life-threatening complications, such as diabetic ketoacidosis and hyperosmolar hyperglycaemic

syndrome. The HbA_{1c} test is the primary clinical test used for both diabetes management and diabetes research (National Institute of Diabetes and Digestive and Kidney Diseases, 2018). The HbA_{1c} test is based on the long-lasting attachment of glucose to hemoglobin, and thus reflects a person's average blood glucose levels over the lifespan of haemoglobin, or 3 months (National Institute of Diabetes and Digestive and Kidney Diseases, 2018). This makes it a more robust measure of chronic elevated blood glucose as compared to measurement of blood sugar levels, which are more transient and have high variability hour-to-hour. Additionally, HbA_{1c} correlates with risk of long-term diabetes complications. Reduction in HbA_{1c} by <1% can decrease 5-year all-cause mortality rates by 50% (Eeg-Olofsson et al, 2012).

In a meta-analysis by Zaou et al (2015), high level of HbA_{1c} was an important risk factor for lower-extremity amputation in patients with diabetes. Due to its reliability and correlation with significant morbidities, HbA_{1c} is considered the primary test for diabetes monitoring and chronic management (Sherwani et al, 2016).

However, HbA_{1c} measurement is less intuitive than glucose level and patients may not fully understand the relevance of the HbA_{1c} test, leading them to consider it less important than they should. In the United States, 50% of all diabetics have an HbA_{1c} of 7.0% or higher (CDC, 2020). If a patient with diabetes is able to understand the importance of HbA_{1c} levels as a way of keeping track of their disease, and they are aware of their own HbA_{1c} level and its progression, we hypothesise that this would make it easier for them to understand exactly how well they are managing their diabetes. This might give a stronger motivation to make improvements in disease management and potentially improve patient outcomes.

Approximately 80 million Americans have limited health literacy, which is associated with poorer health outcomes and poorer use of health care services (Berkman et al, 2011). This extends to diabetic patients, where diabetes knowledge is an important factor associated with glycaemic control (Bains and Egede, 2011). It is critically important to understand how well diabetic patients are informed of HbA_{1c} as the primary clinical test used to track their disease.

The primary aim of this project is to determine

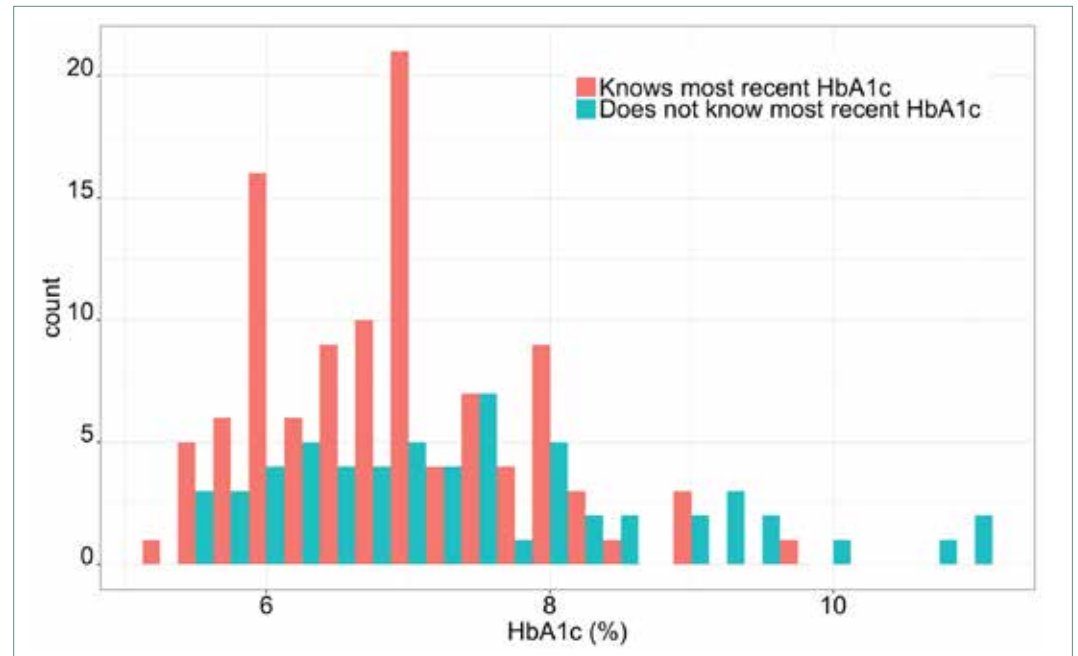
the level of awareness diabetes patients have about the monitoring and treatment of their disease. Specifically, the authors aim to determine the rate at which diabetes patients understand the biological relevance and interpretation of HbA_{1c} levels with regard to their health and to determine the rate at which these patients are aware of their own most recent HbA_{1c} value. In addition, the authors aim to identify whether there is a significant difference in level of diabetes control between patients with higher HbA_{1c} health literacy and patients with lower health literacy.

Material and methods

All patients with an established diagnosis of diabetes coming in for diabetic podiatric care at a New York City tertiary care hospital-based outpatient podiatry practice were surveyed about their HbA_{1c} knowledge. Specifically, patients were asked if they know their most recent HbA_{1c} value and if they know what an HbA_{1c} value is in general. Level of HbA_{1c} health literacy was classified into three categories: (1) patients who did not understand what an HbA_{1c} value meant in general, (2) patients who did understand in general but did not know their own most recent HbA_{1c} value, and (3) patients who knew their most recent HbA_{1c} value. The study duration was 3 months, as people with diabetes routinely visit the podiatrist every 3 months for standard care. For more frequent patients with multiple visits during the observation period, only their first response was recorded. Survey responses were collected and analysed to determine the levels of HbA_{1c} awareness across all patients.

Of the 217 patients identified, 175 were complete observations with responses recorded for both survey questions and measured HbA_{1c} value available in the clinical record. Outliers were defined as any data point with measured HbA_{1c} value more than 1.5 interquartile ranges (IQRs) below the first quartile or above the third quartile for each of the three categories. There were no low outliers in any of the groups, but 10 high-HbA_{1c} outliers were removed (two outliers from the group that did not understand HbA_{1c}, one outlier from the group that understood HbA_{1c} generally, but did not know their own most recent value, and seven outliers from the group that knew their most recent HbA_{1c}).

Figure 1. Bar graph of HbA_{1c} for patients who knew their most recent HbA_{1c} (red), knew about HbA_{1c} in general, but not their own most recent HbA_{1c} (green), and patients who did not know about HbA_{1c} (blue). Distributions were compared by Kruskal-Wallis test: $P=0.06$, with highest median HbA_{1c}% among patients who did not know about HbA_{1c} in general, followed by patients who knew about HbA_{1c}% in general, and lowest in patients who knew their own most recent HbA_{1c}%.



Potential association between HbA_{1c} knowledge and observed HbA_{1c} level was evaluated by comparing the HbA_{1c} levels in each of the three health literacy groups, with three-way Kruskal-Wallis statistical test, then by comparing HbA_{1c} levels in patients that did not know their own most recent HbA_{1c} values ($n=59$) with patients that did ($n=106$) by unpaired Wilcoxon rank sum test. Statistical significance was considered $P\leq 0.05$.

Results

In the 165 patient samples with complete observation of survey results and HbA_{1c} lab values, excluding outliers, HbA_{1c} knowledge was categorised into three groups with the following number of patients identified from each group: patients who did not understand what an HbA_{1c} value meant in general ($n=32$, mean observed HbA_{1c}% = 7.46%), patients who did understand in general but did not know their own most recent HbA_{1c} value ($n=27$, mean observed HbA_{1c}% = 7.32%), and patients who knew their most recent HbA_{1c} value ($n=106$, mean observed HbA_{1c}% = 6.86%).

The difference between mean HbA_{1c} levels comparing the three groups was not statistically significant by three-way Kruskal-Wallis test (P -value = 0.06) (Figure S1, Figure S2). However, the difference in HbA_{1c} between patients who knew their most recent HbA_{1c}% (mean 6.86%) vs. patients who

did not know (mean 7.46%) was significant (Wilcoxon test P -value = 0.01) (Figures 1 & 2).

This seems to suggest that a patient's understanding of HbA_{1c} does have a significant impact on how well their diabetes is controlled, with a mean difference in measured HbA_{1c} of 0.59 between patients who know their most recent HbA_{1c} and patients who do not. Furthermore, 35.4% (62/175) of the total surveyed patients at this tertiary care hospital outpatient podiatry practice were not aware of their own most recent HbA_{1c} value and of these, 53.2% (33/62) were not aware of the significance of HbA_{1c} in general.

Discussion

The key findings of this study are that 35.4% (62/175) of the total patients surveyed did not know their last HbA_{1c} value. The patients who did not know their HbA_{1c} values had a statistically significant higher HbA_{1c} value when compared to patients who did know their most recent HbA_{1c} value. Interestingly, this advantage does not extend to patients who understand HbA_{1c} values in general but do not track their own most recent lab values.

In this study, 64.6% (113/175) of the total patients surveyed knew their last HbA_{1c} value. The low rate of HbA_{1c} health-literacy among people with diabetes surveyed in this study indicates a need for increased outreach and patient education to patients

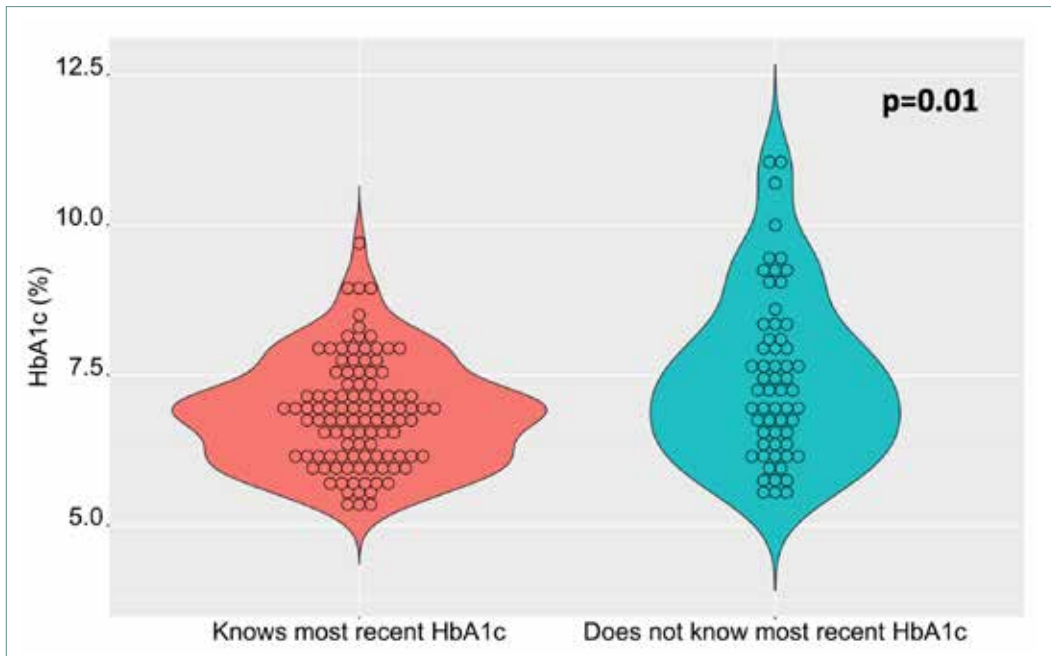


Figure 2. Violin plot of HbA_{1c} for patients who knew their most recent HbA_{1c} (red), knew about HbA_{1c} in general but not their own most recent HbA_{1c} (green), and patients who did not know about HbA_{1c} (blue). Distributions were compared by Kruskal-Wallis test: $P=0.06$, with highest median HbA_{1c}% among patients who did not know about HbA_{1c} in general, followed by patients who knew about HbA_{1c}% in general, and lowest in patients who knew their own most recent HbA_{1c}%.

who do not track their HbA_{1c}. Although the number of patients who did not know their recent HbA_{1c} is high, it is lower than in previous cross-sectional studies profiling different patient populations, which report a very low percentage of people who understand their HbA_{1c} level. Approximately 25% of patients were able to report their HbA_{1c} value in cross-sectional studies in Michigan (Heisler et al, 2005), in Montana (Harwell et al, 2002), and in the United Kingdom (Beard et al, 2010). Additionally, in a Chinese cohort of type 2 diabetes patients, only 25.3% had a good understanding of HbA_{1c} in general (Yang et al, 2016), and in a 1998 cross-sectional study across 22 US states (Beckles et al, 1998), 25% of diabetic patients surveyed had even heard about HbA_{1c}. This low percentage of HbA_{1c} awareness in past studies reflects level of HbA_{1c} literacy among all patients diagnosed with diabetes, through chart review (Yang et al, 2016), diabetes clinics (Beard et al, 2010), and telephone/mail surveys (Beckles et al, 1998; Harwell et al, 2002; Heisler et al, 2005). This may not reflect the patient population actively seeking care for diabetes management at a podiatric practice.

It is possible that the patient population in this study had higher awareness about their HbA_{1c} than the general diabetic population due to a larger patient care team in a tertiary-care medical centre and, therefore, increased opportunities for

educational intervention. Routine diabetic foot care is recommended at least annually to identify ulceration and lower-extremity amputation risk factors (American Diabetes Association, 2020). Patients who are symptomatic or have a history of chronic foot pathologies are evaluated more frequently. Foot ulcers and lower-extremity amputation represent key causes of morbidity and mortality in people with diabetes (American Diabetes Association, 2020). Podiatrists are well-positioned in their role as longitudinal diabetic care providers to monitor their patient's level of diabetes control and assess their HbA_{1c} literacy.

The chief novel finding of this study is that diabetic patients who track and are aware of their own HbA_{1c} level have on average 0.6% lower observed HbA_{1c} than patients that do not know their most recent HbA_{1c}. This suggests that directing patients to track their own lab values should be the focus of HbA_{1c} education, rather than educating patients on HbA_{1c} importance in general. The relative risk for significant comorbidity and mortality associated with even a 1% increase in HbA_{1c} level among patients with type 2 diabetes is significant — 1.15 for all-cause mortality, 1.17 for cardiovascular disease, 1.15 for coronary heart disease, 1.11 for heart failure, 1.11 for stroke, and 1.29 for peripheral arterial disease (Zhang et al, 2012). Due to the widespread prevalence of diabetes, any statistically

meaningful reduction in HbA_{1c} can have a significant impact on patient healthcare outcomes.

This study provides a baseline of the current level of HbA_{1c} literacy at a New York City tertiary care hospital-based outpatient podiatry practice, which may be reassessed in future studies to evaluate the effectiveness of targeted interventions to improve health literacy among people with diabetes focusing on spreading awareness of how important it is for patients to keep track of their own HbA_{1c} values.

Conclusion

These data collectively suggest that there is a measurable advantage in terms of improved HbA_{1c}% in patients who know their own most recent HbA_{1c} value compared to those who do not. However, this advantage did not extend to patients who understand HbA_{1c} values in general, but do not track their own most recent lab values. Patients who did not know their own most recent HbA_{1c}% had higher average observed HbA_{1c} values than patients who did (mean 7.46% vs 6.86%, *P*-value=0.01), a clinically significant gap in level of diabetes control.

This points to an underlying gap in health literacy and opportunity for intervention, as only 64.6% of patients with diabetes mellitus pursuing routine outpatient podiatric care knew their own most recent HbA_{1c}. Targeted efforts to motivate the remaining 35.4% of patients to track their HbA_{1c} levels may improve healthcare outcomes and reduce morbidity and mortality associated with poor management of chronic diabetes. Further study is needed across multiple patient populations to confirm whether this trend is generalisable and what other factors (demographic, disease severity, etc) may play a role in the effectiveness of patient education and level of health literacy.

In sum, these data suggest that further efforts in patient education should be personalised to focus on patients' knowledge and motivation to track their specific HbA_{1c} values rather than general education

about the clinical relevance of HbA_{1c}. Health numeracy and health literacy are issues faced in all areas of healthcare, and the prevalence of diabetes in the general population makes health literacy with regard to the HbA_{1c} test a national concern with a significant impact on public health. ■

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