Associations Between Features of Glucose Exposure and A1C

The A1C-Derived Average Glucose (ADAG) Study

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OBJECTIVE—Various methods are used to quantify postprandial glycemia or glucose variability, but few have been compared and none are standardized. Our objective was to examine the relationship among common indexes of postprandial glycemia, overall hyperglycemia, glucose variability, and A1C using detailed glucose measures obtained during everyday life and to study which blood glucose values of the day provide the strongest prediction of A1C.

RESEARCH DESIGN AND METHODS—In the A1C-Derived Average Glucose (ADAG) study, glucose levels were monitored in 507 participants (268 type 1 diabetic, 159 type 2 diabetic, and 80 nondiabetic subjects) with continuous glucose monitoring (CGM) and frequent self-monitoring of blood glucose (SMBG) during 16 weeks. We calculated several indexes of glycemia and analyzed their intercorrelations. The association between glucose measurements at different times of the day (pre- and postprandial) and A1C was examined using multiple linear regression.

RESULTS—Indexes of glucose variability showed strong intercorrelation. Among postprandial indexes, the area under the glucose curve calculated from CGM 2 h after a meal correlated well with the 90-min SMBG postprandial measurements. Fasting blood glucose (FBG) levels were only moderately correlated with indexes of hyperglycemia and average or postprandial glucose levels. Indexes derived with SMBG strongly correlated with those from CGM. Some SMBG time points had a stronger association with A1C than others. Overall, preprandial glucose values had a stronger association with A1C than postprandial values for both diabetes types, particularly for type 2 diabetes.

CONCLUSIONS—Indexes of glucose variability and average and postprandial glycemia intercorrelate strongly within each category. Variability indexes are weakly correlated with the other categories, indicating that these measures convey different information. FBG is not a clear indicator of general glycemia. Preprandial glucose values have a larger impact on A1C levels than postprandial values. *Diabetes* 59:1585–1590, 2010

New treatment regimens and guidelines have increasingly focused on postprandial hyperglycemia as an additional target beyond average glucose control (1). However, direct evidence for an effect of specifically controlling postprandial glucose (PPG) and glucose excursions (over and above the effect of reducing average glucose levels on long-term diabetes complications) is limited. The current debate about whether postprandial hyperglycemia and excessive glucose variability are associated with an increased risk of diabetes complications is largely based on epidemiological studies (2–6). Many of these findings (2,4–6) are based on an extrapolation of glucose levels 2 h after an oral glucose tolerance test (OGTT) as a model for the postprandial state rather than on "real-life" PPG measurements. Only a few studies (4,7,8) have also measured the effect of A1C for comparison, and these show conflicting results.

Studies examining PPG control use various methods to quantify PPG, overall hyperglycemia, and glucose variability (9), without any standardization of methods. One approach to assess the role of PPG has been to examine the extent to which it contributes to overall glucose exposure, measured as A1C (10–13). Limited evidence suggests that postprandial glycemia is the dominant contributor to overall hyperglycemia in patients with good to moderate glycemic control (A1C <8.5%), while fasting glucose levels represent the major contributor at higher A1C levels (14). These findings have been used to support the need to measure and treat PPG in order to reach clinical guideline levels of A1C (15,16). Measures of nocturnal glycemia are rarely used in the prediction of A1C. Available literature exploring the nocturnal glucose exposure is sparse and mostly focused on nocturnal hypoglycemia or assessment of glucose variability during glucose-lowering therapies.

Our aim was to examine the relationship among the most commonly used indexes of PPG, overall hyperglycemia, glucose variability, nocturnal glycemia, and A1C using glucose measures obtained during everyday activities from the A1C-Derived Average Glucose (ADAG) study. Additionally, we studied which blood glucose value(s) of the day provide the strongest prediction of mean blood glucose, as measured by A1C, especially focusing on pre- and postprandial glucose contributions to mean blood glucose levels.

RESEARCH DESIGN AND METHODS

The ADAG study was conducted at 10 centers in the U.S., Europe, and Africa from 2006 to 2008 to define the relationship between A1C and average glucose

levels. A full description of the study has been published (17). A total of 268 individuals with type 1 diabetes, 159 individuals with type 2 diabetes, as well as 80 nondiabetic control subjects (aged 18–70 years) completed the study. Participants were selected based on stable glycemic control as evidenced by two A1C values within one percentage point of each other in the 5 months prior to recruitment. Individuals with a wide range of A1C levels were included. The nondiabetic control subjects had a plasma glucose level ≤5.4 mmol/l (97 mg/dl) after overnight fasting, A1C levels <6.5%, and no history of diabetes or use of antidiabetes medication. The study was approved by the human studies ethical committees at the participating institutions, and informed consent was obtained from all participants.

Measurements of glycemia. During the study period, levels of glucose concentrations were assessed through three different methods. Continuous interstitial glucose monitoring (Medtronic Minimed, Northridge, CA) was performed four times with 4-week intervals during the 16-week study period. Monitoring periods lasted at least 48 h, during which time glucose levels were assessed every 5 min. Continuous glucose monitoring (CGM) data were accepted for analysis if there were no gaps longer than 120 min and if the mean absolute difference with the Hemocue calibration results was <18%, as recommended by the manufacturer.

For calibration purposes, and for measurement of pre- and postprandial glycemia, participants performed an eight-point self-monitoring of blood glucose (SMBG) profile (preprandial, 90 min postprandial, bedtime, and 3:00 A.M.) with the HemoCue meter (Hemocue Glucose 201 Plus; Hemocue, Ängelholm, Sweden) during the days of CGM. In addition, during the weeks when CGM was not performed, subjects performed a seven-point SMBG (the same as the eight-point profile above without the 3:00 A.M. measurement) (OneTouch Ultra; LifeScan, Milipitas, CA) for at least 3 days per week.

All blood glucose values stated are plasma equivalents. Blood samples were analyzed for A1C levels with four different Diabetes Control and Complications Trial–aligned assays: a high-performance liquid chromatography assay, two immunoassays, and an affinity assay (all approved by the National Glycohemoglobin Study Program). The mean value at the end of the 12-week study period was used (17).

Calculated indexes of glycemia. Indexes of glucose variability and postprandial glucose levels were calculated from the glucose monitoring data. The average blood glucose and SD were calculated based on CGM data and the seven-point SMBG (LifeScan) data. A combined average blood glucose was calculated from CGM and SMBG, weighted by the days of monitoring for each. Indexes based on CGM were calculated after exclusion of the initial 2 h of monitoring, which is considered to be an unstable calibration period.

Two indexes of intraday glucose variability were calculated based on CGM: the mean amplitude of glycemic excursions (MAGE) and the continuous overlapping net glycemic action (CONGA). MAGE is the mean of the differences between consecutive peaks and nadirs, only including changes of >1 SD of glycemic values and thus capturing only major fluctuations (18,19). For the calculation of $CONGA_n$, the difference of the current observation and the observation n hours previously is calculated for each observation after the first n hours. The $CONGA_n$ is the SD of these differences (19). We analyzed CONGA for 1, 2, and 4 h. Both high MAGE and CONGA values indicate high intraday glucose variability.

As an indicator of overall hyperglycemia, the 24-h cumulative exposure to glucose levels above different thresholds was calculated as the area under the curve (AUC) of CGM above levels of 7.0, 11.1, and 16.7 mmol/l (or 126, 200, and 300 mg/dl, respectively). This was done for the first 24 h of each CGM period after the initial calibration period. Indexes of nocturnal blood glucose were calculated as the mean blood glucose from the CGM period 6 h prior to the fasting blood glucose (FBG) measurement. Furthermore, for each individual, a mean of all 3:00 A.M. SMBGs (HemoCue) was calculated. Also from CGM, a postprandial AUC (AUC_{pp}) was calculated for periods of 2 or 4 h after a meal (without blood glucose thresholds), and the postprandial increment was calculated from the preprandial glucose level to the highest peak for periods of 2 or 4 h after a meal. Finally, pre- and postprandial measurements from SMBG (HemoCue) were used to calculate mean pre- and postprandial blood glucose, as well as pre- and postbreakfast, lunch, and dinner values. The prebreakfast blood glucose was used as the FBG.

Statistical analyses. The Pearson correlation coefficient (r) was computed for each pair of glycemic indexes. This was done including only the diabetic population, as the measurements from nondiabetic participants inflate the correlations. Scatterplots of all pairs are presented with an indicator of the Pearson correlation coefficient (r).

A1C was modeled by multiple linear regression using SMBG measurements at different times of the day as explanatory variables. The association to A1C was examined in three separate analyses, including glucose before and after main meals, mean of all pre- and postmeal glucose measures, and adding nocturnal (3:00 A.M.) SMBG. These models were fitted for all individuals with diabetes and separately for type 1 and type 2

diabetes treated with and without insulin. We defined the proportion of A1C variation (SD) explained by each model as the difference between the A1C SD for each subgroup and the residual SD of the model divided by the SD.

RESULTS

Glucose monitoring in the ADAG study was completed by 507 participants. Approximately 2,700 glucose values from each participant were available for analysis. We excluded 10 nondiabetic participants from the analyses of average SMBG and SDs due to missing LifeScan measurements and 1 participant with type 1 diabetes due to erroneous, extreme HemoCue measurements of pre- and postprandial values.

Characteristics of the study population are summarized in Table 1. A1C levels were higher among those with type 1 diabetes (7.3 vs. 6.8% for type 2 diabetes, $P < 0.01$). Also, the degree of variability, expressed as the SD of the CGM or SMBG measurements and the calculated MAGE and CONGA, was higher among individuals with type 1 diabetes compared with those with type 2 diabetes or nondiabetic individuals ($P < 0.01$).

As an indicator of overall hyperglycemia, the 24-h cumulative exposure to glucose levels above selected glucose thresholds was calculated as the AUC of glucose (AUC [in hours × mmol/l]) by subgroups defined by type of diabetes and, for type 2 diabetes, insulin therapy. In each subgroup, a different proportion of participants reached each respective threshold at least at some point during the CGM period. While >80% of those with type 1 diabetes and 63% of those with type 2 diabetes on insulin treatment reached a level of 16.7 mmol/l (300 mg/dl), only 31% of those with type 2 diabetes without insulin treatment did so. One individual without diabetes reached this level briefly. (These results can be seen in the online appendix Table, available at http://diabetes.diabetes journals.org/cgi/content/full/db09-1774/DC1).

The relationship between the different indexes of glycemia is illustrated in pairwise scatterplots in Fig. 1 (and in an extended online appendix Fig. 2). Although the different indexes were strongly correlated within each category, some indexes do capture somewhat different information. All glucose variability indexes calculated from CGM were closely correlated. CONGA analyses for 1, 2, and 6 h correlated to $CONGA_{4h}$ with correlation coefficients of 0.94, 0.98, and 0.99, respectively (data not shown). $CONGA_4$ and CGM SD (not shown) were both strongly correlated with MAGE ($r = 0.95$). The SMBG variability index (SD) correlated with the CGM indexes MAGE, the CGM SD, and the $CONGA_4$, with coefficients of 0.83, 0.86, and 0.83, respectively. The variability measures did not correlate well with the postprandial measurements or indexes of fasting or average glycemia (illustrated in Supplemental Fig. 2 in the online appendix). The postprandial indexes calculated from CGM 2 or 4 h after meal, AUC_{pp2} and AUC_{pp4}, were strongly correlated ($r = 0.97$) and correlated well with the SMBG postprandial measurements ($r = 0.92$ and 0.89, respectively) (only AUC_{pp2} is shown). The postprandial increment, from preprandial blood glucose level to highest blood glucose peak within a 2- or 4-h postprandial window, did not correlate well with any other measure. The correlation coefficients with SMBG postprandial measurements were as low as 0.51. The nocturnal blood glucose mean from CGM and the self-monitored 3:00 A.M. "random" night blood glucose correlated by a correlation coefficient of 0.83.

TABLE 1
Clinical and glycemic characteristics

	All	Type 1 diabetes	Type 2 diabetes	No diabetes
n	507	268	159	80
Age (years)	47.6 ± 13.6	44.1 ± 12.9	56.6 ± 9.4	41 ± 13.8
Sex (% female)	54	52	51	69
Ethnicity (% Caucasian)	82	91	74	68
BMI (kg/m^2)				
Female	28.1 ± 7	26.3 ± 4.7	32.7 ± 8.7	25.9 ± 5.5
Male	27.6 ± 5.1	26.1 ± 3.4	30.8 ± 6.2	25 ± 3.3
Treatment with insulin	65	100	38	0
A1C (%)	6.8 ± 1.3	7.3 ± 1.1	6.8 ± 1.1	5.2 ± 0.3
FBG (mmol/l)	7.8 ± 2.4	8.5 ± 2.5	7.8 ± 2.1	5.3 ± 0.6
Average blood glucose (mmol/l)	8.3 ± 2.2	9 ± 2	8.3 ± 2	5.6 ± 0.4
CGM average (mmol/l)	8.5 ± 2.2	9.3 ± 2	8.5 ± 2	5.8 ± 0.6
SMBG average (mmol/l)	8.2 ± 2.2	8.9 ± 2.1	8.3 ± 2	5.5 ± 0.5
Nocturnal measures				
Mean 3:00 A.M. SMBG (mmol/l)	8.1 ± 2.7	9.2 ± 2.7	7.6 ± 2.3	5.6 ± 0.7
Mean nocturnal blood glucose CGM (mmol/l)	8.0 ± 2.3	8.9 ± 2.3	7.8 ± 2.1	5.6 ± 0.6
Prandial measures				
Preprandial SMBG (mmol/l)	7.7 ± 2.1	8.4 ± 2	7.6 ± 1.9	5.4 ± 0.5
Postprandial SMBG (mmol/l)*	9 ± 2.4	9.7 ± 2.1	9.4 ± 2.2	6.1 ± 0.7
AUC$_{pp}$ 2-h CGM (h/mmol/l)	17.6 ± 4.5	19.1 ± 4.1	17.8 ± 4	12 ± 1.4
PPG increment 2-h CGM (mmol/l)†	2.8 ± 1.4	3.4 ± 1.2	2.7 ± 1.2	1.2 ± 0.5
Variability measures				
CGM SD (mmol/l)	2.7 ± 1.4	3.6 ± 0.9	2.2 ± 0.9	0.8 ± 0.2
SMBG SD (mmol/l)§	3.2 ± 1.5	4.1 ± 1	2.6 ± 1	1.1 ± 0.4
MAGE (mmol/l)	4.8 ± 2.4	6.4 ± 1.8	3.8 ± 1.5	1.4 ± 0.5
CONGA$_4$ (mmol/l)	3.7 ± 1.9	4.9 ± 1.3	2.9 ± 1.2	1 ± 0.3

Data are means $\pm$ SD or percent. Glucose values are expressed as plasma equivalent mmol/l. *Defined as mean of 90-min postprandial self-monitored glucose levels. †Defined as the increment from the preprandial blood glucose to highest peak 2-h postprandially. §Defined as the SDs of all self-monitored blood glucose.

Table 2 shows the effects of specific SMBG of the day on A1C levels. Among participants with type 1 diabetes, prebreakfast, prelunch, and postlunch blood glucose measurements had the largest effect on A1C. Among participants with type 2 diabetes, prebreakfast, postlunch, and predinner values had the largest effects on A1C, regardless of insulin treatment. In general, the mean of all preprandial values predicted A1C better than the mean of all postprandial values among those with either type of diabetes both before and after adding nocturnal blood glucose to the model (statistical significant difference [$P < 0.05$] for the total diabetic group but not for diabetic subgroups or the nondiabetic group). The proportion of A1C variation (SD) explained by the glucose features of each model can be seen in Table 2 and can be compared with variation explained by average blood glucose. Adding a nocturnal glucose index (3:00 A.M. SMBG) only minimally increased the proportion of variation explained.

DISCUSSION

Based on frequent glucose monitoring during usual daily activities, we found, in a large set of individuals with type 1 diabetes, type 2 diabetes, or those without diabetes, that many of the commonly used indexes of glycemic variability, average glycemia, and postprandial glycemia were strongly correlated within each category. Indexes of glucose variability (CONGA, SD of CGM or SMBG, and MAGE) were especially highly correlated. These findings indicate that the different methods of characterizing glucose variability tend to convey similar information.

The putative roles of glucose variability and PPG as risk factors for diabetes complications are based on 1) studies

reporting an association between excessive PPG levels and factors that may lead to development of diabetes complications (20–23), 2) epidemiological studies associating 2-h post-OGTT values with increased mortality and cardiovascular disease (2–5), and 3) a few clinical trials in very specific subgroups (e.g., pregnant women [24] and individuals with impaired glucose tolerance [25] or type 2 diabetes post-AMI [26]), which have addressed the issue with different methods and have had conflicting results. The roles of PPG and glucose variability as risk markers need further exploration, and an understanding of the differences and similarities among the different measures of PPG, overall hyperglycemia, and glucose variability is critical.

MAGE (18) has previously been described as the gold standard with which to measure variability (19,27). Our findings show that CONGA or the "simple" SD captures variability to a very similar degree as MAGE. Regarding the methods to assess PPG, we found that the postprandial AUC from CGM 2 h after a meal correlates well with SMBG postprandial measurements, with a correlation coefficient of 0.92. This suggests that a routine 90-min postprandial SMBG measurement contains much of the information about the glucose curve in the hours after a meal. The ADAG study also showed that seven-point profile SMBG levels, measured on average 3 days per week, and CGM, measured on 2 days per month, both over a 3-month period, predict average glucose and A1C similarly (17).

The postprandial increment in glucose levels (the difference from preprandial to highest postprandial value in a 2-h window) showed generally weak correlations with postprandial blood glucose levels ($r = 0.45$–0.51) and with
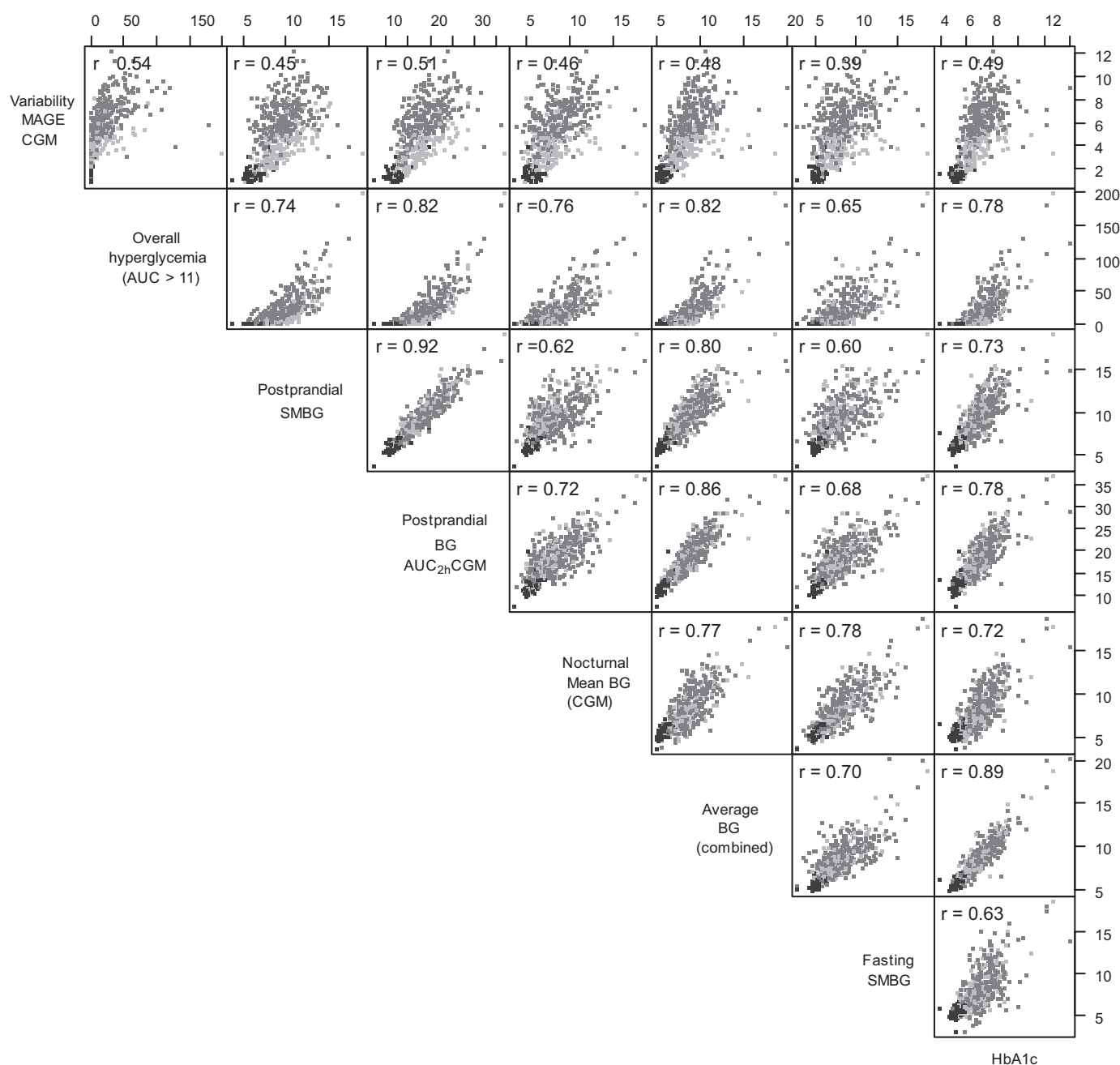
FIG. 1. Pairwise scatter diagrams illustrating selected correlations of glycemic variables with Pearson correlation coefficients (r) for each pair of indexes (not including data for no diabetes), highlighting the different participant subgroups with different shades (type 1 diabetes, dark gray; type 2 diabetes, light gray; and no diabetes, black).

indexes of average glycemia ($r = 0.26–0.27$). Postprandial increments have been used to assess glucose variability and PPG in other studies (14,28). The difference between the calculated increments (from CGM) and the difference between the pre- and postprandial measurements from SMBG (Table 1) might be because the latter is measured by the participant ~90 min after eating (not necessarily capturing the highest postprandial value). One might expect large postprandial increments to reflect high glucose variability; however, the correlation with the variability measures was also only moderate ($r =$ from 0.41 [SMBG SD] to 0.54 [CONGA$_4$]).

As expected, A1C correlated well with average blood glucose from CGM, SMBG, and the two combined. When exploring the contribution of glucose levels from SMBG at

different times of the day to average glycemia (Table 3), the preprandial glucose levels had a larger effect on A1C than postprandial glucose levels, presumably because they resemble the 24-h glucose levels (and thus the long-term exposure to glucose) more closely. This result was the same before and after including the nocturnal blood glucose index to the regression model, which, surprisingly, only lead to a small increase in the proportion of A1C variation explained.

The frequently cited article by Monnier et al. (14) concludes that postprandial glucose levels are the dominant contributor to A1C levels in patients with A1C <8.5%, while fasting glucose levels were the major contributor for patients with A1C >8.5%. The calculations underpinning this conclusion were based on AUCs derived from meal-

TABLE 2
Effects of specific glucose measurements and A1C in three multiple linear regression models

	All diabetes ($n = 427$)	Type 1 diabetes ($n = 268$)	Type 2 diabetes ($n = 99$) Non–insulin-treated	Type 2 diabetes ($n = 60$) Insulin-treated
A				
Prebreakfast	0.122 (0.086–0.157)*	0.107 (0.065–0.149)*	0.116 (0.031–0.201)*	0.179 (0.088–0.270)*
Postbreakfast	0.020 (−0.011 to 0.050)	0.000 (−0.37 to 0.038)	0.029 (−0.035 to 0.093)	0.078 (0.008–0.148)*
Prelunch	0.097 (0.059–0.134)*	0.130 (0.086–0.175)*	0.055 (−0.053 to 0.164)	0.002 (−0.088 to 0.091)
Postlunch	0.108 (0.071–0.145)*	0.120 (0.077–0.164)*	0.092 (−0.009 to 0.192)	0.103 (0.015–0.191)*
Predinner	0.093 (0.058–0.128)*	0.053 (0.012–0.095)*	0.085 (−0.034 to 0.204)	0.140 (0.052–0.229)*
Postdinner	0.052 (0.018–0.085)*	0.077 (0.037–0.117)*	0.066 (−0.021 to 0.153)	−0.012 (−0.109 to 0.085)
A1C variation explained†	41%	39%	49%	43%
B				
All preprandial	0.315 (0.267–0.362)*	0.288 (0.227–0.349)*	0.259 (0.164–0.354)*	0.340 (0.207–0.473)*
All postprandial	0.167 (0.123–0.211)*	0.186 (0.129–0.242)*	0.177 (0.094–0.259)*	0.134 (0.024–0.245)*
Difference pre-/postprandial‡	$P < 0.01$	$P = 0.07$	$P = 0.34$	$P = 0.08$
A1C variation explained†	40%	37%	48%	38%
C				
All preprandial	0.257 (0.204–0.310)*	0.244 (0.178–0.310)*	0.136 (0.004–0.268)*	0.312 (0.176–0.447)*
All postprandial	0.163 (0.120–0.206)*	0.183 (0.128–0.239)*	0.182 (0.102–0.262)*	0.106 (−0.008 to 0.220)
Nocturnal SMBG	0.071 (0.040–0.102)*	0.060 (0.022–0.098)*	0.117 (0.027–0.207)*	0.069 (−0.019 to 0.156)
Difference pre-/postprandial[1]	$P = 0.04$	$P = 0.28$	$P = 0.64$	$P = 0.07$
A1C variation explained†	41%	38%	50%	39%
A1C variation explained by average blood glucose§	53%	51%	56%	53%

Data are β coefficients (in % A1C per mmol/l) from multiple linear regression models (95% CI), unless otherwise indicated. A: model including mealtime measurements. B: model including mean of all pre- and postprandial values. C: model with both prandial and nocturnal blood glucose. *P value for estimates <0.05. †The proportion of A1C variation (SD) explained by the glucose features of each model. ‡P values from test of difference between pre- and postprandial estimates. §For comparison, the A1C variation explained by average blood glucose is illustrated.

period measurements only, thus disregarding the contribution of glucose exposure outside meal periods to A1C.

Monnier et al. (14) define postprandial glycemia as the AUC above each individual's fasting value, while preprandial glycemia is defined as the AUC between 6.1 mmol/l (110 mg/dl) and measured FBG for each individual. This approach introduces a bias when comparing the association between these two indexes and A1C. Individuals with A1C levels >8.5% will strongly tend to also have high FBG. Their postprandial AUC values will therefore be small by artifact, as only excursions above these high individual FBG values are considered postprandial glucose exposure. Simultaneously, Monnier et al.'s definition yields larger preprandial AUCs in this same group, thus introducing the reported effect. This methodological problem might explain why Monnier et al.'s results differ from our findings and those of others (12,29).

Our study shows that no single blood glucose measurement during the day accurately predicts A1C. This is in accordance with previous studies (29–31) showing that single or limited numbers of blood glucose measurements daily do not accurately reflect A1C levels. However, any insights into the specific timed glucose measurement or combination of measurements that have the largest effect on A1C can help patients and clinicians to plan optimal glucose-monitoring regimens.

Levels of FBG alone were not clear indicators of overall hyperglycemia. The correlation coefficients to indexes of hyperglycemia and average or postprandial blood glucose levels are between 0.60 and 0.70 in the present study. This adds to previous findings (30,31) showing that A1C and postchallenge blood glucose are difficult to predict from FBG values alone. Bouma et al. (30) found a correlation

coefficient of 0.77 between A1C and FBG in 1,020 individuals with type 2 diabetes.

This study is based on frequent glucose monitoring during real-life activities in a large, heterogeneous population of people with diabetes and those without diabetes and provides the opportunity to assess reliably the different features of glycemia. The limitations of the study are that the ADAG study population was selected to exclude patients with severe renal/liver disease, pregnancy, and anemia. Therefore, the results may not be extrapolated to all patients with diabetes. However, patients were chosen to span a large range of A1C levels. Moreover, the ADAG study recruited a broad multicenter population, so we feel it is justifiable to draw general conclusions from our results.

The fact that participants had stable A1C (<1% A1C change 6 months prior to study) could have lead to underestimation of glucose variability. However, high levels of glucose variability were seen among our subjects despite stable A1C levels. Even though type 1 diabetes and type 2 diabetes have different glucose patterns due to different disease mechanisms, the mechanism of hemoglobin glycation is likely to be the same. The correlation of the glycemic indexes were therefore calculated for the combined group. Limitations of the MiniMed CGM system include the inability to measure glucose values <2.2 mmol/l (40 mg/dl) or >22.2 mmol/l (400 mg/dl) (measurements outside this range were treated as 2.2 or 22.2 mmol/l, respectively, for the analyses). The mean FBG is derived from prebreakfast measurements and thus can contain blood glucose not preceded by 8 h of fasting.

In summary, the role of glucose excursions and postprandial glycemia in day-to-day diabetes control and risk

management is still debated. We found relatively weak correlations between variability indexes and indexes of fasting, postprandial, and mean glycemia, indicating that the variability indexes convey different information. Fasting glucose values had only a moderate correlation with other indexes, confirming that it is not a clear indicator of general glycemia. The mean of all preprandial glucose levels had a larger impact on A1C levels than postprandial glucose levels in type 1 and type 2 diabetic patients.

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