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Revisit Frequency and Its Association with Quality of Care among Diabetic Patients: Translating Research Into Action for Diabetes (TRIAD)

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Abstract

Objective—To describe patient and provider characteristics associated with outpatient revisit frequency and to examine the associations between the revisit frequency and the processes and intermediate outcomes of diabetes care.

Research Design and Methods—We analyzed data from Translating Research Into Action for Diabetes (TRIAD), a prospective, multicenter, observational study of diabetes care in managed care.

Results—Our analysis included 6,040 eligible adult participants with type 2 diabetes (42.6% 65 years of age, 54.1% female) whose primary care providers were the main provider of the participants' diabetes care. The median (interquartile range) revisit frequency was 4.0 (3.7, 6.0) visits per year. Being female, having lower education, lower income, more complex diabetes treatment, cardiovascular disease, higher Charlson comorbidity index, and impaired mobility were associated with higher revisit frequency. The proportion of participants who had annual assessments of HbA1c and LDL-cholesterol, foot examinations, advised or documented aspirin use, and influenza immunizations were higher for those with higher revisit frequency. The proportion of participants who met HbA1c (<9.5%) and LDL-cholesterol (<130 mg/dL) treatment

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AUTHOR CONTRIBUTIONS

K.A. researched data, and drafted and edited the manuscript. L.N.M. and W.H.H. assisted with the data analysis, contributed to the discussion, and reviewed/edited the manuscript. J.C.C., and B.W. contributed to the discussion and reviewed/edited the manuscript.

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goals was higher for those with a higher revisit frequency. The predicted probabilities of achieving more aggressive goals, HbA1c <8.5%, LDL-cholesterol <100 mg/dL, and blood pressure <130/85 or even <140/90 mmHg were not associated with higher revisit frequency.

Conclusions—Revisit frequency was highly variable and was associated with both sociodemographic characteristics and disease severity. A higher revisit frequency was associated with better processes of diabetes care, but the association with intermediate outcomes was less clear.

Although the American Diabetes Association clinical practice guidelines recommend specific intervals for diabetes-related preventive services (American Diabetes Association, 2013), little is known about the optimal frequency of outpatient visits. Excessive revisits may unnecessarily increase resource utilization, while inappropriately infrequent revisits may compromise clinical care. Previous reports have demonstrated that the physician-recommended revisit intervals for common diseases are highly variable (K. DeSalvo, Block, Muntner, & Merrill, 2003; K. B. DeSalvo, Bowdish, Alper, Grossman, & Merrill, 2000; Morrison, Shubina, & Turchin, 2011; Petitti & Grumbach, 1993; Schwartz, Woloshin, Wasson, Renfrew, & Welch, 1999; Tobacman, Zeitler, Cilursu, & Mori, 1992; Welch, Chapko, James, Schwartz, & Woloshin, 1999), although providers tend to agree on the revisit interval for patients with severe conditions, such as high blood pressure or high serum glucose values, or acute conditions, such as cellulitis (Tobacman et al., 1992). Visits that involve ordering tests and changing therapy are followed by a shorter revisit interval than visits not involving these activities (K. B. DeSalvo et al., 2000). Provider characteristics are also important predictors of the revisit interval (K. DeSalvo et al., 2003; Schwartz et al., 1999). Family medicine compared to internal medicine physicians recommended shorter revisit intervals (Petitti & Grumbach, 1993). Female physicians recommended a shorter revisit interval in some studies (K. DeSalvo et al., 2003; K. B. DeSalvo et al., 2000) but not consistently (Petitti & Grumbach, 1993). Revisit intervals clustered within groups of providers who practice at the same facility (Welch et al., 1999).

To date, there are no randomized trials to determine the ideal revisit interval and other studies have had mixed findings with regard to the relationship between revisit interval and health outcomes. One such study showed that frequent outpatient encounters decreased the time required to achieve treatment goals for blood pressure (BP), cholesterol, and glucose control among patients with diabetes mellitus (Morrison et al., 2011). Another study found higher revisit frequency associated with a lower BP but not lower cholesterol in cardiac patients (Redfern, Menzies, Briffa, & Freedman, 2010), while an intervention study found that longer revisit intervals were not associated with deteriorated diabetes outcomes (Schechtman et al., 2005). These previous studies have been limited by their focus on physicians in training (K. B. DeSalvo et al., 2000), being set within health care systems with limited scope (Morrison et al., 2011; Schechtman et al., 2005; Welch et al., 1999), the use of hypothetical scenarios (K. B. DeSalvo et al., 2000; Petitti & Grumbach, 1993), or relatively small sample sizes (K. DeSalvo et al., 2003; Schwartz et al., 1999; Welch et al., 1999).

We analyzed data from a large, multicenter, prospective observational study of diabetes care in managed care, Translating Research Into Action for Diabetes (TRIAD), to describe

patient and provider characteristics associated with revisit frequency in participants with type 2 diabetes and to examine the associations between revisit frequency and both the processes and intermediate outcomes of diabetes care.

RESEARCH DESIGN AND METHODS

Setting and Study Design

TRIAD was a multicenter cohort study examining whether the structural and organizational characteristics of health systems affect the processes and outcomes of diabetes care (TRIAD, 2002). It included six translational research centers, collaborating with 10 health plans serving approximately 180,000 patients with diabetes. TRIAD data collection included patient surveys, chart reviews, clinician surveys, provider group surveys, health plan surveys, and administrative data collected at baseline in 2000–2001. We recruited patients from the health plans if they were 18 years of age or older, community dwelling, English- or Spanish-speaking, and continuously enrolled in one of the health plans for at least 18 months. Participants were not pregnant and had one or more claims for health services during the 18 months before recruitment. We enrolled patients from provider groups that had at least 50 patients with diabetes using stratified random sampling. The institutional review board at each participating site approved the study. For this study, we employed a cross-sectional design using baseline data for this study.

Study Subjects

There were 11,927 participants with diabetes who responded to the survey at baseline. The adjusted response rate (the Council of American Survey Research Organization (CASRO) response rate) was 68%, and the participation rate in contacted eligible patients was 92%. For this analysis, we included participants who had available chart review data, at least one outpatient visit during the 18-month chart review period, and type 2 diabetes, were not bed-bound, and whose primary care providers were the main source of their diabetes care. For the analysis involving provider characteristics, we studied the subset of the eligible participants with type 2 diabetes whose primary care providers at baseline completed the clinician survey conducted at the 18-month after the baseline patient survey.

Revisit Frequency

The medical chart review included a count of the total number of outpatient visits to a primary care provider, nurse practitioner, endocrinologist, or diabetologist during the prior 18 months. This count of outpatient visits excluded telephone encounters, visits to other specialists, emergency room visits, urgent care visits, and visits for laboratory tests, infusions, and influenza immunization or allergy shots. We converted the number of revisits in 18 months to an annual revisit count.

Patient and Provider Characteristics Associated with Revisit Frequency

We assessed a number of patient and provider characteristics for their possible association with revisit frequency. From patient surveys, we determined age, sex, race/ethnicity, education, annual household income, smoking status, co-payment requirement for primary care physicians, diabetes duration, diabetes treatment modality, body mass index (BMI),

presence or absence of diabetic microvascular and neuropathic complications, cardiovascular disease, and self-reported mobility. We calculated the Charlson comorbidity index using medical chart review data. For the subset of participants who could be matched to a provider who completed a clinician survey, we determined the providers' sex, race/ethnicity, specialty (family medicine, general internal medicine, or other), calendar year of internship, total number of patients with type 2 diabetes, availability of a diabetes registry, and the proportion of the providers' compensation not based on fee-for-service.

Quality of Care Measures

To assess diabetes care quality, we evaluated both processes and intermediate outcomes. We used the quality of care measures endorsed by the Diabetes Quality Improvement Project (DQIP) (Fleming et al., 2001) or developed specifically for TRIAD (Kerr et al., 2004) appropriate to the timeframe when the study was conducted. The processes of care included documented tests of hemoglobin A1c (HbA1c), low-density lipoprotein cholesterol (LDL-c), and proteinuria, dilated retinal and foot examinations, aspirin use (advised or documented), and influenza immunization in the past 12 months. We obtained information on HbA1c, LDL-c, and proteinuria testing from chart review; information on foot examinations and influenza immunization from the baseline patient survey, and information on dilated retinal examinations and aspirin use from both the baseline patient survey and chart review.

Intermediate outcomes included the most recent documented HbA1c value categorized as <9.5% or <8.5%, the most recent documented BP categorized as <140/90 mmHg or <130/85 mmHg, and the most recent documented LDL-c categorized as <130 mg/dL or <100 mg/dL in the past 12 months. We obtained information on HbA1c, BP, and LDL-c values from chart reviews. If participants did not have measurements, we recorded the data as missing.

Statistical Analysis

First, we described the characteristics of the eligible participants and of the subset of eligible participants whose providers completed the clinician survey. We assessed the differences in characteristics of patients included and not included in the subset data with chi-square tests.

We then used multi-level linear regression models to assess potential participant characteristics associated with revisit frequency after accounting for the random effects of provider groups and health plans. We log-transformed revisit frequency since the distribution was right-skewed. For each characteristic, we ran a univariate model and then a multivariate model adjusting for all covariates. We estimated the predicted marginal means of revisit frequency (Bieler, Brown, Williams, & Brogan, 2010). We tested the overall statistical significance of each characteristic using the Wald F-statistics and the statistical significance of pairwise comparisons within characteristics using the *t*-statistics. To reduce the effective number of pairwise comparisons, we tested pairwise comparisons for statistical significance only if the characteristics showed overall significance. Similarly, within the subset of participants whose providers completed the clinician surveys, we constructed multi-level linear regression models to determine potential provider characteristics associated with revisit frequency after accounting for random effects of providers and health

plans. We did not include provider groups in the latter models since a provider could belong to multiple provider groups.

To assess the association between revisit frequency and quality of care measures, we used multi-level logistic regression models. We tested the overall statistical significance of each characteristic and of pairwise comparisons within the characteristic. The quartiles of revisit frequency served as the independent variable and the dichotomous quality of care measures (meeting or not meeting the standard of care) were the dependent variables. For each quality of care measure, we first constructed a univariate model and then a multivariate model adjusted for all potential patient characteristics. The models accounted for random effects of provider groups and health plans. We present the results as the predicted marginal prevalence of meeting the quality of care standards for the first quartile (the least frequent revisits) (Bieler et al., 2010). We then present predicated marginal prevalence ratios of meeting the quality of care standards for each second through fourth quartile of the revisit frequency relative to the first quartile (Bieler et al., 2010). We tested the overall statistical significance of each characteristic using the Wald F-statistics and the statistical significance of pairwise comparisons within characteristics using the *t*-statistics. To reduce the effective number of pairwise comparisons, we tested pairwise comparisons for statistical significance only if the characteristics showed overall significance.

Finally, we created three composite quality of care measures by summing the number of indices that met each quality of care measure. The first composite measure was for the processes of care (HbA1c, LDL-c, proteinuria, dilated retinal examinations, foot examinations, aspirin use [advised or documented], and influenza immunizations). The second was for the less aggressive intermediate outcomes of care (the most recent HbA1c <9.5%, the most recent BP <140/90 mmHg, and the most recent LDL-c <130 mg/dL). The third was for the more aggressive intermediate outcomes (the most recent HbA1c <8.5%, the most recent BP <130/85 mmHg, and the most recent LDL-c <100 mg/dL). We present the results as the predicted marginal probability of achieving the quality of care measure from multi-level multinomial regression models after adjusting for all covariates.

All statistical analysis were performed with SAS software version 9.2 (SAS Institute, Cary NC) (SAS Institute Inc., 2008) and SUDAAN 10 (RTI International, Research Triangle Park, NC), which uses generalized estimating equations (GEE) for the parameterization (RTI International, 2001). We defined a Type I error of less 0.05 as being statistically significant.

RESULTS

Participant Characteristics

Among the 11,927 TRIAD participants at baseline, 6,040 (50.6%) met the inclusion criteria and were included in this analysis (Supplemental Figure). Each of the 10 health plans provided a median of 624 (interquartile range [IQR]: 169, 926) participants. There were 71 provider groups represented, each of which provided a median of 42 (IQR: 20, 92) participants. There were 1,850 participants in the subset whose data could be linked to provider characteristics determined from the clinician surveys. There were 687 providers

associated with this subset of participants, and the median number of participants under the care of each provider was 1 (IQR: 1, 3).

The characteristics of the TRIAD participants included in this analysis were quite variable (Table 1). The characteristics of the subset analyzed were significantly different from those not included in the subset: they were younger, more likely to be Asians/Pacific islanders and less likely to be Hispanic, more likely to have a higher education and higher annual household income, more likely to be non-smokers, more likely to have diabetic nephropathy, less likely to have peripheral neuropathy, and less likely to have problems with mobility.

Patient and Provider Characteristics Associated with Revisit Frequency

The revisit frequency distribution was skewed to the right. The geometric mean of the number of revisits per year was 3.8 (95% confidence interval: 3.7 to 3.9), and the 25th, 50th (median), and 75th percentiles of the outpatient revisits per year were 3.7, 4.0, and 6.0, respectively.

At the patient level, the revisit frequency was significantly higher for participants who were 65 years of age or older and who were female. Overall, the effect of race/ethnicity was not statistically significant. Lower levels of education and lower annual household income were significantly associated with higher revisit frequency. Diabetes duration 15 years was significantly associated with higher revisit frequency compared to <5 years and 5 to 15 years. The revisit frequency for participants taking oral anti-diabetic medications was significantly higher than the frequency for those treated with diet alone; and the revisit frequency for those taking insulin with or without oral anti-diabetic medications was significantly higher than for those treated with diet alone or oral anti-diabetic medications. Having a history of diabetic retinopathy, nephropathy, peripheral neuropathy, and cardiovascular disease were associated with higher revisit frequency. A higher Charlson comorbidity index was associated with higher revisit frequency. Participants with self-reported mobility problems had a higher revisit frequency (Table 2).

In multivariate analysis, the association between revisit frequency and age and race/ethnicity did not remain significant. Being a woman, having lower levels of education, lower annual household income, more complex treatment modalities for diabetes, a higher Charlson comorbidity index, and self-reported mobility problems remained significantly associated with a higher revisit frequency even after adjusting for multiple potential confounders. However, a history of any diabetic microvascular or neuropathic complications (retinopathy, nephropathy, or peripheral neuropathy) was no longer associated with revisit frequency, but history of cardiovascular disease was associated with a higher revisit frequency (Table 2).

With respect to provider characteristics, family medicine specialty compared to internal medicine specialty or other specialties, not having a diabetes registry, and having a larger proportion of one's compensation coming from sources other than fee-for-service were associated with a higher revisit frequency using univariate models. Among those characteristics, family medicine specialty compared to internal medicine or other specialties and having no diabetes registry remained significant after adjusting for multiple provider

characteristics. After also adjusting for patient characteristics, however, none of the provider characteristics remained significant (Supplemental Table).

Revisit Frequency and Quality of Care

Both before and after adjustment, the predicted probabilities of meeting each process and intermediate outcome of diabetes care was generally lower for participants in the lowest quartile of revisit frequency compared to the other three quartiles (Table 3). Regarding processes of care, the proportion of the participants who had HbA1c assessments, dilated retinal examinations, proteinuria assessments, LDL-c assessments, foot examinations, aspirin use (advised or documented), and influenza immunizations were significantly different across the quartiles of revisit frequency before adjusting for potential confounders. All but annual proteinuria assessments and foot examinations remained significantly different after adjusting for potential confounders. The proportion of participants who met the various processes of care measures was not significantly different between the third and fourth quartiles except for having had an annual dilated retinal examination. The composite quality of care measures for the processes (Figure 1-a) showed a positive, monotonic association between the quality of care measures and the revisit frequency.

HbA1c, BP, and LDL-c values were available for 5,265 (87%), 4,151 (69%), and 5,706 (94%) participants among 6,040 eligible participants for this analysis. Regarding intermediate outcomes, the predicted probabilities of meeting the goal for HbA1c <9.5% but not the goal <8.5%, and LDL-c <130 mg/dL but not the goal <100 mg/dL, were higher for those who had a higher revisit frequency before adjusting for potential confounders. Only the goal for HbA1c <9.5% remained significantly associated with revisit frequency after adjusting for potential confounders. The predicted probabilities of achieving a BP <130/85 mmHg and 140/90 mmHg were not associated with revisit frequency. The proportion of participants who meet the less aggressive intermediate outcomes were not significantly different between the third and fourth quartiles. The composite quality of care measures for the intermediate outcomes (Figure 1-b and c) showed monotonic positive associations between the intermediate outcomes and the revisit frequency.

CONCLUSIONS

We examined the patient and provider characteristics associated with revisit frequency among patients with type 2 diabetes and the association between revisit frequency and the processes and intermediate outcomes of diabetes care. We found that revisit frequency was highly variable. Both patient and provider characteristics, such as participants' sex, education, household income, treatment modality, history of cardiovascular disease, number of comorbidities, self-reported mobility, and providers' specialty, were associated with revisit frequency. Processes of care measures were more likely to be achieved for participants with a higher revisit frequency. Achieving less aggressive intermediate outcomes of HbA1c <9.5% and LDL-c <130 mg/dL was also associated with a higher revisit frequency but achieving more aggressive goals of HbA1c <8.5% or LDL-c <100 mg/dL was not. Revisit frequency was not associated with the likelihood of meeting the BP goals.

In our analysis, women had a higher revisit frequency than men, even after adjusting for potential confounders, including diabetic complications and comorbidities. It is known that women seek medical attention more often than men (Tabenkin, Goodwin, Zyzanski, Stange, & Medalie, 2004). In our analysis, lower socioeconomic status, indicated by education and annual household income, were independently associated with a higher revisit frequency even after adjusting for potential confounders, including diabetic complications and comorbidities. Debilitating physical conditions might decrease income and require frequent visits. On the other hand, since the predominantly middle-aged participants in this study are not likely to currently be in school, the association between the lower education and frequent outpatient revisits can be better explained by lower competencies of diabetes self-management in participants with lower education. If this is true, managed care systems could help reducing the barrier to higher quality of care for patients with lower competencies of self-management.

Regarding provider characteristics, unlike a previous study (Petitti & Grumbach, 1993), we did not find any difference in the revisit frequency by physicians' gender. We did find a difference based on providers' area of specialty, which is consistent with a previous study (Petitti & Grumbach, 1993). Family medicine providers see their participants with diabetes more often than internal medicine providers or providers with other specialties. This difference remained significant after adjusting for patient characteristics. Therefore, the difference is not fully explained by differences in the characteristics of the patients treated by family medicine and internal medicine primary care providers. Instead, it may be related to providers' training and practice patterns within the specialties.

In our study, a higher revisit frequency was associated with better processes of diabetes care than intermediate outcomes. It is possible that the difference between process and intermediate outcomes results in part from the higher degree of incompleteness in assessing intermediate outcomes. For example, the HbA1c values for participants who did not have an HbA1c measurement could be worse than for those who had HbA1c checked. The pattern of association for meeting the goal HbA1c could have been attenuated because of this incomplete ascertainment of HbA1c values.

We observed a ceiling effect of revisit frequency for most processes and intermediate outcome of diabetes care. As shown in Table 3, even though more processes and intermediate health outcomes of diabetes care were associated with higher revisit frequency, there was no significant difference in quality of care between the third (4 to 6 revisits per year) and fourth (6 revisits or more per year) quartiles of revisit frequency. This suggests that increasing revisit frequency above the third quartile for the population, that is, to 6 revisits or more per year, may not be an effective or cost-effective way to improve process or intermediate outcome of care.

It is also worth noting that achieving less aggressive goals for HbA1c (<9.5%) and LDL-c (<130 mg/dL) were associated with a higher revisit frequency, but more aggressive goals for HbA1c (<8.5%) or LDL-c (<100 mg/dL) were not. A minimum number of revisits may be necessary to get patients to moderate control, but more frequent revisits will not by

themselves get patients to more aggressive levels of HbA1c (<7.0%) or LDL-c (<100 mg/dL) control (American Diabetes Association, 2013).

There are a number of limitations to our study. First, its cross-sectional design prohibits causal inference, particularly in the association between revisit frequency and intermediate outcomes. For example, a provider might recommend frequent revisits for the patient whose diabetes is poorly controlled. However, from our study, we are not certain if increasing revisit frequency would positively influence processes or intermediate outcomes of diabetes care. An interventional trial is the appropriate study design to address this issue. To date, there have been three interventional studies related to prolonging the revisit interval in a primary care setting (Schechtman et al., 2005; Wasson et al., 1992; Welch, Johnson, & Edson, 2000). One of the studies (Schechtman et al., 2005) showed that the revisit interval could be extended without compromising processes and intermediate outcomes after an educational intervention for providers. However, the study compared outcomes before and after the intervention, thus there might be confounders because of the time course (Schechtman et al., 2005). The two additional studies randomized patients to usual care or telephone follow-up and face-to-face revisits at twice the interval of usual care (Wasson et al., 1992; Welch et al., 2000). The results of these studies were inconsistent. Since the optimal revisit interval remains unknown, it may be worth considering a randomized trial to see if revisit intervals for diabetes management can be optimized (Chapko, Fisher, & Welch, 1999).

Second, although we adjusted for many potential confounders, the findings of our study may be affected by unmeasured confounders. One example is in allocation of treatments, including prescriptions for certain medications. The allocation of treatments might be associated with both revisit frequency and quality of care, and thus, the allocation of treatments might confound the association between revisit frequency and quality of care. Another example of possible unmeasured confounders is mobility. Even though we excluded bed-bound patients and accounted for self-reported mobility, various degrees of limited mobility might have had a residual confounding effect.

Third, we calculated the revisit frequency in our study as an average over 12 months but did not have information on actual revisit intervals. Participants might return to clinics very frequently while their diabetes is poorly controlled but return less frequently after they improve. Previous studies have shown that a shorter revisit interval is associated with shorter time to achieve the goal for BP (Morrison et al., 2011; Turchin, Goldberg, Shubina, Einbinder, & Conlin, 2010) and glucose and LDL-c levels (Morrison et al., 2011).

Fourth, in this study, we calculated the revisit frequency from the number of completed visits per year. The actual revisit frequency is likely determined by a provider's recommendation and availability and a patient's preferences and availability. We do not have enough information to discuss the attribution of each component. There is also a possibility that the distribution of the revisit frequency observed in our study is not typical. However, we found that the mean revisit frequency was generally consistent with the revisit frequency reported in a previous publication (Turchin et al., 2010).

Lastly, generalizability might be limited due to the characteristics of the population and the sample size. In this study, we included only participants whose diabetes was under the care of primary care providers. We selected this group of participants because participants who are under the care of endocrinologists or other types of providers may have different characteristics. Thus, the conclusions from this study might have limited generalizability for patients under the care of specialists. In addition, our subset analysis regarding providers' characteristics was based on a relatively small proportion of the participants who were eligible for the main analysis and who differed somewhat from the remaining participants. The number of participants per provider was also small. Although this might negatively impact the precision of our estimation of the associations between provider characteristic's and revisit frequency, it would serve to enhance the generalizability of the estimates. Furthermore, uninsured or under-insured patients might have different patterns of revisit frequency and quality of care measures than insured patients, who were studied in this report.

Given the limited resources available in the primary care setting (Bodenheimer & Pham, 2010) and the high prevalence of type 2 diabetes, it is critical to understand the appropriate revisit frequency to optimize the efficiency of diabetes management. Further longitudinal data analysis and interventional studies will be important to reevaluate this topic.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1-a **Figure 1-b** **Figure 1-c** **Figure 1.**

Predicted marginal probability based on multi-level multinomial regression models. **Figure 1-a (left):** The composite quality of care measure is the sum of the number of indices that met the goals in the processes (annual HbA1c, LDL-c, and proteinuria assessments, annual dilated retinal and foot examinations, aspirin use advised or documented, and annual influenza immunization). **Figure 1-b (middle):** The composite quality of care measure is the sum of the number of indices that met the goals in less aggressive intermediate outcomes (the most recent HbA1c < 9.5%, the most recent BP < 140/90 mmHg, and the most recent LDL-c < 130 mg/dL). **Figure 1-c (right):** The composite quality of care measure is the sum of the number of indices that met the goals in more aggressive intermediate outcomes (the most recent HbA1c < 8.5%, the most recent BP < 130/85 mmHg, and the most recent LDL-c < 100 mg/dL).

Characteristics of participants with type 2 diabetes and the subset of participants with linked primary care provider data, the Translating Research Into Action for Diabetes (TRIAD), 2000–2001.

Table 1

Characteristics	Total (N=6,040)		Subset (N=1,850)		P-value
	N	%	N	%	
Age, 65 years old	2,572	42.6	730	39.5	<.01
Sex, Female	3,265	54.1	1,024	55.4	0.18
Race/ethnicity					<.01
White Non-Hispanic	2,544	43.9	737	41.6	
Black Non-Hispanic	959	16.5	285	16.1	
Hispanic	977	16.9	219	12.4	
Asian/Pacific Islander	817	14.1	343	19.4	
Other	500	8.6	186	10.5	
Education					0.03
Some high school or less	1,372	23.0	380	20.8	
High school	1,773	29.8	560	30.7	
Some college	1,718	28.8	526	28.8	
4 year college	1,096	18.4	359	19.7	
Annual household income					<.01
< \$10,000	918	16.9	252	15.1	
\$10,000 – \$20,000	1,111	20.5	350	20.9	
\$20,000 – \$40,000	1,312	24.2	374	22.4	
\$40,000	2,085	38.4	695	41.6	
Smoking, Some or every day	1,095	18.3	297	16.2	<.01
Co-pay for primary care provider visit	4,433	74.4	1,342	73.6	0.36
Diabetes duration					0.78
<5 years	1,743	28.9	542	29.3	
5–15 years	2,718	45.0	820	44.3	

Characteristics	Total (N=6,040)		Subset (N=1,850)		P-value
	N	%	N	%	
15 years	1,579	26.1	488	26.4	
Treatment modality for diabetes					0.51
Diet only	452	7.5	125	6.8	
Oral anti-diabetic medications	3,945	65.3	1,215	65.7	
Insulin	836	13.8	255	13.8	
Insulin and oral anti-diabetic medications	807	13.4	255	13.8	
Body mass index					0.08
<25 kg/m ²	818	13.9	224	12.4	
25–30 kg/m ²	1,832	31.1	573	31.7	
30 kg/m ²	3,232	54.9	1,013	56.0	
Diabetic retinopathy	989	16.4	323	17.5	0.13
Diabetic nephropathy	1,074	17.8	375	20.3	<.01
Diabetic peripheral neuropathy	997	16.6	276	15.0	0.03
Cardiovascular disease	1,549	25.6	447	24.2	0.08
Charlson comorbidity index					0.07
0 or 1	2,274	37.7	668	36.1	
2	1,746	28.9	571	30.9	
3	987	16.3	313	16.9	
4	1,030	17.1	298	16.1	
Mobility, Having some problems	2,655	44.5	780	42.5	0.04

Table 2

Patient characteristics associated with revisit frequency, Translating Research Into Action for Diabetes (TRIAD), 2000–2001 (N=6,040)

Patient Characteristics	Revisit Frequency per Year			
	Univariate		Multivariate	
	Predicted Marginal Mean (95% CI)	P-value [¶]	Predicted Marginal Mean (95% CI)	P-value [¶]
Age				
<65 years old	3.63 (3.20, 4.11)	0.02	3.77 (3.41, 4.17)	0.80
65 years old	4.08 (3.78, 4.41)		3.74 (3.43, 4.08)	
Sex				
Male	3.52 (3.28, 3.79)	<.01	3.64 (3.35, 3.96)	<.01
Female	4.08 (3.69, 4.51)		3.87 (3.52, 4.25)	
Race/ethnicity				
White Non-Hispanic	3.66 (3.31, 4.06)	0.26	3.67 (3.29, 4.09)	0.82
Black Non-Hispanic	4.24 (3.64, 4.94) [†]		3.84 (3.42, 4.32)	
Hispanic	3.79 (3.48, 4.13)		3.71 (3.37, 4.07)	
Asian/Pacific Islander	3.66 (3.33, 4.03)		3.93 (3.44, 4.50)	
Other	3.97 (3.38, 4.66)		3.89 (3.37, 4.48)	
Education				
Some high school or less	4.54 (4.14, 4.98)	<.01	4.02 (3.68, 4.40)	<.01
High school	4.01 (3.70, 4.35) [†]		3.89 (3.57, 4.23)	
Some college	3.46 (3.20, 3.74) ^{†‡}		3.55 (3.26, 3.87) ^{†‡}	
4 year college	3.25 (2.96, 3.57) ^{†‡§}		3.62 (3.27, 4.00) ^{†‡}	
Annual household income				
< \$10,000	4.90 (4.55, 5.26)	<.01	4.54 (4.18, 4.94)	<.01
\$10,000 – \$20,000	4.31 (3.99, 4.65) [†]		4.09 (3.73, 4.48)	
\$20,000 – \$40,000	3.66 (3.39, 3.95) ^{†‡}		3.68 (3.38, 4.00) ^{†‡}	
\$40,000	3.19 (2.94, 3.47) ^{†‡§}		3.37 (3.11, 3.66) ^{†‡§}	
Smoking				
None	3.80 (3.50, 4.14)	0.79	3.78 (3.46, 4.13)	0.38
Some or every day	3.86 (3.32, 4.49)		3.68 (3.28, 4.12)	
Co-pay for PCP				
No	4.05 (3.25, 5.04)	0.47	3.82 (3.50, 4.16)	0.22
Yes	3.73 (3.50, 3.98)		3.58 (3.08, 4.18)	
Diabetes duration				
<5 years	3.59 (3.24, 3.99)	<.01	3.84 (3.50, 4.21)	0.08
5–15 years	3.71 (3.37, 4.09)		3.67 (3.35, 4.02)	

Patient Characteristics	Revisit Frequency per Year			
	Univariate		Multivariate	
	Predicted Marginal Mean (95% CI)	P-value [¶]	Predicted Marginal Mean (95% CI)	P-value [¶]
15 years	4.27 (3.92, 4.64) [‡]		3.83 (3.48, 4.22) [‡]	
Treatment modality for diabetes				
Diet only	3.17 (2.90, 3.47)	<.01	3.25 (2.96, 3.58)	<.01
Oral medications	3.65 (3.37, 3.95) [†]		3.69 (3.37, 4.05) [†]	
Insulin	4.33 (3.92, 4.79) [‡]		3.83 (3.51, 4.18) [†]	
Insulin and oral medications	4.62 (4.13, 5.17) [‡]		4.36 (3.96, 4.79) ^{‡§}	
Body mass index				
<25 kg/m ²	3.64 (3.35, 3.96)	0.27	3.59 (3.23, 3.99)	0.26
25–30 kg/m ²	3.69 (3.44, 3.97)		3.72 (3.41, 4.05)	
30 kg/m ²	3.93 (3.50, 4.41)		3.82 (3.48, 4.20)	
Diabetic retinopathy				
No	3.76 (3.43, 4.12)	<.01	3.79 (3.46, 4.16)	0.09
Yes	4.10 (3.69, 4.56)		3.58 (3.25, 3.95)	
Diabetic nephropathy				
No	3.73 (3.39, 4.12)	0.01	3.75 (3.43, 4.09)	0.63
Yes	4.21 (3.75, 4.73)		3.81 (3.40, 4.28)	
Diabetic peripheral neuropathy				
No	3.74 (3.44, 4.07)	0.02	3.78 (3.47, 4.12)	0.33
Yes	4.18 (3.63, 4.82)		3.64 (3.18, 4.15)	
Cardiovascular disease				
No	3.57 (3.27, 3.90)	<.01	3.68 (3.35, 4.03)	<.01
Yes	4.61 (4.19, 5.07)		4.02 (3.68, 4.39)	
Charlson comorbidity index				
0 or 1	3.30 (3.07, 3.55)	<.01	3.43 (3.15, 3.74)	<.01
2	3.70 (3.30, 4.15) [†]		3.70 (3.35, 4.08) [†]	
3	4.41 (4.01, 4.86) [‡]		4.11 (3.74, 4.51) [‡]	
4	4.81 (4.37, 5.29) ^{‡§}		4.38 (3.97, 4.83) ^{‡§}	
Mobility				
No problem	3.47 (3.23, 3.73)	<.01	3.66 (3.35, 4.00)	<.01
Some problems	4.26 (3.86, 4.71)		3.89 (3.55, 4.26)	

The univariate models include the characteristic as an independent variable in addition to the random effects of provider groups and health plans. The multivariate model includes all variables listed in the table as well as the random effects of provider groups and health plans.

[¶]P-values were estimated by the Wald F-statistics for variable's overall significance. P-values for the pairwise comparisons for the characteristics with more than two categories were estimated by the *t*-statistics, and are expressed with the following notations:

[†] $P < 0.05$ compared to the first category within the characteristic;

[‡] $P < 0.05$ compared to the second category within the characteristic;

[§] $P < 0.05$ compared to the third category within the characteristic. CI: confidence interval, PCP: primary care provider.

Table 3

The prevalence of achieving the processes and intermediate outcomes of diabetes care by revisit frequency quartile; upper row (in regular font) by univariate models and bottom row (in bold font) by multivariate models, Translating Research Into Action for Diabetes (TRIAD), 2000–2001 (N=4,870)

Quality of care measures	Predicted Marginal Prevalence (S.E.)				Predicted Marginal Prevalence Ratio (95% CI)	P-value [§]
	Quartile 1	Quartile 2	Quartile 3	Quartile 4		
Process						
Annual HbA1c	0.80 (0.02)	1.10 (1.06, 1.15) †	1.14 (1.09, 1.19) †‡	1.13 (1.09, 1.18) †	<0.01	
	0.80 (0.02)	1.09 (1.05, 1.14) †	1.14 (1.09, 1.19) †‡	1.14 (1.09, 1.19) †‡	<0.01	
Annual retinal examination	0.75 (0.03)	1.07 (1.02, 1.11) †	1.05 (1.00, 1.10) †	1.08 (1.02, 1.14) †	<0.01	
	0.74 (0.03)	1.07 (1.02, 1.13) †	1.06 (0.99, 1.13)	1.10 (1.02, 1.18) †§	<0.01	
Annual proteinuria screen	0.73 (0.03)	1.08 (1.03, 1.13) †	1.10 (1.04, 1.17) †	1.12 (1.04, 1.21) †	<0.01	
	0.66 (0.03)	1.07 (1.00, 1.14) †	1.07 (0.98, 1.17)	1.07 (0.98, 1.17)	0.06	
Annual LDL-c	0.65 (0.03)	1.12 (1.06, 1.18) †	1.12 (1.05, 1.20) †	1.09 (1.01, 1.17) †	<0.01	
	0.64 (0.04)	1.16 (1.10, 1.21) †	1.15 (1.10, 1.22) †	1.17 (1.09, 1.25) †	<0.01	
Annual foot examination	0.79 (0.02)	1.08 (1.04, 1.11) †	1.10 (1.06, 1.15) †	1.13 (1.08, 1.19) †‡	<0.01	
	0.81 (0.02)	1.04 (1.01, 1.08) †	1.06 (1.02, 1.11) †	1.08 (1.03, 1.13) †	0.05	
Aspirin use advised	0.47 (0.03)	1.17 (1.10, 1.25) †	1.22 (1.13, 1.32) †	1.27 (1.15, 1.41) †‡	<0.01	
	0.48 (0.03)	1.16 (1.08, 1.24) †	1.17 (1.08, 1.27) †	1.19 (1.09, 1.30) †	<0.01	
Annual influenza immunization	0.60 (0.02)	1.10 (1.04, 1.17) †	1.16 (1.10, 1.21) †‡	1.19 (1.12, 1.26) †‡	<0.01	
	0.61 (0.03)	1.10 (1.03, 1.17) †	1.13 (1.06, 1.20) †	1.16 (1.09, 1.24) †‡	<0.01	
Intermediate Outcomes						
HbA1c < 8.5%	0.67 (0.02)	1.01 (0.96, 1.07)	1.04 (0.99, 1.10) †	1.06 (1.00, 1.12) †	0.18	
	0.65 (0.02)	1.03 (0.98, 1.09)	1.08 (1.02, 1.15) †‡	1.13 (1.04, 1.22) †‡	0.01	
HbA1c < 9.5%	0.80 (0.02)	1.01 (0.97, 1.04)	1.04 (1.00, 1.08) ‡	1.05 (1.01, 1.09) ‡	0.01	
	0.79 (0.02)	1.01 (0.97, 1.06)	1.07 (1.02, 1.11) †‡	1.08 (1.02, 1.14) †‡	<0.01	
BP < 130/85 mmHg	0.31 (0.02)	1.01 (0.89, 1.14)	1.00 (0.85, 1.18)	1.04 (0.93, 1.16)	0.89	
	0.31 (0.02)	1.02 (0.91, 1.15)	1.03 (0.89, 1.21)	1.08 (0.94, 1.24)	0.74	
BP < 140/90 mmHg	0.52 (0.02)	1.04 (0.96, 1.12)	1.05 (0.97, 1.14)	1.02 (0.95, 1.09)	0.65	
	0.52 (0.02)	1.06 (0.98, 1.14)	1.05 (0.97, 1.14)	1.05 (0.97, 1.14)	0.52	

Quality of care measures	Predicted Marginal Prevalence (S.E.)	Predicted Marginal Prevalence Ratio (95% CI)			P-value [¶]
	Quartile 1	Quartile 2	Quartile 3	Quartile 4	
LDL-c < 100 mg/dL	0.34 (0.02)	1.06 (0.95, 1.18)	1.12 (0.98, 1.28)	1.18 (1.04, 1.35) †	0.09
	0.34 (0.02)	1.05 (0.92, 1.20)	1.15 (0.98, 1.34)	1.20 (1.03, 1.39) †	0.09
LDL-c < 130 mg/dL	0.70 (0.02)	1.04 (0.99, 1.09)	1.07 (1.01, 1.13) †	1.07 (1.03, 1.12) †	0.01
	0.70 (0.02)	1.03 (0.98, 1.09)	1.07 (0.99, 1.16)	1.08 (1.02, 1.14) †	0.05

The univariate models include the quartiles of revisit frequency as the sole independent variable in addition to the random effects of provider group and health plan. The multivariate model includes the quartiles of revisit frequency and participant demographic and socioeconomic characteristics, participants' diabetes conditions and comorbidities as well as the random effects of provider group and health plan.

[¶] P-values were estimated by the Wald F-statistics for variable's overall significance. P-values for the pairwise comparisons between quartiles were estimated by the t-statistics, and are expressed with the following notations: P<0.05 compared to the quartile 1 (†), to the quartile 2 (§), and to the quartile 3 (§). CI: confidence interval, BP: blood pressure, LDL-c: low-density lipoprotein cholesterol.