Glucate: Redefining Diabetes Management for a Healthier Tomorrow

Sarah Gedi I 2023-2024 I Science and Engineering Fair

Introduction

In recent years, diabetes has emerged as one of the fastest-growing diseases globally, posing a significant public health challenge. Urbanization and changing cultural practices contribute to the increased prevalence, as modernization often brings about a shift towards less active routines and diets rich in processed foods. The tendency of diabetes to cause various health problems that impact essential organs and systems is among the most concerning aspects of the disease.

Some risks include:

- ➔ Heart disease,
- ➔ Strokes
- ➔ Renal Failure
- ➔ Blindness
- ➔ Visual impairment
- ➔ Nerve damage

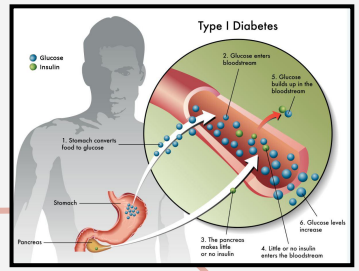
The prevalence of diabetes (type 2 diabetes and type 1 diabetes) will increase by 54% to more than 54.9 million Americans between 2015 and 2030; annual deaths attributed to diabetes will climb by 38% to 385,800; and total annual medical and societal costs related to diabetes will increase 53% to more than $622 billion by 2030.(Rowley et al. Diabetes 2030: Insights from yesterday, Today, and future trends)

Background

38.4 million people have diabetes—that's 11.6% of the US population. 29.7 million people have been diagnosed with diabetes. 8.7 million people who have diabetes have not been diagnosed and do not know they have it. (Centers for Disease Control and Prevention National Diabetes Statistics Report)

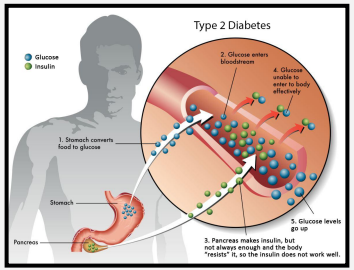
Type 1

Type 1 diabetes occurs when the immune system attacks the pancreas, necessitating insulin; 5–10% of cases are diagnosed in childhood most of the time.



Type 2

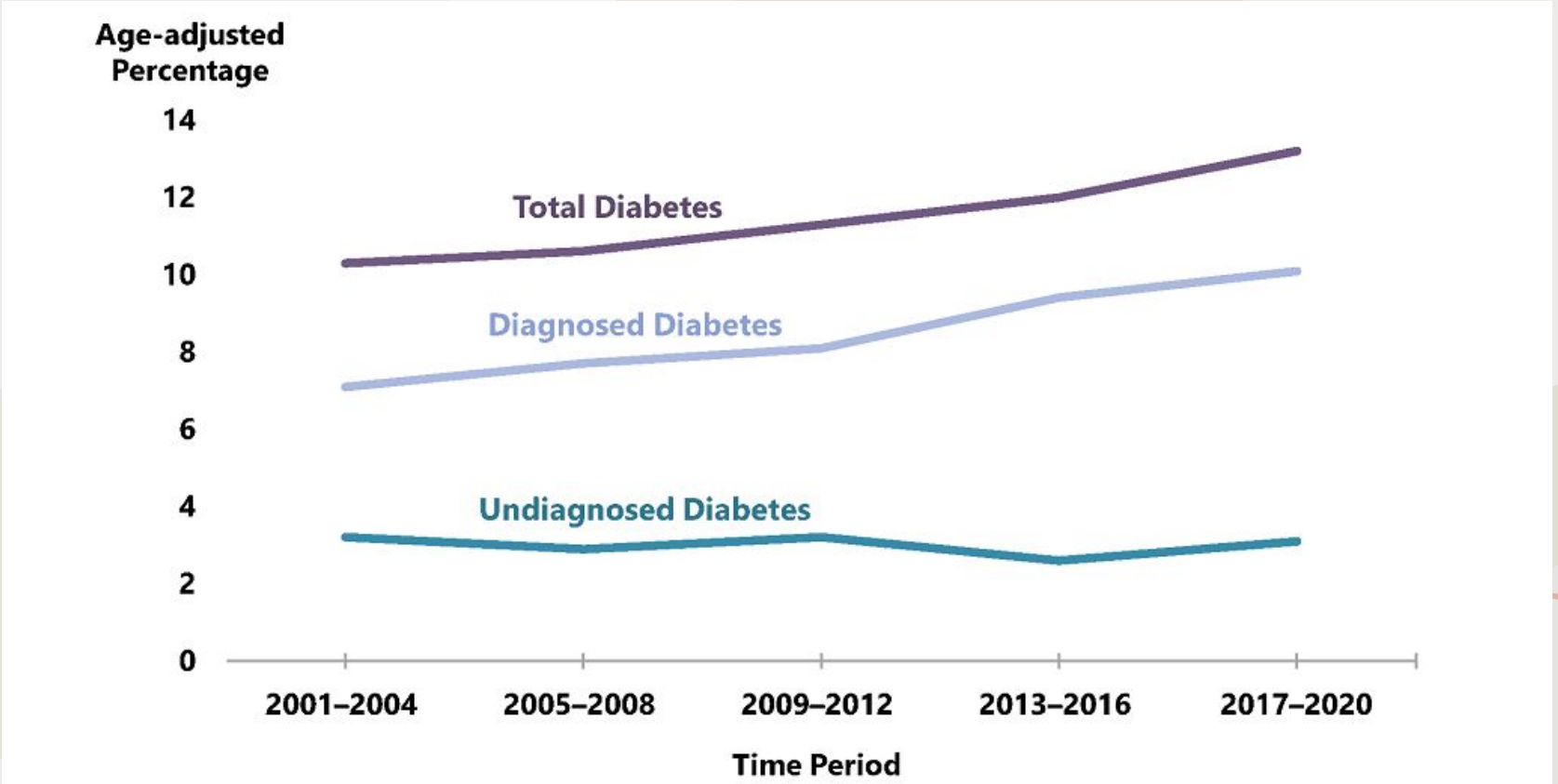
Type 2 diabetes is caused by insulin resistance and lifestyle factors; it develops in adulthood and is controlled with lifestyle modifications, medications, and insulin.



Pre-diabetes

And then there is also Prediabetes.Prediabetes is not really the same as diabetes however it can put you at risk for type 2 diabetes, storke, and heart disease. About 98 million American adults—more than 1 in 3—have prediabetes. And "More than 8 in 10 adults with prediabetes don t know they have it.

Background Cont.



"National Diabetes Statistics Report." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 29 Nov. 2023 www.cdc.gov/diabetes/data/statistics-report/index.html.

Purpose

As of right now there is no cure for the disease causing more and more to affected with no cure. However there are ways to help people with diabetes to take charge and manage their sugars like apps but most apps are not easy to use nor are affordable causing people not to feel motivated to take charge of their health."many apps aren't being used – or are being used a few times and then dropped – because they're unreliable or ineffective."((Eric Wicklund Diabetes app market 'fragile' but improving)

My main purpose is to collect first-hand accounts from people who deal with the complexities of diabetes daily. Then based on this information create a groundbreaking app for blood sugar stability based off of all the participants suggestions. My app will seek to improve diabetes management, help limit related health risks, and encourage a proactive attitude to personal well-being.

SURVEY

Despite the abundance of knowledge available online, I choose to use a more personalized strategy. I created and sent out a survey to people who have diabetes in an effort to learn more about their particular struggles and experiences. My intention with this survey is to get firsthand accounts from people who live with diabetes on a daily basis, in addition to the basic information that can be accessed online. The information acquired from this survey will be used as a basis for creating an app that can truly enhance the lives of those who are living with diabetes.

Survey Questions

About how many times a day do you check your blood sugar levels?

This question is very important because it makes sure that a diabetic has their blood sugar in check, which will overall help them maintain a more steady schedule daily.

Do you check your glucose levels before and after each meal or just once before?

People with diabetes are often recommended to check their levels at least once before each meal, which is on average three times daily. According to the Mayo Clinic staff, "Often, testing is advised before meals and at bedtime " ("Blood sugar testing: why, when, and how")

Do you check your carbohydrates to manage diabetes?

The answers to these two survey questions are crucial to understanding how individuals manage their diabetes. Asking about the monitoring of their carbohydrate consumption, a crucial component of diabetes management, is the third question that evaluates their level of active engagement.

Do you believe that managing your carbohydrate intake is vital to your blood sugar levels?

“Many people with diabetes count carbs to make managing blood sugar easier, which can also help them: stay healthy longer. Feel better and improve their quality of life. Prevent or delay diabetes complications such as kidney disease, eye disease, heart disease, and stroke."

Survey Questions Cont.

Do you check your calories to manage diabetes?

This question evaluates their level of active participation by asking if they keep track of their caloric intake, an important part of managing diabetes.

Do you believe that managing your calorie intake is vital to your blood sugar levels?

This questions asks about the significance of regulating caloric intake to regulate blood sugar levels, providing insight into their perspectives and comprehension of the nutritional facets of diabetes control. "In fact, cutting back on the number of calories you eat each day can lower your blood sugar levels"(Linda M Delahanty, MS, RD UpToDate).

Do you utilize diabetes apps daily?

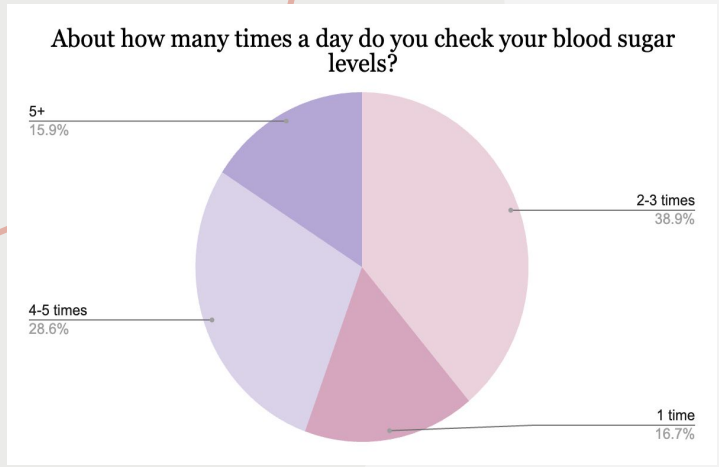
To better understand how many of these participants use diabetes apps.

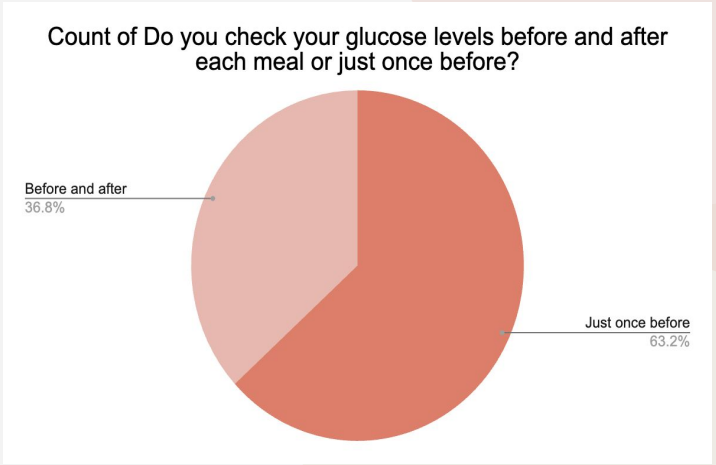
Are you willing to use a new app that would not restrict your meals but still keep track of your glucose levels?

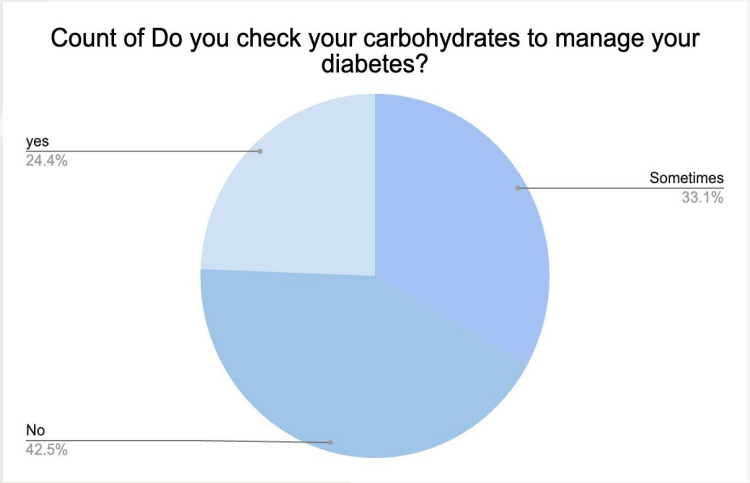
To see if the participants are open to utilizing a new app?

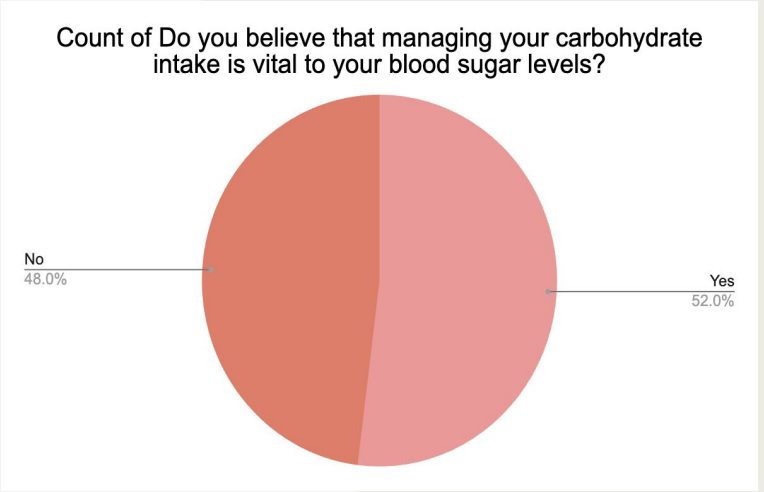
Survey Data

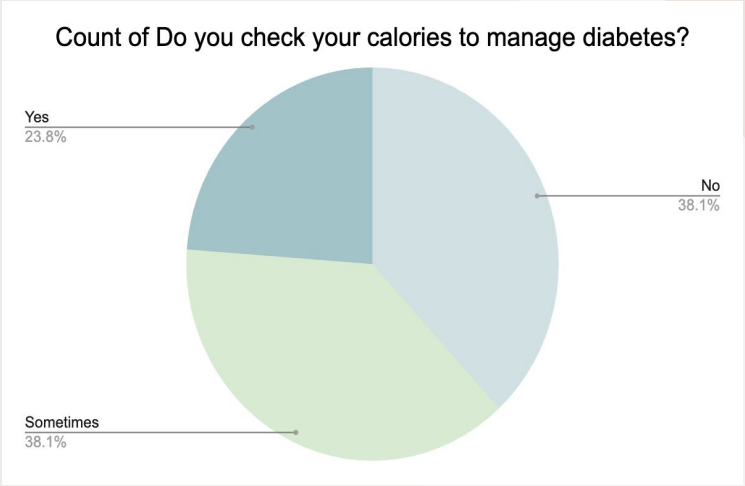
My survey consisted of about 270 participants. To ensure that it was a complete random sample I sent it in random diabetes group chats and posted on social media.

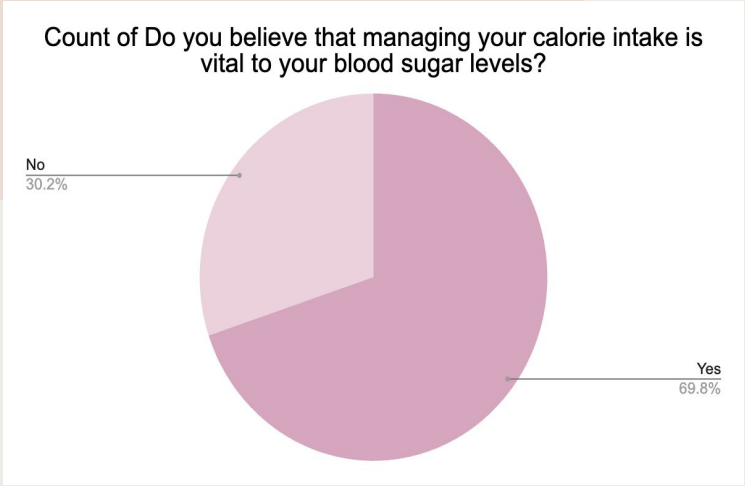

About how many times a day do you check your blood sugar levels?
5+
15.9%
2-3 times
38.9%
4-5 times
28.6%
1 time
16.7%

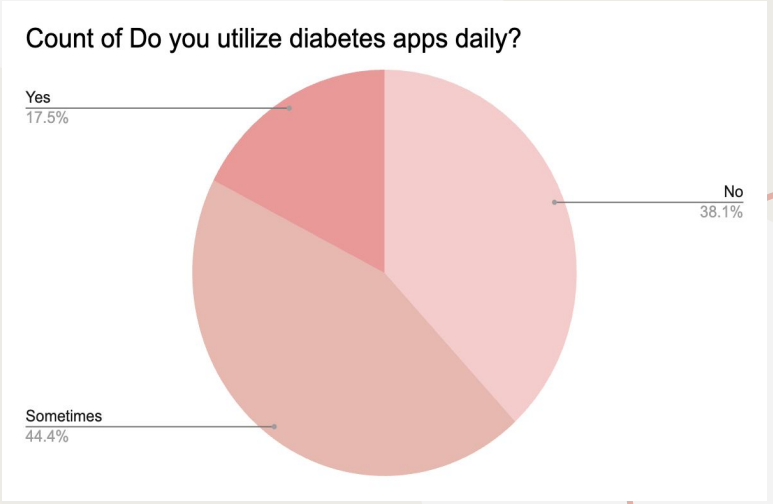

Count of Do you check your glucose levels before and after each meal or just once before?
Before and after
36.8%
Just once before
63.2%

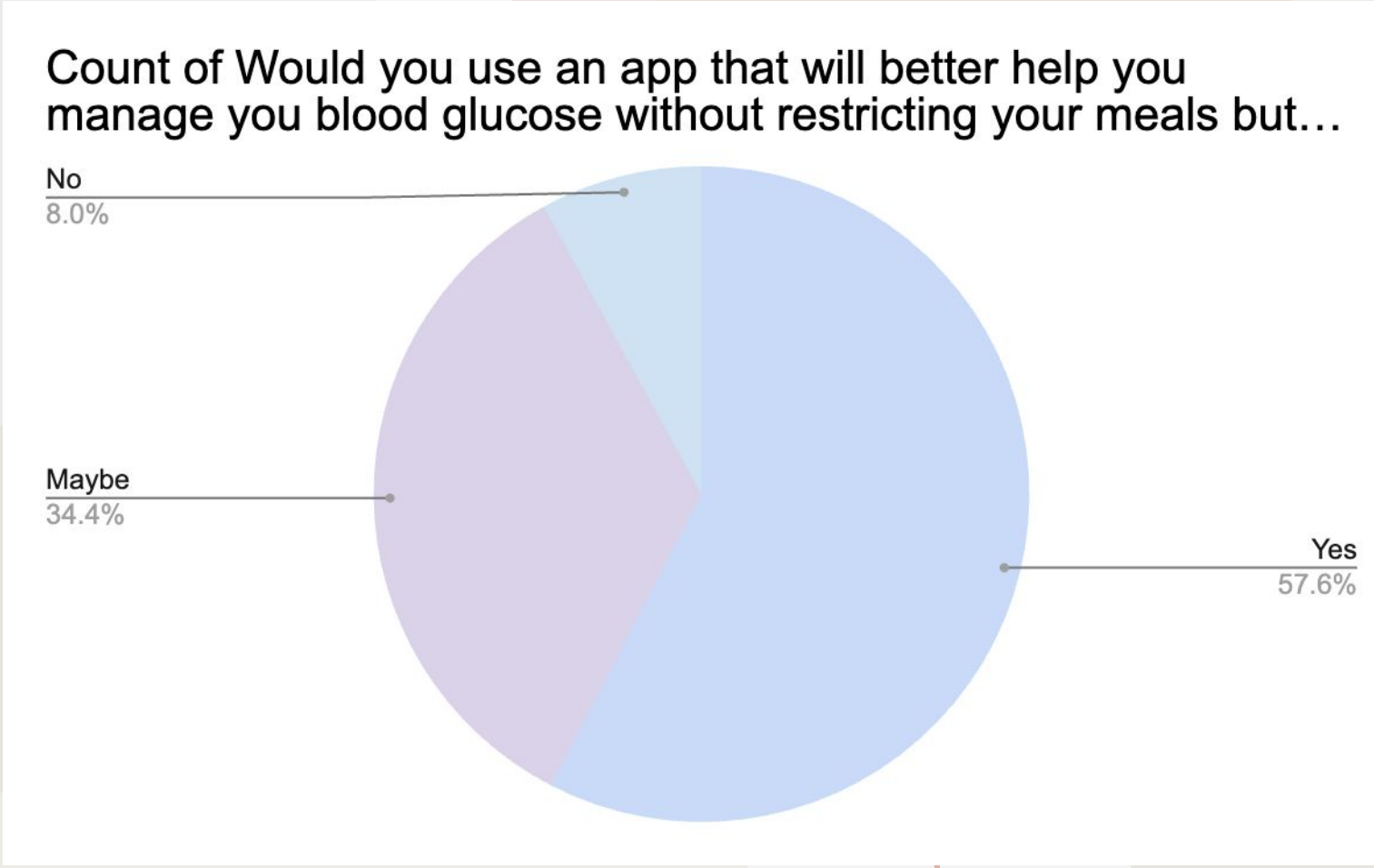

Count of Do you check your carbohydrates to manage your diabetes?
yes
24.4%
Sometimes
33.1%
No
42.5%


Count of Do you believe that managing your carbohydrate intake is vital to your blood sugar levels?
No
48.0%
Yes
52.0%


Count of Do you check your calories to manage diabetes?
Yes
23.8%
No
38.1%
Sometimes
38.1%


Count of Do you believe that managing your calorie intake is vital to your blood sugar levels?
No
30.2%
Yes
69.8%


Count of Do you utilize diabetes apps daily?
Yes
17.5%
No
38.1%
Sometimes
44.4%


Count of Would you use an app that will better help you manage you blood glucose without restricting your meals but…
No
8.0%
Maybe
34.4%
Yes
57.6%

Survey Conclusion/Engineering Goal

- A way to help diabetics track their blood sugar before every meal.
- A way to set a goal for the amount of carbohydrates and calories each diabetic should intake daily. could be recommended by a doctor.
- Letting the user be able to input the food they are eating every meal and then utilize something that is accurate to calculate the amount of carbs and calories and display them graphically so the user can keep track.
- Also, displaying the blood sugar levels before each meal graphically on a separate graph allows the user to be able to track that.
- Make sure that the app is very easy to use, effective, and not time-consuming for the user.
- My ultimate goal is to help progress diabetes management by offering a key tool that targets particular requirements while also improving the overall quality of life and limiting the chances of other health risks for all individuals affected.

Methods

01

Simplify Food Tracking

Create a user-friendly platform for diabetics to quickly input their meal choices, simplifying nutritional tracking in under a minute.

02

Nutritional Breakdowns

Develop a platform that calculates and visually presents precise nutritional breakdowns, including carbs and calories, in a clear graphical format, aiding users in making informed dietary choices.

03

Graphical Representation

Enable users to input and monitor their pre-meal glucose levels over time, facilitating a deeper understanding of trends and patterns in their blood sugar levels.

04

Flexibility

Enhance diabetes management flexibility by enabling users to select meals within specific carbohydrate and calorie limits, offering a personalized and adaptable strategy for stabilizing blood sugar levels.

Calorie/Carbohydrate Tracker

Calorie Ninjas	Nutritionix
Offers: - Custom Portions - Global Nutrition facts. - Branded items - Data for 100,000 food items.	**Offers:** - Custom Portions - Can process food phrases, and tags. - 200,000 Restaurant items. - Branded items - Data for one million food items.

From comparing the two API's we can clearly see that Nutritionix has a lot more to offer however I want research more by testing multiple food items on both API's.

Vs.

	Control		CalorieNinja		Nutritionix	
	Cal:	Carb:	Cal:	Carb:	Cal:	Carb:
White Bread(1)	77	13.3g	*75	*12.3g	77	13.3g
Brown Bread(1)	75	13.0g	*79.7	*15.2g	75	13.0g
1 egg	74	0.38g	*70.2	*0.26g	74	0.38g
3 eggs	219	1.2g	*215	*0.9g	219	1.2g
1lb. of chicken breast	760	0g	*800	*0g	760	0g
1 cup of white rice	205	44.6	*208.5	*46.7g	205	44.6g
1 cup of brown rice	218	45.8g	*107.3	*22.5g	218	45.8g
1 cup of orange juice	110	27g	*115.6	*28.9	110	27g
1 cup of apple juice	114	28g	*110	*26g	114	28g
3 cherry tomatoes	9.4	2g	*9.0	*2g	*9.3	2g

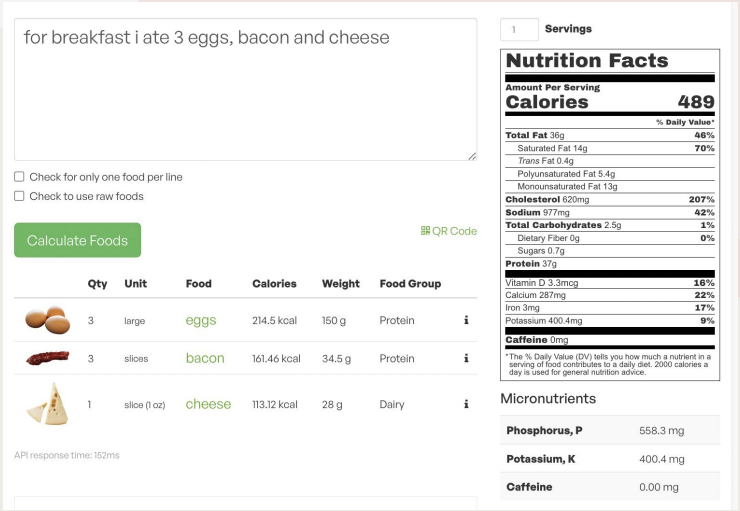
*means inaccurate

- From this chart we can conclude that Nutritionix is the most accurate option given that there was only one inaccurate calorie count and it was only by .1

App Design

- I started by creating a basic template React Native JavaScript application which allows the app to be interactive, and set up authentication using Google's Firebase. Users are able to login using a created username and password.
- Then, I set up the user's initial survey, where questions on their carbohydrate and calorie goals, as well as their blood sugar levels are recorded and saved to Google's Firebase, which is a secure database that stores user's health data.
- To estimate calorie and carbohydrate data from the user's self reported meals, I used an API called Nutritionix that estimates this data given a natural language description of the meal (ex. '3 eggs and a waffle').
- Finally, I visualized user's blood sugar, carbohydrate, and calorie data in line graphs utilizing react library that show the last week's readings of each. Users can edit the responses to the initial user survey as their needs change, and these changes are reflected in the graph.

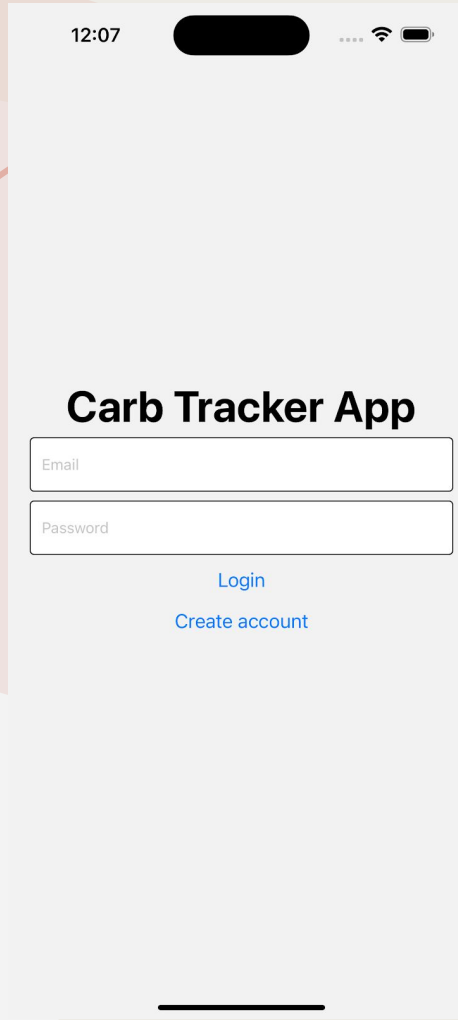
- An example of how Nutritionix API works:
- Below is an example of the result of a breakfast example that consists of 3 eggs, Bacon, and cheese.:

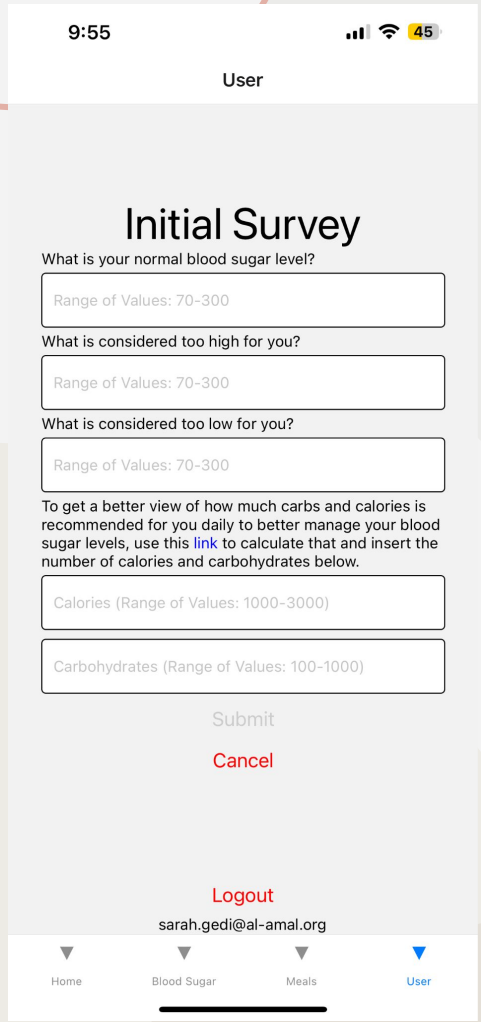


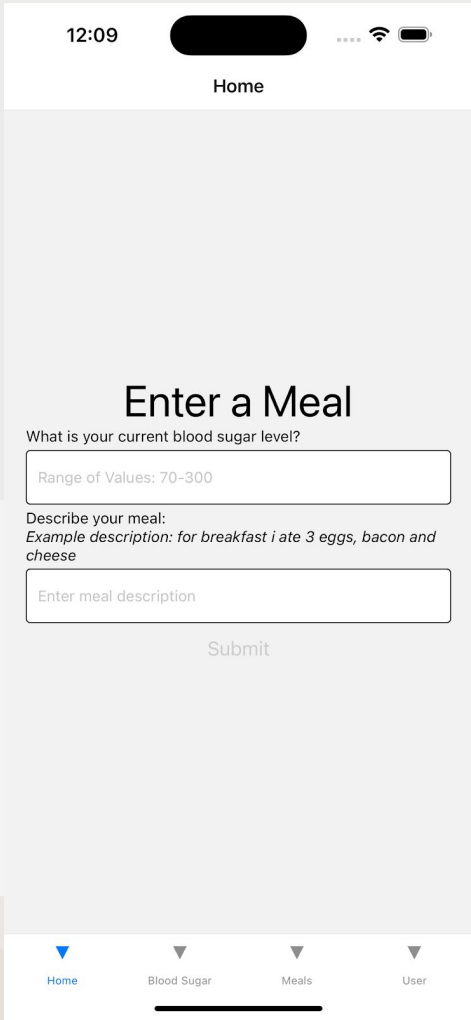
Code

```
return (
    <ScrollView contentContainerStyle={{...styles.container, flexGrow: 1}} keyboardShouldPersistTaps='handled'>
        <Text style={{textAlign: 'center', fontSize: 40, fontWeight: 'bold'}}>Carb Tracker App</Text>
        <KeyboardAvoidingView behavior="padding">
            <TextInput
                style={styles.input}
                placeholder="Email"
                autoCapitalize="none"
                onChangeText={(text) => setEmail(text)}
            ></TextInput>
            <TextInput
                style={styles.input}
                placeholder="Password"
                autoCapitalize="none"
                onChangeText={(text) => setPassword(text)}
                secureTextEntry={true}
            ></TextInput>

            {loading ? <ActivityIndicator size="large" color="#0000ff" />
            : <>
                <Button title="Login" onPress={signIn}/>
                <Button title="Create account" onPress={signUp}/>
            </>}
        </KeyboardAvoidingView>

    </ScrollView>
)
```

APP

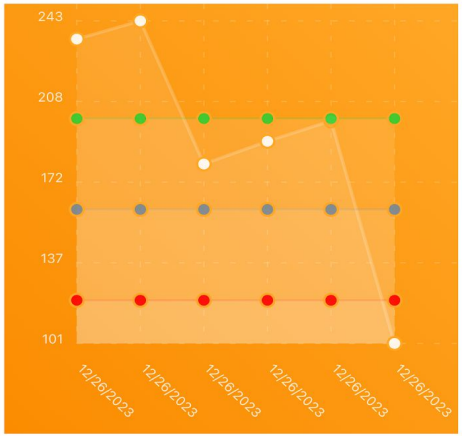

12:07
Carb Tracker App
Email
Password
Login
Create account


9:55
User
Initial Survey
What is your normal blood sugar level?
Range of Values: 70-300
What is considered too high for you?
Range of Values: 70-300
What is considered too low for you?
Range of Values: 70-300
To get a better view of how much carbs and calories is recommended for you daily to better manage your blood sugar levels, use this link to calculate that and insert the number of calories and carbohydrates below.
Calories (Range of Values: 1000-3000)
Carbohydrates (Range of Values: 100-1000)
Submit
Cancel
Logout
sarah.gedi@al-amal.org
Home
Blood Sugar
Meals
User


12:09
Home
Enter a Meal
What is your current blood sugar level?
Range of Values: 70-300
Describe your meal:
Example description: for breakfast i ate 3 eggs, bacon and cheese
Enter meal description
Submit
Home
Blood Sugar
Meals
User

12:08

Blood Sugar



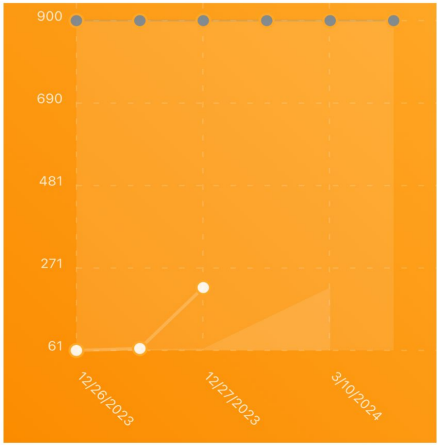
Date	Blood Sugar Level
12/26/2023	235
12/26/2023	243
12/26/2023	180
12/26/2023	190
12/26/2023	199
12/26/2023	101

Home | Blood Sugar | Meals | User

3:48

Meals

Calories | Carbohydrates



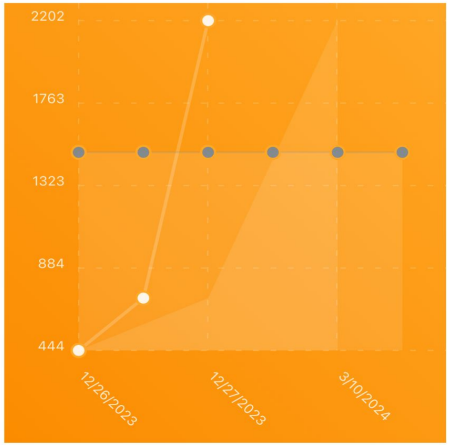
Date	Carbohydrates
12/26/2023	61
12/27/2023	66
3/10/2024	221

Home | Blood Sugar | Meals | User

3:48

Meals

Calories | Carbohydrates



Date	Calories
12/26/2023	444
12/27/2023	723
3/10/2024	2202

Home | Blood Sugar | Meals | User


Enter a Meal

Conclusion

- The developed software's main goal was to allow users to take charge of their diabetics with a tool that not only is proven to be accurate but also easy to use for just about anyone and the app was able to make that happen. It prioritizes user comfort and empowerment, providing a tailored approach to health monitoring while lowering the chances of health risks associated to diabetes. This research is a huge step toward greater inclusion and efficacy for people with diabetes from various backgrounds.

Discussion

- No participants tested the app in this experiment since there were no health hazards, confirming its safety. Furthermore, the API's excellent accuracy and dependability (previously tested) support the app's safety and efficacy.

Limitations

- The app currently stores information for only one week, Monday through Sunday. This constraint is due to the app's prototype status, and we're using the free version of Nutritionix.
- While it does notify users if they have over their daily carb and calorie goals, it does not yet provide alternate alternatives.

Further Expansion

- I will arrange a fundraiser to purchase the necessary API, which will allow me to expand the functionality of my software. Thanks to this assistance, patients can watch their development for longer periods of time, maybe weeks or even months.
- By enabling participants to test the app and investing in the API, we may properly test its functioning over a longer period of time with a wider user base.

Practical Application

This app is inclusive for everyone, regardless of whether they have diabetes or not. Even those simply interested in monitoring their carb and calorie intake can benefit from its features.

Acknowledgments

I would like to thank my family, friends, and school for supporting me in making this happen. I would not have been able to do this without them. I would also like to thank my science fair teacher for helping me during this process I would not have been able to do it without her.

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