MyHealthGoals Project

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Abstract

With the rapid growth in the use of smart devices and mobile phones, there is increasing personal health data that is being collected through a variety of Internet of Things (IoT) devices. This data holds the key to helping people better understand their current health and to allow a user to monitor and set goals for different health categories like sleep, weight and exercise. This data has typically been stored across multiple applications making it difficult to view in summary form and establish health/fitness goals where desired. The MyHealthGoals database allows a user of Apple's iPhone to unlock this data to provide additional information on maintaining a healthy lifestyle by understanding the baseline health measures and setting goals where improvement is desired.[1]

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[1] Apple Inc.. HealthKit. Retrieved March 06, 2019, from https://developer.apple.com/healthkit/

Benefits

The features of the MyHealthGoals database will be demonstrated to show how personal health information can be summarized from the following categories to achieve an overall picture of personal health:

1. Weight data (weight, body mass index, body fat %),
2. Sleep (total sleep)
3: Activity (flights climbed, steps)

Information will then be summarized, so a user can compare baseline measurements to external benchmarks for the measures above. Goals can then be set for each measure and be monitored on a daily, weekly or monthly basis. A user can then see if overall health is increasing or decreasing, how they are doing compared to the goals they set and be notified for celebrations when goals are met.

User Profile

The appeal of Apple's iPhone-based applications is the ease of use and wide-ranging appeal to users of all ages. The tracking of health information interests' people at varying stages of life and this database needs to be flexible, so that it can be used by a target audience from age 15 to 75 with a focus on those individuals who use a broad range of IoT devices to collect health information. The application will need to appeal to users who are new to technology so a simple user experience will be needed while also having a platform that provides for the development of more advanced features to appeal to the more technologically advanced users.

Questions a User Can Answer with This Data

1. How am I performing on my health measures compared to my goals?
2. How does my performance compare with others whom I choose to share my information?
3. How do my health measures compare to external benchmarks?
4. Based on my performance to benchmarks, what goals can I set to practice more healthy behaviors?
5. What is the trend of my health measures over time?

Note: Answers to these questions will be provided in the Summary section.

Business Rules

ID	Description
1	Zero or many person(s) have attributes such as Name/Birth Date/Sex/Height. A person may also own zero or many Internet of Things (IoT) devices.
2	Zero or many devices may also track zero to many health measures.
3	For each health measure, zero or many entities/attributes such as Sleep (minutes of total sleep per night), Body Measurements (weight in pounds, body mass index, % body fat, time/date) and Activities (steps, flights climbed, date) can be recorded.
4	Zero or many people may have zero or one baseline which summarizes averages of total sleep, asleep, weight, body mass index, body fat percentage, step count and flights climbed.
5	A person can then establish zero or one goal for each attribute (minutes of total sleep per night, weight in pounds, body mass index, % body fat, steps and flights climbed) based on zero or one baseline values.
6	Zero or one goal will be compared to zero or one baselines to determine increase/decrease/no change.

Logical Model

The Logical Model is a graphical representation which is used during the design of a relational database to show the tables, columns, keys, and constraints.[2] Figure 1 below is the Logical Model for the MyHealthGoals project.

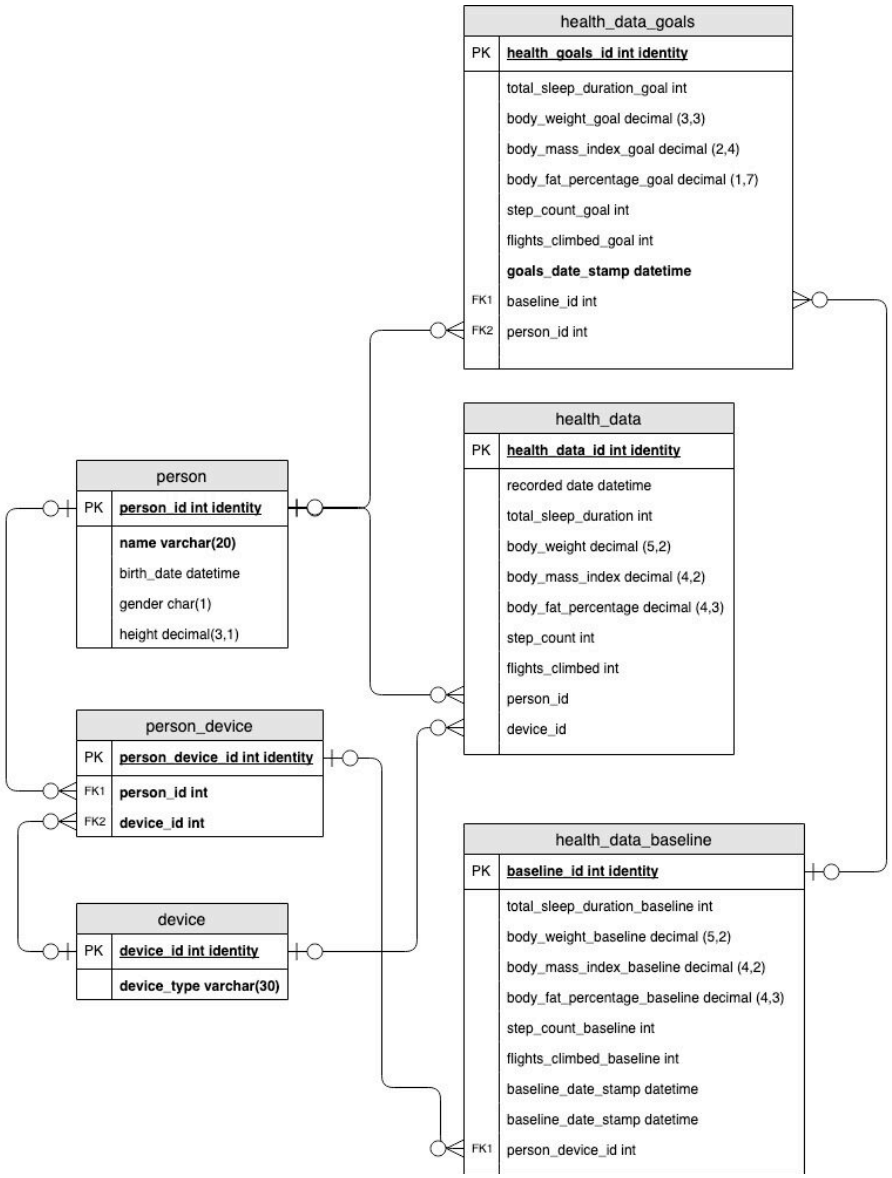

Figure 1: Logical Model from draw.io

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[2] Hoffer, J. A., Ramesh, V., & Topi, H. (2016). *Modern database management*. Boston: Pearson Education.

Stakeholders

There are numerous stakeholders that would need to be involved to make this project a success. The table below lists some of the stakeholders and their expected needs and contributions to this project.

Stakeholder	Need	Contribution
Users	A product that is easy to use and helps me improve my health	The user needs to see adequate value to purchase the product and provide feedback on improvements
Management	A product that fits a market need and can be produced/supported profitably	Provide investment and guidance during all phases of the project (development, launch, support)
Project Team (IT and business subject-matter experts)	A well designed conceptual and logical product that can be delivered and tracked via an Agile model	Develop the infrastructure and provide incremental improvements while keeping the project on track
Sales & Marketing	Training on the product and marketing support so customers have an awareness and interest in buying the product	Create the demand from potential users and provide feedback on issues and potential improvements
Customer Care	Training and infrastructure to support users of the product	Provide support through a variety of different methods when users have questions

Project Detail

The project implementation was broken down into the following phases and the details for each step will be provided in the following sections:

1. Create Tables & Insert Data
2. Develop Views & Security
3. Add/Delete Data
4. Database Connections
5. Create Form & Report
6. Create Graphical Report
7. Database Backup
8. Stakeholder Next Steps

1. Create Tables & Insert Data

After completing the Logical Model, the first step in developing the SQL code was to create the tables, columns and constraints. Below in Figure 2 is a screenshot that shows how data can be exported from several IoT devices like a Withings internet-connected scale or the SleepTracker system through an iPhone and then merged using an SQL database. To put this into production, an ETL (extract/transmit/load) stored procedure would need to be developed using the Apple Health SDK (software development toolkit). This is outside of the scope of this project and would need to be considered as part of the move to production.

To see the details for the SQL used to build the table and data shown in Figure 2, please look in the Appendix at the end of this document. *Note: The null values in Figure 2 were eliminated in a subsequent data load described in Section 3 below.*

SELECT * FROM Health_Data

	Health_Data_ID	Recorded_Date	Total_Sleep_Duration	Body_Weight	Body_Mass_Index	Body_Fat_Percentage	Step_Count	Flights_Climbed	Person_Device_ID
1	1	2019-01-01 00:00:00.000	369	NULL	NULL	NULL	9247	9	2
2	2	2019-01-01 00:00:00.000	366	197.96	26.87	0.260	10853	10	1
3	3	2019-01-02 00:00:00.000	224	NULL	NULL	NULL	1939	NULL	1
4	4	2019-01-03 00:00:00.000	438	197.14	26.76	0.263	290	NULL	1
5	5	2019-01-04 00:00:00.000	NULL	196.45	26.67	0.257	1624	NULL	1
6	6	2019-01-05 00:00:00.000	512	196.06	26.61	0.259	1435	NULL	1
7	7	2019-01-02 00:00:00.000	258	127.50	NULL	0.252	890	1	2
8	8	2019-01-03 00:00:00.000	461	127.20	NULL	0.267	736	2	2
9	9	2019-01-04 00:00:00.000	322	NULL	NULL	NULL	687	NULL	2
10	10	2019-01-05 00:00:00.000	403	NULL	NULL	NULL	1061	NULL	2
11	11	2019-01-06 00:00:00.000	462	128.10	NULL	NULL	5488	2	2

Figure 2: Screenshot by Author from Microsoft SQL Server - Health_Data table

The next step in the process was to take the raw health data and setup a baseline (average) that can be compared to a user generated goal to track their progress. This was more challenging than expected due to complex Insert statements with the AVG function and JOIN statements (see Page 23 for the SQL detail). This was an important technical hurdle to overcome so the user can see a baseline of their health data and then set goals through a form in Microsoft Access. This will be described in detail in Section 5.

SELECT * FROM Health_Data_Baseline

	Baseline_ID	Total_Sleep_Duration_Baseline	Body_Weight_Baseline	Body_Mass_Index_Baseline	Body_Fat_Percentage_Baseline	Step_Count_Baseline	Flights_Climbed_Baseline	Baseline_Date_Stamp	Person_Device_ID
1	1	385	196.90	26.73	0.260	3228	10	2019-02-26 16:36:28.373	1
2	2	379	127.60	NULL	0.260	3018	3	2019-02-26 16:36:28.373	2

Figure 3: Screenshot by Author from Microsoft SQL Server - Health_Data_Baseline table

There is also a need for these Baselines to be automatically updated and a Trigger was created using the SQL code in Figure 4, so a new Baseline is now created each time a record is added to the Health_Data table.

```
--Creating a trigger to update the baseline table whenever a new record is inserted in the health data table
CREATE TRIGGER BaselineUpdate
ON Health_Data
AFTER INSERT
AS
INSERT INTO Health_Data_Baseline(Total_Sleep_Duration_Baseline,Body_Weight_Baseline,Body_Mass_Index_Baseline,Body_Fat_Percentage_Baseline,Step_Count_Baseline,Flights_Climbed_Baseline,Health_Data.Person_Device_ID)
    SELECT
    AVG(Total_Sleep_Duration) as "Average Minutes of Sleep Per Night"
    ,AVG(Body_Weight) as "Average Weight in Pounds"
    ,AVG(Body_Mass_Index) as "Average Body Mass Index"
    ,AVG(Body_Fat_Percentage) as "Average Body Fat %"
    ,AVG(Step_Count) as "Average Step Count"
    ,AVG(Flights_Climbed) as "Average Flights Climbed"
    ,Health_Data.Person_Device_ID
    FROM Health_Data
    JOIN Person_Device ON Person_Device.Person_Device_ID = Health_Data.Person_Device_ID
    GROUP BY Health_Data.Person_Device_ID
```

Figure 4: Screenshot by Author from Microsoft SQL Server - SQL code for trigger

The next step in the data insertion and manipulation process was to insert Goals that could be later updated in Access by a user. The query used to generate Figure 5 shows a consolidated view of Baseline (averages) over time compared to the new Goals that were added. This query will be the foundation for a Form and Report also created later in Microsoft Access.

	Name	Goal_Date_Stamp	Total_Sleep_Duration_Baseline	Total_Sleep_Duration_Goal	Body_Weight_Baseline	Body_Weight_Goal	Body_Mass_Index_Baseline	Body_Mass_Index_Goal
1	Heather Fields	2019-02-26 16:37:10.690	379	420	127.60	126.00	NULL	NULL
2	John Fields	2019-02-26 16:37:10.690	385	456	196.90	190.00	26.73	26.00

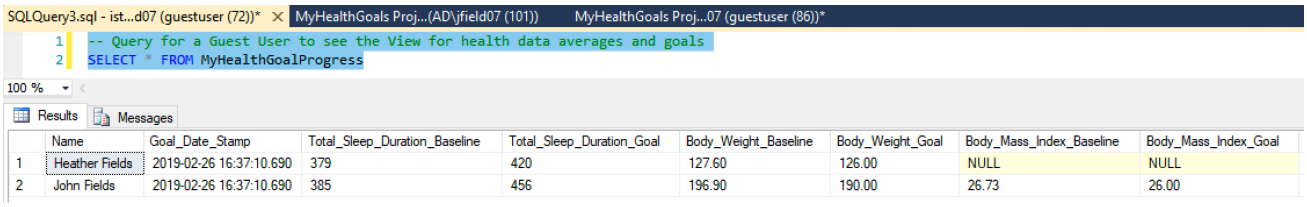
Body_Fat_Percentage_Baseline	Body_Fat_Percentage_Goal	Step_Count_Baseline	Step_Count_Goal	Flights_Climbed_Baseline	Flights_Climbed_Goal
0.260	0.250	3018	4000	3	5
0.260	0.250	3228	4000	10	12

Figure 5: Screenshot by Author from Microsoft SQL Server - query comparing health data goals with baselines

At the end of this first stage, all the data insertion and updating challenges were overcome except for having the Health_Goals table use the most recent Baseline_ID created with the Trigger statement shown in Figure 4. During prototyping, this technical challenge is overcome by manually updating the Health_Goals table. Before moving to production, this will need to be automated. It should also be noted that inserting default values into the tables was considered for this project but there were no data fields where this was required.

2. Develop Views & Security

Now that the tables, columns, constraints, and queries are built, the project shifted toward creating views in SQL and a guest user account. Security is a very important part of this project due to the Personally Identifiable Information (PII) that it contains. It is very important that users feel their information is secure and the first step related to this was to create a guest user account as shown in Figure 6.



	Name	Goal_Date_Stamp	Total_Sleep_Duration_Baseline	Total_Sleep_Duration_Goal	Body_Weight_Baseline	Body_Weight_Goal	Body_Mass_Index_Baseline	Body_Mass_Index_Goal
1	Heather Fields	2019-02-26 16:37:10.690	379	420	127.60	126.00	NULL	NULL
2	John Fields	2019-02-26 16:37:10.690	385	456	196.90	190.00	26.73	26.00

Figure 6: Screenshot by Author from Microsoft SQL Server - Guest User SELECT statement on MyHealthGoalProgress view

The guest user account in SQL will provide a level of security for IT users that may need to access this information. For data transferred to Microsoft Access (or eventually to an app on an Apple iPhone), a detailed plan for user account security and the encryption of the information "at-rest" and "in-motion" needs to be developed to ensure that users trust providing this information and unauthorized breaches are prevented.

3. Add/Delete Data

After testing the database through the ODBC connection in Access, it was apparent that more data was needed before creating the forms and reports. Additional SQL was written to populate more users, devices, and health data. The Person Table is shown in Figure 7 below after additional users were added. Other data that was added is included in the Appendix on pages 26-27.

	Person_ID	Name	Birth_Date	Gender	Height
1	1	Personally		M	72.0
2	2	Identifiable		F	63.5
3	3	Information		NULL	NULL
4	4			NULL	NULL
5	5	Redacted		M	70.0
6	6			F	68.0
7	7			M	70.0

Figure 7: Screenshot by Author from Microsoft SQL Server - Person table

Two additional users were accidently added through Microsoft Access for Person_ID's 3 & 4. These were removed with a DELETE statement in SQL to eliminate this incorrect data.

4. Database Connections

At the end of Step 3 in the project, we now have a fully functioning database in SQL. The logical model in Figure 1 (with normalizations) proved to be a solid design that is ready to link to Microsoft Access through an ODBC connection. This now provides the link between these systems so the prototyping of the user report and form can begin in Access as described in Step 5. Figure 8 is a screen shot from Access showing the ODBC connections between SQL Server and Access.

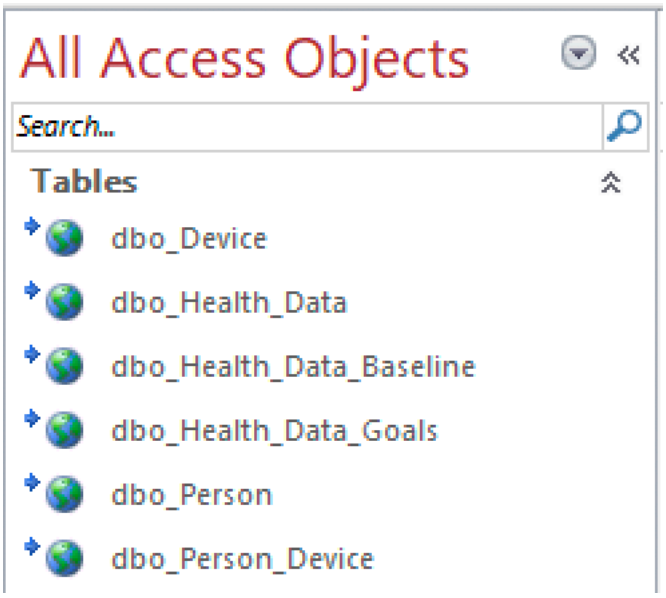


Figure 8: Screenshot by Author from Microsoft Access - Tables showing the ODBC connections

5. Create Form & Text Report

Now that we have the database complete in SQL and a connection to send this data to Access via ODBC, the relationships in Access were created to show the Primary Keys, Foreign Keys and relationships. Once this is completed in Access, a prototype of forms and reports can also be created that will be more user friendly than the SQL environment.

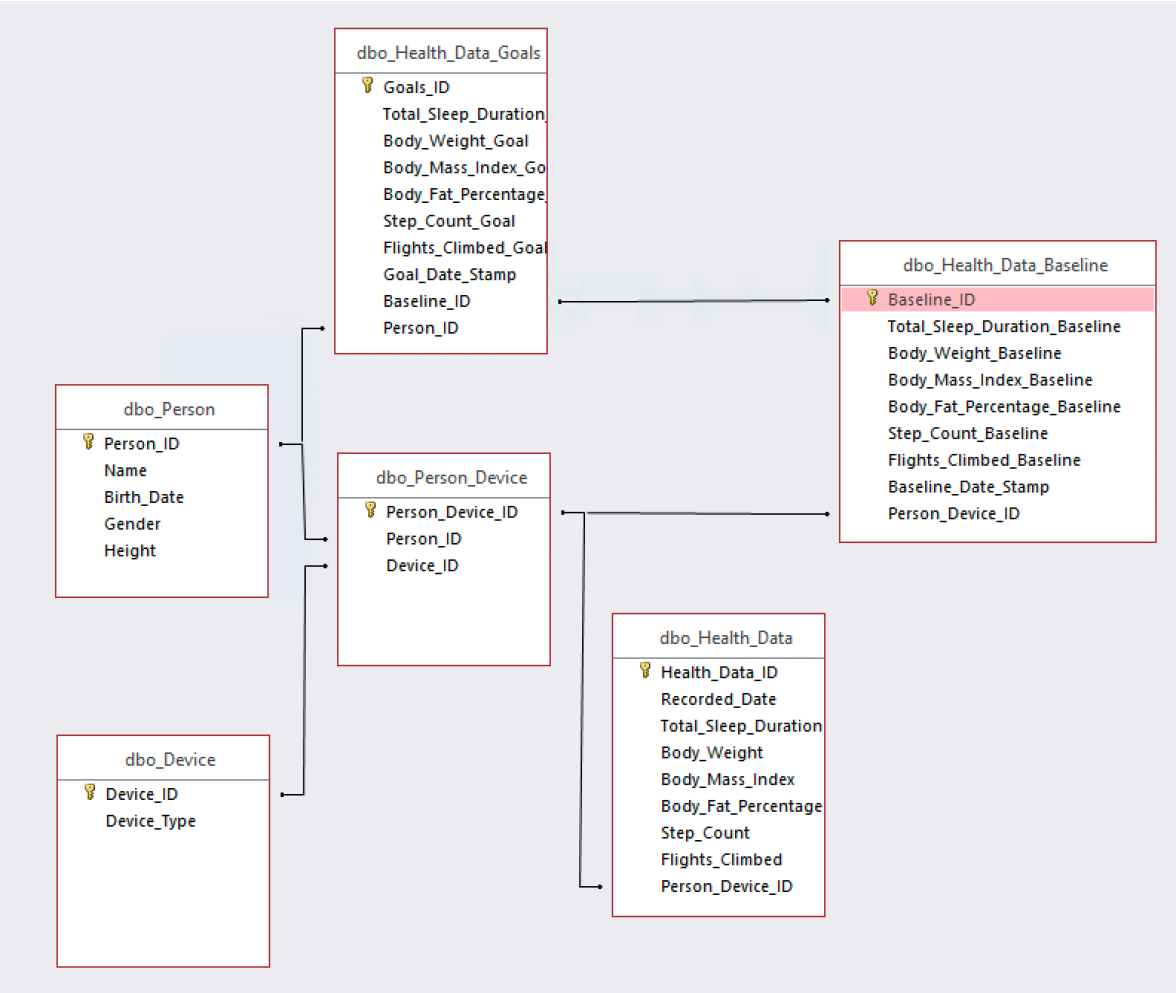
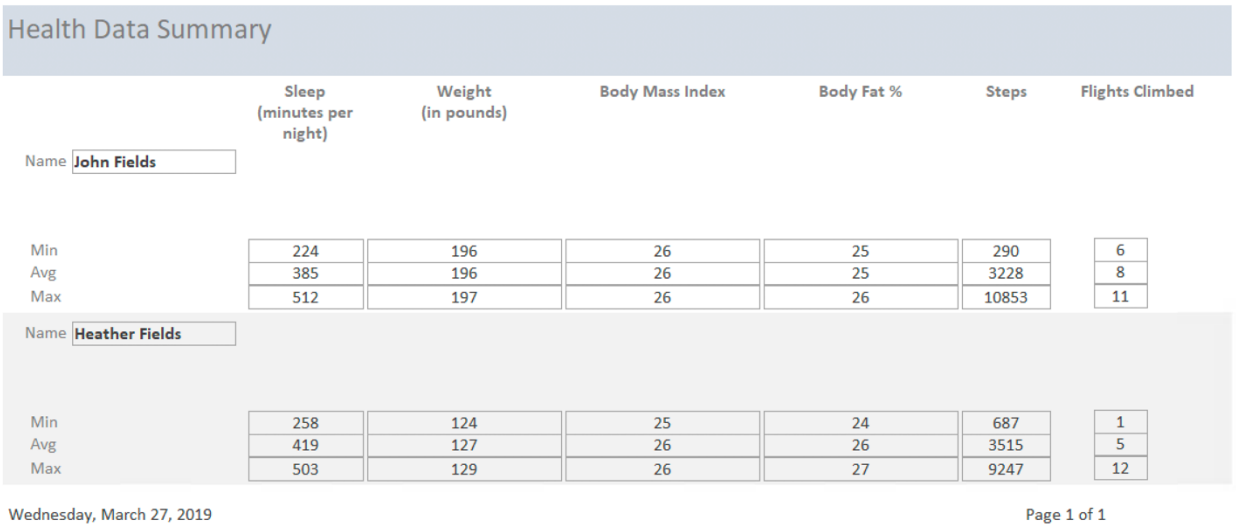


Figure 9: Screenshot by Author from Microsoft Access - Relationships

After completing the Access relationships in Figure 9, the first user report in Access was created as shown in Figure 10. This form allows a user to view the Minimum, Average and Maximum values for each health measure. Prior to moving this to a production system, this report would need to be tied to a user login in Access as described in Step 2 above.



Health Data Summary

	Sleep (minutes per night)	Weight (in pounds)	Body Mass Index	Body Fat %	Steps	Flights Climbed
Name **John Fields**						
Min	224	196	26	25	290	6
Avg	385	196	26	25	3228	8
Max	512	197	26	26	10853	11
Name **Heather Fields**						
Min	258	124	25	24	687	1
Avg	419	127	26	26	3515	5
Max	503	129	26	27	9247	12

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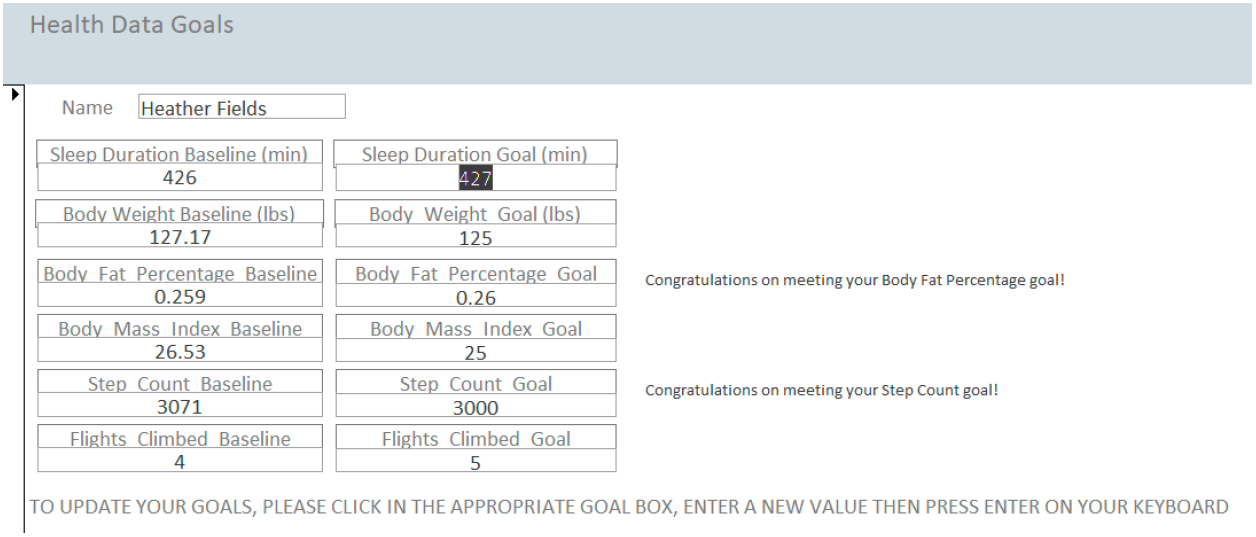
Figure 10: Screenshot by Author from Microsoft Access - Health Data Summary Report

Once the summary report was complete, the next technical challenge was to develop a form which combined Baseline information by user with Goal information. This was accomplished by developing a user view for baseline information and if a Goal is achieved, a "Congratulations on meeting your goal..." message is displayed. As shown in Figure 11, the user can also set a new Goal on this form if they have achieved a prior goal and want to set a new one (see instructions at the bottom of the screenshot). For data integrity reasons, all other fields in the form except for Goals are set to "locked" in Access to prevent the user from changing other data that could corrupt the database.



Health Data Goals

Name Heather Fields

Sleep Duration Baseline (min) 426	Sleep Duration Goal (min) 427
Body Weight Baseline (lbs) 127.17	Body Weight Goal (lbs) 125
Body Fat Percentage Baseline 0.259	Body Fat Percentage Goal 0.26
Body Mass Index Baseline 26.53	Body Mass Index Goal 25
Step Count Baseline 3071	Step Count Goal 3000
Flights Climbed Baseline 4	Flights Climbed Goal 5

Congratulations on meeting your Body Fat Percentage goal!

Congratulations on meeting your Step Count goal!

TO UPDATE YOUR GOALS, PLEASE CLICK IN THE APPROPRIATE GOAL BOX, ENTER A NEW VALUE THEN PRESS ENTER ON YOUR KEYBOARD

Figure 11: Screenshot by Author from Microsoft Access - Health Data Goals Form

Note: In the Health Data Summary report in Figure 10, the INT function in Access was used to round the numbers to integer values. The INT function did not work on the Health Data Goals form in Figure 11 so there is variation in the decimal values displayed. This would need to be corrected through additional custom code in Access before to moving the application to production.

6. Create Graphical Report

The form and report created in Access provide the user with text-based information to see how they are progressing on their health goals. The addition of a graphical report was included in this project to show how this could be accomplished in R software. Figure 13 is the programming in R to establish the connection with the SQL database and output an example report (Figure 12) showing the Sleep Duration per night for the available data. Ideally, the report in Figure 12 would also include the day of the week or date below each vertical bar and this is another change that would be implemented prior to moving this to a production environment.

Using R to add predictive analytics to this application could provide significant value for the users and continue to have this application remain viable in what could become a more competitive space in the future. Predictive analytics could model trends and suggest useful tips such as considering earlier bed times to increase sleep or increased exercise to lose weight. Individual applications provide this type of advice but there is not an application today that provides this type of holistic information with predictive analytics.

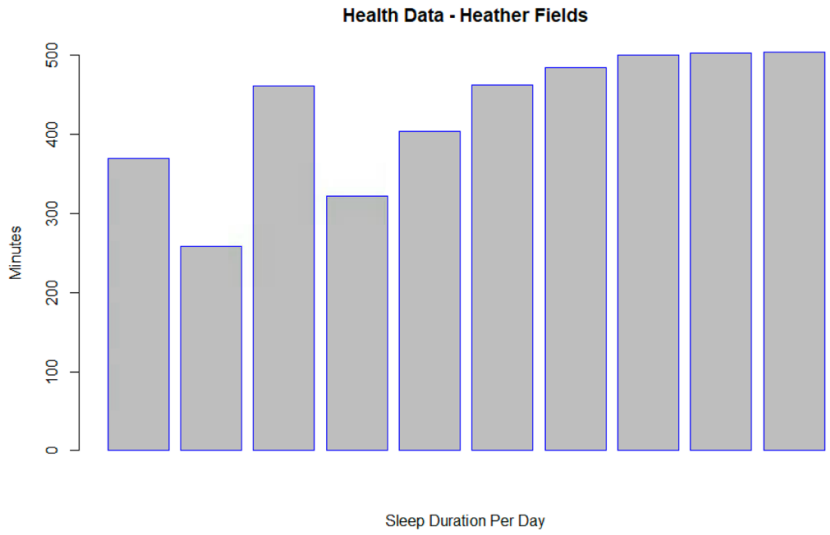


Figure 12: Screenshot by Author from R Studio - Sleep Duration Report

R code used to connect to ODBC and generate the graphical report in Figure 12.

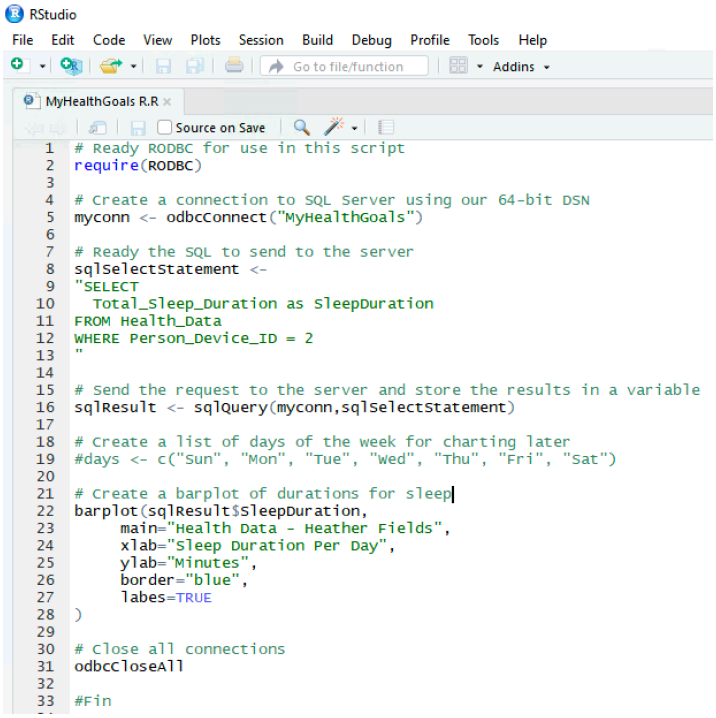


Figure 13: Screenshot by Author from R Studio- Code to connect to ODBC and generate graphical report

7. Database Backup

An important final step in the project was to back up the databases created in Microsoft SQL server and Microsoft Access.

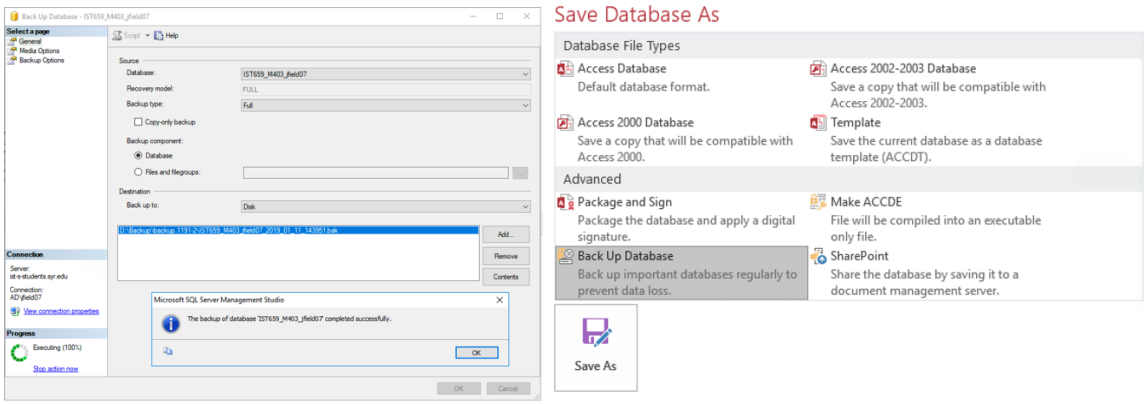


Figure 14: Screenshot by Author from Microsoft Access and SQL Server - Database backups

8. Stakeholder Next Steps

Now that the prototyping of the database, views, user interface and reporting is complete, the stakeholders listed below would need to be engaged in the following areas before launching the product development and implementation plan.

Stakeholder	Next Step
Users	Involve users in a demonstration of the prototype to receive feedback
Management	Demonstrate the capability of the product and discuss the investments needed and resource support required
Project Team (IT and business subject-matter experts)	Review the project/technical design and discuss any concerns or recommendations
Sales & Marketing	Demo the product to generate interest and seek users interested in piloting
Customer Care	Review the product and receive feedback on recommended support considerations

Summary

The objective of this project was to build a user-friendly application database that provides consolidated Internet of Things (IoT) health information so users can set up and track goals to improve overall health. As part of achieving this objective, we listed "Questions the Data Can Answer" at the beginning of this report. Below we will show how the application can answer these questions with the MyHealthGoals database:

1. How am I performing on my health measures compared to my goals?

The report in Figure 11 shows a user (Heather Fields) has achieved her goals for Body Fat % and Steps. She receives a "congratulations" message to celebrate these achievements. She could also decide to change her goal using the instructions at the bottom of the form.

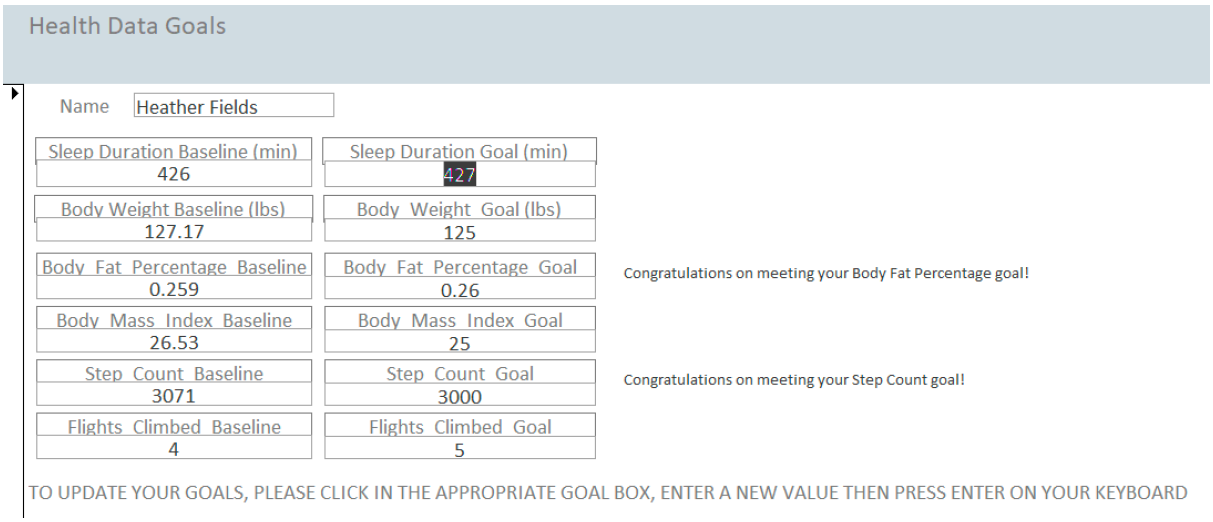
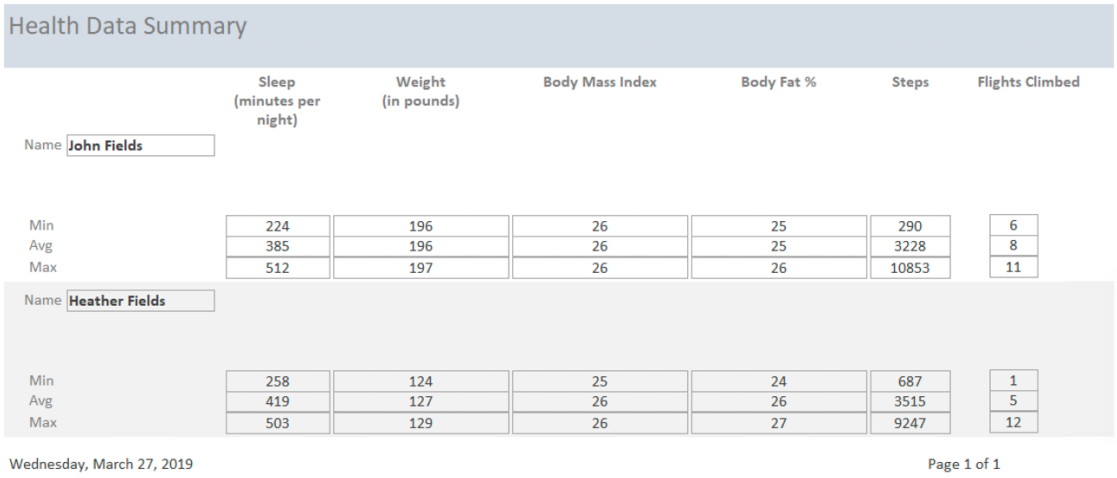


Figure 11: Screenshot by Author from Microsoft Access - Health Data Goals Form

2. How does my performance compare with others whom I choose to share my information?

Once the security between users is set up, users (John and Heather) could share the report in Figure 10 below to see how they are doing. With this information, they may want to establish similar goals for Steps to see if they can both achieve an average of 4000 per day.



Health Data Summary

	Sleep (minutes per night)	Weight (in pounds)	Body Mass Index	Body Fat %	Steps	Flights Climbed
Name **John Fields**						
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Avg	385	196	26	25	3228	8
Max	512	197	26	26	10853	11
Name **Heather Fields**						
Min	258	124	25	24	687	1
Avg	419	127	26	26	3515	5
Max	503	129	26	27	9247	12

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Figure 10: Screenshot by Author from Microsoft Access - Health Data Summary Report

3. How do my health measures compare to external benchmarks?

HealthStatus.com suggests a Body Mass Index (BMI) between 19.5 and 24.9 for adults. The user in Question #1 above has a BMI goal of 25, so if she achieves 24.9 she would be in the recommended range.

Note: The author was unable to find a consolidated benchmark reference for all the different health measures described in this project. Another potential enhancement to this database is a list of benchmarks based on the user's age, sex, height, weight, etc which would generate baselines for sleep, weight, body fat %, steps, and flights climbed.

4. Based on my performance to benchmarks, what goals can I set to practice more healthy behaviors?

In question #3 above, the BMI benchmark indicates the user is above the Body Mass Index recommended level. An enhancement to this program could be to substitute for the "Congratulations" message if a user is not meeting the goal. The messages could be tailored to the user to suggest "Try to snack less between meals" or "Try to avoid snacks or meals after 9pm at night" if the BMI, body fat percentage or weight is above goal. This option would need to be carefully considered with input from users, marketing, sales and customer care to ensure that these messages are not seen as annoying, intrusive or unhelpful by users.

5. What is the trend of my health measures over time?

In Figure 12 below, a user (Heather Fields) can see that her sleep per night is improving each night. Perhaps, she has been trying to go to bed earlier or avoid watching TV or using her mobile phone, and she can see the positive results.

Note: Only sleep duration is in this example. Other measures could be easily plotted in the future using R.

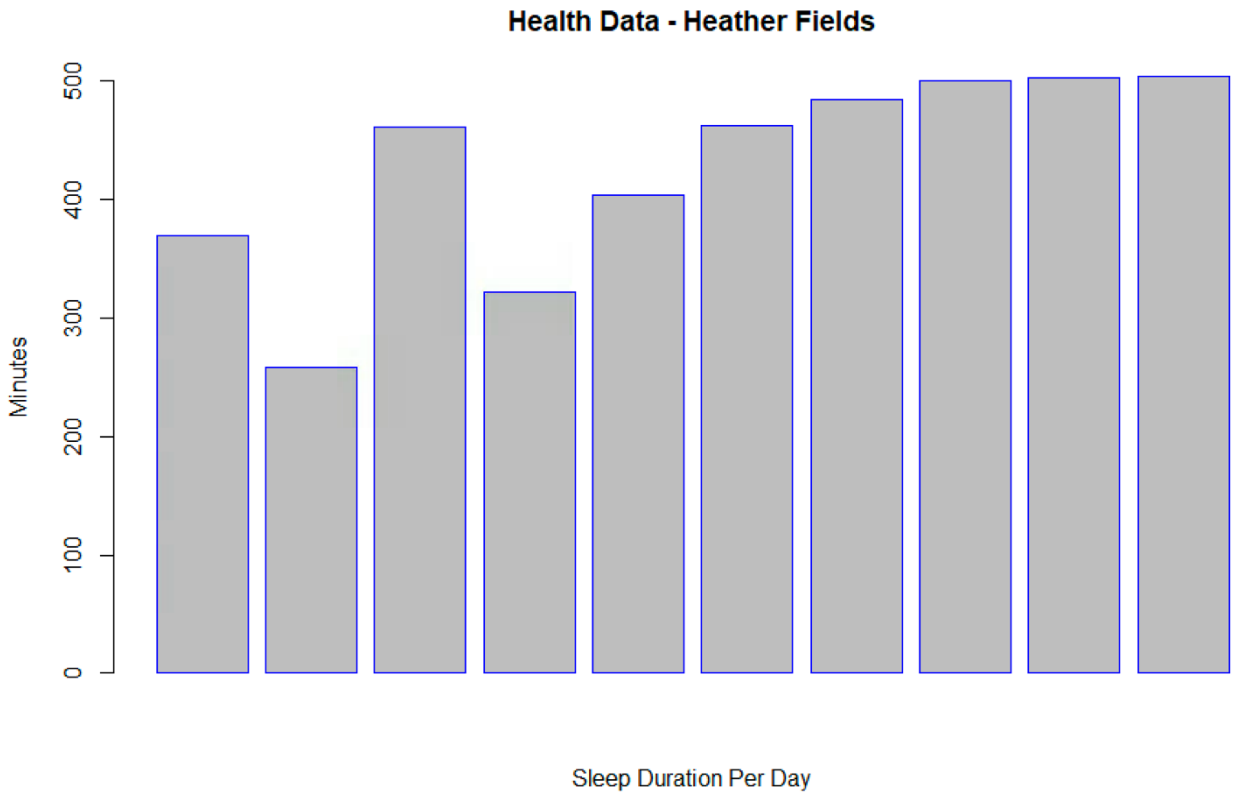

Figure 12: Screenshot by Author from R Studio - Sleep Duration Report

Conclusion

In addition to answering the questions above, this project was successful in using the database, forms, and reports to consolidate personal health information for improved data integrity and efficiency. Throughout the paper, there are several areas that highlighted improvements such as ETL, stored procedures and user security in Access. Several examples of feature enhancements were also listed such as benchmark information and the use of predictive analytics for targeted messages for encouragement/improvement. MyHealthGoals was developed with the basic features expected to help users in the initial product while also considering a roadmap for future enhancements.

Once this project is complete, there is an excellent business opportunity to create an Apple iOS app connected to this database that provides a secure, user-friendly application for iPhone users to view complete health data and set goals to improve their overall health.

Appendix

1. SQL Detail

Note: For the complete SQL code, please see the file John_Fields_Project2_SQL.sql

```
*/
        Author :    John Fields
        Course :    IST659 M403
        Term        :       Winter 2019
        Project :   MyHealthGoals
*/

    --The app QS Access was used to export the iPhone health data to Excel to create a data set that was used to populate the Person, Device, Person_Device and Health Data tables manually for prototyping this database.
    -- Prior to moving this application to production, consideration should be given to developing an API using the Apple Health Kit to automate loading this data.

    --Creating the Person table
    CREATE TABLE Person (
        --Columns for the Person table
        Person_ID int identity,
        Name varchar(30) not null,
        Birth_Date datetime,
        Gender char(1),
        Height decimal(3,1)
        --Constraints on the Person table
        CONSTRAINT PK_Person PRIMARY KEY (Person_ID)
    )
    --End creating the Person table

    --Adding data to the Person table
    --This table contains Personally Identifiable Information (PII) and it should be appropriately secured
    INSERT INTO Person(Name,Birth_Date,Gender,Height)
        VALUES
            ('John Fields','01/01/1966','M','72'),
            ('Heather Fields','01/01/1966','F','63.5')

    SELECT * FROM Person
```

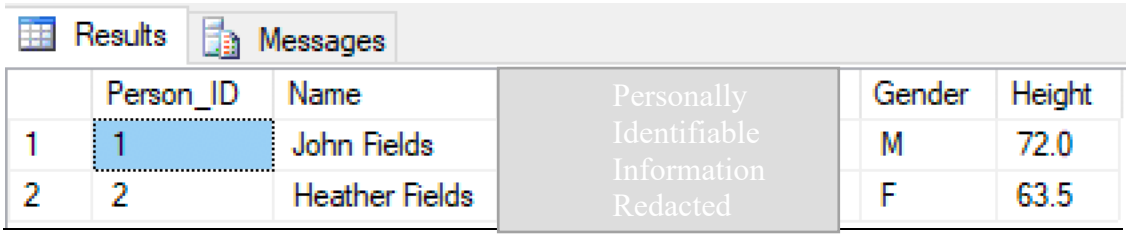

Figure 15: Screenshot by Author from Microsoft SQL Server - Person Table

```
--Creating the Device table
CREATE TABLE Device (
	--Columns for the Device table
	Device_ID int identity,
	Device_Type varchar(30) not null,
	--Constraints on the Device table
	CONSTRAINT PK_Device PRIMARY KEY (Device_ID)
)
--End creating the Device table

--Adding data to the Device table
--This database is currently designed for Apple iOS devices.  If enhanced for other devices in the future, consideration would need to be made for the differences in how these devices handle health data.
INSERT INTO Device(Device_Type)
	VALUES
		('iPhone XS'),
		('iPhone 8+')

SELECT * FROM Device
```

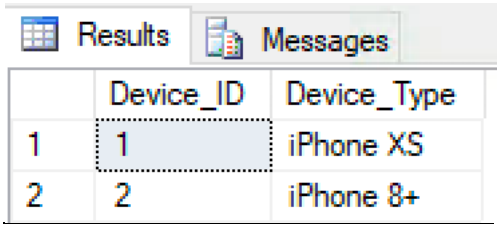

Figure 16: Screenshot by Author from Microsoft SQL Server - Device Table

```
--Creating the Health Data table
CREATE TABLE Health_Data (
	--Columns for the Health Data table
	Health_Data_ID int identity,
	Recorded_Date datetime,
	Total_Sleep_Duration int,
	Body_Weight decimal(5,2),
	Body_Mass_Index decimal(4,2),
```

```
		Body_Fat_Percentage decimal(4,3),
		Step_Count int,
		Flights_Climbed int,
		Person_ID int,
		Device_ID int,
		--Constraints on the Health Data table
		CONSTRAINT PK_Health_Data PRIMARY KEY (Health_Data_ID),
		CONSTRAINT FK1_Health_Data FOREIGN KEY (Person_ID) REFERENCES
Person(Person_ID),
		CONSTRAINT FK2_Health_Data FOREIGN KEY (Device_ID) REFERENCES
Device(Device_ID)
	)
	--End creating the Health Data table

	--Adding data to the Health Data table
	--The QS Data iOS app was not initially syncing the data from some IoT devices.  This
was later corrected and the data was manually added.
	--When loading this data is automated in the future, consideration should be given to how
often the IoT device data is sent to the Apple Health app.
	INSERT INTO
Health_Data(Recorded_Date,Total_Sleep_Duration,Body_Weight,Body_Mass_Index,Body_Fat_
Percentage,Step_Count,Flights_Climbed,Person_Device_ID)
		VALUES
			('1/1/19','369',null,null,null,'9247','9',2),
			('1/1/19','366','197.96','26.87','0.26','10853','10',1),
			('1/2/19','224',null,null,null,'1939',null,1),
			('1/3/19','438','197.14','26.76','0.263','290',null,1),
			('1/4/19',null,'196.45','26.67','0.257','1624',null,1),
			('1/5/19','512','196.06','26.61','0.259','1435',null,1),
			('1/2/19','258',null,null,null,'890',1,2),
			('1/3/19','461',null,null,null,'736',2,2),
			('1/4/19','322',null,null,null,'687',null,2)
			('1/5/19','403',null,null,null,'1061',null,2)
			('1/6/19','462','128.1',null,null,'5488',2,2)

	--Update Heather's Data where data is now available for some Null values
	UPDATE Health_Data
	SET
Total_Sleep_Duration='258',Body_Weight='127.5',Body_Mass_Index=null,Body_Fat_Percentag
e='0.252',Step_Count='890',Flights_Climbed='1'
	WHERE Recorded_Date='1/2/19'AND Person_Device_ID=2
	UPDATE Health_Data
	SET
Total_Sleep_Duration='461',Body_Weight='127.2',Body_Mass_Index=null,Body_Fat_Percentag
e='0.267',Step_Count='736',Flights_Climbed='2'
	WHERE Recorded_Date='1/3/19'AND Person_Device_ID=2
```

```
	--Creating the Health Data Baseline table
	CREATE TABLE Health_Data_Baseline (
		--Columns for the Health Data table
		Baseline_ID int identity,
		Total_Sleep_Duration_Baseline int,
		Body_Weight_Baseline decimal(5,2),
		Body_Mass_Index_Baseline decimal(4,2),
		Body_Fat_Percentage_Baseline decimal(4,3),
		Step_Count_Baseline int,
		Flights_Climbed_Baseline int,
		Person_ID int,
		Device_ID int,
		Health_Data_ID int,
		--Constraints on the Health Data Baseline table
		CONSTRAINT PK_Health_Data_Baseline PRIMARY KEY (Baseline_ID),
		CONSTRAINT FK1_Health_Data_Baseline FOREIGN KEY (Person_ID)
REFERENCES Person (Person_ID),
		CONSTRAINT FK2_Health_Data_Baseline FOREIGN KEY (Device_ID)
REFERENCES Device (Device_ID),
		CONSTRAINT FK3_Health_Data_Baseline FOREIGN KEY (Health_Data_ID)
REFERENCES Health_Data (Health_Data_ID)1
	SELECT
		AVG(Body_Weight) as "Average Weight in Pounds"
		,AVG(Body_Mass_Index) as "Average Body Mass Index"
		,AVG(Body_Fat_Percentage) as "Average Body Fat %"
		,AVG(Step_Count) as "Average Step Count"
		,AVG(Flights_Climbed) as "Average Flights Climbed"
		FROM Health_Data
		GROUP BY Person_ID

	--Adding data to the Health Data Baseline table
	--The Baseline is the average of the existing values from the Health Data table.
	--At the end of this SQL code, a trigger was added to run the Baseline each time the
Health Data table was updated.
	INSERT INTO
Health_Data_Baseline(Total_Sleep_Duration_Baseline,Body_Weight_Baseline,Body_Mass_Ind
ex_Baseline,Body_Fat_Percentage_Baseline,Step_Count_Baseline,Flights_Climbed_Baseline,H
ealth_Data.Person_Device_ID)
		SELECT
		AVG(Total_Sleep_Duration) as "Average Minutes of Sleep Per Night"
		,AVG(Body_Weight) as "Average Weight in Pounds"
		,AVG(Body_Mass_Index) as "Average Body Mass Index"
		,AVG(Body_Fat_Percentage) as "Average Body Fat %"
		,AVG(Step_Count) as "Average Step Count"
		,AVG(Flights_Climbed) as "Average Flights Climbed"
```

```
		,Health_Data.Person_Device_ID
		FROM Health_Data
		JOIN Person_Device ON Person_Device.Person_Device_ID =
Health_Data.Person_Device_ID
		GROUP BY Health_Data.Person_Device_ID

	--Creating the Health Goals table
	CREATE TABLE Health_Data_Goals (
		--Columns for the Health Goals table
		Goals_ID int identity,
		Total_Sleep_Duration_Goal int,
		Body_Weight_Goal decimal(5,2),
		Body_Mass_Index_Goal decimal(4,2),
		Body_Fat_Percentage_Goal decimal(4,3),
		Step_Count_Goal int,
		Flights_Climbed_Goal int,
		Goal_Date_Stamp datetime not null default GetDate(),
		Baseline_ID int,
		Person_ID int,
		--Constraints on the Health Goals table
		CONSTRAINT PK_Health_Data_Goals PRIMARY KEY (Goals_ID),
		CONSTRAINT FK1_Health_Data_Goals FOREIGN KEY (Baseline_ID)
REFERENCES Health_Data_Baseline (Baseline_ID),
		CONSTRAINT FK2_Health_Data_Goals FOREIGN KEY (Person_ID)
REFERENCES Person (Person_ID)
	)

	--Adding data to the Health Data Goals table
	--As mentioned above, a trigger was written to run the Baseline each time Health Data
was updated.  One future enhancement is to insert the most recent Baseline ID in the SQL code
below whenever the Goals are updated.
	--For the prototyping of this project, the Baseline ID's were manually inserted.
	INSERT
Health_Data_Goals(Total_Sleep_Duration_Goal,Body_Weight_Goal,Body_Mass_Index_Goal,B
ody_Fat_Percentage_Goal,Step_Count_Goal,Flights_Climbed_Goal,Baseline_ID,Person_ID)
		VALUES
		('420','126',null,'0.25','4000','5',2,2),
		('456','190','26','0.25','4000','12',1,1)

	--Query to compare Goal to Baseline
	SELECT
		Person.Name,
		Goal_Date_Stamp,
		Health_Data_Baseline.Total_Sleep_Duration_Baseline,
		Total_Sleep_Duration_Goal,
		Body_Weight_Baseline,
```

```
            Body_Weight_Goal,
            Body_Mass_Index_Baseline,
            Body_Mass_Index_Goal,
            Body_Fat_Percentage_Baseline,
            Body_Fat_Percentage_Goal,
            Step_Count_Baseline,
            Step_Count_Goal,
            Flights_Climbed_Baseline,
            Flights_Climbed_Goal
        FROM Health_Data_Goals
        JOIN Health_Data_Baseline ON Health_Data_Baseline.Baseline_ID =
Health_Data_Goals.Baseline_ID
        JOIN Person ON Person.Person_ID = Health_Data_Goals.Person_ID

        -- Create a view to retrieve the Goal to Baseline
        -- To enable an authorized IT user to view information in this database, a guestuser
account was created to allow access to the MyHealthGoalProgress view.
        CREATE VIEW MyHealthGoalProgress AS
            SELECT
                Person.Name,
                Goal_Date_Stamp,
                Health_Data_Baseline.Total_Sleep_Duration_Baseline,
                Total_Sleep_Duration_Goal,
                Body_Weight_Baseline,
                Body_Weight_Goal,
                Body_Mass_Index_Baseline,
                Body_Mass_Index_Goal,
                Body_Fat_Percentage_Baseline,
                Body_Fat_Percentage_Goal,
                Step_Count_Baseline,
                Step_Count_Goal,
                Flights_Climbed_Baseline,
                Flights_Climbed_Goal
            FROM Health_Data_Goals
            JOIN Health_Data_Baseline ON Health_Data_Baseline.Baseline_ID =
Health_Data_Goals.Baseline_ID
            JOIN Person ON Person.Person_ID = Health_Data_Goals.Person_ID
        GO

        -- Creating a guestuser database user
        CREATE USER guestuser FOR LOGIN guestuser

        -- Give them the view
        GRANT SELECT ON MyHealthGoalProgress to guestuser
```

```
--After creating the ODBC connection between SQL Server and Microsoft Access, more data was needed for the report and form in Access to work properly.
--Adding additional data to the Person table
INSERT INTO Person(Name,Birth_Date,Gender,Height)
	VALUES
		('Fred Fields','01/01/1999','M','70'),
		('Alice Fields','01/01/1997','F','68'),
		('Theophilus Fields', '01/01/1950','M','70')
DELETE FROM Person WHERE Person_ID = 3

DELETE FROM Person WHERE Person_ID = 4
```

	Person_ID	Name	Birth_Date	Gender	Height
1	1	Personally		M	72.0
2	2	Identifiable		F	63.5
3	5			M	70.0
4	6	Information		F	68.0
5	7			M	70.0

Figure 17: Screenshot by Author from Microsoft SQL Server - Person Table

```
--Adding additional data to the Device table

INSERT INTO Device(Device_Type)
	VALUES
		('iPhone 7'),
		('iPhone 8')
```

	Device_ID	Device_Type
1	1	iPhone XS
2	2	iPhone 8+
3	3	iPhone 7
4	4	iPhone 8
5	5	iPhone 6

Figure 18: Screenshot by Author from Microsoft SQL Server - Device Table

```
--Adding data to the Person Device table
INSERT INTO Person_Device (Person_ID,Device_ID)
```

```
VALUES
		((SELECT Person_ID FROM Person WHERE Name='Fred Fields'),
		(SELECT Device_ID FROM Device WHERE Device_Type='iPhone 7')),
		((SELECT Person_ID FROM Person WHERE Name='Alice Fields'),
		(SELECT Device_ID FROM Device WHERE Device_Type='iPhone 8')),
		((SELECT Person_ID FROM Person WHERE Name='Theophilus
Fields'),
		(SELECT Device_ID FROM Device WHERE Device_Type='iPhone 6'))
```

	Person_Device_ID	Person_ID	Device_ID
1	1	1	1
2	2	2	2
3	3	5	3
4	4	6	4
5	5	7	5

Figure 19: Screenshot by Author from Microsoft SQL Server - Person_Device Table

```
	--Creating a trigger to update the baseline table whenever a new record is inserted in the
health data table
	--As mentioned above, adding a trigger improved the database so each time data is added
to the Health Data table, the Baseline is updated.
	CREATE TRIGGER BaselineUpdate
	ON Health_Data
	AFTER INSERT
	AS
	INSERT INTO
Health_Data_Baseline(Total_Sleep_Duration_Baseline,Body_Weight_Baseline,Body_Mass_Ind
ex_Baseline,Body_Fat_Percentage_Baseline,Step_Count_Baseline,Flights_Climbed_Baseline,H
ealth_Data.Person_Device_ID)
		SELECT
		AVG(Total_Sleep_Duration) as "Average Minutes of Sleep Per Night"
		,AVG(Body_Weight) as "Average Weight in Pounds"
		,AVG(Body_Mass_Index) as "Average Body Mass Index"
		,AVG(Body_Fat_Percentage) as "Average Body Fat %"
		,AVG(Step_Count) as "Average Step Count"
		,AVG(Flights_Climbed) as "Average Flights Climbed"
		,Health_Data.Person_Device_ID
		FROM Health_Data
		JOIN Person_Device ON Person_Device.Person_Device_ID =
Health_Data.Person_Device_ID
		GROUP BY Health_Data.Person_Device_ID
```

2. Data Definitions

DATA ENTITY/ATTRIBUTE	DESCRIPTION	DATA TYPE	PROPERTIES
Person	A person with health data from an IoT device		
Person ID	Unique number to identify each instance of a person	int	identity
Name	Forename and Surname	varchar(20)	not null
Birth Date	Date of birth in mm/dd/yyyy format	datetime	
Gender	Male (M) or Female (F)	char(1)	
Height	Height in inches	decimal(3,1)	
Person Device	Bridge table between Person and Device		
Person Device ID	Primary Key for the Person Device table	int	identity
Person ID	Foreign Key to the Person table	int	not null
Device ID	Foreign Key to the Device table	int	not null
Device	An IoT device that collects health data on the Apple iOS platform		
Device ID	Primary Key to identify each instance of a device	int	identity
Device Type	Apple iPhone XS, Apple iPhone 8, etc.	varchar(30)	not null
Health Data	Health data collected from an IoT device		
Health Data ID	Primary key for the Health Data	int identity	identity
Total Sleep Duration	Minutes asleep	int	
Body Weight	Weight in xxx.xx lbs. format	decimal (5,2)	
Body Mass Index	BMI in xx.xx format	decimal(4,2)	
Body Fat Percentage	Body Fat Percentage in x.xxx format	decimal(4,3)	
Recorded Date	Date/Time of Body data capture in MM/YYYY hh:mm format	datetime	

Step Count	Number of steps per day	int	
Flights Climbed	Number of flights climbed per day	int	
Person ID	Foreign key to the Person table	int	not null
Device ID	Foreign key to the Device table	int	not null
Health Data Baseline	Summary health data averages by person by day/week/month		
Baseline ID	Unique number to identify each instance of the baseline health measurement	int	identity
Total Sleep Duration Baseline	Average of Total Sleep in minutes per user by day/week/month	datetime	
Body Weight Baseline	Average of Weight in xxx.xx lbs. per user by day/week/month	decimal(5,2)	
Body Mass Index Baseline	Average of BMI in xx.xx format per user by day/week/month	decimal(4,2)	
Body Fat Percentage Baseline	Body Fat Percentage in x.xxx format per user by day/week/month	decimal(4,3)	
Step Count Baseline	Step Count average per day/week/month	int	
Flights Climbed Baseline	Flights climbed average per day/week/month	int	
Person Device	Foreign key to the Person Device table	int	not null
Health Data Goals	Health goals set by the user		
Health Goals ID	Unique number to identify each instance of health goals data	int	identity
Total Sleep Duration Goal	Single, editable goal set by a person for Average of Total Sleep in h:mm format	datetime	
Body Weight Goal	Single, editable goal set by a person for a weight goal in xxx lbs. format	int	
Body Mass Index Goal	Single, editable goal set by a person for BMI in xx% format	decimal(1,2)	

Body Fat Percentage Goal	Single, editable goal set by a person for Body Fat Percentage in xx% format	decimal(1,2)	
Step Count Goal	Single, editable goal set by a person for xx,xxx steps per day format	int	
Flights Climbed Goal	Single, editable goal set by a person for xxx flights climbed per day	int	
Goals Date Stamp	Date/Time of Goals data capture in MM/YYYY hh:mm format	datetime	
Baseline ID	Foreign key to the Health Data Baseline table	int	not null
Person ID	Foreign key to the Person table	int	not null

3. Reflections

IST659 was an excellent class to help me establish a strong technical foundation as I make a career shift to data science. The course was well structured, and I liked both the online and offline content plus the textbook. Professor Thompson and other students were also very collaborative and responsive. So, although it's an online program, I felt very connected during the class.

I enjoyed this project as it gave me a real-world example to apply what I have learned in this class. My biggest challenge during the project was the shift from the technical SQL activities to writing this paper. One suggestion is to update the syllabus with more detail on expectations for the paper so more time can be spent in the last three live sessions on the topics in Chapters 8-11.

Again, I really enjoyed this class and would recommend it to others.