

# A Real-Time CGM-Enabled Digital Health Tool Highlights a Relationship Between Sentiment and Diabetes Distress in People Using Bolus Insulin

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## BACKGROUND/PURPOSE

Managing bolus insulin therapy can be a significant burden for people living with diabetes, who must diligently self-manage food, activity, and insulin dose calculations. Diabetes distress refers to an emotional state where people experience feelings such as stress, guilt, or denial that arise from living with diabetes and the burden of self-management. Diabetes distress has also been linked to worse health outcomes<sup>1</sup>. Little is known about the emotions (sentiments) these bolus insulin users express about their interactions with their technology and how technology can affect their degree of diabetes distress and coping self-management behaviors. Sentiment analysis is a natural language process that analyzes text for positive, negative, or neutral emotions<sup>2</sup>.

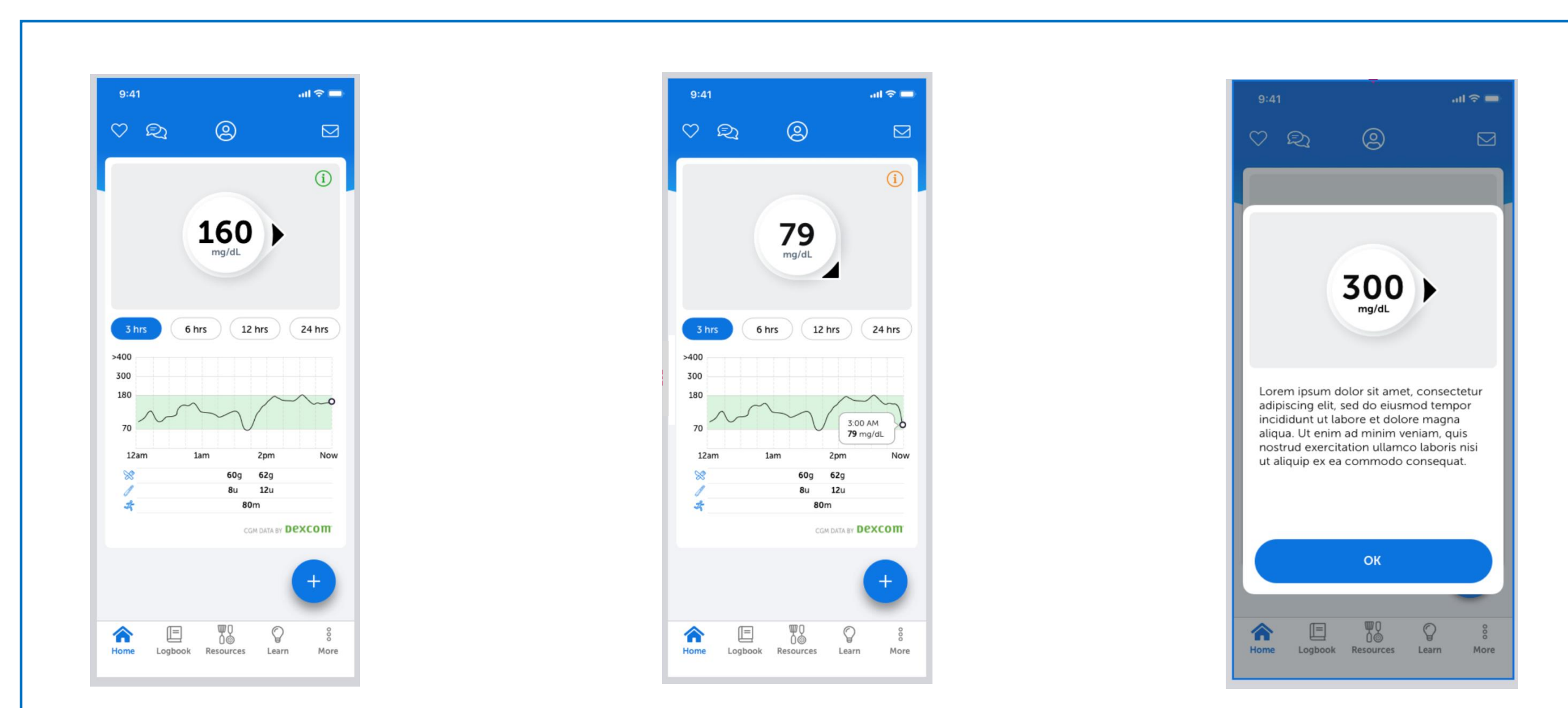
## SPECIFIC AIMS

We have previously shown that use of a continuous glucose monitoring (CGM)-enabled digital health investigational device – that supports insulin dosing by accounting for food, activity, and CGM trend arrows – is associated with improved time in range<sup>3</sup> and reduction in diabetes distress<sup>4</sup>. Digital health solutions also provide the opportunity to capture quantitative and qualitative insights and individual perspectives or sentiments via surveys. In this analysis, we sought to examine the interactions and factors impacting diabetes distress scores by analyzing both distress scores and the sentiments being expressed through surveys.

## METHODS

The 17-question diabetes distress survey (DDS17)<sup>1</sup> was administered at the beginning and end of a 30-day prospective study using the digital health investigational device. In addition, study participants (n=54, 56% type 1, 44% type 2) were surveyed about the device during study visits. Using natural language processing (NLP), the free text responses from the surveys were analyzed for sentiments. The sentiments were classified as being positive, negative, or neutral.

Figure 1: Screenshots of the IBC Mobile Application\*



\*The insulin bolus calculator (IBC) is an investigational device not yet cleared by the U.S. Food and Drug Administration

Figure 2: The 17-point Diabetes Distress Survey

	Not a Problem	A Slight Problem	A Moderate Problem	Somewhat Serious Problem	A Serious Problem	A Very Serious Problem
1. Feeling that diabetes is taking up too much of my mental and physical energy every day.	1	2	3	4	5	6
2. Feeling that my doctor doesn't know enough about diabetes and diabetes care.	1	2	3	4	5	6
3. Not feeling confident in my day-to-day ability to manage diabetes.	1	2	3	4	5	6
4. Feeling angry, scared and/or depressed when I think about living with diabetes.	1	2	3	4	5	6
5. Feeling that my doctor doesn't give me clear enough directions on how to manage my diabetes.	1	2	3	4	5	6
6. Feeling that I am not testing my blood sugars frequently enough.	1	2	3	4	5	6
7. Feeling that I will end up with serious long-term complications, no matter what I do.	1	2	3	4	5	6
8. Feeling that I am often failing with my diabetes routine.	1	2	3	4	5	6
9. Feeling that friends or family are not supportive enough of self-care efforts (e.g. planning activities that conflict with my schedule, encouraging me to eat the "wrong" foods).	1	2	3	4	5	6
10. Feeling that diabetes controls my life.	1	2	3	4	5	6
11. Feeling that my doctor doesn't take my concerns seriously enough.	1	2	3	4	5	6
12. Feeling that I am not sticking closely enough to a good meal plan.	1	2	3	4	5	6
13. Feeling that friends or family don't appreciate how difficult living with diabetes can be.	1	2	3	4	5	6
14. Feeling overwhelmed by the demands of living with diabetes.	1	2	3	4	5	6
15. Feeling that I don't have a doctor who I can see regularly enough about my diabetes.	1	2	3	4	5	6
16. Not feeling motivated to keep up my diabetes self management.	1	2	3	4	5	6
17. Feeling that friends or family don't give me the emotional support that I would like.	1	2	3	4	5	6

## RESULTS

Figure 3: Demographic Information

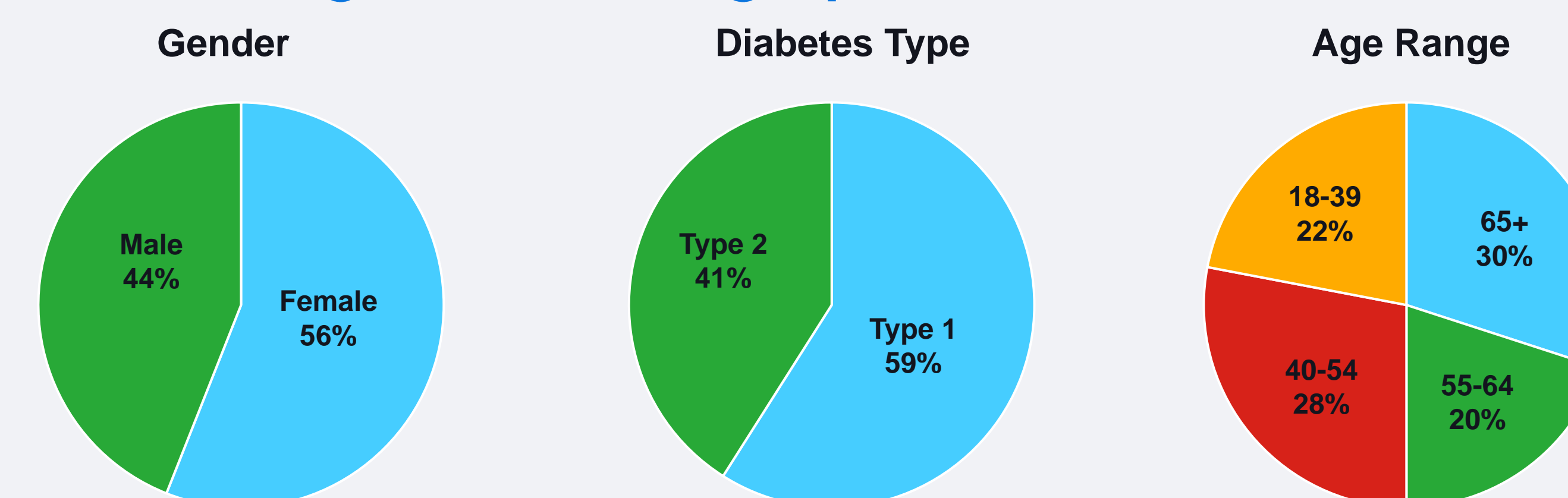
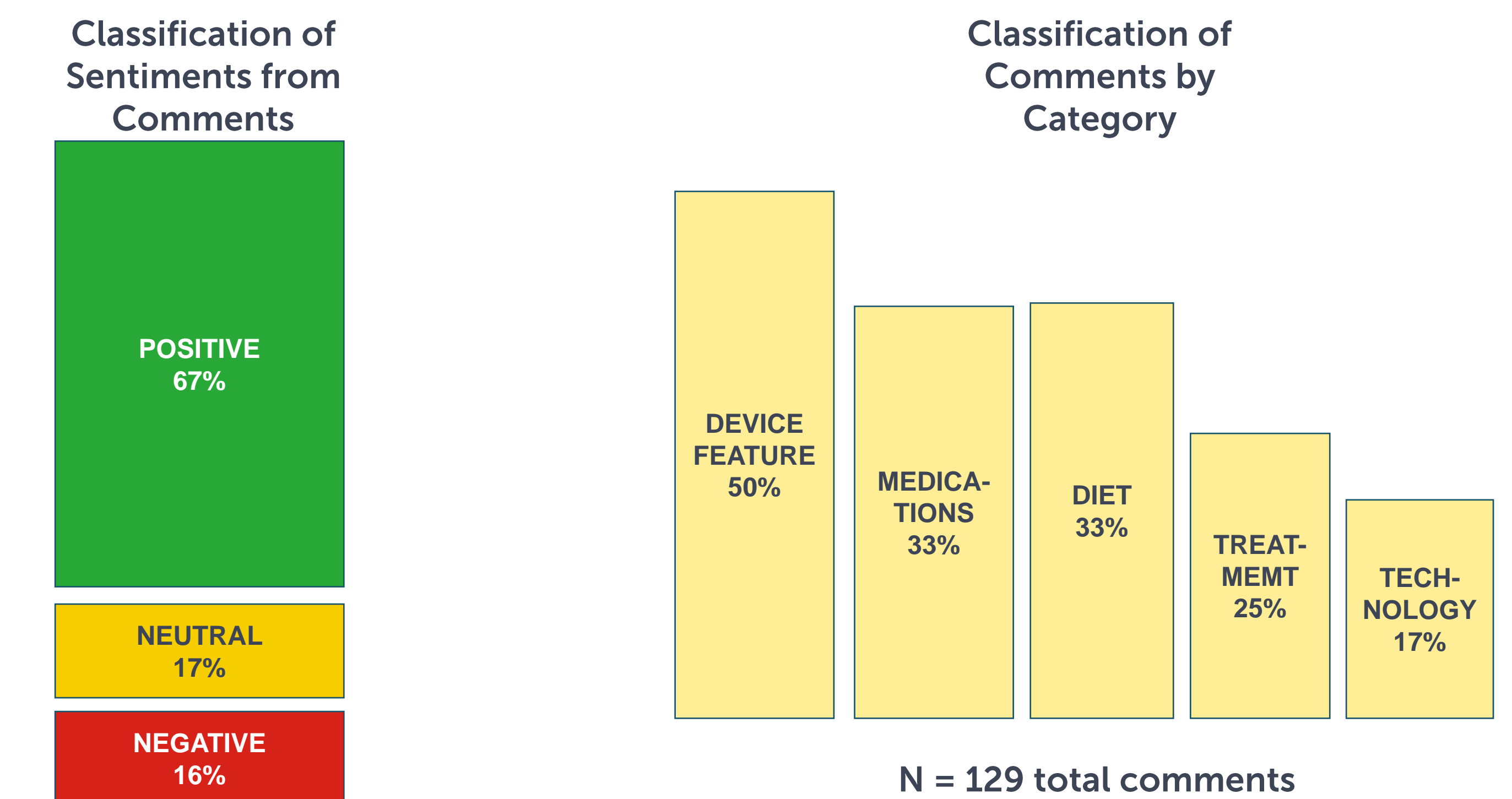


Figure 4: Sentiment Analysis and Classification of App Use Comments by Study Participants



- 74% of the 129 comments were associated with a reduced DDS score
- The proportion of positive comments amongst those who *reduced* their DDS17 was significantly higher than that of those who *increased* their DDS17 ( $p < 0.05$ ).
- Unexpectedly, those with *increased* DDS17 did not have significantly higher proportion of negative sentiments when compared with those with *decreased* DDS17 ( $p > 0.05$ ).
- Positive sentiment was most associated with comments about device features, treatment support, medication management, and food. Negative sentiment was most associated with unfamiliarity with technology.

## CONCLUSIONS

In bolus insulin users, reduction in diabetes distress was associated with positive sentiment derived from the study comments. In previous work, we have shown that additional annotations in a digital health tool around ADCES7 behaviors is associated with greater engagement and improvements in A1C<sup>5</sup>. Taken together, these findings suggest that in-app comments, survey response and in the future, in-app annotations, coupled with sentiment analysis, could be useful for a DCES to help people with diabetes better cope with and manage diabetes distress. Future work will explore the use of AI-based natural language processing and sentiment classifiers to increase the levels of precision and personalization that can be realized with scalable digital health coaching.

## REFERENCES

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