Low diabetes numeracy predicts worse glycemic control

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Background

- Numeracy, or quantitative skill, is an important part of health literacy
- Literacy evaluations may not adequately represent a patients' numeracy skills
- Numeracy is commonly applied in many diabetes self-management tasks

Background

- In patients with diabetes, low literacy is common and associated with less knowledge about diabetes and diabetes self-management, and possibly worse glycemic control.

  Schillinger D et. al JAMA 2002 ; DeWalt DA et al. JGIM 2005

- The Diabetes Numeracy Test (DNT) is a valid measure of diabetes-related numeracy.

  Huizinga MM et al. 2008 BMC Health Services Res

- Diabetes-related numeracy is associated with better diabetes knowledge, self-efficacy, and modestly with glycemic control.

  Cavanaugh KL et al. 2008 Annals Int Med

- The impact of numeracy on glycemic control over time is unknown.

Aim

To examine the relationship between diabetes-related numeracy and glycemic control (A1C) over a 6-month period

Methods

- **Study design**
  - **Prospective cohort nested in a randomized controlled trial**
  - RCT Goal: Determine the efficacy of enhanced diabetes education using a literacy and numeracy sensitive interactive toolkit

    Cavanaugh KL et al. 2009 Diabetes Care

- **Locations** Vanderbilt Eskind Diabetes Center
  Primary Care Clinic, University of North Carolina at Chapel Hill

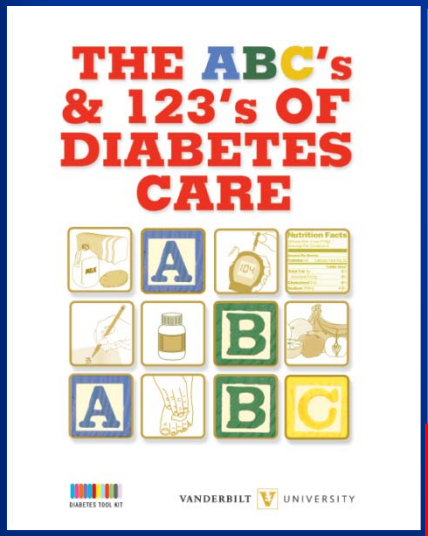
- **Participants**

Inclusion criteria
- Adults (age 18-80)
- Type 1 or 2 diabetes mellitus
- English-speaking
- Most recent A1C ≥ 7.0%

Exclusion criteria
- Diagnosis of dementia, psychosis, or blindness

Methods

Description of the RCT



Intervention	Control
Nurse practitioner or PharmD/CDE visits (1-3)	Nurse practitioner/CDE visits (1-3)
Dietician/CDE visits (1-3)	Dietician/CDE visits (1-3)
Provider clear health communication training	
Diabetes Literacy & Numeracy Education Toolkit (DLNET)	Usual diabetes patient education materials
Usual care from primary care or endocrine physician	Usual care from primary care or endocrine physician

Methods

- Measures:

  Diabetes-related Numeracy (DNT)

  - 43-items (DNT) or 15-items (DNT-15)
  - Applied numeracy skills
  - No time limit
  - Calculators can be used

  Huizinga MM, et al. BMC Health Services Research 2008: 8;96

- Other measures
  - Demographics
  - Health Literacy - REALM

Diabetes Care Domains
Nutrition
Blood Glucose Monitoring
Medications
Numeracy Domains
Calculation
Fractions / Decimals
Multi-step mathematics
Time
Numeration / Counting / Hierarchy

Methods

Examples DNT items

Q1. If you ate the entire bag of chips, how many total grams of carbohydrate would you eat?

Nutrition Facts **Serving Size 1oz. (28g/About 10 chips)** **Servings Per Container 3.5**	
Amount Per Serving	
Calories **140**	**Calories from Fat 60**
	% Daily Value*
Total Fat **6g**	10%
Saturated Fat 0.5g	4%
Cholesterol **0mg**	0%
Sodium **150 mg**	7%
Total Carbohydrate **18g**	6%

Answer: 63 grams
Correct response: **34 %**

Q2. Your target blood sugar is between 60 and 120. Please circle the values below that are in the target range (circle all that apply):

55 **145** **118**

Answer: Circle 118 only
Correct response: **67%**

Methods

- Primary outcome
  - Hemoglobin A1C (%) at 3- and 6-months
- Statistical Analyses
  - Spearman's rho calculation at each time point
  - Multivariable linear regression
    - Potential confounding variables
      - Age, gender, race, study site (VUMC or UNC), diabetes type, income, study group (intervention or control), time of A1C assessment, and baseline A1C

Results

Patient Characteristics

Characteristic	n=198 Median (IQR)
Age (yrs)	52 (42, 59)
% Female	64%
% White	54%
Education (yrs)	13 (12, 14.5)
% Income <$20k/yr	48%
% Type 2 DM	90%
Diabetes Duration (yrs)	8 (3, 14)
% Insulin	64%
% Prior diabetes education	70%
Body mass index (kg/m^2)	36 (31, 41)
% Literacy <9th grade	37%
DNT Score (0-100%)	59 (26, 86)
A1C (%)	9.1 (7.7, 10.4)

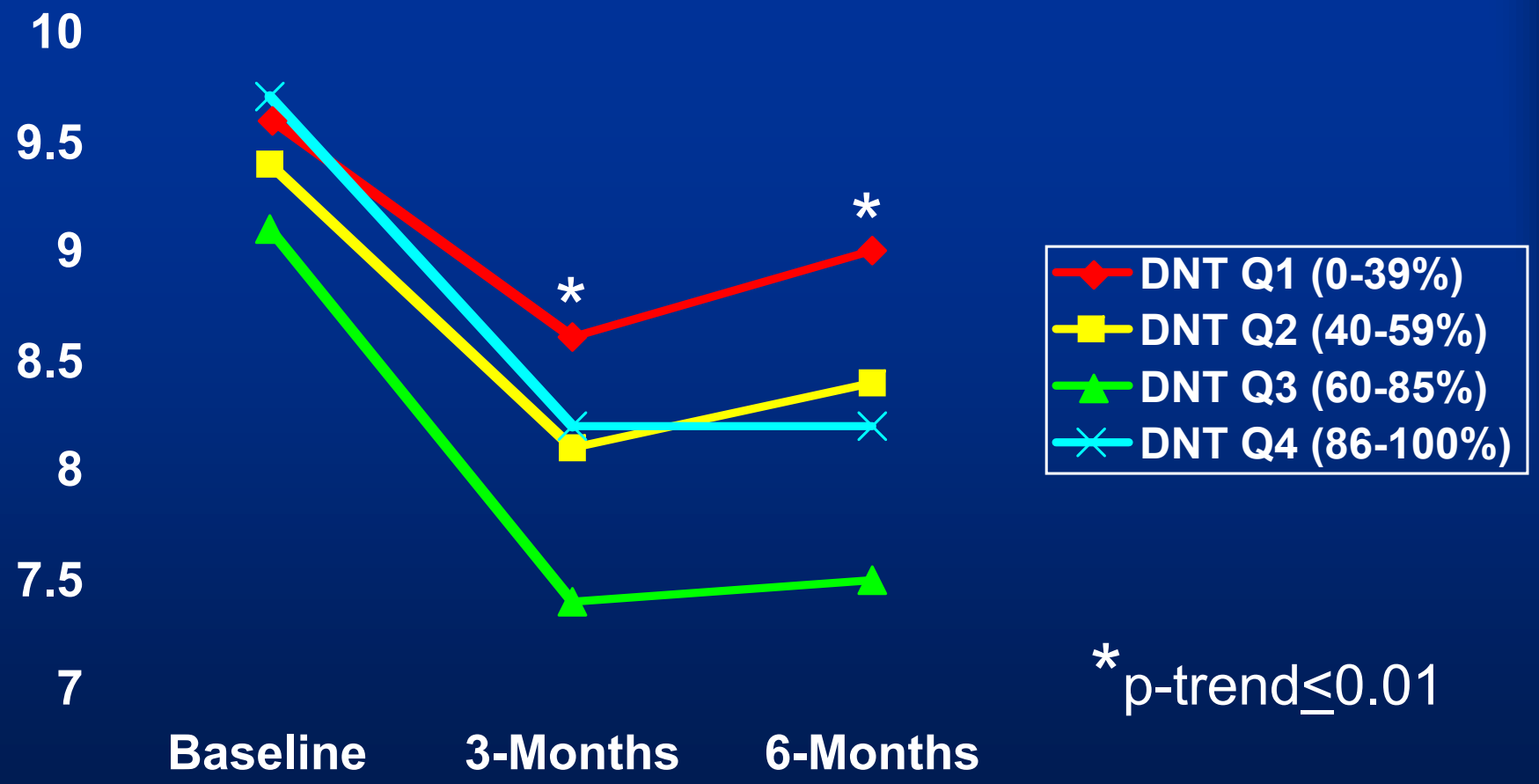
Results

Unadjusted DNT Correlations with A1C

Outcome	Spearman's rho	p-value
Baseline A1C	-0.03	0.673
3-Month A1C n=167	-0.23	0.003
6-Month A1C n=171	-0.30	<0.001
Δ A1C 3-month n=167	-0.20	0.009
Δ A1C 6-month n=171	-0.24	0.002

Results

Unadjusted A1C by DNT Score quartile



*p-trend≤0.01

Results

Adjusted Regression Analysis A1C (6M)

	β (95% CI)	p-value*
Diabetes Numeracy Test Score (%)	**-0.62 (-1.22, -0.02)**	**0.044**
Age (years)	-0.30 (-0.68, 0.08)	0.119
Sex (Male)	-0.07 (-0.50, 0.36)	0.756
Race (White)	-0.67 (-1.18, -0.15)	0.013
Diabetes Type (Type 1)	1.21 (0.36, 2.06)	0.006
Baseline A1C	1.22 (0.91, 1.52)	<0.001
Group (Intervention)	-0.06 (-0.44, 0.32)	0.770

*Also adjusted for income, study site, indicator of time point evaluation.

β represents the average change in glycemic control by interquartile range difference for continuous variables.

Summary

- Limited diabetes-related numeracy skills are common
- Lower diabetes-related numeracy skill is associated with higher A1C and less improvement in A1C after a diabetes education management program
- No association was found between health literacy and A1C

Limitations

- Possible residual confounding
  - Observational study nested in RCT
- Losses to follow-up evaluation (~15%)
- Generalizability

Implications

- Assessment of diabetes numeracy may identify patients at more risk for persistent poor glycemic control

- Diabetes numeracy may be an important target in future interventions to improve diabetes care

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- Vanderbilt Program for Effective Health Communication

  http://medicine.mc.vanderbilt.edu/healthcomm
- Providers and patients of the Vanderbilt Eskind Diabetes Center
- University of North Carolina diabetes providers/clinical research group

Extra Slides

Results

Patient Characteristics correlations with DNT

Characteristic	Rho	P-value
Age (yrs)	-0.36	<0.001
Gender	-0.06	0.419
Race	-0.43	<0.001
Education (yrs)	0.61	<0.001
Income	0.58	<0.001
Diabetes Type	-0.36	<0.001
Diabetes Duration (yrs)	-0.19	0.007
Insulin use	-0.12	0.086
% Prior diabetes education	-0.07	0.345
Body mass index (kg/m^2)	0.17	0.097
REALM Score	0.67	<0.001
Study Site	0.48	<0.001
Group Assignment	-0.11	0.114

Results

Glycemic control

Outcome	Median (IQR)
Baseline A1C (%)	9.1 (7.7, 10.4)
3-Month A1C (%) n=167	7.5 (6.7, 8.9)
6-Month A1C (%) n=171	7.7 (6.6, 9.0)
Δ A1C (%) 3-month n=167	-1.1 (-2.1, -0.2)
Δ A1C (%) 6-month n=171	-0.9 (-2.4, 0.0)

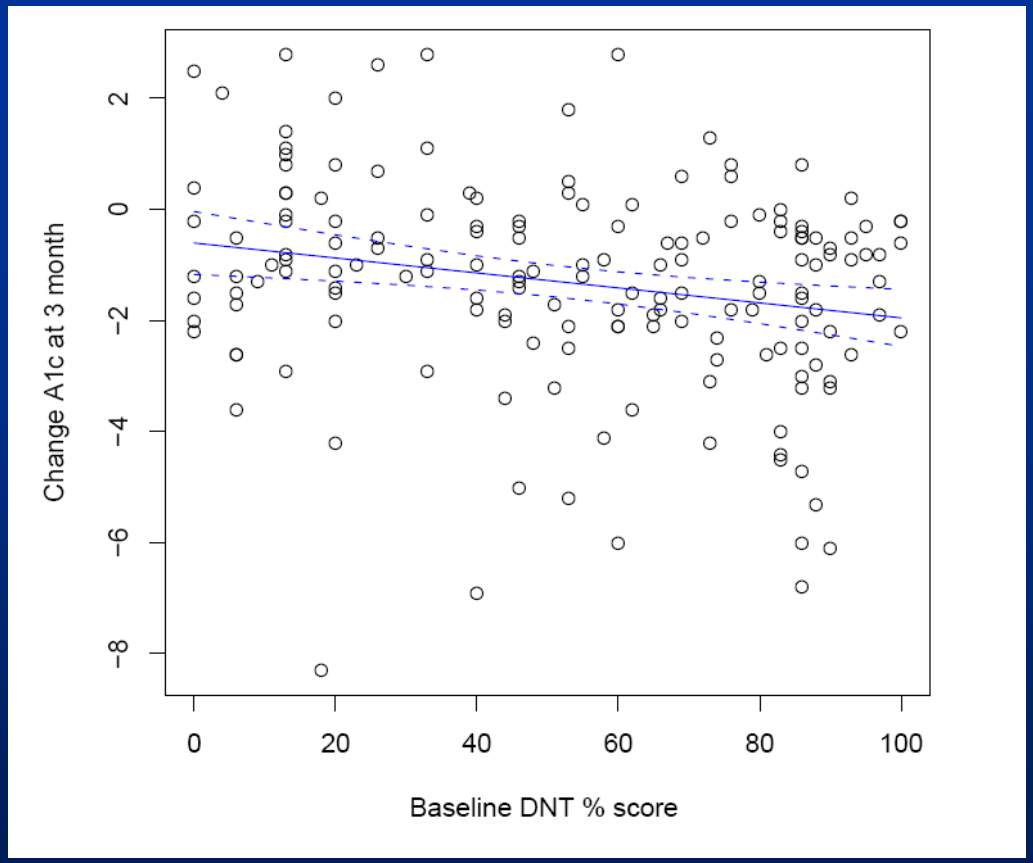
Results

Values for DNT Quartiles and A1C Outcomes

Characteristic	**DNT Q1** 0%-29%	**DNT Q2** 30%-58%	**DNT Q3** 59%-86%	**DNT Q4** 87%-100%	**p-value trend**
Baseline A1C (%)	9.6 (2.5)	9.4 (2.1)	9.1 (2.1)	9.7 (2.3)	0.992
3-month A1C (%) *n=167*	8.6 (1.3)	8.1 (1.9)	7.4 (1.7)	8.2 (2.2)	0.010
6-month A1C (%) *n=171*	9.0 (2.3)	8.4 (2.2)	7.5 (1.9)	8.2 (2.3)	0.001
Δ A1C (%) 3-month	-0.7 (1.9)	-1.3 (1.6)	-1.7 (1.9)	-1.6 (1.6)	0.007
Δ A1C (%) 6-month	-0.3 (2.2)	-1.1 (2.1)	-1.7 (1.9)	-1.5 (2.2)	0.003

Results

DNT & Change in A1C – 3 months Scatterplot



— best fit regression line; --- 95% Confidence intervals

Results

DNT-15 Correlations with A1C

Outcome	Spearman's rho	p-value
Baseline A1C	-0.05	0.442
3-Month A1C n=167	-0.25	0.001
6-Month A1C n=171	-0.31	<0.001
Δ A1C 3-month n=167	-0.18	0.022
Δ A1C 6-month n=171	-0.23	0.003