Socio-Clinical Correlations with Threat Perception and Self-Efficacy in People with Type 2 Diabetes

Jianli Hu, MD, PhD[1], Sarah Bauerle Bass, PhD, MPH[2], Deborah Swavely, DNP, RN[3], Yaara Zisman-Ilani, PhD, MA[2,4], Sophia K. Chen, BS[5], Sarah Kim, BS[5], Patrick JA Kelly, MPH[6], Ariel Hoadley, MPH[2], and Daniel J. Rubin, MD, MSc[1, *]

[1]Section of Endocrinology, Diabetes, and Metabolism, Lewis Katz School of Medicine, Temple University, Philadelphia, PA;

[2]Department of Social and Behavioral Sciences, College of Public Health, Temple University, Philadelphia, PA;

[3]Nursing Clinical Inquiry and Research, Tower Health, West Reading, PA;

[4]Department of Clinical, Educational and Health Psychology, Division of Psychology and Language Sciences, University College London (UCL), London, UK;

[5]Lewis Katz School of Medicine, Temple University, Philadelphia, PA;

[6]Department of Behavioral Social Sciences, Brown University School of Public Health, Providence RI.

*Corresponding Author, Email: Daniel.Rubin@tuhs.temple.edu

Abstract

Introduction Medically underserved people perform suboptimal type 2 diabetes (T2D) self-care, which contributes to worse diabetes control and higher complication rates. A better understanding of how beliefs about self-efficacy and the threat of diabetic complications affect self-management behavior may be informative to develop more effective interventions.

Research Design and Methods The Extended Parallel Processing Model (EPPM), a theoretical framework of perceived efficacy and disease threat, was used in a cross-sectional study to categorize 168 adults with T2D from urban safety-net clinics and the local community by self-efficacy and perceived threat from T2D and cardiovascular disease. The EPPM model offers four categories: high threat (HT)/high efficacy (HE), low threat (LT)/low efficacy (LE), HT/LE, and LT/HE. Participant demographic information, complications, medications, and other characteristics were compared across the EPPM groups.

Results The sample included 168 participants, of which 76% were Black, 16% were Hispanic, and 7% were White. HT/LE people had the lowest medication adherence ($p<0.01$), the lowest T2D management score ($p<0.0001$), the highest A1C numerically ($p=0.10$), and the most microvascular complications relative to other EPPM groups ($p<0.01$). Gender, Race/Ethnicity, education, and health insurance did not vary among EPPM groups.

Conclusions The EPPM is associated with T2D clinical outcomes and self-management behaviors. Moving people from HT/LE to LT/HE may improve T2D management. This model may be useful to target people with T2D for behavioral intervention.

Summary Box

What is already known on this topic?

EPPM is an effective model to understand the beliefs and self-management behaviors of people with T2D. In the current study, we used EPPM to categorize 168 adults with T2D from urban safety-net clinics and the local community and compare clinical and sociodemographic characteristics among different EPPM categories.

What this study adds?

We have identified different characteristics among EPPM categories, which validates this model as a clinically useful way to sort people with T2D and identify low-efficacy people who may benefit from additional self-management training.

How this study might affect research, practice or policy?

EPPM is associated with clinical outcomes and self-management behaviors among people with T2D. This model may be an effective framework to target people with T2D most likely to benefit from behavioral intervention.

Type 2 diabetes mellitus (T2D) has rapidly become one of the most common chronic diseases globally, ranking as a major cause of age-standardized years lived with disability[1]. Over 11% of the US population had diabetes as of 2019 [2]. T2D disproportionately affects medically underserved populations such as racial/ethnic minorities and those with low income [3]. These populations have increased diabetes prevalence, worse diabetes control, and higher rates of diabetic complications [4 5]. Low health literacy, unmet social needs, and mistrust of the healthcare system contribute to these healthcare disparities [6]. There is an urgent need to address these disparities to improve suboptimal T2D management.

Interventions targeting diabetes self-management may improve short-term outcomes, but systematic reviews are mixed. One systematic review included 118 unique interventions and found that 61.9% reported significant improvements in HbA1C [7]. Another systematic review and meta-analysis of randomized controlled trials (RCTs) [8] showed that educational interventions increase diabetes knowledge and potentially improve glycemic control levels in people with type 2 diabetes despite heterogeneity across studies. Another systematic review by Winkley K. et al. [9] suggested that psychological interventions improved dietary behavior and quality of life, yet offered minimal clinical benefit in improving HbA1c levels, blood pressure, body mass index or depressive symptoms.

Unfortunately, psychological and socioeconomic barriers to attending diabetes education and engaging in treatments are significant challenges [10]. Some research has shown that attention to these barriers, however, may improve the efficacy of diabetes education. Hawthorne et al. [11] conducted systematic review with meta-analysis of 10 RCTs and found that culturally appropriate health education was more effective than usual health education in improving HbA1c levels and knowledge in the short to medium term for people with diabetes from ethnic minority groups. The same group of researchers [12] analyzed 33 RCTs and reached the same conclusion. One study focused on the minority immigrant Korean Americans and examined their challenges in diabetes self-management [13]. The study suggested that providing diabetes education at the community level is important to raise public awareness of diabetes and to eliminate social stigma.

Moreover, it is appropriate to include the entire family in diabetes educational programs to facilitate family support for individuals with type 2 diabetes.

To address disparities in T2D self-management in medically underserved populations, a better understanding of how beliefs about the threat of diabetic complications and self-efficacy affect self-management behavior may be informative. In order to explore these relationships, we applied the Extended Parallel Processing Model (EPPM), a theoretical framework used in health risk communication [14] (Figure 1). EPPM describes how rational considerations like beliefs about efficacy interact with emotions such as fear of a health threat to determine behavior. It has been applied to understand behavior in several healthcare contexts, such as managing fear and promoting HIV/AIDS prevention, smoking cessation, and COVID-19 prevention [15-17]. Previously, EPPM was used by our group to evaluate the self-management of T2D in a qualitative study [18], showing that EPPM is an effective model to understand the beliefs and self-management behaviors of people with T2D. That small study suggested potential clinical and sociodemographic differences across EPPM groups that warranted further investigation.

In the current study, we used EPPM to categorize 168 adults with T2D from urban safety-net clinics and the local community. The aim was to compare clinical and sociodemographic characteristics among EPPM categories. Identifying different characteristics among EPPM categories may validate this model as a clinically useful way to sort people with T2D and identify low-efficacy people who may benefit from additional self-management training.

Methods

Study Design, Setting, and Population

This was a cross-sectional study of people with T2D who were patients in a Temple University Hospital (TUH) ambulatory practice and/or lived near TUH in North Philadelphia. Data were collected between November 2019 – May 2022. TUH is the safety-net hospital for the region, in which 45% of residents live below the poverty level [19]. Eligible participants were: (1) English-speaking, (2) age 18 years or older, (3) diagnosed with T2D, (4) living in the primary service area for TUH as identified by zip code, and (5) receiving ambulatory care at Temple Endocrinology, Internal Medicine, or Family Medicine at the TUH-Main campus, or participating in the Temple Health Block-by-Block (THB^3) community cohort [20]. THB^3 was a prospective cohort of local residents designed to facilitate research in community dwellers. About 40% of THB^3 participants had at least one clinical encounter with a Temple healthcare provider documented in the electronic health record. Enrolling participants from the community setting partially mitigates selection bias from only including participants from a clinic setting.

Ethics Statement

This study was reviewed and approved by Temple University Institutional Review Board (Protocol No. 26007). Participants provided written informed consent.

Variables and Data Collection

Participants were administered a series of questionnaires by a research assistant in-person or by phone. Diabetes self-efficacy was assessed with the validated 8-item Diabetes Empowerment Scale-Short Form (DES-SF) [21], and categorized as high efficacy (≥35) or low efficacy (<35) based on the median score of 35. Each item was rated on a 5-point Likert scale, yielding a potential score range of 8 to 40. Perceived threat was assessed with a single-item measure adapted from Witte's Risk Behavior Diagnosis Scale for measuring EPPM constructs: “Compared to most people your age and sex, what would you say your chances are of having future heart and other health problems are because you have diabetes and/or heart problems?” [22]. This item was scored on a 4-point Likert scale (Much lower, Lower, Higher, or Much higher) and categorized as low threat or high threat. Participants were then classified into one of four groups according to EPPM as high threat (HT)/high efficacy (HE), low threat (LT)/low efficacy (LE), HT/LE, and LT/HE.

Medication adherence was assessed with the 5-item Medication Adherence Report Scale (MARS-5) [23]. The total score range is between 5 and 25, with higher scores representing higher diabetes medication adherence. T2D self-management behaviors were assessed with the T2D Management Scale, an adaptation of the Illness Management and Recovery Scale (IMRS) [24-26], originally developed for people with serious mental illness. Diabetes knowledge was assessed with the Diabetes Knowledge Test (DKT2) [27]. The Brief Health Literacy Screen (BHLS) was used to assess subjective health literacy, with higher scores representing higher literacy in the possible score range of 3 to 15 [28]. Sociodemographic data including gender, race/ethnicity, age, education level, and type of health insurance were self-reported. Medical history (diabetes duration, diabetic complications), prescription of medications (statins, anti-hypertensive agents, insulin), body weight, height, and most recent HbA1c result were extracted from the electronic health record or self-reported.

Statistical Analysis

Categorical variables were presented as counts and percentages. Continuous variables were presented as mean ± standard deviation for normally distributed variables or median [interquartile range, iQR] for non-normally distributed variables. The primary outcome was HbA1c level and all other characteristics were secondary outcomes. All variables were compared across EPPM groups. Categorical variables were analyzed by Fisher's exact test or Chi-square as appropriate for cell count and distribution. Continuous variables were analyzed by parametric or non-parametric ANOVA analysis followed by post-hoc tests if the initial p-value was <0.05. All statistical analyses were conducted using GraphPad Prism 9.4.1. A p-value <0.05 was considered statistically significant.

Results

Participant Characteristics

A total of 376 people were approached for participation, of whom 178 provided consent. After exclusion of 10 participants for missing data, 168 participants were included in the analysis, of whom 73 were recruited from an ambulatory practice and 95 were community dwellers. More than two-thirds (68%) of participants were female, and three-quarters (76%) were Black (Table 1). Most participants (82%) had at least a high school or equivalent education, and most (75%) had Medicaid or Medicare insurance. The mean age of participants was 61.6 years, the median diabetes duration was 13.5 years [6.9-21.8], BMI was 33.5 [29.0-37.6], and HbA1c was 8.0% [6.8-9.3%]. Nearly half (48%) were using insulin. On average, self-reported medication adherence was good (MARS-5 Score 23 [21-25]) and health literacy was moderate (BHLS 8 [6-10]).

Table 1 Characteristics of Participants with Type 2 Diabetes Based on EPPM

	Total, N = 168
Variables	**n, %**
Female	113, 68%
Race/ Ethnicity	
Black	127, 76%
Hispanic	27, 16%
White	11, 7%
Others[a]	2, 1%
School	
Less than high school	30, 18%
Finished high school or GED	69, 42%
College[b]	66, 40%
Health Insurance	
Private	30, 18%
Medicare	62, 37%
Medicaid	64, 38%
Unknown/blank/no insurance	12, 7%
Microvascular complications	80, 49%
Macrovascular complications	57, 35%
Statin	118, 70%
Blood pressure medication	122, 73%
Insulin	80, 48%
Variables	**Mean (SD) or Median [iQR]**
Age, years	61.6 (11.7)
MARS-5 Score	23 [21-25]
DKT Score	61 [48-70]
T2DM Management Score	3.8 (0.5)
Brief Health Literacy Score	8 [6-10]
Weight, kg	90.7 [80.4-106.2]
BMI, kg/m^2	33.5 [29.0-37.6]
Diabetes duration, years	13.5 [6.9-21.8]
HbA1C, %	8.0 [6.8-9.3]

M: Mean or Median; iQR: lower quartile and upper quartile; MARS-5: Medication Adherence Report Scale; DKT: Diabetes Knowledge Test; BMI: Body Mass Index; Others[a]: Asian or Pacific Island, Native American or Alaska Native, Multiracial/Multiethnic; College[b]: Technical/vocational/community college + Some college + College or above

Participant Characteristics by EPPM Group

There were 56 participants in HT/HE group, 54 in HT/LE group, 30 in LT/HE group, and 28 in LT/LE group (Table 2). Although HbA1c was not statistically significantly different across EPPM groups (p=0.10), the value was highest in the HT/LE group (8.6 [7.3-9.8]) and lowest in the LT/LE group (7.2 [6.5-9.1], Figure 2A), a difference of 1.4%. There were, however, statistically significant or borderline significant differences in some characteristics among EPPM groups, including medication adherence (p=0.007), T2D Management score (p<0.001), the prevalence of microvascular complications (p=0.007), and use of blood pressure medication (p=0.05).

Respondents in the HT/LE group had the lowest medication adherence (23 [19.8-23.3]; Figure 2B) and T2D management score (3.5 $\pm$ 0.5; Figure 2C), the most microvascular complications (63%, p=0.007; Figure 2D), and greatest use of blood pressure medications (85%, p=0.05; Figure 2E). In contrast, respondents in LT/HE group had the highest medication adherence (25 [23-25], p=0.007; Figure 2B) and T2D management score (4.2 $\pm$ 0.4, p<0.001; Figure 2C), the least microvascular complications (29%, p=0.007; Figure 2D), and relatively low use of blood pressure medications (63%, p=0.054; Figure 2E). Even though T2D management scores and medication adherence were significantly different across EPPM groups, diabetes knowledge and health literacy did not vary by EPPM group. Likewise, there were no significant differences in age, gender, race/ethnicity, education level, health insurance, weight, BMI, and diabetes duration.

Table 2 Comparisons of Participants with Type 2 Diabetes Based on EPPM

	Comparison of EPPM Groups								
	High Threat / High Efficacy		High Threat / Low Efficacy		Low Threat / High Efficacy		Low Threat / Low Efficacy		Analysis
	n = 56		n = 54		n = 30		n = 28		
Variables	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	***p***
Female	38	68%	34	64%	21	70%	20	71%	0.91
Race/ Ethnicity									
Black	38	68%	39	74%	25	83%	25	89%	
Hispanic	9	16%	12	23%	4	13%	2	7%	0.31[c]
White	8	14%	1	2%	1	3%	1	4%	
Others[a]	1	2%	1	2%	0	0%	0	0%	
School									
Less than high school	12	21%	6	12%	4	13%	8	29%	
Finished high school or GED	20	35%	22	44%	15	50%	12	43%	0.43
College[b]	25	44%	22	44%	11	37%	8	29%	
Health Insurance									
Private	9	16%	9	17%	9	30%	3	11%	
Medicare	18	32%	17	31%	14	47%	13	46%	0.31[d]
Medicaid	24	43%	22	41%	7	23%	11	39%	
Unknown/blank/no insurance	5	9%	6	11%	0	0%	1	4%	
Microvascular complications	29	54%	34	63%	8	29%	9	33%	0.007
Macrovascular complications	21	40%	22	41%	5	18%	9	35%	0.18
Statin use	40	71%	39	72%	16	53%	23	82%	0.11
Blood Pressure meds	40	71%	46	85%	19	63%	17	61%	0.05
On Insulin	27	48%	31	57%	11	37%	11	39%	0.23
Variables	**M**	**SD or iQR**	**M**	**SD or iQR**	**M**	**SD or iQR**	**M**	**SD or iQR**	***p***
Age, years	59.8	11.7	60.4	12.1	62.4	11.7	66.4	9.9	0.08
MARS-5 Score	23.0	20-25	23	19.8-23.3	25	23-25	23	21.3-24	0.007
DKT Score	63.0	52-73	61	48-78	57	46.8-71	57	48-68.8	0.41
T2DM Management Score	3.9	0.4	3.5	0.5	4.2	0.4	3.6	0.4	<0.001
Brief Health Literacy Score	8.0	7-10	8	6-10	8	7-9	8	6-9.8	0.50
Weight, kg	90.7	82.6-105.3	92.7	80.6-110.0	88	79.0-100.0	86.6	73.8-112.2	0.63
BMI, kg/m^2	33.7	29.7-38.5	33.5	29.7-37.7	33.9	27.2-35.9	29.8	26.8-38.4	0.30
Diabetes Duration, years	11.5	4.9-19.7	15	6.8-21.8	16.8	9.7-24.5	13.1	7.8-23.4	0.30
HbA1C, %	7.6	6.7-9.0	8.6	7.25-9.8	7.5	6.5-9	7.2	6.5-9.1	0.097

M: Mean or Median; iQR: lower quartile and upper quartile; MARS-5: Medication Adherence Report Scale; DKT: Diabetes Knowledge Test; BMI: Body Mass Index; Others[a]: Asian or Pacific Island, Native American or Alaska Native, Multiracial/Multiethnic; College[b]: Technical/vocational/community college + Some college + College or above; c: White and Others are excluded from statistical analysis due to small cell size; d: Unknown/blank/no insurance are excluded from statistical analysis due to small cell size.

Discussion

This cross-sectional study describes a novel application of the EPPM in a sample of 168 mostly racial/ethnic minority adults living in a low-income neighborhood with T2D. The four EPPM groups were significantly or nearly significantly different in medication adherence, self-management behaviors, microvascular complication prevalence, and use of blood pressure medication. These differences match EPPM predictions, with HT/LE participants having lower medication adherence, worse self-management behaviors, more complications and use of blood pressure medication than LT/HE participants. Although HbA1c was not statistically significantly different across EPPM groups, HbA1c was 1.4% higher in the HT/LE group than in the LT/LE group, a clinically meaningful difference that is consistent with perceived threat from diabetes. Notably, there were no significant differences across EPPM groups in socio-demographic characteristics such as race/ethnicity, education, health insurance, and health literacy. This suggests that the observed differences in clinical characteristics are not confounded by socio-demographics, supporting the conclusion that EPPM categorizes people with T2D in a clinically meaningful way.

Prior work by our group applied EPPM to people with T2D for the first time in a qualitative study, describing differences in perceptions of and approaches to diabetes self-management [18]. The current study extends this application of EPPM as a method to categorize people with T2D, revealing clinically important differences among groups. EPPM may therefore be useful to identify HT/LE people with T2D who may benefit from diabetes education more than other EPPM groups.

We are aware of one other study that applied EPPM to investigate diabetes knowledge, health literacy, and self-care behaviors [29]. In that study, 404 people with T2D in Iran were administered a diabetes self-care behavior questionnaire based on EPPM constructs of threat and efficacy. The study found that perceived susceptibility, efficacy, self-efficacy, diabetes knowledge and health literacy were associated with self-care behaviors, although the specific behaviors assessed were not reported. Our study extends these findings by comparing clinical and sociodemographic characteristics across EPPM groups.

Our findings are consistent with other studies of self-efficacy and diabetes self-management behaviors, showing higher self-efficacy is associated with better diabetes self-management and glycemic control [30 31]. Two studies have found that perceiving diabetes as a threat was associated with a less healthy diet [32 33].

Numerous behavioral interventions for people with T2D have been tested [8]. In general, such interventions improve diabetes self-management behaviors and HbA1c levels. It is plausible that using EPPM to categorize people could identify groups more or less likely to respond to behavioral interventions. This raises the possibility that behavioral interventions could be tailored to people with T2D by their EPPM group, which could be easily captured using the two short measures. Such an approach would be a kind of personalized diabetes management according to EPPM, selecting patients most likely to benefit and targeting interventions to them.

There are limitations to this study. We focused on people with T2D, who were patients at a single urban safety-net medical center and/or living in the local community, a population mostly of low-income Black and Hispanic people. It is unclear whether our findings would generalize to other sites and settings. In addition, the modest sample size provided insufficient power to detect statistically significant differences in important clinical characteristics like HbA1c and statin use, despite the clinically meaningful numerical differences observed. There is also a potential for selection bias by enrolling participants from patients presenting at a clinic visit or participating in the THB3 community cohort. Lastly, the cross-sectional study design precludes inference of causality or directionality among the observed clinical characteristics and EPPM categories.

These limitations suggest multiple opportunities for future research. Generalizability of the EPPM in other populations with T2D should be explored in larger sample sizes. Prospective studies are needed to describe how EPPM categories might change over time; for example, perceived threat of T2D might change the longer someone has been diagnosed. Randomized controlled trials would be needed to determine whether the EPPM can be used to select patients and increase the benefits of behavioral intervention. For example, perhaps an intervention could change a recipient’s diabetes threat and self-efficacy level from HT/LE to LT/HE and yield better glycemic control.

In summary, EPPM is associated with clinical outcomes and self-management behaviors among people with T2D. This model may be an effective framework to target people with T2D most likely to benefit from behavioral intervention.

Competing interests

DJR's institution received research funding from AstraZeneca. All other authors report no conflicts.

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Figure Legends

Figure 1. Theoretical Framework Extended Parallel Processing Model (EPPM) Application in Patients with Diabetes. Description of four categories in people with type 2 diabetes based on EPPM.

Figure 2. Comparison of the characteristics of people with type 2 diabetes among different Extended Parallel Processing Model (EPPM) categories. A, HbA1c was numerically highest in the HT/LE group and lowest in the LT/LE group. **B,** Participants in HT/LE group had the lowest medication adherence. **C,** Participants in HT/LE group had the lowest T2D management score. **D,** HT/LE participants had the most microvascular complications. **E**, HT/LE participants had the greatest use of blood pressure medications. HT: High Threat; HE: High Efficacy; LT: Low Threat; LE: Low Efficacy.

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