

# Beyond Tracking: The Benefits of Contextual Annotation in a Diabetes Digital Therapeutic

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## Background and Objectives

- ❖ Digital therapeutics typically help patients manage chronic diseases by leveraging structured data like blood glucose, diet, and medication adherence
- ❖ The addition of unstructured data may help patients and providers make sense of trends by tracking unique concerns
- ❖ The purpose of this research was to:
  - develop a lexicon to characterize annotations made by patients using a digital therapeutic
  - explore the impact of annotations on diabetes outcomes

## BlueStar Digital Therapeutic

- ❖ Retrospective data on users of BlueStar, an FDA-cleared digital therapeutic for Type 2 Diabetes
- ❖ BlueStar is a primarily mobile platform that facilitates self-monitoring of diabetes management and provides automated coaching<sup>1,2</sup>
- ❖ Users can contextualize self-management entries with structured (e.g., 'I feel sad') or patient-generated freetext (e.g., 'feeling bad, groggy, can't focus on work') annotations

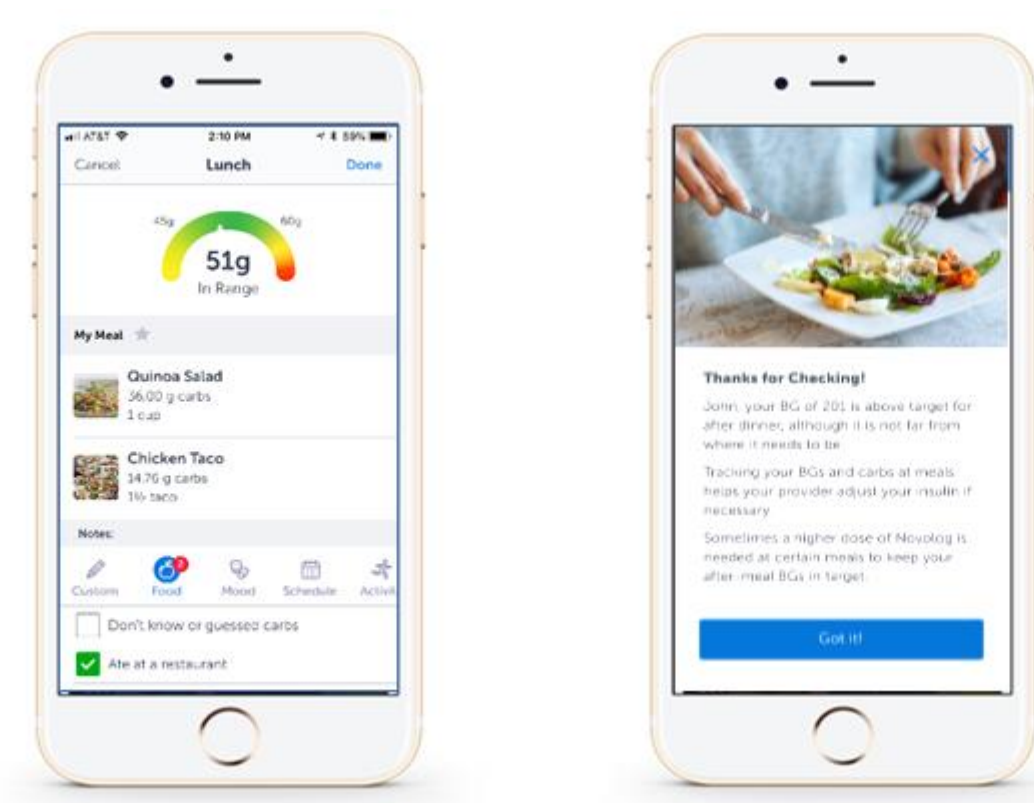


Figure 1. Screenshots of BlueStar app.



## Sample and Data

- ❖ Data from 3,142 patients users of BlueStar with Type 2 diabetes (50.3% women; 62.1% aged 40-63 years; 44.1% A1c  $\geq 8.0$ )
- ❖ 941 users (29.9%) recorded 31,443 annotations
- ❖ NLP techniques used to identify most frequent words used in free-text annotations
- ❖ Annotation themes were then identified according to frequent words

## Results

Table 1. Annotation themes, their frequency, and top words.

Theme	No. of Notes (%)	Top Words
Diet	13,498 (42.9%)	Ate, dinner, lunch, breakfast, salad, chicken, snack, eat, cheese, carbs
Medication	7,409 (23.6%)	Meds, units, took, insulin, take, taken, taking, Humalog, Novolog, Lantus
Biomedical Readings	6,860 (21.8%)	BG, blood sugar, reading, BP, glucose, low, meter, pulse, check
Health	5,734 (18.2%)	Pain, sinus, sick, allergies, back, legs, cold, hot, better, headache
Mood	3,092 (9.8%)	Stressed, depressed, feeling, feel, pressure, stress, tired, felt
Sleep	2,339 (7.4%)	Sleep, bed, bedtime, woke, slept, sleeping, awake, sleepy, awoke
Activity	2,001 (6.4%)	Gym, exercise, workout, miles, walked, walk, steps

## Association with A1C

- ❖ Examined moderating effect of annotations on BlueStar outcomes with repeated measures ANCOVA, controlling for demographics and usage
- ❖ Highest note takers exhibiting significantly larger declines in A1C compared with those who took no notes or very few notes  $F(3,357) = 3.55, p = .02$

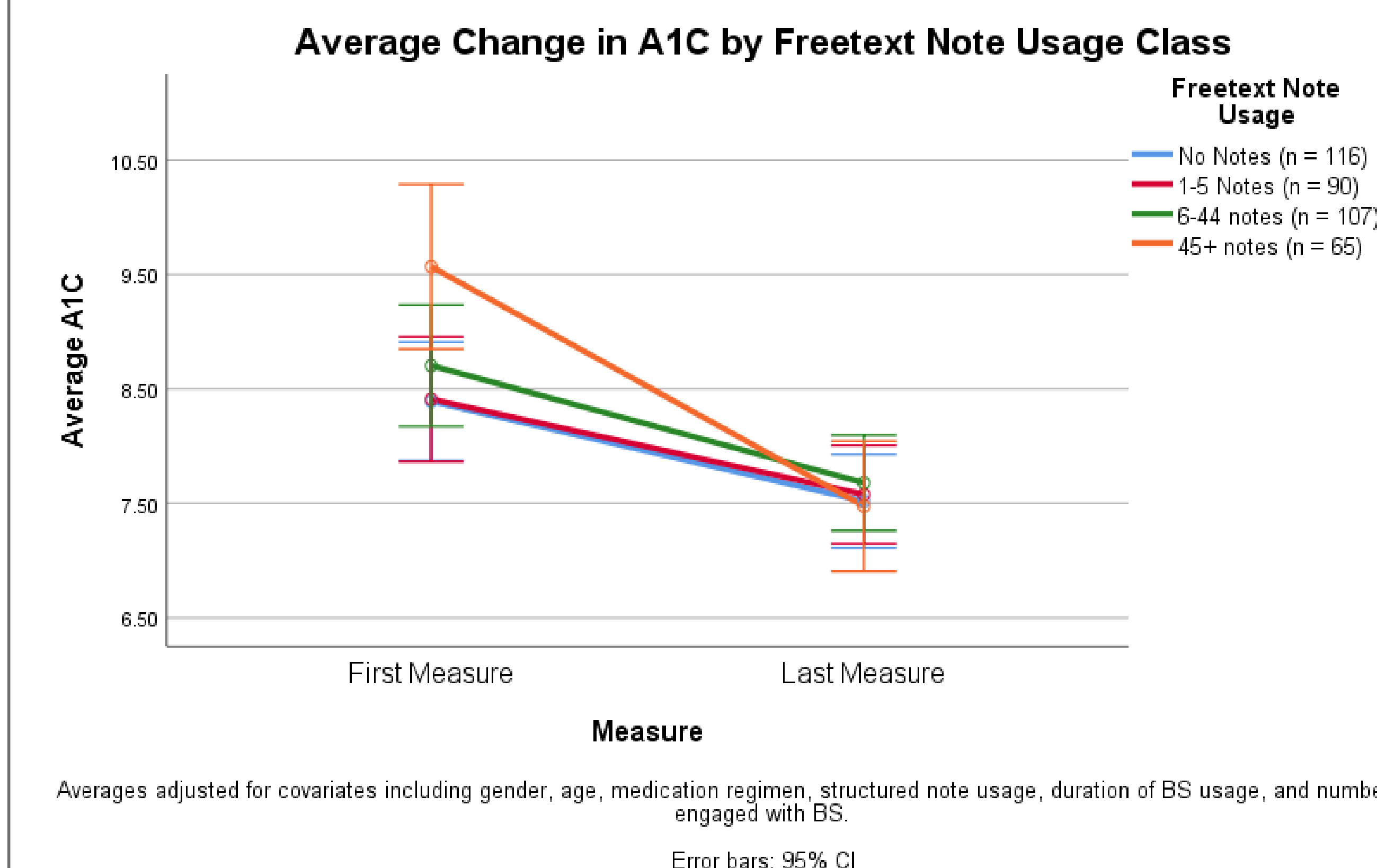


Figure 2. Trends in first and last measures of A1C by usage of annotations.

## Conclusion

- ❖ A substantial subgroup of users made annotations to their data entries
- ❖ Annotations reflected a diverse range of themes including wellbeing and core diabetes concerns
- ❖ Annotation is associated with greater A1C improvement
- ❖ Free-text annotation may offer unique benefit to digital therapeutic users

## References

1. Quinn, C. C., Clough, S. S., Minor, J. M., Lender, D., Okafor, M. C., & Gruber-Baldini, A. (2008). WellDoc™ mobile diabetes management randomized controlled trial: change in clinical and behavioral outcomes and patient and physician satisfaction. *Diabetes Technology & Therapeutics*, 10(3), 160-168.
2. Quinn, C. C., Shardell, M. D., Terrin, M. L., Barr, E. A., Ballew, S. H., & Gruber-Baldini, A. L. (2011). Cluster-randomized trial of a mobile phone personalized behavioral intervention for blood glucose control. *Diabetes Care*, 34(9), 1934-1942.