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INVESTING TIME IN HEALTH: DO SOCIOECONOMICALLY DISADVANTAGED PATIENTS SPEND MORE OR LESS EXTRA TIME ON DIABETES SELF-CARE?

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SUMMARY

Background: Research on self-care for chronic disease has not examined time requirements. Translating Research into Action for Diabetes (TRIAD), a multi-site study of managed care patients with diabetes, is among the first to assess self-care time.

Objective: To examine associations between socioeconomic position and extra time patients spend on foot care, shopping/cooking, and exercise due to diabetes.

Data: Eleven thousand nine hundred and twenty-seven patient surveys from 2000 to 2001.

Methods: Bayesian two-part models were used to estimate associations of self-reported extra time spent on self-care with race/ethnicity, education, and income, controlling for demographic and clinical characteristics.

Results: Proportions of patients spending no extra time on foot care, shopping/cooking, and exercise were, respectively, 37, 52, and 31%. Extra time spent on foot care and shopping/cooking was greater among racial/ethnic minorities, less-educated and lower-income patients. For example, African-Americans were about 10 percentage points more likely to report spending extra time on foot care than whites and extra time spent was about 3 min more per day.

Discussion: Extra time spent on self-care was greater for socioeconomically disadvantaged patients than for advantaged patients, perhaps because their perceived opportunity cost of time is lower or they cannot afford substitutes. Our findings suggest that poorly controlled diabetes risk factors among disadvantaged populations may not be attributable to self-care practices. Copyright © 2008 John Wiley & Sons, Ltd.

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KEY WORDS: self-care; opportunity costs of time; diabetes; disparities; socioeconomic status

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1. INTRODUCTION

As articulated by Grossman (1972) in his seminal article and subsequently extended by Heckman (2007) to a lifecycle investment framework, health can be viewed as a capital stock, subject to depreciation over time, in which consumers invest financial resources as well as time, e.g. obtaining care or engaging in healthy behaviors. Consumers with higher wage rates (often proxied by education) have a stronger incentive to invest time in their health to prevent sick days. Yet their greater opportunity cost of time suggests that they might instead cut back on prevention activities or substitute other health inputs. Thus opportunity costs are relevant not only because of the earnings losses associated with disability but also the time required to produce health. The importance of opportunity costs in influencing health behaviors has previously been highlighted, e.g. in literature concluding that the reduced time required to prepare food has been the driving force behind the increase in obesity rates over time (Cutler *et al.*, 2003).

Grossman's model is particularly useful for thinking about patients with chronic diseases, for whom the time investment required to maintain good health is substantial. Recommended self-care practices often include time-consuming activities such as exercising, eating special diets, and self-administering injections. Given concerns about socioeconomic differences in healthcare utilization and outcomes, particularly among chronically ill populations, it is important to understand the role of factors such as race/ethnicity, education, and income in decisions about time spent on self-care activities. Less engagement in self-care, due to a weaker economic incentive to stay healthy (or alternatively to less information and worse patient–doctor communication), would impose a dual vulnerability on patients from socioeconomically disadvantaged groups, given the disparities often seen in their access to health services. On the other hand, the opportunity costs of the time associated with self-care might act as a stronger deterrent to more advantaged patients. More-educated patients may also be more efficient producers of health (Grossman, 1972), suggesting a negative correlation between education and self-care time.

To examine these issues, we focus on diabetes, which offers several advantages as a case study for understanding the role of self-care time and how it relates to socioeconomic position (SEP). Diabetes and its complications are common, complex, and costly (ADA, 1998; CDC, 1997). The risk for diabetes complications and comorbidities may be reduced through timely and effective glycemic control; control of blood pressure and lipids; smoking cessation; immunizations; and early treatment for eye, kidney, and foot diseases (Herman, 1999; Javitt *et al.*, 1994; Litzelman *et al.*, 1993; Pan *et al.*, 1997; UKPDS, 1998a, b). Yet a considerable portion of diabetes management relies on self-care, for example, foot care, exercise, dietary changes, self-testing of glucose, and administration of medications.

Because self-care is essential for good diabetes management, considerable research has focused on how best to educate patients about self-care tasks and motivate them to engage in long-term adherence (ADA, 1998; Deakin *et al.*, 2005; Loveman *et al.*, 2003; Muhlhauser *et al.*, 1998; Newman *et al.*, 2004; van den Arend *et al.*, 2000). Surprisingly, few studies have measured the time required to carry out self-care tasks or the time patients actually spend. Estimates of the time needed for self-care tasks recommended by the American Diabetes Association for a typical diabetic patient in a stable phase of care range from 2 to 3 h per day (Russell *et al.*, 2005; Shubrook and Schwartz, 2006). The substantial time investment may act as a deterrent to self-care behaviors.

Studies of diabetic patients found worse processes of care and more poorly controlled risk factors (e.g. elevated A1C, lipids, blood pressure) among racial and ethnic minorities and persons of lower education or income (Bell *et al.*, 2001; Bonds *et al.*, 2003; Chin *et al.*, 1998; Gary *et al.*, 2004; Harris *et al.*, 1999; Harris, 2001; Saaddine *et al.*, 2002; Schectman *et al.*, 2002; Schneider *et al.*, 2002). In studies conducted in settings with more uniform access to care, fewer SEP-related disparities were observed in processes of care, although some differences persisted in risk factors (Brown *et al.*, 2005; Heisler *et al.*, 2003; Karter *et al.*, 2002; Young *et al.*, 2003). Because self-management is a key

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component of diabetes care (Funnell and Anderson, 2000), it may partially account for persistent disparities in risk factors.

To our knowledge, the Translating Research into Action for Diabetes (TRIAD) study (Gregg and the TRIAD Study Group, 2002) was the first to ask patients with diabetes how much extra time they spent on self-care tasks because of their diabetes. In an analysis limited to New Jersey data, diabetic patients reported spending about one extra hour daily (Safford *et al.*, 2005), with extra time spent being higher among African-Americans than whites. We explore this unexpected finding by examining data from all six TRIAD sites and using more detailed SEP measures.

This study tests the hypothesis that the extra time spent on self-care is greater among patients with higher SEP, where SEP measures include race/ethnicity, education, and income. In addition to their stronger financial incentives to maintain their own health, higher-SEP patients likely have greater health knowledge, which in turn should lead to a greater perception of the health benefits associated with self-care activities. Their higher incomes allow them to purchase complements to self-care time (e.g. exercise equipment or nutritious foods) and pay others for chores such as house cleaning, thus freeing up time for self-care. Higher-SEP patients also tend to be employed in occupations that allow them autonomy over how they use their time.

An equally compelling line of reasoning, however, suggests the counter-hypothesis that higher-SEP patients spend less extra time on diabetes self-care. Higher wages give them an incentive to spend more time on paid work and less on unpaid self-care. Higher incomes can be used to purchase substitutes for their self-care time, such as high-quality take-out food or even a paid cook. If the ability to buy substitutes dominates, the income effect could reinforce the price effect, leading higher-SEP patients to spend less time on self-care than lower-SEP patients. From the perspective of lower-SEP patients, the opportunity cost of an additional hour spent on self-care rather than work is lower, so they might engage in more self-care than higher-SEP patients. Further, such patients might view self-care as an opportunity to compensate for worse access to formal medical services.

Given these conflicting theoretical arguments, empirical analysis to test the competing hypotheses is critical. This study is based on the same interview questions as Safford *et al.* (2005) but uses all six sites. The larger sample size and greater geographic and socioeconomic diversity allow us to examine a wider range of possible SEP differences. We also used innovative Bayesian methods to estimate self-care time.

2. DESIGN AND METHODS

2.1. Setting, study population, and data collection

TRIAD is a multi-site study of patients with diabetes in 10 large managed care plans, including staff model health maintenance organizations, network/independent practice associations, point-of-service plans, and preferred provider organizations (Gregg and the TRIAD Study Group, 2002). Patients were eligible if they were 18 or over, community-dwelling, were not pregnant, had had diabetes for at least one year, spoke English or Spanish, were continuously enrolled in their health plan for at least 18 months, used at least one service during that time, and could give informed consent. Data were collected in 2000–2001 from 11,927 patients through a combination of computer-assisted telephone interviews and some mail surveys. The survey response rate was 91% among contacted eligible people and 69% overall.

2.2. Dependent variables

TRIAD investigators created and pilot-tested questions about the extra time spent daily on three diabetes self-care activities. Selected activities were those that clinician consultants believed were most likely to be important time users and not done by the majority of people, regardless of their diabetes status (Safford, 2005; Safford *et al.*, 2005). Participants were asked the following: ‘Think about the extra

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time you yourself spend taking care of your diabetes-related health problems. Related problems might include high blood pressure, high cholesterol, or heart and circulation problems. On a typical day, how many extra minutes do you spend: A. Caring for your feet? B. Exercising? C. Shopping for and cooking special foods?' The question asked about 'extra' (rather than total) time in order to get a more precise estimate of the time costs associated with diabetes in particular and understand how the disease had led respondents to change their use of time.

2.3. Measures of patient SEP

Using self-reported race and ethnicity, we classified respondents as Latinos/Hispanics of any race (hereinafter referred to as 'Latinos'), non-Latino African-Americans (referred to as 'African-Americans'), non-Latino Asian/Pacific Islanders (referred to as 'Asians'), non-Latino respondents of other non-white races (referred to as 'others'), and non-Latino whites (referred to as 'whites'). Whites were the reference group. Education categories were less than high school, high school graduate and some college; four or more years of college was the reference group. Annual household income was classified as less than \$15 000, \$15 000–\$39 999, and \$40 000–\$74 999; \$75 000 or more was the reference group.

2.4. Other covariates

All models controlled for fixed health plan effects, the patient's age group (18–44, 45–64, 65–74, 75 years or older), sex, and sources of secondary insurance (private, Medicare, other public). The main models also controlled for the following clinical characteristics: type of diabetes treatment (insulin only, insulin plus oral agents, oral medications only, or diet only); years since diagnosis; body mass index (kg/m^2), classified as normal ($\text{BMI}<25$), overweight ($25\leq\text{BMI}<30$), obese ($30\leq\text{BMI}<40$), and very obese ($\text{BMI}\geq 40$); self-assessed health (excellent/very good, good, fair/poor); 12-item Short Form Health Survey physical and mental component summary scale (PCS and MCS) scores; and (for foot care only) whether the patient had an amputation and a foot neuropathy score adapted from the Michigan Neuropathy Screening Instrument (http://www.med.umich.edu/mdrtc/profs/survey.html#mnsi).

Due to concerns that clinical characteristics might themselves be influenced by self-care, we ran sensitivity analyses excluding these covariates from the model. The estimated associations tended to be larger and more statistically significant when clinical characteristics were excluded, so the estimates presented here should be conservative.

2.5. Statistical analysis

We used (Bayesian) two-part models to estimate time spent on self-care because a large percentage of TRIAD participants reported spending no extra time (Duan *et al.*, 1983). For the first part of the model, we used Bayesian logistic regression to estimate whether any extra time was spent. Let $z_i = 1$ if self-care time for person i is greater than zero and let $z_i = 0$ otherwise:

$$
\begin{aligned}
z_i &\sim \text{Bernoulli}(\pi_i) \\
\ln\left(\frac{\pi_i}{1-\pi_i}\right) &= x_i^{\mathrm{T}}\alpha \qquad (1) \\
p(\alpha) &\propto 1
\end{aligned}
$$

Here π_i is the probability that extra time spent on self-care by person i is greater than zero, x_i is a vector of independent variables for person i, and α is a vector of parameters. An improper,[1] flat prior distribution (which assumes that all outcomes are equally likely) is placed on α.

[1]An improper distribution is one where the probabilities do not integrate to one.

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In the second part of the two-part model, Bayesian Student-t linear regression was used to estimate the amount of time spent on self-care among those who spend any time. We considered several transformations for conditional time spent. The data are skewed to the right and a transformation is needed to make the data more symmetric. Let $g(\cdot)$ denote a one-to-one transformation and define $y_i = g$ (time spent on self-care) for person i if $z_i = 1$. That is, y_i is defined only if extra time spent on self-care is greater than zero. Geweke (1993) showed that the Student-t model for y_i with v degrees of freedom, mean μ_i, and variance σ^2, $y_i \sim t_v(\mu_i, \sigma^2)$ is equivalent to the normal model, $y_i \sim N(\mu_i, \omega_i\sigma^2)$, with a hierarchical prior, $v/\omega_i \sim \chi^2(v)$, for ω_i. Therefore, the Student-t model is a generalization of the normal regression model that allows for non-constant variance. We used the normal-chi-squared representation because it facilitates development of a Gibbs sampler algorithm for simulation of the posterior distribution (Gelman *et al.*, 2004). The second part of the two-part model is thus:

$$\begin{aligned}
&y_i \sim \text{Normal}(\mu_i, \omega_i\sigma^2)\\
&\mu_i = x_i^{\mathrm{T}}\beta\\
&v/\omega_i \sim \chi^2(v)\\
&p(\beta, \sigma^2) \propto 1/\sigma^2\\
&v \sim \text{Uniform}(2, 200)
\end{aligned} \tag{2}$$

Improper, flat priors are used for β and σ^2. Note that as v becomes large, the Student-t model approximates the usual normal regression.

Our first choice for $g(\cdot)$ was the log-transformation, but it sometimes resulted in extremely large posterior predictions. Instead, we considered the following transformations that bounded the retransformed predictions for time spent per day to be between 0 and 12 h:

$$\text{Logistic:}\quad \ln\left(\frac{y/12}{1-y/12}\right)$$

$$\text{Probit:}\quad \phi^{-1}\left(\frac{y}{12}\right)$$

$$\text{Complementary log-log:}\quad \ln\left[-\ln\left(1-\frac{y}{12}\right)\right]$$

$$\text{Loglog:}\quad -\ln\left[-\ln\left(\frac{y}{12}\right)\right]$$

The posterior distribution of the retransformed results was obtained by retransforming the individual draws from the posterior distribution obtained by analyzing the transformed data. To select the best transformation for each outcome and check how well each model fit the data, we conducted posterior predictive checks by replicating the entire data set for each posterior draw of the model parameters and then calculating a test quantity that reflects the relevant aspects of the model. The posterior distribution of the test quantity is then compared with its value from the observed data. Our test quantities were the mean and standard deviation at each level of the SEP measures (five levels for race, four levels for education, and four levels for income). We compared the distribution of these 26 test quantities to the corresponding observed values using the first imputed data set by checking that the middle 95% of the distribution contained the observed values. Posterior predictive checks were conducted for each of the four transformations and all three outcomes separately (a total of 312 test quantities). We selected the logistic transformation for extra time spent checking feet, the probit for extra time spent cooking and shopping for food, and the complementary log–log for extra time spent exercising. The

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transformations selected meet our test criteria, i.e. the middle 95% of the posterior distribution contained the observed values, 100% of the time.

In summary, we used Bayesian logistic regression to predict the probability of spending time on each self-care practice and Bayesian Student-*t* linear regression to predict the number of minutes spent on a self-care activity conditioning on those who reported spending positive non-zero time. Multiplying the probability of spending time on a self-care practice by the conditional number of minutes spent on it provides an estimate of unconditional minutes spent for the whole sample. Predicted values were calculated for each individual, assuming a specific value for the SEP measure of interest but using observed values for all other variables, and averaging over the sample (Graubard and Korn, 1999). Differences in the predictions using different values for the variable of interest, known as predictive margins, were used to summarize the associations of each SEP measure with the dependent variables. We report the means of the posterior distributions for these predictive margins produced by the simulations. Ninety-five percent posterior intervals were used to express the uncertainty in our estimates and to determine statistical significance. These intervals can be interpreted as having a 95% chance of containing the true parameter that we are estimating.

This methodology was used to calculate three estimates from each two-part model, along with 95% posterior intervals. These estimates represent the mean difference between SEP groups in (1) the predicted probability of spending any extra time on the self-care activity, (2) the predicted number of extra minutes spent on the activity, conditional on spending any extra time, and (3) the predicted number of extra minutes spent on the activity averaged over the entire sample. Due to the large number of comparisons, the discussion focuses on broad patterns of results rather than individually significant estimates.

Multiple imputations were used to account for missing data. As recommended by the statistical literature (Allison, 2002; Schafer, 1997; Harrell, 2001; Little, 1992), all dependent as well as independent variables were included in the imputation. The percentage of missing values for individual variables ranged from 0 to 16% (see Table I). Five sets of imputations for the missing data were obtained using a Markov chain Monte Carlo multiple imputation algorithm (Raghunathan *et al.*, 2002). Five complete data sets were then built by combining the observed data with the imputations. Only missing value imputations differ among these data sets. We obtained simulations for each data set using the methods described above and then pooled simulations from the five imputed data sets to obtain our final results (Gelman *et al.*, 2004).

3. RESULTS

3.1. Population characteristics

The patient population was diverse in terms of race/ethnicity, education, and income (Table I). Only 42% of the respondents were white; 17% were African-American, 16% were Latino, 16% were Asian/Pacific Islander, and 9% were other non-white races. Educational achievement was fairly evenly distributed; respectively 23, 30, 28, and 18% had less than a high school education, high school, some college, and at least a four-year college degree. The income distribution also demonstrated a good spread: 29% of the sample earned less than \$15 000 per year in household income, 32% earned between \$15 000 and \$39 999, 24% earned between \$40 000 and \$74 999, and 15% earned \$75 000 or more.

Although a large proportion of patients reported spending extra time on self-care activities because of their diabetes-related health problems, a substantial minority did not (Table II). Respectively 63, 48, and 69% of the sample reported spending extra time on foot care, shopping/cooking, and exercise. Among those who spent extra time on these activities, the mean number of extra minutes spent daily was 13.41 for foot care (SD = 17.42), 49.42 for shopping/cooking (SD = 42.19), and 38.57 for exercise (SD = 44.73). Among the entire sample, including those who reported spending no extra time, the mean

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Table I. Sociodemographic and clinical characteristics of TRIAD participants ($N = 11\,927$)

Characteristic	Percent[a] OR MEAN (SD)
Female (0.01% missing)	53%
Race/ethnicity (7.73% missing)	
Latino	16%
African-American	17%
White	42%
Asian/Pacific Islander	16%
Other	9%
Age group (0.00% missing)	
18–44	12%
45–64	49%
65–74	26%
75 and above	13%
Education (3.40% missing)	
<High school	23%
High school graduate	30%
Some college	28%
≥4 years of college	18%
Annual income (13.16% missing)	
<$15 000	29%
$15 000–$39 999	32%
$40 000–$74 999	24%
>$75 000	15%
Insurance (7.31% missing)	
Has (secondary) medicare insurance	24%
Has (secondary) public insurance (Medicaid, VA, or 'other')	10%
Has (secondary) private insurance	4%
Diabetes medications (0.00% missing)	
Insulin	18%
Insulin plus oral medications	12%
Oral medications only	62%
No medications	8%
Body mass index (3.48% missing)	
Very obese	12%
Obese	41%
Overweight	32%
Normal	16%
Self-assessed health (0.94% missing)	
Excellent or very good	22%
Good	40%
Fair or poor	38%
Years since diabetes diagnosis (6.25% missing)	11.98 (SD = 10.28)
Physical component score (9.23% missing)	43.30 (SD = 7.11)
Mental component score (9.23% missing)	44.84 (SD = 6.65)
Foot symptoms (16.03% missing)[b]	4.93 (SD = 2.48)
Whether had amputation (11.24% missing)[b]	2%

[a]Percentages calculated among those with non-missing data only.
[b]Included in foot care regressions only.

number of extra minutes per day was 8.49 (SD = 15.30) for foot care, 23.78 (SD = 38.29) for shopping/cooking, and 26.42 (SD = 41.13) for exercise.

In summary, about two-thirds of the study patients spent extra time on foot care and exercise because of their diabetes-related health problems. For foot care that requires less time to begin with, not much extra time was spent. In contrast, only about half of the study patients spent extra time on shopping and cooking, but because shopping and cooking tend to be time-consuming, those spending extra time spent almost an extra hour per day on these activities on average. As a result, the mean number of extra minutes spent was almost the same for shopping and cooking as it was for exercise when looking across the entire sample.

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Table II. Self-care behaviors of TRIAD participants

	Percent who spent extra time on self-care activity	Mean extra minutes per day spent on self-care activity, among those spending extra time	Mean extra minutes per day spent on self-care activity, over entire sample
Foot care (16% missing)	63%	13.4 (SD = 17.4) (*N* = 6371)	8.5 (SD = 15.3) (*N* = 10 063)
Shopping and cooking (18% missing)	48%	49.4 (SD = 42.2) (*N* = 4702)	23.8 (SD = 38.3) (*N* = 9772)
Exercise (15% missing)	69%	38.6 (SD = 44.7) (*N* = 6916)	26.4 (SD = 41.1) (*N* = 10 095)

3.2. Relationship of SEP with diabetes self-care activities

3.2.1. Foot care (Table IIIA). After adjusting for observable confounders, members of other racial and ethnic groups, except for Asian/Pacific Islanders, were more likely than whites to report spending extra time on foot care. Furthermore, among respondents reporting extra time, members of minority racial/ethnic groups spent more time than whites. For example, controlling for all of the other covariates in Table I, African-Americans were 10.1 percentage points more likely to report spending extra time on foot care than whites (69.1 vs 59.0%) and among African-Americans and whites who reported spending any extra minutes, African-Americans spent 3.5 more per day than whites did. Across the entire sample, including patients who did not spend extra time on foot care, the predictive margin showed that extra minutes per day spent on foot care were highest among African-Americans (3.6 min more than whites). The comparable estimates were 3.4 min for Latinos, 0.9 min for Asian/Pacific Islanders, and 1.9 min for members of other racial groups, all compared with whites. All of these differences were statistically significant.

After regression adjustment, the extra time spent on foot care was greater among less-educated and lower-income patients, compared with college graduates and higher-income patients. Patients with some college only were more likely to report spending any extra time on foot care than college graduates (64.9 vs 61.2%). In addition, among those spending extra time, the number of extra minutes per day was higher for patients with lower educational attainment and income. The increase in extra minutes spent on foot care among those spending any extra time ranged from 1.3 for those with some college to 3.6 for those with less than a high school education, compared with college graduates; and from 1.9 for those with incomes $40 000–$74 999 to 4.3 for those with incomes under $15 000, compared with those with incomes $75 000 and above. The same patterns were seen for the mean number of extra minutes across the entire sample. For example, all else equal, extra time spent on foot care was predicted to be 2.4 min higher for patients with less than high school education than those with a college degree. Extra minutes per day on foot care would be predicted to be 3.2 min more for patients with income of less than $15 000 per year than those with an income of $75 000 or more.

3.2.2. Shopping/cooking (Table IIIB). The general pattern of results for shopping and cooking was similar to that for foot care. Compared with whites, racial/ethnic minority group members had a higher probability of spending extra time. If they did spend extra time, they tended to spend more of it than whites, although the differences were statistically significant only for African-Americans and Asians. Education was not associated with the probability of spending extra time, but among those who spent extra time, the extra time spent was greater among patients at all levels of education less than college, compared with college graduates. The probability of reporting extra time and the amount of extra time

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Table III. Two-part model results for (A) foot care, (B) shopping and cooking, (C) exercise

(A)[a]	Probability of spending extra time on foot care	Extra time spent on foot care, among those spending extra time	Extra time spent on foot care, over entire sample
Race/ethnicity			
White (reference)	*59.0% (57.1%, 60.8%)*	*11.6 (11.1, 12.1)*	*6.8 (6.5, 7.2)*
Latino	**+10.9% (7.7%, 13.9%)**	**+3.0 (2.0, 4.0)**	**+3.4 (2.6, 4.2)**
African-American	**+10.1% (6.9%, 13.2%)**	**+3.5 (2.5, 4.5)**	**+3.6 (2.8, 4.4)**
Asian/Pacific Islander	+1.2% (−2.5%, 5.0%)	**+1.3 (0.2, 2.4)**	**+0.9 (0.2, 1.7)**
Other	**+4.7% (0.7%, 8.5%)**	**+2.2 (0.9, 3.6)**	**+1.9 (1.0, 2.9)**
Education			
≥4 years of college (reference)	*61.2% (58.6%, 63.7%)*	*11.3 (10.7, 12.0)*	*6.9 (6.5, 7.4)*
Some college	**+3.7% (0.5%, 7.0%)**	**+1.3 (0.5, 2.2)**	**+1.29 (0.7, 1.9)**
High school graduate	+2.3% (−1.1%, 5.6%)	**+2.1 (1.3, 3.0)**	**+1.62 (1.0, 2.3)**
<High school	+1.7% (−2.2%, 5.8%)	**+3.6 (2.5, 4.7)**	**+2.44 (1.6, 3.3)**
Annual income			
\$75 000+(reference)	*63.3% (60.0%, 66.4%)*	*10.3 (9.5, 11.1)*	*6.5 (5.9, 7.1)*
\$40 000–\$74 999	−0.1% (−3.9%, 3.6%)	**+1.9 (1.0, 2.8)**	**+1.2 (0.5, 1.9)**
\$15 000–\$39 999	−0.2% (−5.2%, 1.9%)	**+3.5 (2.3, 4.6)**	**+2.0 (1.2, 2.7)**
<\$15 000	+2.9% (−1.3%, 7.4%)	**+4.3 (3.3, 5.4)**	**+3.2 (2.4, 4.0)**
(B)[a]	Probability of spending extra time shopping and cooking	Extra time spent shopping and cooking, among those spending extra time	Extra time spent shopping and cooking, over entire sample
Race/ethnicity			
White (reference)	*43.4% (41.5%, 45.3%)*	*47.1 (45.9, 49.3)*	*20.4 (19.2, 22.7)*
Latino	**+9.8% (6.5%, 13.1%)**	+2.44 (−1.0, 6.1)	**+5.9 (3.7, 8.3)**
African-American	**+10.5% (7.0%, 13.9%)**	**+5.1 (1.5, 8.8)**	**+7.7 (5.3, 10.2)**
Asian/Pacific Islander	**+7.0% (3.0%, 10.7%)**	**+4.5 (0.1, 9.0)**	**+5.6 (2.8, 8.3)**
Other	**+5.8% (1.1%, 10.0%)**	+2.8 (−1.4, 7.0)	**+4.1 (1.1, 7.0)**
Education			
≥ 4 years of college (reference)	*47.5% (44.8%, 50.1%)*	*43.5 (40.9, 46.2)*	*20.7 (19.0, 22.3)*
Some college	0.8% (−2.5%, 4.1%)	**+5.1 (2.0, 8.3)**2	**+2.8 (0.8, 4.9)**
High school graduate	0.1% (−3.1%, 3.2%)	**+6.8 (3.3, 10.2)**	**+3.3 (1.1, 5.4)**
<High school	+3.8% (−0.1%, 7.8%)	**+9.4 (5.3, 13.3)**	**+6.5 (3.8, 9.0)**
Annual income			
\$75 000+(reference)	*40.2% (37.1%, 43.1%)*	*42.4 (39.3, 45.8)*	*17.0 (15.2, 18.9)*
\$40 000–\$74 999	**+5.3% (1.8%, 8.9%)**	**+6.3 (2.6, 10.0)**	**+5.1 (2.9, 7.3)**
\$15 000–\$39 999	**+9.0% (5.3%, 12.6%)**	**+7.3 (3.1, 11.2)**	**+7.4 (5.0, 9.7)**
<\$15 000	**+15.1% (11.2%, 19.1%)**	**+8.9 (4.4, 13.1)**	**+11.3 (8.6, 14.1)**
(C)[a]	Probability of spending extra time on exercise	Extra time spent on exercise, among those spending extra time	Extra time spent on exercise, over entire sample
Race/ethnicity			
White (reference)	*65.8% (64.1%, 67.4%)*	*39.1 (37.6, 40.8)*	*25.7 (24.6, 27.0)*
Latino	**+4.8% (1.9%, 7.8%)**	−0.5 (−3.1, 2.1)	+1.6 (−0.5, 3.6)
African-American	**+6.1% (3.3%, 9.0%)**	+0.8 (−1.9, 3.5)	**+3.0 (0.8, 5.2)**
Asian/Pacific Islander	+3.6% (0.0%, 7.1%)	**−3.6 (−6.3, −1.0)**	−1.1 (−3.4, 1.1)
Other	+1.0% (−2.9%, 4.8%)	+1.5 (−1.5, 4.6)	+1.4 (−1.1, 4.0)
Education			
≥ 4 years of college (reference)	*71.5% (69.1%, 73.9%)*	*37.7 (36.0, 39.6)*	*27.0 (25.5, 28.5)*
Some college	−1.9% (−4.8%, 0.8%)	+1.6 (−0.7, 3.9)	+0.4 (−1.6, 2.3)
High school graduate	**−4.2% (−7.3%, −1.0%)**	+1.0 (−1.3, 3.3)	−0.9 (−2.9, 1.1)
< High School	**−5.4% (−9.1%, −1.8%)**	+0.1 (−2.7, 2.8)	−2.0 (−4.3, 0.3)
Annual income			
\$75 000+(reference)	*68.7% (66.0%, 71.4%)*	*38.2 (36.1, 40.3)*	*26.2 (24.5, 28.0)*
\$40 000–\$74 999	−2.5% (−6.0%, 0.8%)	+1.9 (−0.8, 4.5)	+0.3 (−1.9, 2.5)
\$15 000–\$39 999	−1.1% (−4.4%, 2.2%)	+0.3 (−2.3, 2.9)	−0.2 (−2.4, 2.1)
<\$15 000	+2.3% (−1.2%, 6.0%)	−0.5 (−3.3, 2.2)	+0.5 (−1.9, 2.9)

[a]Bold denotes significance at $\alpha = 0.05$. Regression estimates control for fixed health plan effects and all patient characteristics presented in Table I. Table displays risk differences or predictive margins and (in parentheses) 95% posterior intervals. Italicized numbers are the predicted probabilities or number of minutes among the reference group.

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among those who spent any were both higher among individuals with an annual income below $75 000, compared with those with incomes of $75 000 or more.

As a result, the extra time spent shopping and cooking each day as a result of their diabetes-related health problems was greater among minority group members, less-educated patients, and patients with lower incomes, controlling for the other covariates in the model. For example, on average the extra minutes spent were 7.7 more for African-Americans than whites, 6.5 more for patients with less than a high school education than college graduates, and 11.3 more for patients with less than $15 000 per year income than those with at least $75 000.

3.2.3. Exercise (Table IIIC). Fewer significant associations were found between the SEP measures and extra time exercising. Latinos and African-Americans had, respectively, 4.8 and 6.1 percentage points higher probabilities than whites of spending extra time exercising due to their diabetes-related health conditions, and Asians spent 3.6 fewer extra minutes exercising than whites when they spent any extra time. However, over the entire sample, the extra time spent on exercise was predicted to be significantly greater (by 3.0 min) only for African-Americans vs whites. Patients with a high school or less than high school education had about 5 percentage points lower probability of spending extra time exercising than college graduates. However, these effects were offset by (insignificant) associations of lower education with higher numbers of minutes among those spending extra time, so that over the entire sample, education was not significantly associated with extra time spent exercising. Income showed no noteworthy associations with extra time exercising.

3.3. Sensitivity analyses

When analyzing the impact of household income, we were unable to adjust for household size, because this question was not included in the initial TRIAD survey. However, a sensitivity analysis that controlled for subsequent marital status did not change the findings. We also explored whether SEP differences in time spent on activities such as shopping and cooking might arise because of transportation barriers faced by low-SEP patients. Interestingly, we found that while low-SEP patients reported more serious problems with access to supermarkets and exercise facilities, they were actually less likely to report having problems with access to transportation. Unfortunately, our data set did not allow a detailed examination of this issue.

We also investigated the possibility that low-SEP patients were more likely to have been exposed to diabetes education (e.g. through programs for low-income patients) and hence had greater knowledge of the self-care behaviors recommended for diabetes. Cross-tabulations revealed the opposite; the high-SEP patients were generally more likely to report having received any diabetes education.

Finally, our initial analyses examined whether days worked per week might mediate the associations between SEP and self-care time. Days worked sometimes had a significant relationship with self-care time, but inclusion of this variable in the model did not change our conclusions regarding the associations between time spent and SEP. Days worked is admittedly an imperfect measure of the opportunity cost of the patient's time, particularly if lower-SEP patients do not have flexibility in their work hours. Nonetheless, the lack of a strong mediating effect suggests that the SEP gradient in diabetes self-care activities is explained by more than just competing demands from employment.

4. DISCUSSION

Using diabetes as a prototypical example of a chronic disease requiring a substantial investment of time in self-care, we identified numerous socioeconomic differences (see Appendices B–D for

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summary of the findings). On average, after controlling for observable demographic and clinical characteristics, the extra time spent on foot care and shopping/cooking because of diabetes-related health problems was greater for traditionally disadvantaged groups, e.g. racial/ethnic minorities, poorly educated, and low-income patients. Although there were few significant associations of extra time spent exercising with SEP, the one significant finding for the unconditional sample (greater overall amount of extra time spent by African-Americans vs whites) was consistent with the results for foot care and shopping/cooking.

When differences in the extra time spent on self-care were statistically significant, they were often clinically meaningful as well, with differences as large as one-quarter to one-half of the baseline values. Another way to think about the magnitude of the effects is in comparison with the time health educators estimated it would take patients with diabetes to perform recommended self-care activities. For example, the estimated amount of time it would take patients to perform the foot care recommended by diabetes self-management is about 10 min (Russell *et al.*, 2005); among our sample, white patients were predicted to spent only 6.8 min extra on this task on average, while Latino patients were predicted to spend 10.2 min extra. The 'extra time' spent on foot care is likely to reflect total time, since patients are unlikely to spend substantial amounts of time on foot care except as part of diabetes self-care. Thus, in some cases, the increased time spent on diabetes self-care among lower-SEP groups could mean the difference between meeting and not meeting recommended clinical targets.

Although our findings might be unusual in the disparities literature, they are consistent with economic models of how patients choose the time they invest in their own health production. Higher opportunity costs of time might explain why the highest-SEP patients, who likely have the fewest barriers to self-care in terms of knowledge or ability to carry out these tasks, are the least likely to report spending any additional time on self-care as a result of their diabetes. The opportunity cost theory suggests that higher-SEP patients spend less extra time on self-care because they earn higher wages, so on the margin it is more costly to them to cut back on their work hours to spend time on other activities, including self-care. Our speculation that extra self-care time is lower among high-SEP patients because of higher time costs is consistent with conclusions from a study in which a randomized lifestyle intervention program for obese patients with diabetes yielded greater weight loss for less-educated patients (Gurka *et al.*, 2006). The educational differences were partly due to differential weight regain, hypothesized by the authors to be associated with cessation of physical activity.

An alternative explanation is that high-SEP patients are better able to purchase services that substitute for their own self-care time, e.g. healthy pre-made meals or podiatrist visits. They might also be more efficient in their use of time; for example, better-educated patients might understand better how to care for their feet and hence require less time to do it. That is, the 'quality', not just 'quantity', of time spent on self-care is likely to be important. Although the focus of our paper is on socioeconomic differences, it is also interesting to ask whether patients with diabetes are spending sufficient time on self-care overall. Among patients who spend extra time on self-care activities due to diabetes, the mean extra time reported corresponds surprisingly closely to previous estimates of how long such activities should take (UKPDS, 1998b). Yet a disturbingly high proportion of patients (37% for foot care, 52% for shopping and cooking, and 31% for exercise) do not report spending any extra time on these activities. With one exception, the probability of spending extra time tended to be higher for low-SEP groups.

These results must be interpreted in light of the question asked, namely, the *extra* time spent on self-care activities due to diabetes-related health problems, *not* the total time spent on these activities. For example, higher-SEP patients may have already spent a substantial amount of time on foot care, cooking healthy foods, or exercise before they were diagnosed with diabetes. If so, they might be less inclined to attribute part of the time to their diabetes-related health problems, accounting for their lower 'extra' time spent on these activities. Better-educated patients may also be more likely to interpret the question correctly and report only the 'extra' and not 'total' time spent. If these arguments are valid, however, one might expect that the association between low SEP and more self-care time would be strongest for activities that, in the absence of diabetes, might appeal more strongly to high-SEP patients (e.g. exercise). The associations should be weakest for activities that people without diabetes are unlikely to engage in regularly (e.g. foot care), or activities that might have a greater cultural appeal to low-SEP patients (e.g. shopping and cooking for racial/ethnic minority group members). This is the opposite of the observed pattern of results, however, which indicated SEP differences that were smaller (and sometimes of opposite sign) for exercise than for foot care or shopping/cooking.

Our findings should be interpreted in light of certain study limitations. First, although TRIAD is among the largest multi-site studies of patients with diabetes ever conducted, it was not designed to be nationally representative. In particular, it focused on managed care patients, who might have better access to services. Second, we do not know whether the inverse relationship between SEP and self-care time would persist across a broader range of activities. Third, self-reported time is prone to measurement error. However, random measurement error tends to bias estimated effects toward zero and to attribute our results to systematic reporting bias, one would have to argue that patients who are minority group members, less-educated, and lower-income systematically over-report time spent on self-care activities relative to patients who are white, better-educated, and higher-income. Although we cannot rule out this possibility, social desirability theory suggests that over-reports of self-care may be more likely among higher-SEP patients (who may be better-informed about diabetes self-care practices).

Finally, unmeasured severity of illness might confound our findings if disadvantaged patients have worse health problems. Nevertheless, the study controlled for several clinical characteristics, including widely validated health status measures such as the PCS. Thus, the strength of bias is unlikely to be sufficient to reverse the direction of effect to conform to the conventional expectation of poorer self-care in lower-SEP patients. Similarly, it is possible that high-SEP patients had greater caregiver support and hence less need to spend their own time on self-care. However, controlling for marital status (arguably the most important source of informal care) did not alter our conclusions. Another sensitivity analysis provided little support for the argument that the extra time spent by low-SEP patients is due to transportation barriers, although the data for examining this issue were too limited to definitively rule out this possibility.

One explanation worth considering is that socioeconomically vulnerable patients might have more exposure to friends and relatives who suffered diabetes complications, and that this experience provides them with greater motivation to take care of themselves. Alternatively, disadvantaged patients may be attempting to compensate for having worse access to formal care by increasing the amount of extra time they spend trying to take care of their diabetes on their own. Regardless of the explanation, our findings imply that disparities in outcomes that might otherwise result from access barriers may be attenuated as a result of greater self-care by disadvantaged patients.

The literature summarized in the introduction suggests that socioeconomically vulnerable patients with diabetes are more likely to have poorly controlled risk factors. These observations could lead to the conjecture that self-care practices might explain the disparities. For example, less advantaged patients may lack the requisite knowledge or have more pressing problems to deal with in their lives, leading to less engagement in self-care behaviors. However, in our study, lower-SEP patients were as, or more, likely to spend extra time on self-care than higher-SEP patients, both because they were more likely to report spending any extra time and because when they reported spending any extra time, they spent more of it. The fact that extra time spent was higher, rather than lower, suggests that alternative explanations may be needed for why disadvantaged patients have worse risk factors.

The self-care literature, although large, has devoted almost no attention to the time required to perform self-care, even though time itself is likely to pose one of the biggest barriers to adopting these

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practices. The importance of self-care in the overall management of chronic conditions makes it essential to understand better how much time patients devote to self-care tasks and what influences their decisions. For these reasons, future studies of chronically ill populations should routinely measure self-care time.

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DISCLOSURES

None

DISCLAIMERS

The findings and conclusions in this report are solely the responsibility of the authors and do not necessarily represent the official views of The Centers for Disease Control and Prevention and the National Institute of Diabetes and Digestive and Kidney Diseases.

APPENDIX A: THE TRANSLATING RESEARCH INTO ACTION FOR DIABETES (TRIAD) STUDY GROUP

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APPENDIX B: SUMMARY OF FINDINGS – FOOT CARE

Model	Minority groups	Education	Annual household income
Spent any extra time?			
Baseline specification	All minority groups except Asians more likely than whites to spend extra time on foot care	Patients with some college more likely to spend extra time than college graduates	No significant differences by income
With marital status	Same as baseline model	Same as baseline model	Same as baseline model
With days worked	Same as baseline model	Same as baseline model	Same as baseline model
Without clinical characteristics	All minority groups except Asians and others more likely than whites to spend extra time on foot care	Same as baseline model	Patients with income $<\$15$ K more likely than those with income $\geq\$75$ K to spend extra time
For those who spent extra time, how much extra time was spent?			
Baseline specification	Extra time spent on foot care is greater for all minority groups than for whites	Extra time spent is greater for patients with <college degree than for college graduates	Extra time spent is greater for patients with $<\$75$ K income than for those with income $\geq\$75$ K
With marital status	Same as baseline model	Same as baseline model	Same as baseline model
With days worked	Same as baseline model	Same as baseline model	Same as baseline model
Without clinical characteristics	Extra time spent on foot care is greater for all minority groups except Asians than for whites	Same as baseline model	Same as baseline model
Among entire sample, how much extra time was spent?			
Baseline specification	Extra time spent on foot care is greater for all minority groups than for whites	Extra time spent is greater among patients with <college degree than college graduates	Extra time spent is greater among patients with $<\$75$ K annual household income than those with $\geq\$75$ K
With marital status	Same as baseline model	Same as baseline model	Same as baseline model
With days worked	Same as baseline model	Same as baseline model	Same as baseline model
Without clinical characteristics	Extra time spent on foot care is greater for all minority groups except Asians than for whites	Same as baseline model	Same as baseline model

Minority categories: Latino, African-American (abbreviated AA), Asian/Pacific Islander (abbreviated Asian), other; reference group is whites. **Education categories**: less than high school, high school graduate, some college, college graduate (reference group). **Income categories**: less than \$15 000, \$15 000–\$39 999; \$40 000–\$74 999; \$75 000 or higher (reference group).

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APPENDIX C: SUMMARY OF FINDINGS – SHOPPING AND COOKING

Model	Minority groups	Education	Annual household income
Spent any extra time?			
Baseline specification	All minority groups are more likely to spend extra time shopping and cooking than whites	No significant differences by education	Patients with $<\$75$ K income less likely to spend extra time than those with $\geq\$75$ K
With marital status	Same as baseline model	Patients with <high school education more likely to spend extra time than college graduates	Same as baseline model
With days worked	All minority groups (except other races) more likely to spend extra time than whites	Same as baseline model	No significant differences by income
Without clinical characteristics	Same as baseline model	Same as baseline model	Same as baseline model
For those who spent extra time, how much extra time was spent?			
Baseline specification	Extra time spent shopping and cooking is greater for AAs and Asians than for whites	Extra time spent is greater for patients with <college degree than for college graduates	Extra time spent is greater for patients with $<\$75$ K income than for those with $\geq\$75$ K
With marital status	Extra time spent shopping and cooking is greater for AAs than whites	Same as baseline model	Same as baseline model
With days worked	Same as baseline model	Same as baseline model	Same as baseline model
Without clinical characteristics	Same as baseline model	Same as baseline model	Same as baseline model
Among entire sample, how much extra time was spent?			
Baseline specification	Extra time spent shopping and cooking is greater for all minority groups than for whites	Extra time spent is greater for patients with <college degree than for college graduates	Extra time spent is greater for patients with $<\$75$ K income than for those with $\geq\$75$ K
With marital status	Same as baseline model	Same as baseline model	Same as baseline model
With days worked	Same as baseline model	Extra time spent is greater for patients with <high school or some college than for college graduates	Same as baseline model
Without clinical characteristics	Same as baseline model	Same as baseline model	Same as baseline model

Minority categories: Latino, African-American (abbreviated AA), Asian/Pacific Islander (abbreviated Asian), other; reference group is whites. **Education categories**: less than high school, high school graduate, some college, college graduate (reference group). **Income categories**: less than \$15 000, \$15 000–\$39 999; \$40 000–\$74 999; \$75 000 or higher (reference group).

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APPENDIX D: SUMMARY OF FINDINGS – EXERCISE

Model	Minority groups	Education	Annual household income
Spent any extra time?			
Baseline specification	Latinos and AAs more likely than whites to spend extra time exercising	College graduates more likely to spend extra time than those with high school education or less	No significant differences by income
With marital status	Same as baseline model	Same as baseline model	Same as baseline model
With days worked	Latinos, AAs and Asians more likely than whites to spend extra time exercising	Same as baseline model	Same as baseline model
Without clinical characteristics	Latinos, AAs and Asians more likely than whites to spend extra time exercising	College graduates more likely to spend extra time than those who did not graduate from college	Patients with income ≥$75 K more likely to spend extra time than those with income $15–75 K
For those who spent extra time, how much extra time was spent?			
Baseline specification	Asians spend less extra time exercising than whites	No significant differences by education	No significant differences by income
With marital status	Same as baseline model	Same as baseline model	Same as baseline model
With days worked	Same as baseline model	Same as baseline model	Same as baseline model
Without clinical characteristics	No significant differences by minority group	Same as baseline model	Same as baseline model
Among entire sample, how much extra time was spent?			
Baseline specification	Extra time spent exercising is greater for AAs than for whites	No significant differences by education	No significant differences by income
With marital status	Same as baseline model	Same as baseline model	Same as baseline model
With days worked	Same as baseline model	Extra time spent is greater for college graduates than those with less than a high school degree	Same as baseline model
Without clinical characteristics	Extra time spent exercising is greater for AAs and Latinos than for whites	Extra time spent is greater for college graduates than those with a high school education or less	Extra time spent is greater for those with income ≥$75 K than for those with income $40 K or less

Minority categories: Latino, African-American (abbreviated AA), Asian/Pacific Islander (abbreviated Asian), other; reference group is whites. **Education categories**: less than high school, high school graduate, some college, college graduate (reference group). **Income categories**: less than $15 000, $15 000–$39 999; $40 000–$74 999; $75 000 or higher (reference group).

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