Mealtime Insulin Calculator
User Manual
GNG 2101

Project Team 13:

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Abstract

The Engineering Design class, GNG2101, provides students with an applied approach to the design process by engaging students with a semester-long project. Our project group, A13, or S.C.A.N Pharmaceuticals, was assigned to design and develop an application capable of calculating the amount of insulin the user needs to take at mealtime, while also helping them monitor their overall health. This document will provide all necessary information regarding the design, development, use, and the further improvements that the application could receive in its final stage.

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Introduction:

According to Diabetes Canada, type 2 diabetes accounts for 90% of diabetes cases in Canada [1]. Diabetes is a lifelong condition where the body either does not produce enough insulin, or cannot effectively use the insulin it produces. If one's body does not have insulin, or cannot use it properly, the result is a high blood glucose level. Since there is no cure for diabetes, patients monitor their condition by adopting a healthy lifestyle and/or using medication to keep their insulin levels on track.

For individuals who take medication, one of the hardest parts is determining the insulin dosage they require to take after every meal. Insulin dosages are affected by current blood glucose levels, the amount of carbohydrates in a given meal, as well as other factors such as time of day and the individual's insulin sensitivity. Moreover, for many people, doing these calculations can be difficult and confusing, so many rely on applications that can determine all the numbers for them. These applications work by taking a user's inputted meal and calculating the insulin dosage based on the carbohydrates in the food as well as the user's personal factors. However, a lot of these applications are not often not user-friendly as they can be hard to navigate and are often not customizable.

Our group was assigned the task of developing an application that is capable of calculating mealtime insulin based on various user-inputted data. The application is designed for individuals facing diabetes and aims to have a simpler mealtime insulin calculator application. The application has a clean interface, is easy to use, and provides the user with all the necessary functions. In addition, our application has extra functions such as hidden sugar reminders, medication reminders and exercise reminders that can be set by the user. It also utilizes visuals to display results to users more vividly.

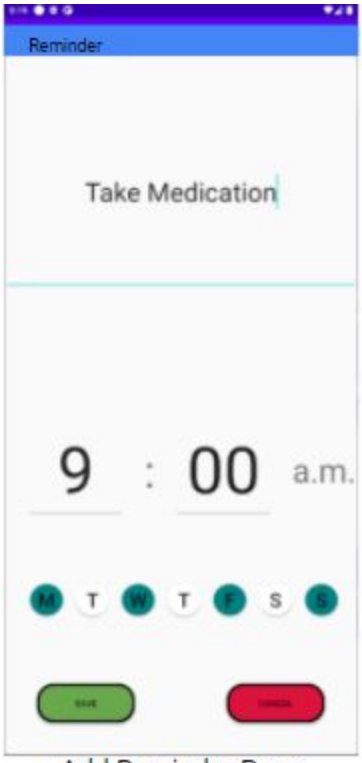
Important Features and Capabilities:

The application has many features and capabilities that provide the user with a positive experience while tracking and monitoring their glucose levels. The main client requested several features be implemented immediately as they are most necessary. This includes a mealtime calculator that will display the required amount of insulin per meal for the amount of food consumed, reminders and notifications that can be customized to the user's preference, and a statistics page that will enable the user to visually understand the data that is being shared with them. The mealtime calculator uses a food database that stores nutritional information for a large selection of food. This allows the user to input the name of the food along with the portion size and instantly receive an insulin dosage for the meal. The nutrition page can be seen in Figure 1. The reminders and notifications were created to be personalized so they could fulfill many purposes (Figure 2). As an example, they can be created to ring on certain days, times, and even be turned off for a day without deleting it entirely. The statistics page (Figure 3) is linked to the mealtime calculator as it displays to the user weekly statistics of their insulin levels.

There are also several features that were not originally asked for, but were developed as the client enjoyed the idea. These include the contact us and profile page (Figures 4 and 5). The profile page is a customizable page that the user will fill out initially when they open the application for the first time. Things such as name, height, weight, target blood sugar level, and calories per day will be recorded for the application to calculate insulin dosages and alert the user if needed. The contact us page was added in case there are any bugs or features that the users may wish to be added. When on this page, it prompts the user to add a subject line and their desired message. We will then receive the message and reply to appeal the problem the user is having.

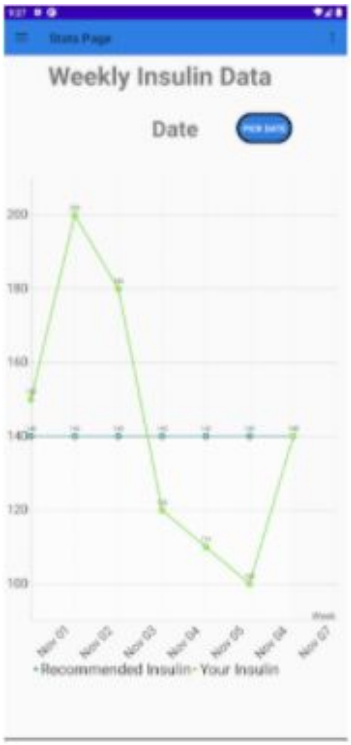
Nutrition Section

Figure 1: Nutrition Section



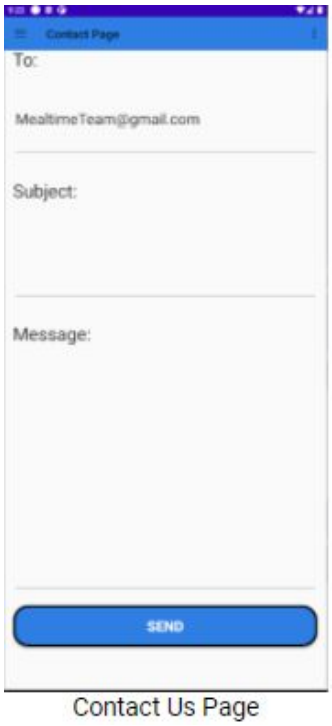
Add Reminder Page

Figure 2: Reminders Page



Statistics Page

Figure 3: Statistics Page



Contact Us Page

Figure 4: Contact Us Page

Profile Page

Figure 5: Profile Page

Developing the Application:

The final prototype of the application was developed over the course of several months. A final application design was created which possessed all features that would make this application functional and successful. Then, the design had to be physically created and implemented into a real application. To do this, Android Studio was used, which is a platform commonly used to create Android Applications. During every step of the design process, every function or feature added to the application was tested on an emulator device to ensure proper functionality.

The application's main function is to calculate mealtime insulin dosages. This is done through calculations that take into account user-inputted data. The insulin calculations used in this application were derived from UCSF's *"Calculating Insulin Dose"* [2]. To calculate mealtime insulin, the user must first input their meal. The nutritional information for every food inputted by the user is taken from a food database found on the USDA website [3]. After the user searches for a food, ei. mango, the application searches for the most relevant item found in the database and displays its nutritional information to the user. Then, if the user chooses to add the food to their meal, the application will calculate the amount of insulin needed for that particular food based on its carbohydrate contents. Moreover, after the user has inputted a full meal, an accumulated insulin dosage will be suggested. Moreover, to store the user's data, Firebase's Cloud Firestore was implemented. Firestore allows for all app data to sync to a cloud database through real-time listeners. All design files and code for this application are available in the app's Github repository which can be found in Appendix I. The link provided can be used to clone the repository onto anyone's computer and design files can be imported into Android studio.

Installation and Maintenance:

As of December 2020, our application can only handle incoming and outgoing data from one user so the application will not be published on the play store until future updates. In order to run the application, the client will need to download the Android Application Package (APK) provided to them by our team. The APK will be provided via a shared Google drive or another source available to the client. For future application updates made by the Mealtime team, an updated APK will be provided to the client which can be downloaded in the same way. In order to download the APK, open the shared drive Google Drive on the Samsung A71 and download the APK. The mobile will prompt you to enable certain settings in order to download the unknown file. Once the setting is enabled another pop up will appear from google play store asking for verification. Verify the pop up and the installation will finally be completed.

Technical Instructions and Troubleshooting:

The app is capable of internally handling any possible errors that may arise. Moreover, any known errors will show the user a pop-up message indicating what the issue is and how to solve it. However, if an unknown error does occur the first step in resolving the issue would be to do a simple restart. That way, if the error was an initialization error it will be resolved on restart. If the error still persists, the Mealtime team can be contacted through the “Contact Us” page with a proper description of the error and how it happened. On one hand, if said error is a database error, our team will resolve it on our end and let the client know when the app is usable again. On the other hand, if it happens to be an internal app error, our team will have to debug the code and will send an updated APK to the user when the application is functional.

It should be noted that this application was developed particularly for and tested on a Samsung A71 device (client’s device). If the application is downloaded and ran on a different Android device, the user interface of the application may not appear properly. This is due to the difference in screen size and screen resolution among different Android devices. Furthermore, this application is not cross-compatible with Apple devices and/or any devices not running the Android operating system.

Health and Safety Guidelines:

1. This app only takes into consideration diabetes and doesn't take into consideration other health issues. If you have other health issues, please consult your doctors specifically.
2. This application is not a substitute for medical advice. Please consult your physician if unsure about taking mealtime insulin.
3. This app will only function properly if you declare your information truthfully, we will not take responsibility for any problem that arises from non-truthful declarations.
4. This application does not guarantee that all the data, such as food nutrition levels and insulin dosages are fully accurate.
5. Use this application to calculate mealtime insulin at your own risk.
6. Our team is not responsible for any side effects that may occur from taking wrong insulin dosages possibly suggested by the application.
7. In case of emergency, contact your doctor immediately.
8. **Important**: Application redistribution is prohibited as it will allow security risks to the users' data!

Conclusions:

Overall, the development of our application was quite successful. We managed to implement the critical functionality of the application along with a few additional features for the user. If another group were to continue developing our prototype we would recommend them to implement a few extra features. The main features would include the ability to track exercise and sleep, as both do play effects on the metabolism and blood sugar levels of the user. A home page would need to be developed that can allow the user to navigate through tracking each statistic as well. Moreover, we would recommend implementing a better nutrition database that has more options. To go along with that, more portion sizes/measurement options should be added to make inputting meals even easier. At the moment, the application considers one portion size to be 100g, but other units of measurements like cups or ounces should be included. Additionally, adding more visuals to the application like nutrition diagrams and macronutrient charts would also be a big improvement. With these additional features, the application would be complete and provide many services in one clean, convenient, and functioning environment for the user.

Bibliography

[1] Canadian Diabetes Association. “Type 2 Diabetes”. Diabetes Canada. https://www.diabetes.ca/about-diabetes/type-2

[2] Diabetes Education Online. “Calculating Insulin Dose”. USCF. https://dtc.ucsf.edu/types-of-diabetes/type2/treatment-of-type-2-diabetes/medications-and-therapies/type-2-insulin-rx/calculating-insulin-dose/

[3] FoodData Central. “FoodData Central”. USDA US Department of Agriculture. https://fdc.nal.usda.gov/.

Appendix I

Link to the application’s Github repository:
https://github.com/Nisarg23/Mealtime-Calculator2