

## Short Report: Care Delivery

# Is the physical functioning of older adults with diabetes associated with the processes and outcomes of care? Evidence from Translating Research Into Action for Diabetes (TRIAD)

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### Abstract

**Aims** To examine the relationship between physical function limitations and diabetes self-management, processes of care and intermediate outcomes in adults  $\geq 65$  years of age with Type 2 diabetes.

**Methods** We studied 1796 participants 65 years of age and older in managed care health plans enrolled in Translating Research into Action for Diabetes (TRIAD). Physical functioning was assessed at baseline with the Physical Component Summary of the Short Form-12 Health Survey. Diabetes self-management was assessed with follow-up surveys, and processes of care (eye examinations, urine microalbumin testing, foot examinations, etc.) and intermediate health outcomes (HbA<sub>1c</sub>, blood pressure, LDL cholesterol) were assessed with medical chart reviews. Multivariate regression models were constructed to examine the associations between physical function limitations and outcomes.

**Results** Frequency of eye examinations (odds ratio 0.69, 95% CI 0.49–0.99) was the only process of care that was worse for participants with physical function limitations ( $n = 573$ ) compared with those without limitations ( $n = 618$ ). Neither self-management nor intermediate outcomes differed by whether patients had or did not have physical function limitations.

**Conclusion** Limitations in physical functioning as assessed by the Short Form-12 were not associated with substantial difference in diabetes care in adults  $\geq 65$  years of age enrolled in managed care health plans.

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**Keywords** geriatrics, physical function, quality of care

**Abbreviations** PCS, Physical Component Summary (of the Short Form-12 Health Survey); TRIAD, Translating Research into Action for Diabetes

### Introduction

Diabetes mellitus is a chronic disease prevalent among older adults. It is associated with complications and co-morbidities that may result in physical function limitations defined as inability to walk one-quarter of a mile, climb stairs or do housework [1,2]. Indeed, 23% of US adults  $\geq 60$  years of age have diabetes [3] and 63–85% of adults  $\geq 45$  years of age with diabetes have physical function limitations [4]. The effect of

coexisting diabetes and physical function limitations on the quality of diabetes care has not been studied. The quality of diabetes care is usually measured by patient self-management, processes of care and intermediate health outcomes.

Diabetes self-management activities including self-monitoring of blood glucose and foot care, and successful diabetes self-management likely requires good physical functioning. Physical function limitations have been reported by patients as a major barrier to self-management [5].

Diabetes processes of care are recommended measures performed by providers, which include assessing a patient's glycaemic (HbA<sub>1c</sub>), blood pressure and LDL cholesterol levels.

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Older adults with more co-morbidities usually have more physical function limitations and receive more processes of care from medical providers [6]. More processes of care have not always led to improvements in diabetes intermediate health outcomes, including glycaemic, blood pressure and LDL cholesterol control [7–9]. Poor health-related behaviours may contribute to this discordance between processes of care and intermediate outcomes [10].

Outcomes are dependent on both patient self-management and provision of care [11]. As many older patients with diabetes have physical function limitations, it is important to investigate if physical function limitations affect their diabetes care. We hypothesized that older adults with Type 2 diabetes and more physical function limitations, compared with those with fewer limitations, might perform less self-management, receive more diabetes processes of care and be less likely to achieve desired intermediate health outcomes.

## Patients and methods

### Study population

Translating Research Into Action for Diabetes (TRIAD) is a multi-centre prospective observational study of diabetes care in managed care health plans. The study's design has been reported previously [12]. Briefly, the study involves six centres and 10 managed care health plans across the USA that serve over 180 000 non-institutionalized patients with diabetes. The patient inclusion criteria were a diagnosis of diabetes, age 18 years or older, continuous enrolment in the participating health plan for a minimum of 18 months, at least one health-care claim in the previous 18 months, receipt of the majority of diabetes care through the plan and the ability to speak English or Spanish. TRIAD recruited a stratified random sample of ~9500 adults with diabetes (1500–2000 per centre). Patients were sampled from provider groups with at least 50 patients with diabetes enrolled in the study's health plans. The cohort was surveyed in 2000–2001, 2002–2003 and 2005 by computerized telephone or mailed survey. The response rates adjusted for inability to contact and mortality were 69, 83 and 75%, respectively [13]. The protocol was reviewed and approved by Institutional Review Boards at all participating sites. All participants provided informed consent.

For this report, we analysed data from participants with Type 2 diabetes of 65 years of age and older who completed TRIAD surveys in 2000–2001 and 2002–2003 and had their medical records reviewed ( $n = 1796$ ).

### Measurements

In 2000–2001, we assessed patients' socio-demographic characteristics, BMI, type and duration of diabetes and insulin use. Co-morbidities were assessed with the Charlson index [14]. The Charlson index is an extensively studied and valid measure that weights various co-morbid conditions that predict

mortality; a higher score indicates more co-morbidities and a greater risk of death. Physical functioning was measured with the Physical Component Summary (PCS) from the Short Form-12 Health Survey (SF-12) [15]. The PCS asked if a patient's health limited his/her ability to perform moderate activities, to climb several flights of stairs, to accomplish daily activities, or to be involved in work or daily activities, and if pain interfered with normal activities. The PCS has a range of 0–100 with a mean score of 50 and a standard deviation (SD) of 10 in the general US population. A higher score indicates better functioning. PCS scores were categorized into tertiles to represent participants with minimal, moderate and extensive physical function limitations.

Outcomes assessed in 2002–2003 included diabetes self-management (frequency of glucose monitoring and extra minutes per day spent caring for feet; assessed via survey), processes of care (eye examinations, urine microalbumin testing, foot examinations, HbA<sub>1c</sub> and LDL cholesterol testing; assessed from medical chart review); and intermediate outcomes (values of HbA<sub>1c</sub>, LDL cholesterol and blood pressure; assessed from medical chart review). Participants using insulin were analysed separately for daily self-monitoring of blood glucose. Desirable intermediate outcomes were defined based on the American Diabetes Association [16] recommendations: HbA<sub>1c</sub> < 53 mmol/mol (7%); LDL cholesterol < 2.59 mmol/l (100 mg/dl); and blood pressure < 130/80 mmHg.

### Statistical analysis

Baseline characteristics are presented as numbers and percentages or mean  $\pm$  standard deviation. Multivariate regression analyses were performed to examine the associations between PCS scores and self-management, processes of care and outcomes. All models were adjusted for age, sex, race, education, income, duration of diabetes, use of insulin, BMI and health plan (as fixed effects). All analyses were performed using SAS (version 9.2; SAS Institute, Cary, NC, USA).

## Results

There were 1796 patients of 65 years of age or older. Mean age was  $72.7 \pm 5.2$  years. Approximately half were women and 54% were white, 13% Hispanic, 13% Asian and 12% Black. Twenty-five per cent had less than 12th grade education (i.e. final year of secondary school) and 34% had an annual income of less than \$15 000. Average Charlson index score was  $2.56 \pm 1.68$ .

All patients had Type 2 diabetes; 53% had diabetes for more than 10 years and 25% were using insulin. Over 82% of the patients had annual eye examinations, urine microalbumin tests, foot examinations or HbA<sub>1c</sub> determinations, and 79% had annual lipid tests. All patients had annual blood pressure measurements.

On average, patients reported spending  $7 \pm 16$  min per day in caring for their feet. Seventy-four per cent of insulin users

**Table 1** Baseline characteristics of patients who participated in the study

Study participants	Number (total <i>n</i> = 1796)	Minimal limitations ( <i>n</i> = 618)	Moderate limitations ( <i>n</i> = 605)	Extensive limitations ( <i>n</i> = 573)	<i>P</i> -values
Age at interview (years, SD)	72.7 (5.2)	72.2 (4.9)	73.0 (5.2)	73.1 (5.4)	0.003
Sex					
Female	921 (51%)	260 (42%)	321 (53%)	340 (59%)	< 0.001
Male	873 (49%)	358 (58%)	284 (47%)	233 (41%)	
Race/ethnicity					
White	930 (54%)	324 (55%)	300 (53%)	306 (56%)	0.003
Hispanic	229 (13%)	80 (13%)	84 (15%)	65 (12%)	
Asian/Pacific Island	214 (13%)	92 (15%)	72 (13%)	50 (9%)	
Black	209 (12%)	49 (8%)	68 (12%)	92 (17%)	
Other	127 (7%)	48 (8%)	43 (7%)	36 (6%)	
Education					
< 12th grade†	446 (25%)	127 (21%)	143 (24%)	176 (31%)	< 0.001
High-school graduate	552 (31%)	174 (28%)	202 (34%)	176 (31%)	
Some college	455 (26%)	154 (25%)	157 (27%)	144 (25%)	
≥ 4 years of college	319 (18%)	158 (26%)	90 (15%)	71 (13%)	
Income					
< \$15 000	543 (34%)	142 (25%)	194 (36%)	207 (41%)	< 0.001
\$15 000 to < \$40 000	628 (39%)	206 (37%)	224 (42%)	198 (39%)	
\$40 000 to < \$75 000	314 (20%)	148 (26%)	92 (17%)	74 (15%)	
≥ \$75 000	120 (7%)	65 (12%)	27 (5%)	28 (6%)	
BMI (kg/m <sup>2</sup> )					
Normal (< 26)	351 (20%)	137 (23%)	116 (20%)	98 (18%)	< 0.001
Overweight (≥ 26 to < 30)	678 (39%)	277 (46%)	228 (39%)	173 (31%)	
Obese (30 to < 35)	638 (36%)	177 (30%)	226 (38%)	232 (42%)	
Grossly obese (≥ 35)	79 (5%)	9 (1%)	18 (3%)	52 (9%)	
Charlson index (mean, SD)	2.56 (1.68)	2.23 (1.48)	2.41 (1.61)	3.07 (1.94)	< 0.001
Duration of diabetes					
< 5 years	419 (24%)	158 (26%)	144 (24%)	117 (21%)	0.127
5–10 years	408 (23%)	145 (24%)	140 (23%)	123 (22%)	
> 10 years	933 (53%)	303 (50%)	308 (52%)	322 (57%)	
Any insulin use	450 (25%)	119 (19%)	145 (24%)	186 (32%)	< 0.001
Diabetes processes of care					
Eye examination	1481 (82%)	531 (86%)	497 (82%)	453 (79%)	0.008
Urine microalbumin assessment	1508 (84%)	515 (83%)	505 (83%)	488 (85%)	0.636
Foot examination	1534 (85%)	530 (86%)	520 (86%)	484 (84%)	0.737
Glycaemic assessment	1576 (88%)	555 (90%)	529 (87%)	492 (86%)	0.112
LDL cholesterol assessment	1416 (79%)	499 (81%)	483 (80%)	434 (76%)	0.082
Diabetes self-management					
Extra minutes spent caring for feet (mean, SD)	7.1 (16.4)	6.27 (14.5)	7.54 (18.5)	7.48 (15.9)	0.376
Self-monitoring of blood ≥ 1 time daily, non-insulin users	591 (45%)	211 (43%)	200 (45%)	180 (48%)	0.382
Self-monitoring of blood ≥ 1 time daily, insulin users	328 (74%)	89 (77%)	101 (70%)	138 (75%)	0.457
Diabetes intermediate outcomes					
HbA <sub>1c</sub> (mean, SD)	57 mmol/mol (8); 7.39% (1.35)	57.5 mmol/mol (9); 7.41% (1.3)	57.8 mmol/mol (8); 7.44% (1.4)	56.6 mmol/mol (8); 7.33% (1.35)	0.414
LDL cholesterol (mean, SD)	2.8 mmol/l (0.8); 107 mg/dl (32)	2.7 mmol/l (0.8); 106 mg/dl (30)	2.8 mmol/l (0.8); 107 mg/dl (34)	2.7 mmol/l (0.8); 106 mg/dl (31)	0.820
Blood pressure (mmHg)					
Systolic blood pressure (mean, SD)	137 (18.2)	136 (18)	138 (18)	138 (18)	0.362
Diastolic blood pressure (mean, SD)	73 (11.2)	73 (11)	73 (11)	73 (12)	0.797
Physical Component Summary (PCS) (mean, SD)	43.6 (2.9)	50.5 (2.4)	44.2 (1.9)	35.4 (4.0)	< 0.001

\*Results are number of patients (percentage of patients) based on each characteristics unless otherwise specified.

†Less than final year of secondary school.

PCS, Physical Component Summary of the Short Form-12 Health Survey.

and 45% of non-insulin users reported daily self-monitoring of blood glucose. Mean HbA<sub>1c</sub> was  $57 \pm 8$  mmol/mol (7.4 ± 1.4%), LDL cholesterol was  $2.77 \pm 0.83$  mmol/l (107 ± 32 mg/dl) and blood pressure was  $137 \pm 18.2/73 \pm 11.2$  mmHg.

The mean PCS score was  $43.6 \pm 2.9$ . We categorized PCS scores into tertiles to represent patients with minimal (PCS score  $50.5 \pm 2.4$ ,  $n = 618$ ), moderate ( $44.2 \pm 1.9$ ,  $n = 605$ ) and extensive ( $35.3 \pm 4.0$ ,  $n = 573$ ) physical function limitations. Compared with patients with minimal or moderate physical function limitations, those with extensive physical function limitations were more likely to be older, female, black, obese, have less education, have less income, use insulin and have higher Charlson scores (Table 1, all  $P < 0.01$ ). After adjustment for age, sex, race, education, income, duration of diabetes, use of insulin, BMI and health plan, patients with extensive physical function limitations were less likely to receive eye examinations (odds ratio 0.69, 95% CI 0.49–0.99) (Table 2) than those with minimal physical function limitations. Otherwise, patients with extensive, moderate and minimal physical function limitations were equally likely to perform self-management, to receive the other four processes of care and to achieve desirable intermediate health outcomes.

The intermediate outcomes recommended by the American Diabetes Association may not be appropriate for older adults with complex health conditions and limited life expectancies [17]. Therefore, we also performed analyses with less stringent targets; i.e. HbA<sub>1c</sub> ≤ 64 mmol/mol (8.0%), LDL cholesterol < 3.37 mmol/l (130 mg/dl) and blood pressure < 140/90 mmHg. Our results remained the same.

## Discussion

The care of older adults with Type 2 diabetes requires ongoing self-management and coordinated provider care. Physical function limitations have been reported to impact patients' self-management. Given the prevalence of physical function limitations among older adults with diabetes, we investigated whether these limitations affected processes of care and outcomes.

We found that limitations in general physical functioning among adults ≥ 65 years of age were not associated with substantial difference in self-management of diabetes or intermediate outcomes. Among the five diabetes processes of care, physical function limitations were associated only with less frequent eye examinations. This finding confirmed and complemented results from a previous study of Medicare beneficiaries participating in the National Long-Term Care Survey [18]. Eye examinations were less likely to be performed in patients with diabetes with more functional limitations. The National Long-Term Care Survey did not include patients enrolled in health maintenance organizations, and patients without limitations in activities of daily living and instrumental activities of daily living were under-represented.

Among all of the process of care measures that we studied, eye examinations were the only measure that could not be performed by primary care physicians or endocrinologists during routine office visits. Our findings suggest that patients with physical function limitations might benefit from a multidisciplinary clinic offering both primary care and eye services.

**Table 2** Adjusted odds ratios of diabetes processes of care, self-management and intermediate outcomes, according to physical function limitations\*

	Physical function status	
	Moderate limitations ( $n = 605$ ) vs. minimal limitations ( $n = 618$ ) (Odds ratio, 95% CI)	Extensive limitations ( $n = 573$ ) vs. minimal limitations ( $n = 618$ ) (Odds ratio, 95% CI)
<b>Processes of care</b>		
Eye examination	0.94 (0.66–1.34)	0.69 (0.49–0.99)
Urine microalbumin assessment	1.17 (0.82–1.67)	1.17 (0.80–1.69)
Foot examination	1.24 (0.85–1.83)	0.85 (0.58–1.25)
Glycaemic assessment	0.89 (0.59–1.34)	0.82 (0.54–1.25)
LDL cholesterol assessment	1.03 (0.74–1.44)	0.87 (0.62–1.22)
<b>Self-management</b>		
Daily self-monitoring of blood glucose, non-insulin user	1.13 (0.84–1.52)	1.13 (0.82–1.55)
Daily self-monitoring of blood glucose, insulin user	0.89 (0.47–1.66)	1.08 (0.57–2.05)
Foot self-care	1.21 (0.91–1.60)	1.18 (0.88–1.59)
<b>Intermediate outcomes</b>		
HbA <sub>1c</sub> < 53 mmol/mol (7%)	1.01 (0.77–1.33)	1.16 (0.87–1.54)
LDL cholesterol < 2.58 mmol/l (100 mg/dl)	1.02 (0.77–1.34)	1.04 (0.78–1.50)
Blood pressure < 130/80 mmHg	0.86 (0.63–1.17)	1.05 (0.77–1.44)

\*Adjusted for age, sex, race, education, income, duration of diabetes, insulin use, BMI and health plan.

Reference group has minimal physical function limitations based on tertiles of the Physical Component Summary (PCS) score of the Short Form-12 Health Survey.

Our study has several limitations. We studied a managed care population with relatively few physical function limitations. The mean PCS score in our population was  $43.6 \pm 2.89$ , whereas the PCS scores for patients with diabetes in the 2001 Medical Expenditure Panel Survey were 35.8 (without depression, mean age  $60.6 \pm 0.5$  years) and 40.4 (with depression, mean age  $57.0 \pm 1.6$  years) [19]. The lack of physical function limitations in our population may have reduced our ability to detect a relationship between physical functioning and diabetes care.

Questions in the PCS assessed general physical functioning instead of assessing a patient's ability to perform specific tasks related to diabetes care, such as ability to inspect feet, dexterity to draw up insulin, etc. Our measure of physical functioning, which was obtained through self-report, may be influenced by social desirability. In addition, we examined only three outcomes. We did not evaluate whether adults with physical function limitations received family support for their care.

Nevertheless, our study is the first to explore the associations between physical function limitations and diabetes self-management, processes of care and intermediate outcomes in older adults. We found that patients enrolled in managed care health plans are less likely to receive eye examinations if they had more general functional limitations, but that general functional limitations do not appear to have a major impact on self-management, processes of care or intermediate outcomes in older adults. Although our results are reassuring, additional studies of older adults are needed that employ more sensitive measures of physical functioning and focus on the functions that are necessary to carry out diabetes care.

## Competing interests

Nothing to declare.

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