HHS Public Access

Author manuscript

J Clin Pharm Ther. Author manuscript; available in PMC 2016 June 01.

Published in final edited form as:

J Clin Pharm Ther. 2016 June ; 41(3): 256–259. doi:10.1111/jcpt.12360.

Medication adherence may be more important than other behaviours for optimizing glycaemic control among low-income adults

C. Y. Osborn, PhD MPH[*], **L. S. Mayberry, MS PhD**[*], and **J. M. Kim, BS**[†]

[*]Vanderbilt University Medical Center, Nashville, TN

[†]Texas A&M Health Science Center, Bryan, TX, USA

SUMMARY

What is known—Patients with type 2 diabetes mellitus (T2DM) are required to perform multiple self-care behaviours to achieve and maintain optimal glycaemic control (HbA1c), which prevents complications and premature mortality. Patients with T2DM and low socioeconomic status (SES) are more likely to have suboptimal HbA1c, often due to being less adherent to recommended self-care activities than their higher-SES counterparts.

Objective—Although studies support performing certain diabetes self-care behaviours for optimizing glycaemic control, there is limited research on the relative importance of each behaviour for this purpose. Identifying what behaviours are most important for HbA1c among low-SES patients with T2DM would be particularly useful for informing policy and intervention efforts for this high-risk group.

Methods—In a cross-sectional study of 314 adults with T2DM and low SES, we used the Summary of Diabetes Self-Care Activities to assess self-care behaviours and multivariate models to test which behaviours were associated with lower HbA1c.

Results and discussion—Only medication adherence was significantly associated with lower HbA1c after adjusting for the other self-care behaviours ($\beta = -0\ 14$, $P = 0\ 028$) and further adjusting for demographic and diabetes characteristics ($\beta = -0\ 16$, $P = 0\ 024$).

What is new—Medication adherence may be the most important self-care behaviour for glycaemic control among adults with T2DM and low SES.

Conclusion—Focused efforts to improve medication adherence among low-SES patient populations may improve glycaemic control.

Keywords

glycaemic control; low income; medication adherence; type 2 diabetes

Correspondence: C. Y. Osborn, Center for Health Behavior and Health Education, Vanderbilt University Medical Center, 2525 West End Ave., Suite 370 Nashville, TN 37203, USA. Tel.: +1 (615) 936 8468; chandra.osborn@vanderbilt.edu.

WHAT IS KNOWN

To achieve optimal glycaemic control, individuals with diabetes are expected to perform self-care behaviours such as eat healthfully, be active, test blood sugars and, when necessary, take medications.[1] An estimated one-half (47 8%) of U.S. adults with diabetes[2] have suboptimal glycaemic control [haemoglobin A1c (HbA1c) ≥7 0%], contributing to a high risk for diabetes-related complications.[2] Performing recommended self-care behaviours is challenging, particularly for populations with low socioeconomic status (SES) who may not be able to afford healthy foods, medications or meter testing strips; lack access to diabetes education and dietician support; or live in unsafe neighbourhoods, limiting outdoor activity.[3] As a result, low-SES populations have the highest rates of suboptimal HbA1c and, in turn, diabetes-related complications.[4]

The Summary of Diabetes Self-Care Activities (SDSCA) is the most widely used measure of diabetes self-care behaviours.[5] Available in 21 languages, the SDSCA is a brief, self-report questionnaire that includes seven subscales assessing general diet, specific diet, exercise, blood glucose testing, medication adherence, foot care and smoking behaviours over the past 7 days, with higher scores indicating better self-care adherence.[6] The SDSCA subscales have criterion and discriminate validity and correlate well with other comprehensive measures of the same behaviours.[6,7] Many randomized controlled trials utilize the SDSCA subscales because of their sensitivity to changes in behaviour.[6] Furthermore, the SDSCA is the only instrument recommended for use when assessing diabetes self-care changes as a result of diabetes education.[8]

OBJECTIVE

Bivariate evidence supports the value of individual self-care behaviours for reducing HbA1c,[7,8] but does not tell us (i) which behaviours have the most influence on HbA1c and, subsequently, (ii) which behaviours to prioritize for optimal glycaemic control. Multivariate evidence adjusting for all behaviours would inform these questions and guide intervention development and resource allocation, especially for patients with limited resources who are more likely to be non-adherent and have suboptimal HbA1c.[2,4] Therefore, with data from a sample of U.S. adults with T2DM and low SES, we tested which SDSCA-assessed self-care behaviours were associated with better HbA1c adjusting for the other self-care behaviours, as well as and demographics and diabetes characteristics known to be associated with both self-care and HbA1c.

METHODS

We recruited English- and Spanish-speaking adults (≥18 years of age) with a diagnosis of T2DM who were prescribed glucose-lowering oral agents and/or insulin from a Federally Qualified Health Center in Nashville, Tennessee to participate in a cross-sectional, survey-based study. Trained research assistants collected self-reported demographics (age, gender, race, ethnicity, income, education and insurance status) and diabetes characteristics (insulin status and duration of diabetes) and responses to five of the SDSCA subscales (i.e. the general diet, specific diet, exercise, blood glucose testing and medications subscales). Items

on the SDSCA ask respondents to report on how many days in the past week they performed a self-care behaviour (e.g. 'On how many of the last 7 days did you take your recommended diabetes medication?'), did so accurately (e.g. 'On how many of the last 7 days did you take the correct number of pills/injections?'), or for the recommended amount of time (e.g. 'On how many of the last 7 days did you participate in at least 30 min of physical activity?'). The SDSCA is scaled from 0 to 7 to reflect the number of days in the past week, with higher scores indicating better adherence. The SDSCA also has a Spanish version with acceptable psychometric properties,[9,10] and both versions have been validated in low-SES samples with diabetes.[6,9,10] We used the English or Spanish version, depending on participants' preferred language. A nurse administered a point-of-care HbA1c test.[11] Additional details of our recruitment and data collection procedures have been previously described,[7] and all procedures were approved by the Vanderbilt Institutional Review Board prior to enrolling participants.

All statistical analyses were performed using STATA 13.1. We calculated summary statistics and Spearman's rho correlations between the SDSCA subscale scores and HbA1c to assess bivariate relationships. Data were missing on two variables included in our analyses: five participants were missing duration of diabetes, and 30 participants were missing income. We used multiple imputation with chained equations to impute 10 data sets.[12] This approach generates multiple data sets, each with different estimated values in place of the original missing values; the estimated values are calculated by the statistical software program using all variables included in regression models of interest, plus any additional variables related to the missing variables. Analyses are then conducted with all imputed data sets; regression coefficients represent the average across data sets; standard errors and *P* values account for the uncertainty associated with any missing data. Multiple imputation produces estimates that are less biased than listwise deletion (which otherwise occurs by default in regression analyses), and is a preferred approach for handling missing data.[12,13] With imputed data, we conducted two multivariate linear regression models with robust standard errors to test which self-care behaviours were most strongly associated with HbA1c. The first model included the five SDSCA subscales simultaneously regressed onto HbA1c. The second model included these subscales plus demographic and diabetes characteristics.

In our largest model, we estimated 14 predictors with $N = 314$. According to recommendations for multivariate linear models, models with six or more predictors should be conducted with samples no smaller than 10 participants per predictor.[14] Thus, a sample as small as 140 would meet the minimum requirements. Power is optimized to detect a small effect with 30 participants per predictor.[14] We had a ratio of 62·8 participants per predictor in the first model and 22·4 in the second.

RESULTS AND DISCUSSION

The sample ($N = 314$) was on average 51 8 ± 11 7 years old and diverse (37% Caucasian/White, 53% African American/Black, 8% Hispanic and 2% other race). Most participants had low SES (45% annual incomes <$10 000; 32% less than high school degree; 46% uninsured), and 66% had suboptimal glycaemic control (HbA1c ≥7·0%), with the average HbA1c 8·2 ± 2·2%. Almost (46%) were prescribed insulin.[7] A table with all participant

characteristics coupled with a more thorough description of the sample (e.g. 3·5% Spanish speaking) has been previously reported.[7]

According to bivariate analyses, exercise and medication adherence were each associated with better HbA1c (Table 1). However, in the first multivariate model that included all five self-care behaviours, only medication adherence remained significantly associated with better HbA1c (β = −0·14, P = 0·028). Upon further adjusting for demographic and diabetes characteristics in the second model, medication adherence continued to be associated with better HbA1c (β = −·16, P = 0·024, see Table 2). No other self-care behaviours were associated with HbA1c in these adjusted models.

WHAT IS NEW

To our knowledge, this study is the first to comparatively assess which self-care behaviours are independently associated with better HbA1c by examining the effects of multiple behaviours in the same statistical models among U.S. patients with low SES. Although exercise and medication adherence were each associated with better glycaemic control in bivariate analyses, only medication adherence was associated with better glycaemic control when adjusted for five self-care behaviours, as well as demographic and diabetes characteristics known to be associated with self-care and HbA1c.

Although other self-care behaviours (i.e. eating a healthful diet, SMBG and exercise) are important for managing diabetes, in our sample these behaviours were not associated with glycaemic control upon adjusting for other self-care behaviours. One might argue these results are somewhat predictable – adherence to medications has the greatest influence on glycaemic control once other self-care behaviours (diet/exercise) have failed or cannot be realized, and our analyses should be performed excluding medication adherence. However, given all participants were prescribed a glucose-lowering agent and/or insulin, our ability to accurately assess the relative value of the other self-care behaviours in the absence of pharmacotherapy is limited. This is echoed by additional analyses we performed in which medication adherence was omitted from the fully adjusted model, and no self-care behaviours were associated with glycaemic control. Houle *et al.*[15] recently found that improved diet and SMBG were associated with long-term improvements in HbA1c among Canadian adults with T2DM; medication adherence predicted long-term HbA1c only among patients with low incomes, and this relationship was even stronger among patients with limited education. Our findings corroborate this in a low-SES sample of adults with T2DM from the U.S.

Patients with low SES may be both limited in the degree to which they can change their diet (i.e. they may have limited access to affordable healthy foods), maintain SMBG (due to costs of testing supplies) and be physically active (i.e. they may have limited access to safe places for physical activity). Among patients with higher SES, the opportunity for diet, SMBG and exercise behaviours may be greater, resulting in a more profound impact on HbA1c.[16] Similarly, our finding that medication adherence was independently associated with glycaemic control may also be unique to the characteristics of our sample. In 2000, Toobert *et al.*[6] reviewed studies using the SDSCA and concluded the medications subscale

may be less useful than the other subscales due to its ceiling effect and limited variability in scores. However, this conclusion was based on only three studies using the medications subscale and each study had a middle-SES sample.[6] Our findings suggest that in samples of predominantly low-SES patients (who are often less adherent), there may be more variability on the medications subscale than in higher-SES samples.

Self-reported adherence is subject to social desirability bias, but strongly correlated with more objective measures (e.g. pharmacy claims data, medication event monitoring systems or MEMS), which cannot assess the timing and accurate dosing of medications. Both subjective and objective adherence measures predict clinical outcomes, but self-report is more feasible for research purposes and clinical administration, especially for adjustable dose regimens.[17] Although we related 7-day self-reported adherence scores (SDSCA) to a 2- to 3-month marker of glycaemic control (HbA1c), other studies measuring adherence with self-reported[18–20] and objective measures[21,22] of varying timeframes also report medication adherence is associated with HbA1c. For instance, Aikens and Piette[18] reported that self-reported adherence according to the four-item Morisky scale[23] predicted glycaemic control 6 months later even after adjusting for baseline glycaemic control and relevant covariates. Although we did not collect data on the Morisky scale to be able to compare it to the SDSCA medications subscale, the SDSCA has been psychometrically validated against objective measures of refill adherence,[6,21,24] and we previously validated the SDSCA against the ARMS (i.e. another self-reported adherence measure associated with pharmacy refill adherence[25]) with data from the same sample.[7] Future studies comparing the relative importance of medication adherence with other diabetes self-care behaviours should include the Morisky scale.

There are additional study limitations to acknowledge. Our sample was recruited from a single clinic serving low-SES patients, and our findings may be unique to this type of patient population. Second, we recruited patients receiving care within the U.S. healthcare system. We are unable to generalize our findings to other countries due to differences in healthcare policies (e.g. free access to medications) and cultural differences in diet and physical activity. Third, like all measures, inherent weaknesses exist with the SDSCA. Self-report is the most practical and cost-effective approach for self-care assessment and correlates well with other measures,[5,6] but is also subject to recall and reporting bias and may overestimate adherence. Thus, our pattern of findings may be different if we used other self-report measures (e.g. the Morisky scale) or other self-care measures like actographs, food diaries or MEMS. Lastly, because of our cross-sectional design, we cannot speak to the causal nature of these relationships or whether SDSCA subscale scores would predict future glycaemic control.

CONCLUSION

Our findings indicate medication adherence may be the most important self-care behaviour for glycaemic control among low-SES populations. Providers and diabetes educators may want to emphasize the importance of medication adherence when discussing diabetes self-care with patients and help them identify available resources to support uninterrupted access to their medications. Our findings also support interventions targeting medication adherence

among low-SES patient populations and the allocation of resources to programmes like the Dispensary of Hope who aggregate medications from all over the U.S. and distribute them to underserved clinics and pharmacies. Furthermore, clinics serving low-SES patient populations may consider providing additional medication adherence support to patients with diabetes such as access to a clinical pharmacist for medication management, counselling and adherence support. Such efforts to support low-SES patients' medication adherence may lead to improvements in glycaemic control and, in turn, less diabetes-related complications, healthcare costs and premature mortality among patients at greatest risk for suboptimal diabetes outcomes.

References

1. American Diabetes Association. Standards of medical care in diabetes—2015. Diabetes Care. 2015; 38:S4.
2. Ali MK, Bullard KM, Saaddine JB, et al. Achievement of goals in US diabetes care, 1999–2010. N Engl J Med. 2013; 368:1613–1624. [PubMed: 23614587]
3. Nelson KM, Reiber G, Boyko EJ. Diet and exercise among adults with type 2 diabetes findings from the third national health and nutrition examination survey (NHANES III). Diabetes Care. 2002; 25:1722–1728. [PubMed: 12351468]
4. Pandit AU, Bailey SC, Curtis LM, et al. Disease-related distress, self-care and clinical outcomes among low-income patients with diabetes. J Epidemiol Community Health. 2014; 68:557–564. [PubMed: 24489044]
5. Gonzalez JS, Schneider HE, Wexler DJ, et al. Validity of medication adherence self-reports in adults with type 2 diabetes. Diabetes Care. 2013; 36:831–837. [PubMed: 23204245]
6. Toobert DJ, Hampson SE, Glasgow RE. The Summary of Diabetes Self-Care Activities measure: results from 7 studies and a revised scale. Diabetes Care. 2000; 23:943–950. [PubMed: 10895844]
7. Mayberry LS, Gonzalez JS, Wallston KA, Kripalani S, Osborn CY. The ARMS-D out performs the SDSCA, but both are reliable, valid, and predict glycemic control. Diabetes Res Clin Pract. 2013; 102:96–104. [PubMed: 24209600]
8. Eigenmann CA, Colagiuri R, Skinner TC, Trevena L. Are current psychometric tools suitable for measuring outcomes of diabetes education? Diabet Med. 2009; 26:425–436. [PubMed: 19388974]
9. Ruggiero L, Riley BB, Hernandez R, et al. Medical assistant coaching to support diabetes self-care among low-income racial/ethnic minority populations: randomized controlled trial. West J Nurs Res. 2014; 36:1052–1073. [PubMed: 24569698]
10. Vincent D, McEwen MM, Pasvogel A. The validity and reliability of a Spanish version of the Summary of Diabetes Self-Care Activities questionnaire. Nurs Res. 2008; 57:101–106. [PubMed: 18347481]
11. Kennedy L, Herman WH. Glycated hemoglobin assessment in clinical practice: comparison of the A1cNow™ point-of-care device with central laboratory testing (GOAL A1C study). Diabetes Technol Ther. 2005; 7:907–912. [PubMed: 16386096]
12. Graham J. Missing data analysis: making it work in the real world. Annu Rev Psychol. 2009; 60:549–576S. [PubMed: 18652544]
13. Little RJ, D'Agostino R, Cohen ML, et al. The prevention and treatment of missing data in clinical trials. N Engl J Med. 2012; 367:1355–1360. [PubMed: 23034025]
14. Wilson VanVoorhis CR, Morgan BL. Understanding power and rules of thumb for determining sample sizes. Tutor Quant Methods Psychol. 2007; 3:43–50.
15. Houle J, Beaulieu MD, Chiasson JL, et al. Glycaemic control and self-management behaviours in type 2 diabetes: results from a 1-year longitudinal cohort study. Diabet Med. 2015; 32:1247–1254. [PubMed: 25581545]
16. Houle J, Beaulieu MD, Chiasson JL, et al. Glycaemic control and self-management behaviours in Type 2 diabetes: results from a 1-year longitudinal cohort study. Diabet Med. 2015; 32:1247–1254. [PubMed: 25581545]

17. Gonzalez JS, Schneider HE. Methodological issues in the assessment of diabetes treatment adherence. Curr Diab Rep. 2011; 11:472–479. [PubMed: 21956675]
18. Aikens JE, Piette JD. Longitudinal association between medication adherence and glycaemic control in type 2 diabetes. Diabet Med. 2013; 30:338–344. [PubMed: 23075262]
19. Krapek K, King K, Warren SS, et al. Medication adherence and associated hemoglobin A1C in type 2 diabetes. Ann Pharmacother. 2004; 38:1357–1362. [PubMed: 15238621]
20. Hood KK, Peterson CM, Rohan JM, Drotar D. Association between adherence and glycemic control in pediatric type 1 diabetes: a meta-analysis. Pediatrics. 2009; 124:e1171–e1179. [PubMed: 19884476]
21. Gonzalez JS, Schneider HE, Wexler DJ, et al. The validity of medication adherence self-reports in adults with type 2 diabetes. Diabetes Care. 2012; 36:831–837. [PubMed: 23204245]
22. Schectman JM, Nadkarni MM, Voss JD. The association between diabetes metabolic control and drug adherence in an indigent population. Diabetes Care. 2002; 25:1015–1021. [PubMed: 12032108]
23. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. Med Care. 1986; 24:67–74. [PubMed: 3945130]
24. Cohen H, Shmukle R, Ullman R, Rivera C, Walker E. Measurements of medication adherence in diabetic patients with poorly controlled HbA1c. Diabet Med. 2010; 27:210–216. [PubMed: 20546266]
25. Kripalani S, Risser J, Gatti ME, Jacobson TA. Development and evaluation of the Adherence to Refills and Medications Scale (ARMS) among low-literacy patients with chronic disease. Value Health. 2009; 12:118–123. [PubMed: 19911444]

Table 1

Spearman's rho correlations between self-care behaviours and HbA1c ($N = 314$)

	Mean ± SD	HbA1c	General diet	Specific diet	Exercise	SMBG	Medications
HbA1c (%)	8·2 ± 2·2	1·00					
General diet	4·1 ± 2·4	−0·01	1·00				
Specific diet	3·9 ± 1·6	−0·11	0·47[c]	1·00			
Exercise	2·6 ± 2·3	−0·11[a]	0·22[c]	0·16[b]	1·00		
SMBG	4·8 ± 2·7	0·01	0·18[b]	0·13[a]	0·16[b]	1·00	
Medications	6·0 ± 1·8	−0·18[b]	0·19 [c]	0·20[c]	0·13[a]	0·23[c]	1·00

HbA1c, glycosylated haemoglobin A1c assessed with a point-of-care device; SD, standard deviation; SMBG, self-monitoring of blood glucose.

[a] $P < 0·05$.

[b] $P < 0·01$.

[c] $P < 0·001$.

Table 2

Multiple linear regression models predicting glycaemic control ($N = 314$)

Outcome: HbA1c (%)	Model 1: all self-care behaviours β	Model 2: all self-care behaviours + covariates β
General diet	0·04	0·06
Specific diet	−0·06	−0·04
Exercise	−0·10[a]	−0·03
SMBG	0·03	−0·002
Medications	−0·14[b]	−0·16[b]

Covariates, age, gender, race, ethnicity, income, education, insurance status, insulin status and duration of diabetes; HbA1c, glycosylated haemoglobin A1c assessed with a point-of-care device; SMBG, self-monitoring of blood glucose.

[a] $P < 0·10$.

[b] $P < 0·05$.