Diabetes & Metabolic Syndrome: Clinical Research & Reviews 13 (2019) 3069–3073

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

Age and glycemic control among adults with type 2 diabetes in the United States: An assessment from the National Health and Nutrition Examination Survey (NHANES) 2013–2014

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ARTICLE INFO

Article history:
Received 24 July 2019
Accepted 11 November 2019

Keywords:
Glycemic control
Type-2 diabetes
Diabetes complications prevention

ABSTRACT

Aim: To assess the age and its association with glycemic control (GC) among adults with type 2-diabetes in the United States.
Materials and materials: Data were collected from the National Nutrition Examination Survey (NHANES) 2013–2014 (n = 697), cross-sectional national survey adults with Type2 diabetes. Characteristics included retinopathy diagnosis, blood pressure, albumin-creatinine ratio, hemoglobin A1c (HbA1c), BMI, cholesterol, smoking status, pills/insulin, exercise, age, age at diagnosis, education, sex, race, and marital status. Diabetes preventive behaviors were included. Predictors of GC were assessed using logistic regression.
Results: The mean age was 61 (SD ±13); the average age at diagnosis 50 (SD ±12.9) and women (51%). Age ≥60, diabetes length >10yrs, taking pills/on insulin, albumin-creatinine ratio ≤30mg/g, optimal BP, no retinopathy diagnosis, optimal cholesterol, seeing a doctor for diabetes, doctors checkup ≥2 times and checking HbA1c annually were significant predictors of GC. The association between GC and age (OR=.97, p<.001; CI: .96-.98) diabetes length >10yrs (OR=1.55, p<.05; CI: 1.02-2.34), creatinine-albumin ratio ≤30mg/g (OR=1.97, p<.001; CI: 1.32-2.94) and checking HbA1c annually (OR=1.86, p<.01; CI: 1.16-3.00) remained significant after adjustment for the effects of all other statistically significant covariates.
Conclusions: GC was prevalent among older individuals; suggestive of intervention programs for young adults with diabetes and continuous HbA1c assessment at least annually.

1. Introduction

The prevalence of Type 2 diabetes has consistently increased in the United States (U.S.), in the last two decades. There has been an increase in individuals diagnosed with Type 2 diabetes in the U.S, tripling. Moreover, the number of new cases doubled between 1990 and 2010 [1]. Between 1994 and 2017, the U.S. population with diabetes increased from 13 to 30 million, a 130% increase [2]. This is five times greater than the increase in the U.S population. Type-2 diabetes has been associated with an increased risk of developing microvascular (nephropathy, retinopathy, and neuropathy), and macrovascular (cardiovascular disease) conditions [3,4]. Thus, an assessment of glucose control is necessary as there is a limited amount of research assessing people with diabetes glycemic control at the population level.

Moreover, the rate of Type 2 diabetes has notably increased in the U.S among individuals ages 20–44 years [5]; indicating an increasing rate of Type-2 diabetes in younger age groups [6–8]. Although there are a few studies evaluating glycemic control there are no recent studies conducted in the U.S [9,10]. In addition, there is limited recent evidence assessing glycemic control and age in the U.S population. Hence, this research presents an analysis of the National Health and Nutrition Examination Survey (NHANES) data on glycemic control using calibrated HbA1c to examine age and glycemic control, among adults with Type-2 diabetes, in the U.S.

2. Methods

Secondary data for individuals aged ≥18 years was drawn from the NHANES 2013–2014 survey conducted by The National Center

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https://doi.org/10.1016/j.dsx.2019.11.004
1871-4021/

for Health Statistics of the Centers for Disease Control and Prevention (CDC).3 Data included a sample of $n = 697$ individuals that is representative of the U.S. population regarding age, sex, and income and race/ethnicity distribution [11].The data used in the current study are publicly available and de-identified. For this study's period (2013–2014), participants were included in the final analysis if they were ≥18 years of age and reported a diagnosis of diabetes as indicated by a positive answer to the survey question: "Have you ever been told by a doctor or health care professional that you have diabetes." Survey respondents were excluded from the final study dataset if they reported having pre-diabetes, borderline diabetes, impaired fasting glucose, or impaired fasting glucose. All participants had a laboratory HbA1c measurement. Participants' HbA1c is recorded from the blood sample taken during their clinical examination in the study's Mobile Examination Center (MEC). The NHANES uses several methods to monitor the quality of the analyses performed by MEC, which have been reported previously [12,13].

Demographic data included age, sex, race/ethnicity, marital status, and educational level. Due to the small sample size in the racial and ethnic categories (i.e., Mexican American, other Hispanic, other race-including Multi-Racial, Black, Non-Hispanic Asian, groups), these were combined into a minority category. Chi-Square test for categorical variables was used to explore associations between demographic characteristics and clinical factors by glycemic control. Results are reported using odds ratios (ORs), with a p-value of $P < .05$ (two-tailed) indicative of statistical significance. The cut-offs points for the bivariate analyses were based on the parameters established in previous research [14,15]. Clinical data included diabetes-related comorbidities, diabetes-medication use (yes vs. no), $HbA1_c$ (≤7% vs. ≥ 8%), age at diagnosis, blood pressure (≤120/80 mmHg vs. >120/80mmHg), glucose (<125 mg/dL vs. ≥126 mg/dL), albumin/creatinine ratio (<30mg/g vs.≥30 mg/g), cholesterol (<200mg/dl, vs. ≥200 mg/dl) and BMI which was categorized as <24.9 was within a normal range and ≥ 25 classified as having an abnormal BMI. To assess glycemic control, laboratory HbA_{1c} was documented for most individuals. If there were any missing values then self-reported HbA_{1c} data were included and categorized as HbA_{1c} ≤7% vs. ≥ 8%.[16]. The HbA_{1c} cut-off point was chosen according to recommendations from the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD), where the HbA1c <7% is the recommended glycemic control point for the majority of individuals with diabetes. [17–19].

Logistic regression was used to assess glycemic control, with age, gender, length of diabetes, on insulin/taking diabetes medications, retinopathy, cholesterol, albumin-creatinine ratio, foot check, smoking history, physical activity, BMI, blood pressure (BP), as independent variables. Descriptive statistics are reported as mean, median, standard deviations, and range values for continuous data and frequencies for categorical variables. Statistical analyses were conducted using SPSS 23® for Windows.

3. Results

Descriptive results for participants with available HbA1c are shown in Table 1. Men made up 49% of the demographic, and women 51%. The mean age was 61 (SD ± 13) years; the average age at diagnosis was 49 years (SD ± 12.9). Four hundred and forty two (63%) of participants reported being from a minority group; either Hispanic/multiracial, Black or Asian. Three hundred and eighty three (55%) reported having a high school diploma or attaining their GED, and 308 (44%) reported having a college degree. Marital status was reported as 386 (55%) married, and 307 (44%) single. The prevalence of diabetes within the NHANES sample was 7%, which is consistent with national estimates for years 2013–2014. 1.

Table 1
Sample demographic characteristics (N = 697).

Demographic Characteristic	
Gender, *n* (%)	
Men	341 (49%)
Women	356 (51%)
Age (years), Mean (SD)	61 (13.2)
Age at Diagnosis, Mean (SD)	49 (14.0)
Race/Ethnicity, *n* (%)	
Hispanic/Multiracial	197 (28%)
Non-Hispanic White	255 (37%)
Non-Hispanic Black	174 (25%)
Non-Hispanic Asian	71 (10%)
Education, *n* (%)	
GED/High School Diploma	383 (55%)
College Degree	308 (44%)
Marital Status, *n* (%)	
Married	386 (55%)
Single	307 (44%)

To assess glycemic control by age, the age ranges are reported according to the methods reported in previous research [20] (18–39, 40–64 and 65 years and older). Fig. 1 shows individuals in the age ranges of 40–59 years (46%) and individuals between 18 and 35 years (35%) with suboptimal glycemic control. The older the individual, the greater the percentage that achieves glycemic control (HbA1c ≤ 7%).

Table 2 summarizes clinical characteristics and preventive behaviors among individuals with Type-2 diabetes for the study sample ($n = 697$). The average diabetes duration was 12 years ($SD = 9.61$) and an average HbA1c of 7.5% ($SD = 9.61$). Most individuals had abnormal BP and BMI, 72% and 85%, respectively.

Table 3 shows bivariate analyses of statistically significant factors associated with glycemic control. Gender, race/ethnicity, marital status were excluded due to no significant association with glycemic control. Individuals age 59 years or younger had a significantly lower probability of having optimal glycemic control (OR = 0.57; 95% CI = 0.42–0.78) compared to older individuals 60 ≥ years. Those who had 10 years or less of living with diagnosed Type-2 diabetes had a significant association with optimal glycemic control (OR = 2.10; 95% CI = 1.54–2.88).

Clinical factors found to be associated with optimal glycemic control were taking medications and/or insulin (OR = 0.27; 95% CI = 0.16–0.45), retinopathy (OR = 1.82; 95% CI = 1.27–2.64), blood pressure and albumin/creatinine ratio (OR = 1.60; 95% CI = 1.11–2.34) and (OR = 1.41; 95% CI = 1.01–1.98), respectively. An assessment of health care preventive behaviors revealed individuals who reported not seeing a doctor for diabetes care (within the last year), had a decreased risk for optimal glycemic control (OR = 0.56; 95% CI = 0.38–0.82). Individuals who were less likely to have optimal glycemic control were going to the doctor to check HbA_{1c} (OR = 0.99; 95% CI 0.67–1.48) and seeing a doctor two or more times a year (OR = 0.68; 95% CI = 0.49–0.95).

Statistically significant factors shown in the bivariate analysis were included in the logistic regression analysis to provide a parsimonious model. The model calculated the probability that clinical and preventive factors predicted glycemic control. The predictor variables were age, length of diabetes, being on insulin, taking medication and insulin, being diagnosed with retinopathy, albumin creatinine ratio, seeing the doctor for diabetes care, and $HBA1_c$ not checked by a doctor within the last year. Missing data in the analysis was ~13%.

Table 4 presents the logistic regression coefficients, Wald test, odds ratios, and confidence intervals for each predictor. Employing a .05 criterion of statistical significance, age, length of diabetes, insulin, taking medication and insulin, albumin creatinine ratio,

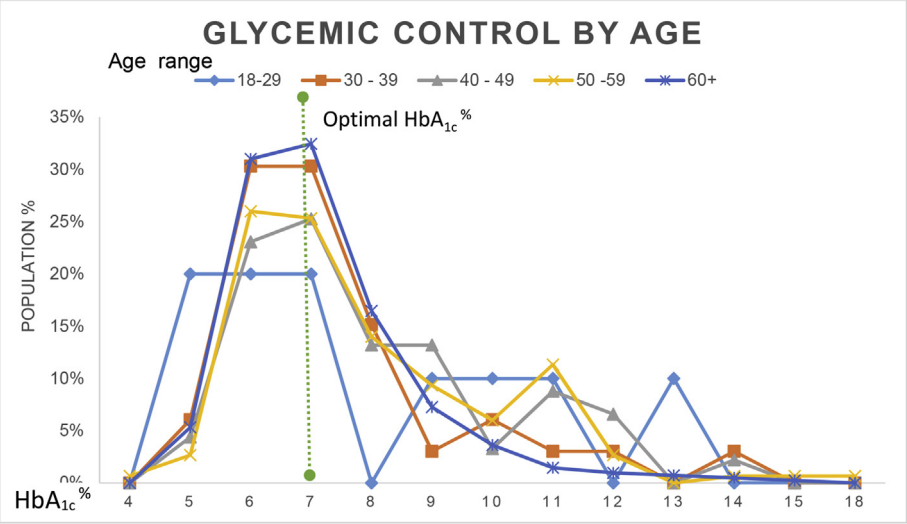

Fig. 1. Glycemic control and age stratification.

Table 2
Clinical characteristics and preventive behaviors among individuals with Type-2 diabetes (N = 697).

Clinical Characteristics	
Length of diabetes (Years) Mean (SD)	12 (9.61)
HbA1C, Mean (SD)	7.5% (1.85)
HbA1C status, *n* (%)	
≤7%	442 (63)
≥8	255 (37)
Taking DM pills, *n* (%)	
Yes	485 (70)
No	210 (30)
On insulin, *n* (%)	
Yes	205 (29)
No	492 (71)
See a doctor for DM, *n* (%)	
Yes	533 (77)
No	164 (24)
Number of times went to DM doctor, *n* (%)[a]	
≥2 times	460 (66)
None	235 (34)
Doctor checked HbA1C[a], *n* (%)	
Yes	501 (72)
No	134 [19]
Checked feet[a,b]	
Annually	493 (71)
None	195 (28)
Eye exam[a,b]	
Annually or more than once	505 (73)
More than 2-yrs	192 (28)
Retinopathy[c]	
No	549 (79)
Yes	148 [21]
Total BP	
≤120/80 mm Hg	172 (25)
>120/80 mm Hg	501 (72)
BMI	
Normal	79 [11]
Abnormal	593(85)

Abbreviations: BP: Blood Pressure; PA: Physical Activity; Total BP: $n = 24$ missing variables; total cholesterol: $n = 27$ missing; Albumin/creatinine ratio: $n = 35$ missing; BMI: $n = 25$ missing; checked feet $n = 9$; went to check HbA1C $n = 62$ missing; Taking DM pills: $n = 2$ missing; number of times went to DM doctor = 2 missing; checked HbA1C: $n = 62$.

[a] Within 12-months.

[b] Examination done by a doctor.

[c] Self-reported doctor diagnosed with retinopathy.

and getting glycemic levels checked emerged as significant predictors of glycemic control. A diagnosis with retinopathy and seeing a doctor for diabetes care was not significant. (χ^2 (8, $n = 604$) = 125.96, $p < .001$; Nagelkerke $R^2 = 25.7\%$, predicted cases = 72.5%).

Results indicated for every one-year increase in age, suboptimal glycemic control reduces by 3% (OR = 0.97, $p < .001$; CI: 0.96-0.98); this means that older people have more optimal glycemic control. Individuals who had diabetes length of more than 10 years had an increased likelihood of glycemic control by 55% compared to those with diabetes for less than 10 years (OR = 1.55, $p < .05$; CI: 1.02–2.34). Furthermore, being on insulin reduces the likelihood of glycemic control by 76% compared to those who are not on insulin (OR = 0.24, $p < .001$; CI: 0.15-0.37). Additionally, not taking medication and insulin reduces the likelihood of glycemic control by 66% compared to those who are taking medication and insulin (OR = 0.34, $p < .001$; CI: 0.18-0.66). Having a lower albumin creatinine ratio predicted optimal glycemic control by 1.97 times more than having a higher albumin creatinine ratio (OR = 1.97, $p < .001$; CI: 1.32–2.94). Lastly, participants who are having HBA1c levels checked by a doctor are 1.86 times more likely to have glycemic control compared those who are not being checked every 12 months (OR = 1.86, $p < .01$; CI: 1.16–3.00).

4. Discussion

This study documented the latest national estimates for glycemic control in a U.S population with type 2 diabetes paying close attention to age groups for glycemic control. Results revealed the prevalence of diabetes was 7%, which is consistent with the rates reported in the years 2013–2014 and the average HbA1c was 7.5% SD 1.85. The average national age was 61 years of age, and the average length of diabetes was 12 years, indicative that on average, this sample was diagnosed at ~45 + years of age. This is consistent with the reported age in which someone with type II diabetes is typically diagnosed. 3.

Stratification by age and glycemic control showed optimal glycemic control was more prevalent among older individuals as compared to younger individuals, perhaps indicating there is a learning curve for glycemic management. This tendency remained significant after adjustment in demographic, clinical, and preventive behaviors. Similar results have been documented in prior

Table 3
Bivariate association between demographic, clinical characteristics and preventive behaviors among individuals with type 2 diabetes (N = 697).

Characteristic:	***n* (%)**	**OR (95% CI)**	***p*-value**
$HbA_{1c} \leq 7\%$ ($n = 442$) vs. $\geq 8\%$ ($n = 255$)			
Age			
≤59	158 (56) vs. 126 (44)	0.57 (0.42–0.78)	0.000*
≥60	284 (69) vs. 129 (31)		
Length of diabetes			
≤10yrs	275 (71) vs. 112 (29)	2.10 (1.54–2.88)	0.000*
>10yrs	167 (54) vs. 143 (46)		
On Insulin			
Yes	72 (35) vs. 133 (65)	0.18 (0.13–0.25)	0.000*
No	370 (75) vs. 122 (25)		
Taking medications and/or on insulin			
Yes	344 (59) vs. 237 (41)	0.27 (0.16–0.45)	0.000*
No	98 (74) vs. 18 (42)		
Retinopathy[c]			
Yes	77 (52) vs. 71 (48)	1.82 (1.27–2.64)	0.001*
No	365 (67) vs. 184 (34)		
Total BP			
<120/80 mm Hg	122 (70) vs. 50 (29)	1.60 (1.11–2.34)	0.013*
≥120/80 mm Hg	302 (60) vs. 199 (40)		
Albumin/creatinine ratio			
≤30 mg/g	300 (67) vs. 148 (33)	1.41 (1.01–1.99)	0.046*
>30 mg/g	126 (59) vs. 88 (41)		
See a doctor for DM			
Yes	322 (60) vs. 211 (40)	0.56 (0.38–0.82)	0.003*
No	120 (73) vs. 44 (27)		
Times went for a checkup[a,b]			
≥2	279 (61) vs. 181 (39)	0.68 (0.49–0.95)	0.025*
None	163 (69) vs. 72 (86)		

[a] Within 12-months/at least once annually; DM: Diabetes Mellitus.
[b] Examination done by a doctor.
[c] Self-reported doctor diagnosed with retinopathy.
*Denotes statistical significance.

studies evaluating age and glycemic control [21]. In addition, individuals who had a diabetes duration of more than 10 years had a greater probability of glycemic control by 55% compared to those with diabetes for 10 years or less (OR = 1.55, p < .05; CI: 1.02–2.34), suggesting that, in an early diagnosis, people may not fully understand the self-management practices of diabetes. This is likely to have an impact on the rates of complications related to diabetes since people live with the disease with little control for longer.

Individuals who reported being on insulin had a reduced likelihood of glycemic control by 76% compared to those who were not on insulin (OR = 0.24, p < .001; CI: 0.15-0.37). A possible explanation to this might be individuals reporting being on insulin may not know how to handle their insulin regimen. Some people might be busy with work-life or their occupation might preclude them from adhering to the prescribed insulin treatment [22].

This study examined the association between clinical characteristics, preventive behaviors, and glycemic control for individuals diagnosed with Type 2 diabetes. The association between seeing a doctor for diabetes and glycemic control was no longer a predictor for glycemic control. However, self-reported medical visits to check HbA1c within the past year had a protective effect on glycemic control, improving glycemic control by 2.0 times. Having a lower albumin creatinine ratio predicted optimal glycemic control by 1.97 times more than having a higher albumin creatinine ratio. Lower levels of albumin-creatinine ratio indicate that this sample has a lower probability of adverse clinical cardiovascular disease outcomes, indicative that most individuals in this sample had optimal glycemic levels.

The study has potential limitations. First, the diabetes questionnaire was based on self-reported data; however, many of the data were available and may not have a direct impact on the analysis outcome. Second, variables that may explain glycemic control or diabetes preventive behaviors such as psychological or other risk factors known to be associated with complications of diabetes, were not captured. These missing factors were limited to the availability of NHANES data.

Findings indicate that adults 60 years and older had better controlled glycemic levels than younger adults. Young adults had significantly less length of diabetes than older adults did, and the average age at diagnosis was 49 years. Individuals with 10 years or less of diagnosis have suboptimal glycemic control than those who have been diagnosed for more than 10 years. It should be noted that in this sample, older adults constitute a majority proportion of adults with diabetes. As such, public health efforts should focus on helping young adults as soon as they are diagnosed to control and maintain optimal glycemic levels. Results suggest that people who had diabetes for more than 10 years exhibited optimal control, which suggests there might be a learning curve to diabetes management. People who reported being on insulin therapy had suboptimal glycemic control. This could mean previous therapies (e.g. taking pills) may not have worked for some people to maintain optimal blood glucose levels and, therefore these individuals were prescribed insulin treatment.

Clinical data indicated a trend towards glycemic control for individuals with risks factors such as cholesterol, the proportion of albumin-creatinine ratio and blood pressure. Future studies should continue to assess glycemic control at the population level as well as evaluate the use of preventive healthcare services people with diabetes use. Periodic national evaluations for glycemic control could serve to implement health services that are tailored to newly diagnosed young adults, this to potentially prevent adverse clinical outcomes. Finally, regarding the utilization of health services, results showed an annual check-up of HbA1c by a doctor has a protective effect with glycemic control. However, this should be done at the time of diagnosis, considering the use of insulin as a first

Table 4
Logistic regression for factors predicting glycemic control (N = 604).

Predictors	B	S.E.	Wald $\chi 2$	OR 95% C.I.	*p*-value
Age	−0.031	0.008	15.876	0.97 (0.95–0.98)	0.000**
Length of diabetes	0.436	0.210	4.309	1.54 (1.02–2.33)	0.038**
On insulin	−1.438	0.227	40.202	0.24 (0.15–0.37)	0.000**
Taking meds and insulin	−1.069	0.334	10.245	0.34 (0.18–0.66)	0.001**
Albumin-creatinine ratio (mg/g)	0.670	0.204	10.763	1.95 (1.31–2.92)	0.001**
Retinopathy	0.142	0.235	0.369	1.15 (0.73–1.83)	0.544
See a doctor for DM	−0.451	0.241	3.499	0.63 (0.40–1.02)	0.061
Doctor checked HbA1C[a]	0.621	0.243	6.540	1.86 (1.16–2.99)	0.011**
Constant	4.876	0.736	43.889	131.168	

Note: **p < .05. S.E = Standard error.
See doctor for DM: Within the last 12-months; glycemic control was measured 0 (Optimal HbA1c = ≤7%) and 1 (suboptimal HbA1c= >8%).
[a] Within 12-months; DM: Diabetes Mellitus.

means to control diabetes as soon as it is diagnosed.

References

[1] Rowley WR, Bezold C, Arikan Y, Byrne E, Krohe S. Diabetes 2030: insights from yesterday, today, and future trends. Popul Health Manag 2017;20(1):6–12. https://doi.org/10.1089/pop.2015.0181.

[2] Diabetes Home. Centers for disease control and prevention. Published October 10, https://www.cdc.gov/diabetes/about/index.html. [Accessed 3 December 2018].

[3] Papatheodorou K, Banach M, Bekiari E, Rizzo M, Edmonds M. Complications of diabetes 2017. Journal of Diabetes Research 2018:3086167. https://doi.org/10.1155/2018/3086167.

[4] Wojciechowska J, Krajewski W, Bolanowski M, Kręcicki T, Zatoński T. Diabetes and cancer: a review of current knowledge. Exp Clin Endocrinol Diabetes: Official Journal, German Society of Endocrinology [and] German Diabetes Association. 2016;124(5):263–75. https://doi.org/10.1055/s-0042-100910.

[5] Nanayakkara N, Ranasinha S, Gadowski AM, et al. Age-related differences in glycaemic control, cardiovascular disease risk factors and treatment in patients with type 2 diabetes: a cross-sectional study from the Australian National Diabetes Audit. BMJ Open 2018;8(8):e020677. https://doi.org/10.1136/bmjopen-2017-020677.

[6] National Diabetes Statistics Report | Data & Statistics | Diabetes | CDC. Centers for disease control and prevention. https://www.cdc.gov/diabetes/data/statistics-report/index.html. [Accessed 15 July 2019].

[7] Urakami T. Increased trend in the incidence of diabetes among youths in the USA during 2002-2012. J. Diabetes Investig 2017;8(6):748–9. https://doi.org/10.1111/jdi.12715.

[8] Dubowitz N, Xue W, Long Q, et al. Aging is associated with increased HbA1c levels, independently of glucose levels and insulin resistance, and also with decreased HbA1c diagnostic specificity. Diabet Med: J. Br. Diabetic Assoc 2014;31(8):927–35. https://doi.org/10.1111/dme.12459.

[9] Bersoux S, Cook CB, Kongable GL, Shu J. Trends in glycemic control over a 2-year period in 126 US hospitals. J Hosp Med 2012;8(3):121–5. https://doi.org/10.1002/jhm.1997.

[10] Suh D-C, Choi I-S, Plauschinat C, Kwon J, Baron M. Impact of comorbid conditions and race/ethnicity on glycemic control among the US population with type 2 diabetes, 1988–1994 to 1999–2004. J Diabetes Complicat 2010;24(6):382–91. https://doi.org/10.1016/j.jdiacomp.2009.07.001.

[11] Zipf G, Chiappa M, Porter KS, Ostchega Y, Lewis BG, Dostal J. National health and nutrition examination survey: plan and operations, 1999-2010. Vital Health Stat Ser 1 Programs Collect Proced 2013;56:1–37. https://www.ncbi.nlm.nih.gov/pubmed/25078429. [Accessed 2 July 2019].

[12] National Glycohemoglobin Standardization Program. http://www.ngsp.org. [Accessed 2 July 2019].

[13] NHANES 2013-2014 Glycohemoglobin. Whole Blood. 1–37, https://wwwn.cdc.gov/nchs/data/nhanes/20132014/labmethods/GHB_H_MET_GLYCOHEMOGLOBIN.pdf. [Accessed 2 July 2019].

[14] Blaum CS, Cigolle CT, Boyd C, et al. Clinical complexity in middle-aged and older adults with diabetes. Med Care 2010;48(4):327–34. https://doi.org/10.1097/mlr.0b013e3181ca4035. *with diabetes. Medical Care*. 2010;48(4):327-334. doi:10.1097/mlr.0b013e3181ca4035.

[15] Kakade AA, Mohanty IR, Rai S. Assessment of factors associated with poor glycemic control among patients with Type II Diabetes mellitus. Integrative Obesity and Diabetes 2018;4(3):1–6. https://doi.org/10.15761/iod.1000209.

[16] American Diabetes Association. Glycemic targets: standards of medical care in diabetes 2018. Diabetes Care 2018;41(Suppl. 1):S55–64. https://doi.org/10.2337/dc18-S006.

[17] Mansari AA, Obeid Y, Islam N, et al. GOAL study: clinical and non-clinical predictive factors for achieving glycemic control in people with type 2 diabetes in real clinical practice. BMJ Open Diabetes Research & Care 2018;6(1):1–10. https://doi.org/10.1136/bmjdrc-2018-000519.

[18] Nathan DM, Buse JB, Davidson MB, et al. Medical management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy: a consensus statement of the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care 2009;32(1):193–203. https://doi.org/10.2337/dc08-9025.

[19] Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med 1993;329:977–86. https://doi.org/10.1056/NEJM199309303291401.

[20] Onosode NCDC. Survey shows age-related variability in diabetes management. EndocrineWeb. https://www.endocrineweb.com/professional/diabetes-complications/cdc-survey-shows-age-related-variability-diabetes-management. [Accessed 2 July 2019].

[21] Puente JB-DL, Mata Cases M, Franch Nadal J, et al. Older type 2 diabetic patients are more likely to achieve glycaemic and cardiovascular risk factors targets than younger patients: analysis of a primary care database. Int J Clin Pract 2015;69(12):1486–95. https://doi.org/10.1111/ijcp.12741.

[22] Tong WT, Vethakkan SR, Ng CJ. Why do some people with type 2 diabetes who are using insulin have poor glycaemic control? A qualitative study. BMJ Open 2015;5(1):1–9. https://doi.org/10.1136/bmjopen-2014-006407.