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# Infant Growth Calculator

## Android Mobile Application

Information Technology

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# ACKNOWLEDGEMENTS

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## ABSTRACT

| | |
|---|---|
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| Name of Supervisor: | Dr. Ghodrat Moghadampour |

The infant growth calculator android mobile application is a convenient application for parents with infant babies to check baby's growth rate. The application allows the user to calculate baby's weight gain rate, height increase rate and head circumference increase rate for boys and girls from birth up to one year separately and compares the result with world health organization (WHO) growth rate percentile standard charts /1/.

The application was built based on world health organization child growth percentile standards of tables and charts for both boys and girls from birth up to 12 months. The tables were used to generate the application's calculation formula and to draw charts for world health organization standard percentiles and the calculation result.

The calculator receives birth weight, current weight, birth height, current height, birth head circumference, current head circumference, gender and age from the user and calculates the percentile growth rate. It displays the result in the form of text and generates a graph for world health organization standard charts with the result for comparison purpose.

Keywords Baby, Growth, Application, Calculator, Android, Mobile

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## LIST OF ABRREVIATIONS

| | |
|---|---|
| WHO | World Health Organization |
| IDE | Integration Development Environment |
| APK | Android Package |
| SDK | Software Development Kit |
| API | Application Programming Interface |
| JDK | Java Development Kit |
| JRE | Java Runtime Environment |
| DB4S | Database Browser for SQLite |
| UI | User Interface |

## LIST OF APPENDICES

# 1. INTRODUCTION

The idea of infant growth calculator came in to my mind when I found out that I was going to have my second child which reminded me how stressed and worried I was during my first child’s regular check-ups ,because that’s where I used to know his growth rate, so I searched for child growth rate calculator application in play store but I couldn’t find that kind of application during that time. That is when I decided to develop the application myself.

Infant growth calculator is an android mobile application which calculates the growth rate of infant babies aged from birth up to one year using world health organization (WHO) standards. The motivation to develop this application is to help parents with infant babies who usually worry wondering how well the baby is growing. As a parent myself and many other parents wonder if the growth rate of their infant baby is normal or not and have to stay in that stressful situation until the baby´s checkup time at the child’s health care unit. By the time this project was started there was no such mobile application which could help parents to calculate baby´s growth rate easily and instantly. There for the need for developing infant growth calculator mobile application was very essential and helpful for users to find out instantly what their infant baby´s growth rate is.

The objective of this project is to help parents who wonder and are concerned about their infant baby’s growth rate by providing a simple application which can calculate baby’s growth rate percentiles of weight gain, height increase, head circumference increases and compares the result with world health organization growth rate standard percentile charts. /1/

The application receives information from the user and calculates most accurate weight per age gain rate, height per age increase rate and head circumference per age increase rate percentiles for both boy´s and girl´s aged from birth up to 12 months old separately. It generates graphs for world health organization child growth rate standard weight per age, height per age and head circumference per age charts separately so that users can see where the calculated growth rate lies in the standard chart.

The application has separate user interfaces for weight gain rate calculation, height increase rate calculation, head circumference increases rate calculation and the result. It also has the “Main menu” user interface where users choose what to calculate. Each calculation´s user interface has a form to fill information on baby´s gender, age, birthweight, current-weight or birth-height, current-height or birth-head circumference and current-head circumference on each relevant screen.

Formulas are used to make each calculation. The formulas are derived from the world health organization growth rate percentile standard tables of weight-for-age, height-for-age and head circumference-for-age. /2,3,4,5,6,7/

It uses the user input information to choose a relevant standard table from the database, uses the standard values , the given values in the relevant formula and makes the calculation. The result displays in the form of text and graph on a different screen. The graph has weight on the y-axis, age in months on x-axis, a legend and a title that describes which WHO growth rate standard chart is displayed.

# 2. RELEVANT TECHNOLOGIES

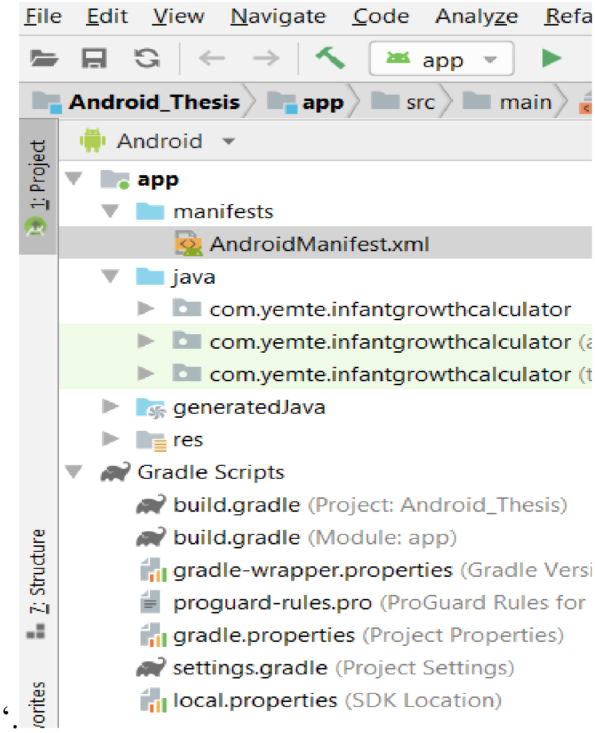
The relevant technologies used for the development of this application are well known and quite widely used by most mobile application developers. Relevant technologies used in this project are explained here.

## 2.1 Android Studio

Android studio is the integration development environment (IDE) for developing android applications. It lies it’s base on IntelliJ IDEA for code editor and developer tools. Android studio version 3.3 is used to develop this project which has many features including:

- Flexible build system based on Gradle which allows a single project to generate different build forms for different devices by customizing the build. /14/
- Fast emulator.
- A unified environment for developing application for all android devices.
- push changes by instant run on the running app without the need to build a new android package (APK).
- GitHub integration to import sample code /15/

Android studio displays a project file in android project view by default as shown in figure 1. It contains the application module and the build files module where all top-level build files are found under the *Gradel Scripts* while *manifes*t, *java* and *res* folders are found in app module. *Manifest* folder contains AndroidManifest.xml file, *java* folder contains java source code files and *res* folder contains xml layouts, UI strings, bitmap images and all non-code resources. /15/

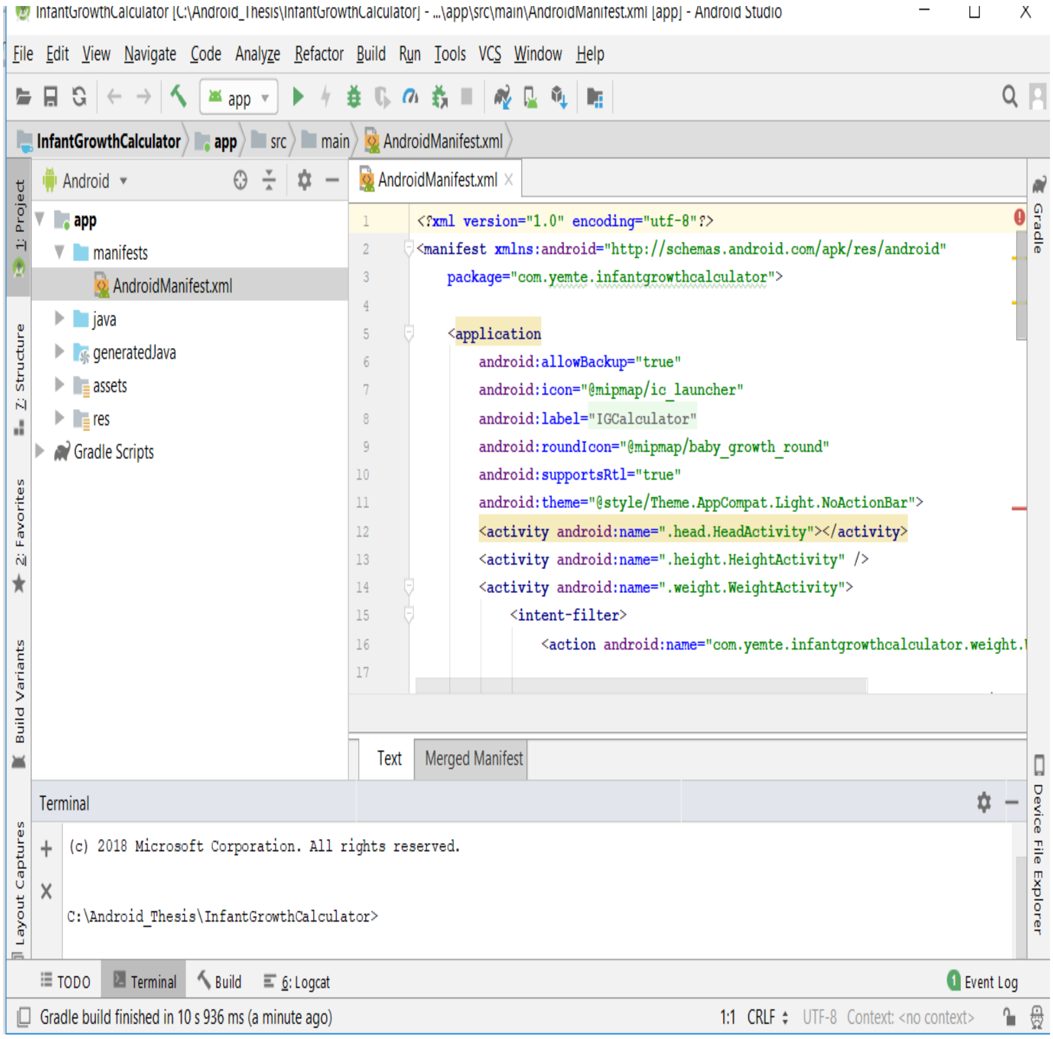

File Edit View Navigate Code Analyze Refa
app
Android_Thesis › app › src › main
Android
1: Project
7: Structure
orites

```
▼ app
    ▼ manifests
        AndroidManifest.xml
    ▼ java
        ▶ com.yemte.infantgrowthcalculator
        ▶ com.yemte.infantgrowthcalculator (a
        ▶ com.yemte.infantgrowthcalculator (t
    ▶ generatedJava
    ▶ res
▼ Gradle Scripts
    build.gradle (Project: Android_Thesis)
    build.gradle (Module: app)
    gradle-wrapper.properties (Gradle Versi
    proguard-rules.pro (ProGuard Rules for
    gradle.properties (Project Properties)
    settings.gradle (Project Settings)
    local.properties (SDK Location)
```

**Figure 1**. Project files in android view

Android studio main window is shown in figure 2 which contains:

- Tool Bar for running the app and launching android tools.
- Navigation bar to navigate through the project and open files for editing.
- Editor-window to create and modify code.
- Tool window bar to expand and collapse individual tool window.
- Tool window to access specific tasks such as search, version control and project management.
- Status bar to display the status of the IDE and the project. /15/



InfantGrowthCalculator [C:\Android_Thesis\InfantGrowthCalculator] - ...\app\src\main\AndroidManifest.xml [app] - Android Studio
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
app
InfantGrowthCalculator app src main AndroidManifest.xml
Android
app
manifests
AndroidManifest.xml
java
generatedJava
assets
res
Gradle Scripts
AndroidManifest.xml
1: Project
Z: Structure
2: Favorites
Build Variants
Layout Captures
Gradle
Device File Explorer
Text
Merged Manifest
Terminal
TODO
Terminal
Build
6: Logcat
Event Log
1:1 CRLF UTF-8 Context: <no context>

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.yemte.infantgrowthcalculator">

    <application
        android:allowBackup="true"
        android:icon="@mipmap/ic_launcher"
        android:label="IGCalculator"
        android:roundIcon="@mipmap/baby_growth_round"
        android:supportsRtl="true"
        android:theme="@style/Theme.AppCompat.Light.NoActionBar">
        <activity android:name=".head.HeadActivity"></activity>
        <activity android:name=".height.HeightActivity" />
        <activity android:name=".weight.WeightActivity">
            <intent-filter>
                <action android:name="com.yemte.infantgrowthcalculator.weight.
```

```
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Android_Thesis\InfantGrowthCalculator>
```

Gradle build finished in 10 s 936 ms (a minute ago)

**Figure 2**. Android studio main window.

Android studio has basic, smart and statement code completion types. Basic code completion displays basic suggestions for expressions, methods, variables and types while smart completion type displays relevant options based on the context. Android studio completes a statement by adding missing parenthesis, brackets, braces etc. Table 1 shows code completion keyboard short cuts for each type. /15/

**Table 1**. Android studio keyboard shortcuts for code completion.

| **Type** | **Windows and Linux** | **Mac** |
|---|---|---|
| Basic | Control + Space | Control + Space |
| Smart | Control + Shift + Space | Control + Shift +Space |
| Statement | Control + Shift +Enter | Control + Command + Enter |

Android studio includes android software development kit (SDK) which contains SDK platform for android platform packages and sources related to the application programming interfaces (API) and SDK tools which includes developer tools like build tools, debugging tools and image tools. For this project the minimum SDK version is 16, target SDK version is 28 and compile SDK version is 28. Android 4.1 is the target for the minimum API 16 which enables the app to run on 99.6% devices available and android 9.0 is the target for API 28 which is the latest one currently. Android user guide was very helpful to understand these technologies. /13/

## 2.2 Android Emulator

The SDK tool includes Android emulator which is used to test and monitor the app on a personal computer. Nexus 4 API 27 target android 8, nexus one API 22 target android 5.1, nexus S API 28 target android 9.0 and nexus 6 API 24 target android 7.0 virtual devices are used for testing. /13/

## 2.3 Java development kit (JDK)

Java development kit (JDK) is a software development environment for java applications. It is java-based software developing tools package that includes java runtime environment (JRE), java and other java tools needed for developing the application. JRE is a java code running tools package. /17/

The codding language in android studio is java which is one of the most popular programming languages that works on different platforms. Java is a secure, fast and powerful open-source programming language which has tens of millions community support. /16/

## 2.4 Android graph view

Android graph view plotting library is an open source library used for plotting graphs in the application. It is used to plot the world health organization growth rate standard charts. Line graphs, point graphs and bar graphs are the supported graph types and it has lots of other features such as combining different graph types, scrolling vertical and horizontal, real-time graph for live data change, drawing multiple series of data on a single graph , custom label for the x- and y- axis, showing legends, view port limitation for displaying part of the data and manual y-axis limits. To draw a graph using this library the gradel dependency shown in code snippet 1 must be added. /11/

```
Implementation ‘com.jjoe64:graphview:4.2.2’
```

**Code Snippet 1.** Gradel dependency for android graph view.

The next step is adding the view to the layout (code snippet 2). /11/

```
<com.jjoe64.graphview.GraphView
   android:id="@+id/graph"
   android:layout_width="match_parent"
   android:layout_height="200dip" />
```

**Code Snippet 2.** View for graph view lay out

Finally, datapoints are added to the graph, code snippet 3 shows an example of how the data points are added to a line graph.

```
GraphView   g = (GraphView) findViewById(R.Id.graph1);

LineGraphSeries<DataPoint> series1 = new LineGraphSeries<Datapoint>(

new Datapoint [] {

new Datapoint[1,3]

new Datapoint [2,5]

new Datapoint [3,7]

new DataPoint [5,11]});
g.addSeries(series1);
```

**Code Snippet 3.** Example of adding the datapoints.

### 2.5 Android SQLiteAssetHelper

Android SQLiteAssetHelper is an open source library found in GitHub which is used to copy a pre-populated existing SQLite database tables from the database browser into the application. It is a database creation and version management android helper class using the application’s raw asset files. /12/

It is implemented as an extension to SQLiteOpenHelper putting appropriately named file *assets* in the project's *"assets"* directory. The initial SQLite database files will be included for creation and upgrading /12/

```
public class DatabaseOpenHelper extends SQLiteAssetHelper {
   private static final String DATABASE_NAME = "Whostandards.db";
   private static final int DATABASE_VERSION = 1;
   public DatabaseOpenHelper(Context context) {
      super(context, DATABASE_NAME, null, 1);
   }
}
```

**code snippet 4.** SQLiteAssetHelper implementation

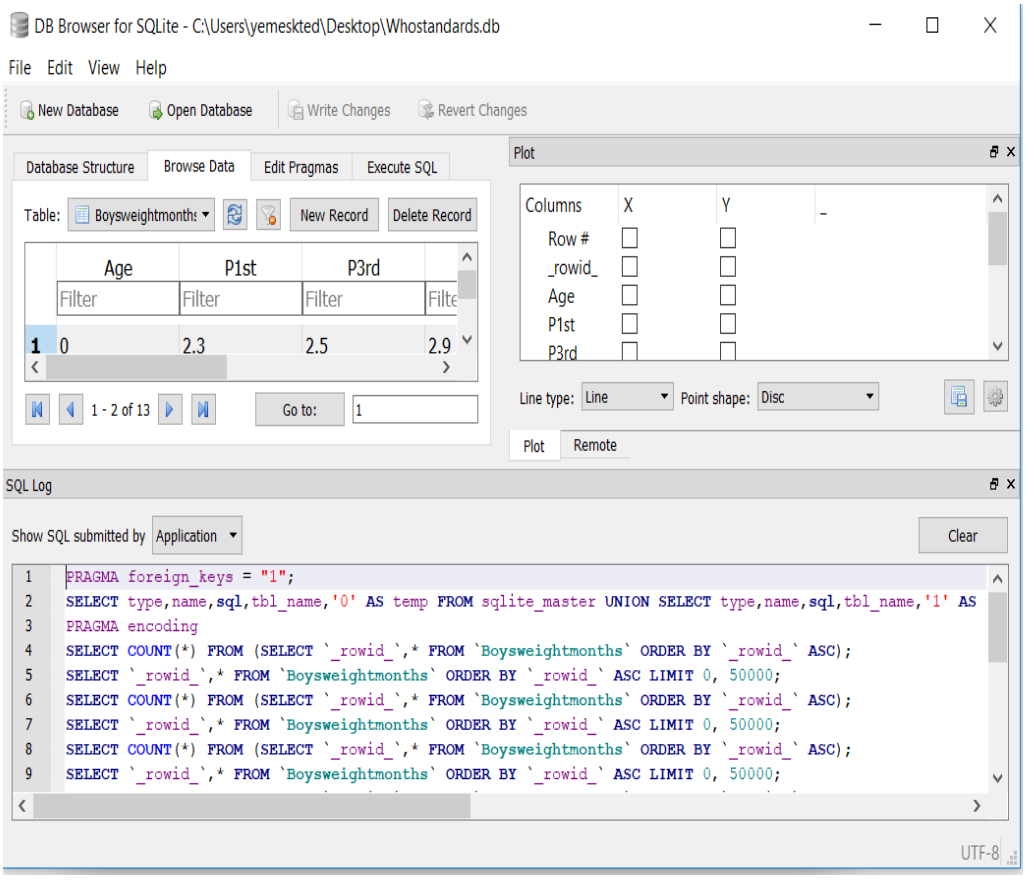
It has a gradel system dependency (code snippet 4) which needs to be added in "build.gradel" file. Android SQLite asset helper depends on asset file and folder naming convention. The project's "*assets"* folder is under the project root containing a "*database"* folder inside it. The application's SQLite database is inside the *database* folder. /12/

```
implementation 'com.readystatesoftware.sqliteasset:sqliteassethelper:2.0.1'
```

**Code Snippet 5.** Android SQLiteAssetHelper gradel dependency.

## 2.6 DB Browser for SQLite (DB4S)

Database browser for SQLite is an open source tool to create, design and edit database files compatible with SQLite /18/. It uses a familiar spread sheet like interface (figure 3) for users and developers who want to create, edit and search databases. /18/



| | Age | P1st | P3rd | |
|---|---|---|---|---|
| 1 | 0 | 2.3 | 2.5 | 2.9 |

```
PRAGMA foreign_keys = "1";
SELECT type,name,sql,tbl_name,'0' AS temp FROM sqlite_master UNION SELECT type,name,sql,tbl_name,'1' AS
PRAGMA encoding
SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `Boysweightmonths` ORDER BY `_rowid_` ASC);
SELECT `_rowid_`,* FROM `Boysweightmonths` ORDER BY `_rowid_` ASC LIMIT 0, 50000;
SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `Boysweightmonths` ORDER BY `_rowid_` ASC);
SELECT `_rowid_`,* FROM `Boysweightmonths` ORDER BY `_rowid_` ASC LIMIT 0, 50000;
SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `Boysweightmonths` ORDER BY `_rowid_` ASC);
SELECT `_rowid_`,* FROM `Boysweightmonths` ORDER BY `_rowid_` ASC LIMIT 0, 50000;
```

**Figure 3.** DB4S interface.

Controls and wizards are available to do many activities such as  create and compact database files, to create, define, modify and delete database tables, to create ,define and delete indexes, to brows ,edit, add and delete records, issue SQL queries and inspect the result and plot simple graph based on table or query data. /18/

# 3. APPLICATION DESCRIPTION

Infant growth calculator android mobile application is a simple, user friendly and accurate infant baby's growth rate calculator. It is designed in such a way that users can navigate through the different screens easily, can make the calculation easily and gets the result in a simple and most familiar way. The layouts of the application are built with android studio layout editor by dragging user interface elements into a visual design editor /19/. Java is used to write the application code while SQLite database is created to put a prepopulated WHO standard tables in DB4S. Android SQLiteAssetHelper library is used to copy the prepopulated database tables from DB4S into the application database folder. The result is displayed in a graph using android graph view.

The main objectives of the application are to calculate weight-for-age, height-for-age and head circumference-for-age growth rate percentiles and plot WHO child growth standard charts to display the result. There are also technological and quality objectives that include device compatibility, application availability to the devices, user interface and graphical qualities, stability, performance and visual quality. /13/

Below is the general concept of the application in block diagram (figure 4). The diagram shows that the application receives a user input information, use the information to choose WHO standard table from the database, validate data, send data to the formula, make the calculation and display the result.

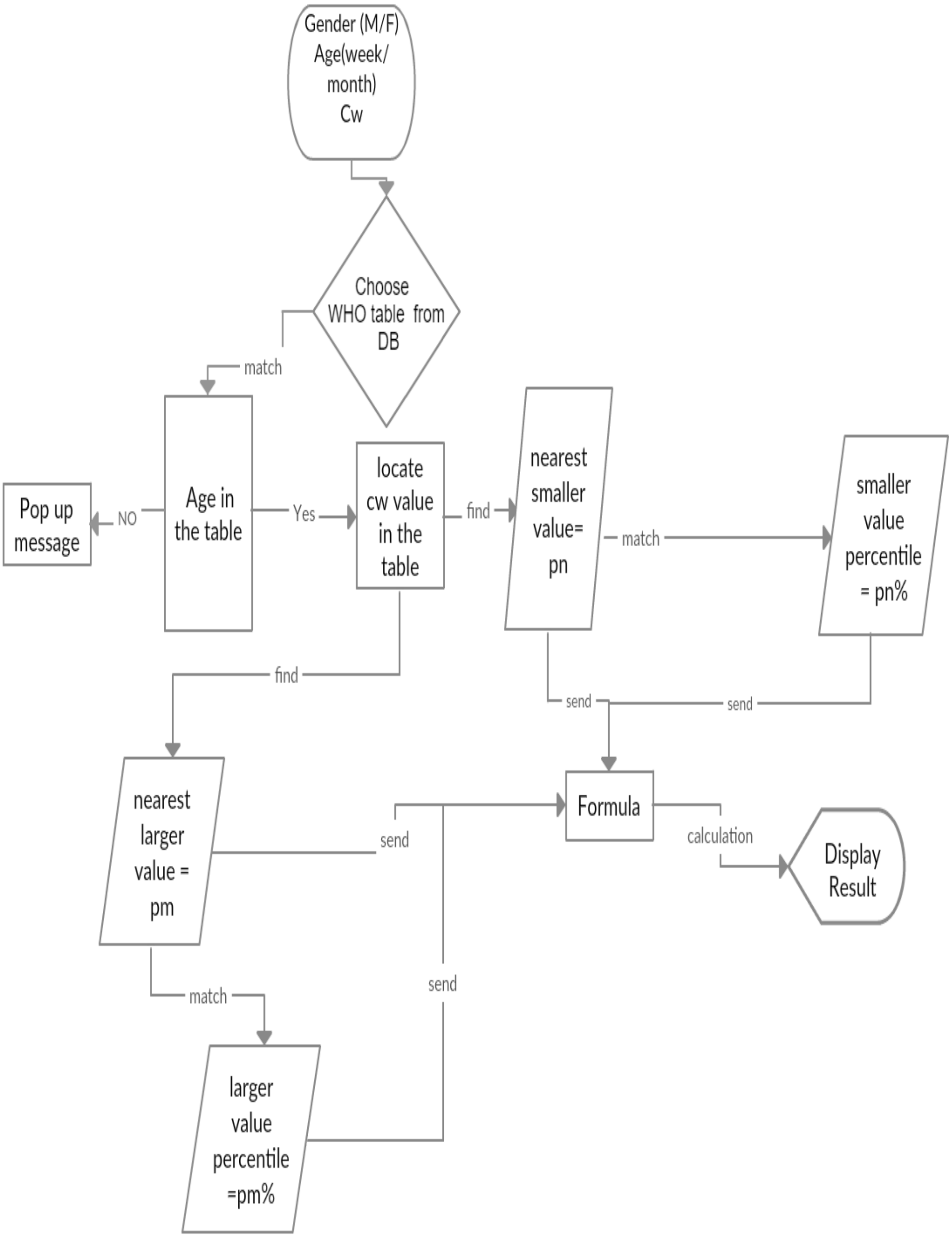


**Figure 4.** Application concept

The Infant Growth Calculator android mobile app has the following main constraints:

- Platform constraint:  the application works only on the android platform device, it doesn´t work on iPhone or windows phones. /13/
- Device constraint:  the application is designed only for mobile phones it may not function normally on tablets or other devices. /13/
- Screen size variability constraint.
- Performance constraint.

## 3.1. Requirements

The requirements of this project are classified in to three categories based on their degree of priority. These categories are “Must have”, “Should have” and “Could have” requirements (Table 2). The requirements under “Must have” category are the most important ones which the application must fulfill and cannot function without them. Requirements under “Should have” category are good to have in the application and they are already included in the app, but they don’t affect the functionality of the application if they are not included. Requirements under the last category are the least important but it could have been nice to have them.

**Table 2**. Requirements and priorities.

| Application requirements | Priorities |
|---|---|
| – weight gain rate calculation | – Must have |
| – Height increase rate calculation | – Must have |
| – Head circumference increase rate calculation | – Must have |
| – Age and Gender selection user input field | – Must have |
| – Birth and current weight user input field | – Must have |
| – Birth and current height user input field | – Must have |
| – Birth and current head user input field | – Must have |
| – Display result in the form of text | – Must have |
| – plot graph for the result and WHO standards | – Must have |
| – Pop-up message on unfilled user inputs | – Should have |
| – Device compatibility | – Should have |
| – Stability, Availability and Visual quality | – Should have |
| – Support both land scape and portrait orientations | – Should have |
| – Good performance | – Should have |
| – Feedback on the calculated result | – Could have |
| – Options for different measurement units | – Could have |
| – User guide Information | – Could have |

### 3.2 Use case diagram

The use case diagram in Figure 5 shows the basic functions of the application that are performed by a user.

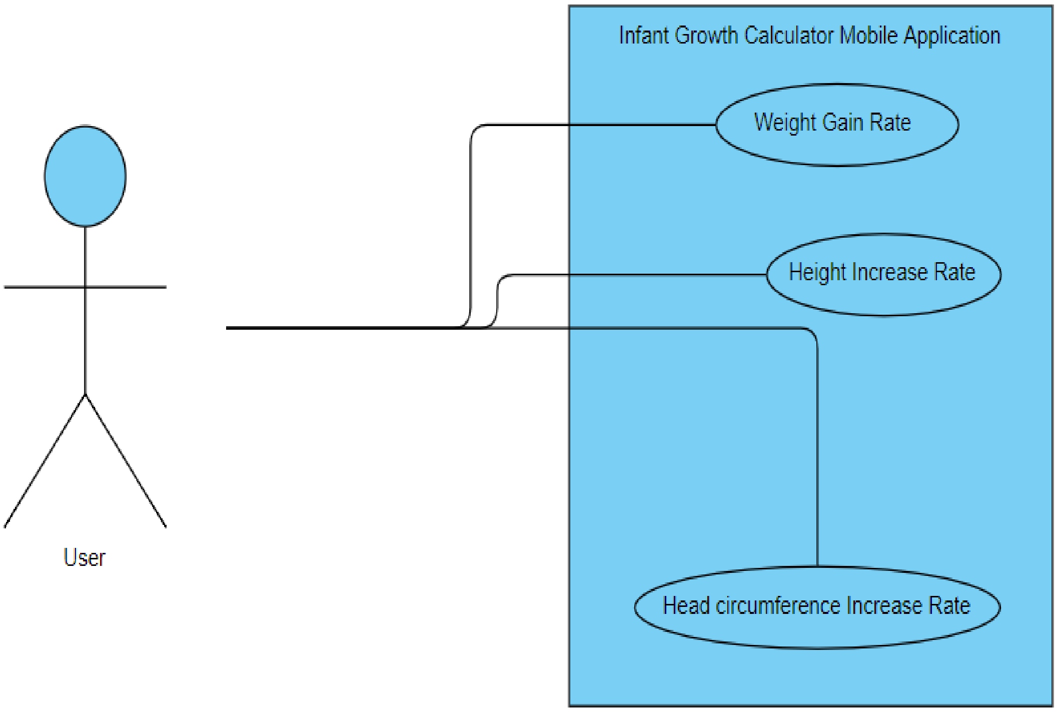

Infant Growth Calculator Mobile Application
Weight Gain Rate
Height Increase Rate
Head circumference Increase Rate
User

**Figure 5.** Use case diagram.

Table 3 shows the detail specification of the app’s functionality. The table shows the input each function use, its description, the error message and the result it displays.

**Table 3.** Functional Specification

| Case | Input | Description | Error | Result |
|---|---|---|---|---|
| Weight gain rate | Gender, birth-weight, current-weight, age | The user fills gender, birth-weight  in kg, current weight in kg, age in weeks or months and click the calculate button. | Invalid or empty inputs. | Display the calculated weight-for age percentile in the form of text, generate graph for the result and WHO weight-for-age standard chart. |
| Height increase rate | Gender, birth-height, current-height, age | The user fills gender, birth-height in cm, current-height in cm inputs and click the calculate button. | Invalid or empty inputs. | Display the calculated height-for-age percentile in the form of text, generate graph for the result and WHO height-for-age standard chart. |
| Head Circum. increase rate | Gender, birth-head circumference, current-head circumference and age | The user fills gender, birth-head circumference in cm, current-head circumference in cm, age in weeks or months and click the calculate button. | Invalid or empty inputs | Display the calculated head circumference-for-age percentile in the form of text, generate graph for the result and WHO head circumference-for-age standard chart. |

## 3.3 Class Diagram

Class diagram shows the structure of the classes, their attributes, operations(methods), and the relationships among objects in the application. In the diagrams a class is shown as a 3-partition rectangle containing the class name at the top of the rectangle, its attributes with their type at the middle and list of operations at the bottom.

There are four packages in this project. These are “weight”, “height”, “head” and “data” packages. The class diagram and class description table of each package are shown below.

### 3.3.1 Package weight

This package has 3 main classes that are responsible for making weight gain rate calculation. Each class and its descriptions are shown in Table 4.

**Table 4.** Descriptions of classes in package weight.

| Class name | Description |
|---|---|
| WeightActivity | Contains methods which are responsible for carrying out the weight-per-age percentiles calculations for boys and girls age given in months or weeks.<br>Plots the graph for WHO weight-for-age standard charts for boys and girls using the methods found in WeightChart and WeightPercentile classes. |
| WeightChart | Contains methods which are responsible for fetching weight-per-age standard charts datapoints from the WHO standard tables in the database using queries. |
| WeightPercentile | Contains methods which are responsible for fetching weigh-for-age standard percentile values from the WHO standard tables in the database using queries. |

The class diagram for classes in package weight (Figure 6) includes the three classes along with their attributes, attribute types, methods and relationships. The diagram shows the class name at the top, attributes and attribute types at the middle and methods at the bottom of the rectangle class annotation. It shows “WeightActivity” class has a dependency relationship with “WeightChart” and “WeightPercentile” classes.

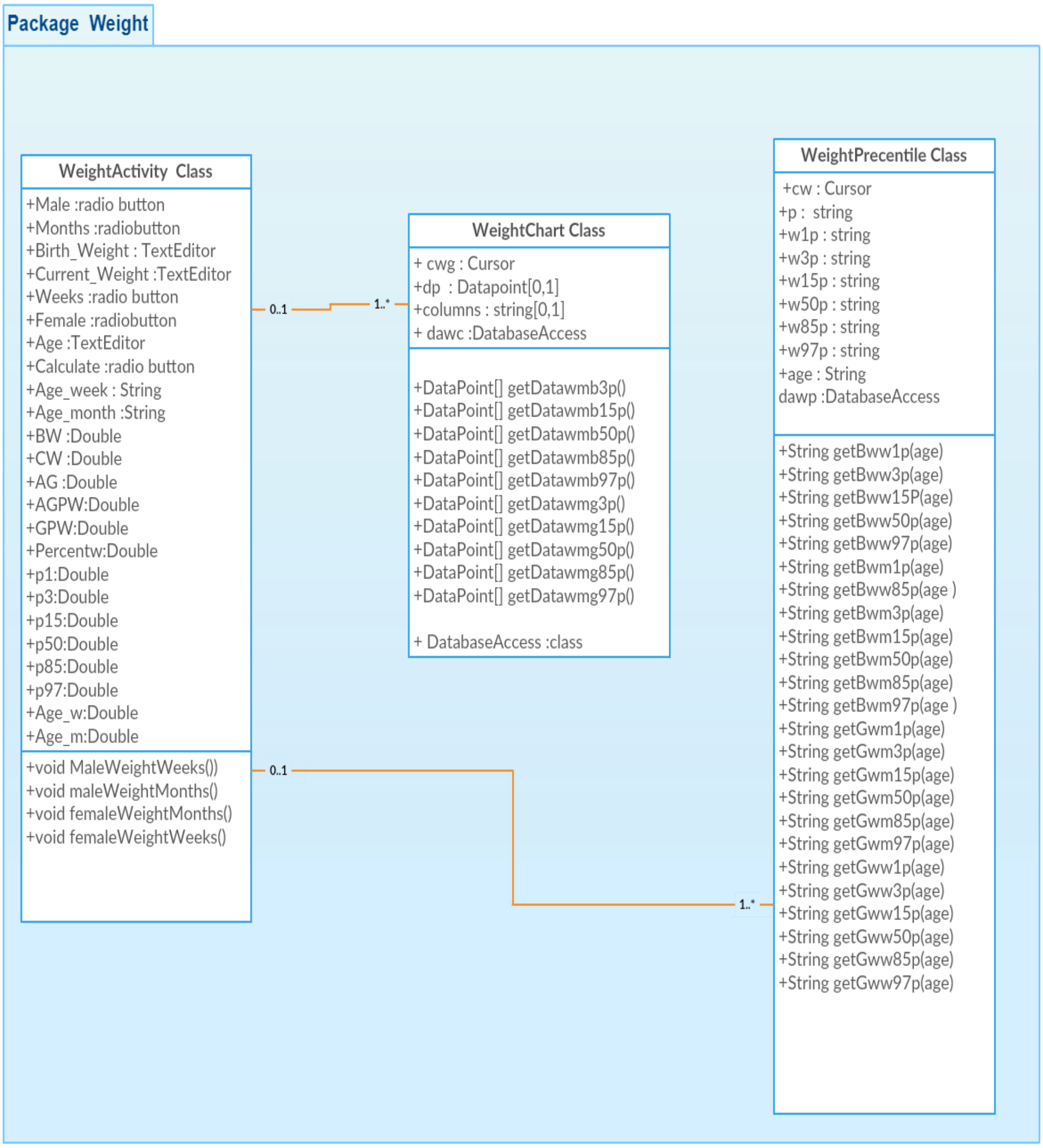


**Figure 6.** Class diagram for the classes in package weight.

### 3.3.2 Package height

This package also has 3 main classes that are responsible for making height increase rate calculation. Each class and its descriptions are shown in Table 5.

**Table 5.** Descriptions of classes in package height.

| Class name | Description |
|---|---|
| HeightActivity | Contains methods which are responsible for carrying out the height-per-age percentiles calculation for boys and girls age given in months or weeks.<br>Plots the graph for WHO height-for-age standard charts for boys and girls using the methods found in HeightChart and HeightPercentile classes. |
| HeightChart | Contains methods which are responsible for fetching height-per-age standard charts datapoints from the WHO standard tables in the database using queries. |
| HeightPercentile | Contains methods which are responsible for fetching height-for-age standard percentile values from the WHO standard tables in the database using queries. |

The class diagram for classes in package height (Figure 7) includes the three classes along with their attributes, attribute types, methods and relationships. The diagram shows the class name at the top, attributes and attribute types at the middle and methods at the bottom of the rectangle class annotation. It shows HeightActivity class has a dependency relationship with HeightChart and HeightPercentile classes.

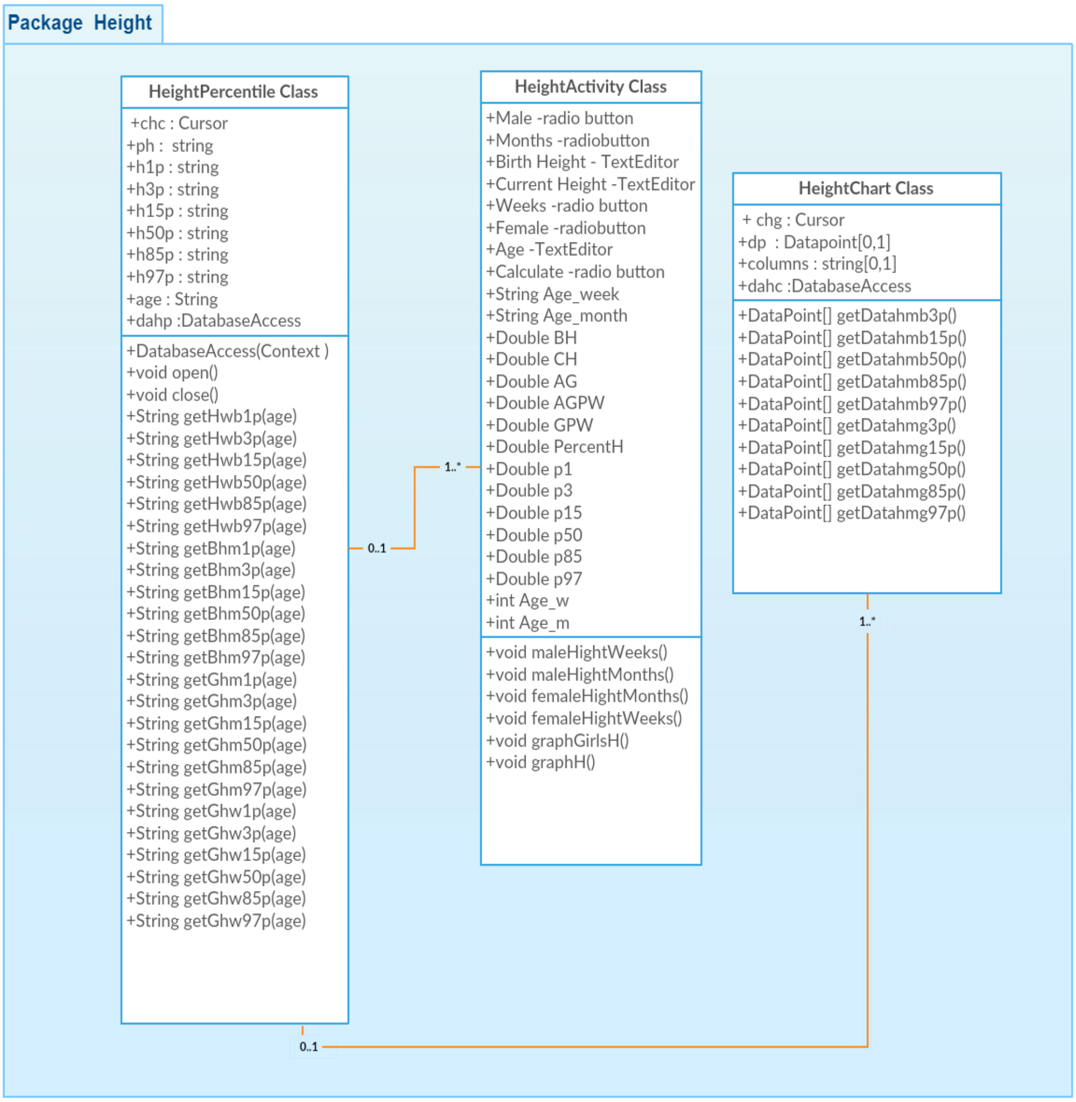


**Figure 7.** Class diagram for the classes in package height.

### 3.3.3 Package head

This package also has 3 main classes that are responsible for making head circumference increase rate calculation. Each class and its descriptions are shown in Table 6.

**Table 6.** Descriptions of classes in package head.

| Class name | Description |
|---|---|
| HeadActivity | Contains methods which are responsible for carrying out the head circumference-per-age percentiles calculation for boys and girls age given in months or weeks.<br>Plots the graph for WHO head circumference-for-age standard charts for boys and girls using the methods found in HeadChart and HeadPercentile classes. |
| HeadChart | Contains methods which are responsible for fetching height-per-age standard charts datapoints from the WHO standard tables in the database using queries. |
| HeadPercentile | Contains methods which are responsible for fetching head-for-age standard percentile values from the WHO standard tables in the database using queries. |

The class diagram for classes in package head (Figure 8) includes the three classes along with their attributes, attribute types, methods and relationships. The diagram shows the class name at the top, attributes and attribute types at the middle and methods at the bottom of the rectangle class annotation. It shows "HeadActivity " class has a dependency relationship with HeadChart and HeadPercentile classes.

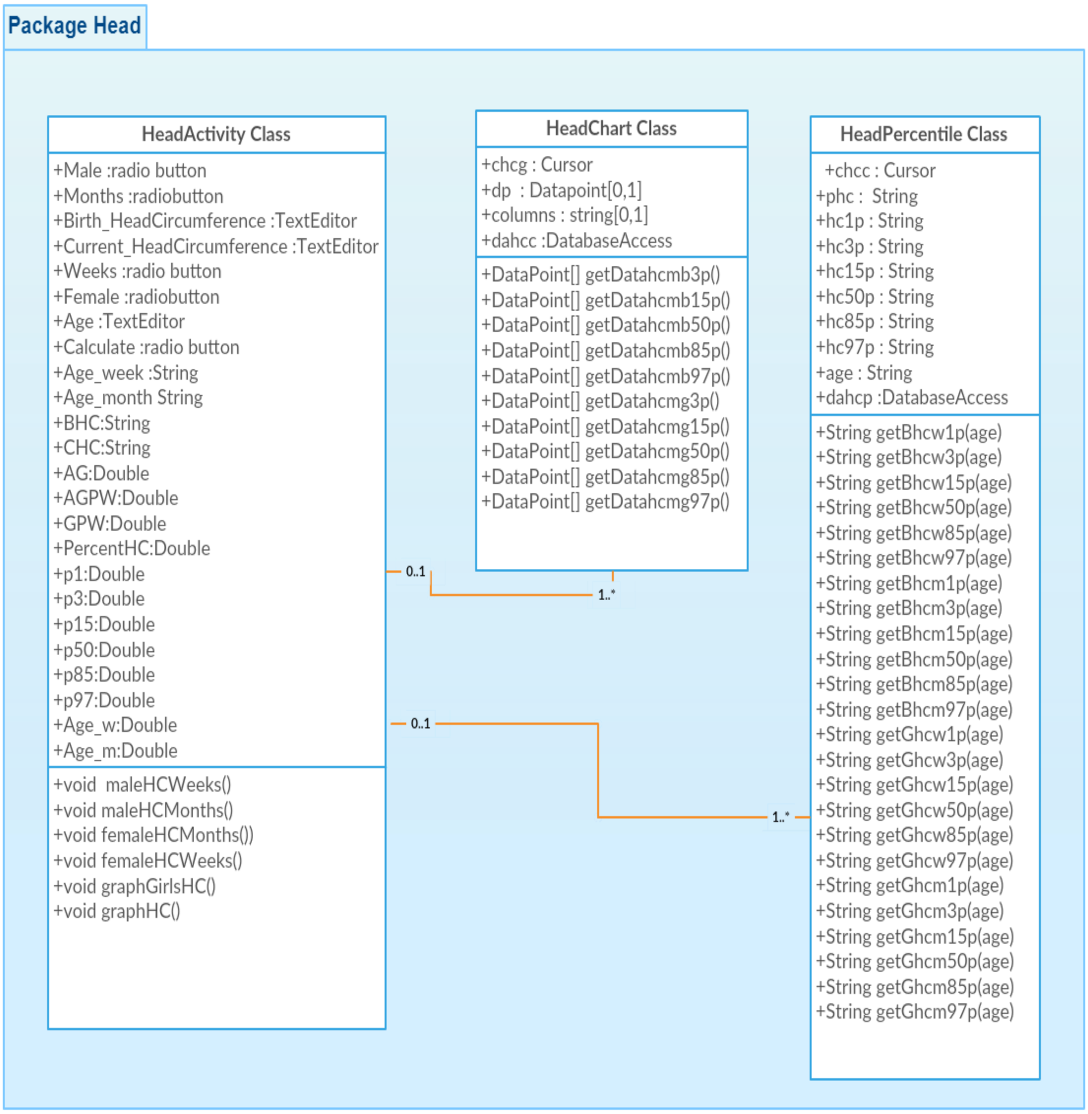


**Figure 8.** Class diagram for the classes in package head.

### 3.3.4 Package data

This package also has 2 classes that are responsible for the SQLite database access. Each class and its descriptions are shown in Table 7.

**Table 7.** Descriptions of classes in package data.

| Class name | Descriptions |
|---|---|
| DatabaseAccess | Contains methods which are responsible to return a single instance of a database, opening and closing the database connection. |
| DatabaseOpenHelper | Extends SQLiteAssetHelper. It contains a method which is responsible for database creation and version management. |

The class diagram for classes in package data (Figure 9) includes the two classes along with their attributes, attribute types, methods and relationships. The diagram shows the class name at the top, attributes and attribute types at the middle and methods at the bottom of the rectangle class annotation. It shows  DatabaseAccess class has a dependency relationship with “DtatabaseOpenHelper” class.

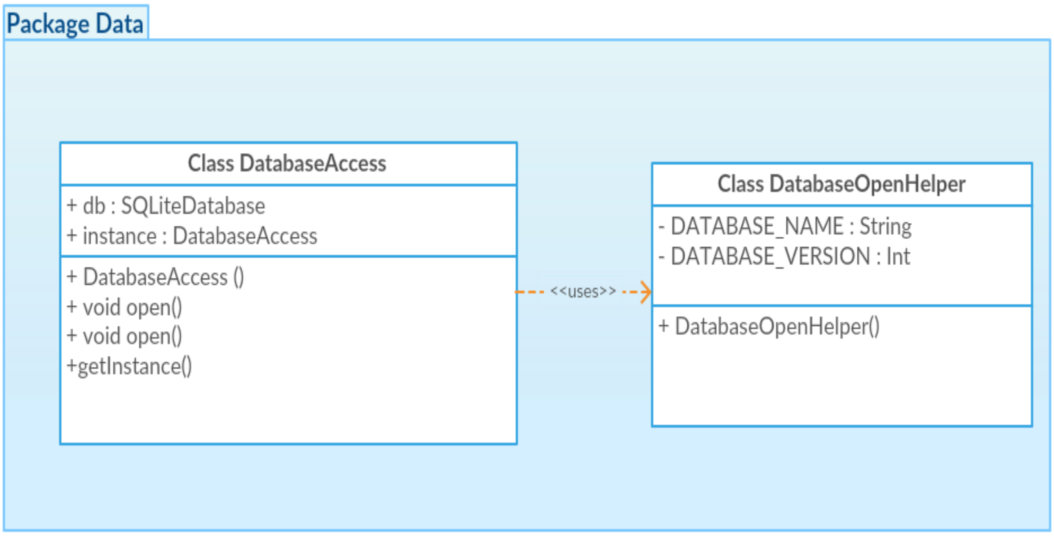


**Figure 9.** Class diagram for the classes in package data.

### 3.4 Sequence Diagram

There are three sequence diagrams in this report. These diagrams show the interaction between the user and the application and between objects in the application. The weight gain rate calculation sequence diagram (Figure 10) shows the sequence of the interaction between the user, the application and objects in the application for the calculation of weight gain rate. The user opens the application on android phone, starts interacting with the application by clicking the starting button, then the application displays the main menu to the user, then the user chooses what kind of calculation to be made, the application then displays the weight gain rate calculator screen where the user fills user input information. If user fills wrong information or miss the necessary information then the app sends back a pop-up message, if not then the application matches the given information to the standard tables in the database, validate the info and return the matched standard values back to the weight gain rate calculator. Finally, the weight gain calculator makes the calculation and display the weight gain rate result to the user.

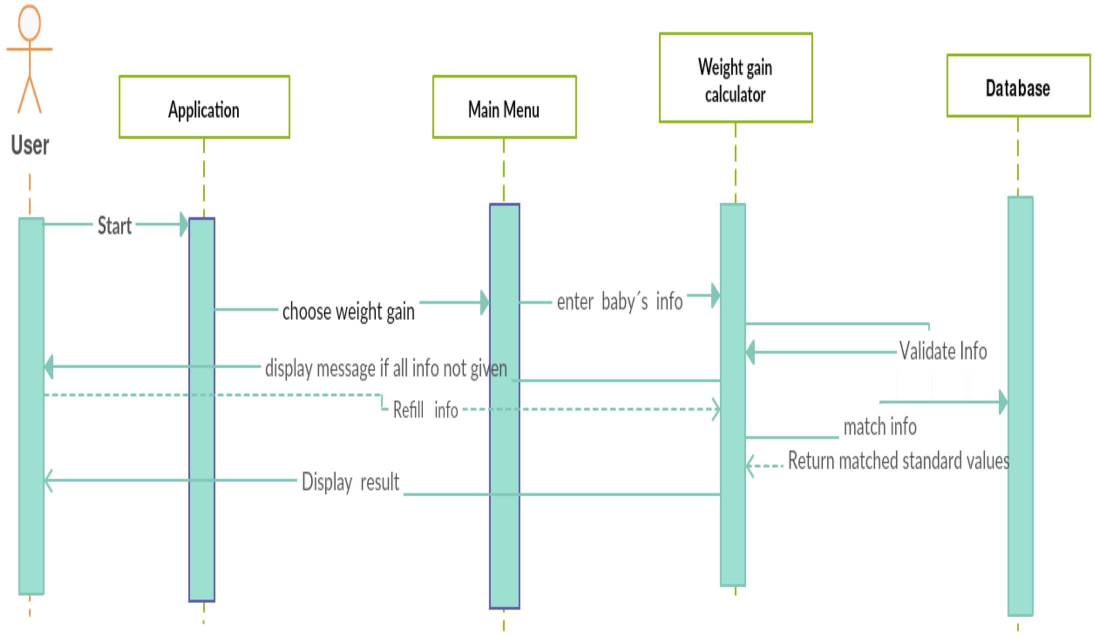


**Figure 10.** weight gain rate sequence diagram.

Height increase rate calculation sequence diagram (Figure 11) shows the sequence when the user opens the application on android phone, starts interacting with the application by clicking the starting button ,then the application displays the main menu to the user, , user chooses height increase rate calculation to be made , the application then displays the height increase rate calculator screen where the user fills user input information. If user fills wrong information or miss the necessary information then the app sends back a pop-up message, if not then the application matches the given information to the standard tables in the database, validate the info and return the matched standard values back to the height increase rate calculator. Finally, the height increase rate calculator makes the calculation and return the height increase rate result to the user.

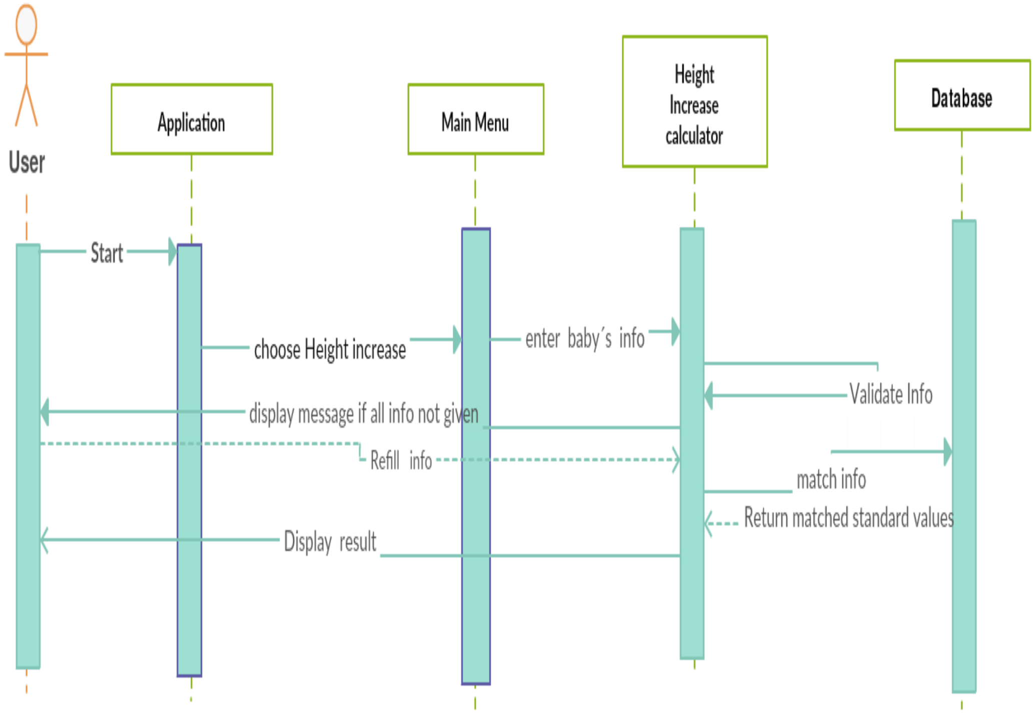


**Figure 11.** Height increase rate calculation sequence diagram.

In head circumference increase rate calculation sequence diagram (Figure 12), the user opens the application on android phone, starts interacting with the application by clicking the starting button ,then the application displays the main menu to the user, , user chooses head circumference increase rate calculation to be made , the application then displays the head circumference increase rate calculator screen where the user fills user input information. If user fills wrong information or miss the necessary information then the app sends back a pop-up message, if not then the application matches the given information to the standard tables in the database, validate the info and return the matched standard values back to the head circumference increase rate calculator. Finally, the calculator makes the calculation, draws the chart and return the head circumference increase rate result to the user.

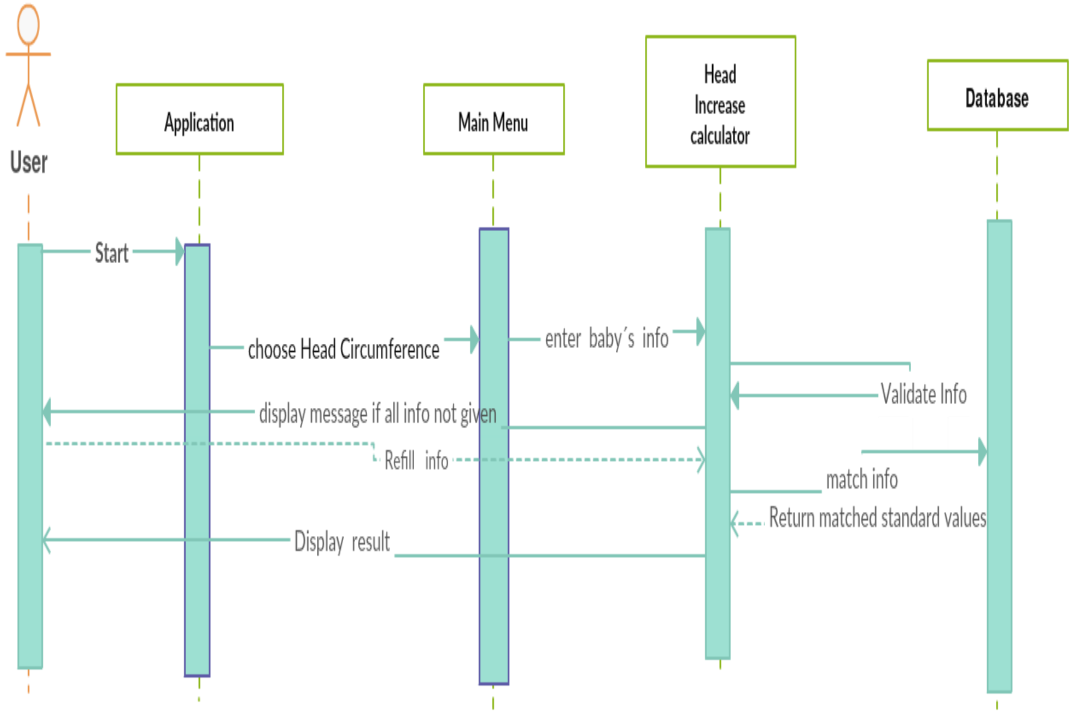


**Figure 12.** Head circumference increase rate sequence diagram.

## 3.5 Component Diagram

The organization of the physical components in the application and their relationships are shown in the components diagram (Figure 13). These components are the packages and java files that are used to make the functionality of the application. The infant growth calculator app and the main menu components are the main user interface components and they are linked with one another. The main menu is also linked with the weight, height and head packages. Each of the weight, height and head components has java file components that are used to make the functionality of each component and are linked with the database package.

Weight component is responsible for the calculation of weight gain rate percentile using the weight chart, weight activity and weight percentile java files. Weight activity java is dependent on the weight chart and weight percentile java files and weight chart and weight percentile java files are dependent on the database access java file.

Height component is responsible for the calculation of height increase rate percentile using the height chart, height activity and height percentile java files. Height activity java is dependent on the height chart and height percentile java files. Height chart and height percentile java files are dependent on the database access java file.

Head component is responsible for the calculation of head increase rate percentile using the head chart, height activity and head percentile java files. Head activity java is dependent on the head chart and height percentile java files. Head chart and height percentile java files are dependent on the database access java file.

Database component is responsible for the connection of the SQLite database using the SQLite open helper and database access java files. Database access java file is dependent on the SQLite open helper java file for its functionality.

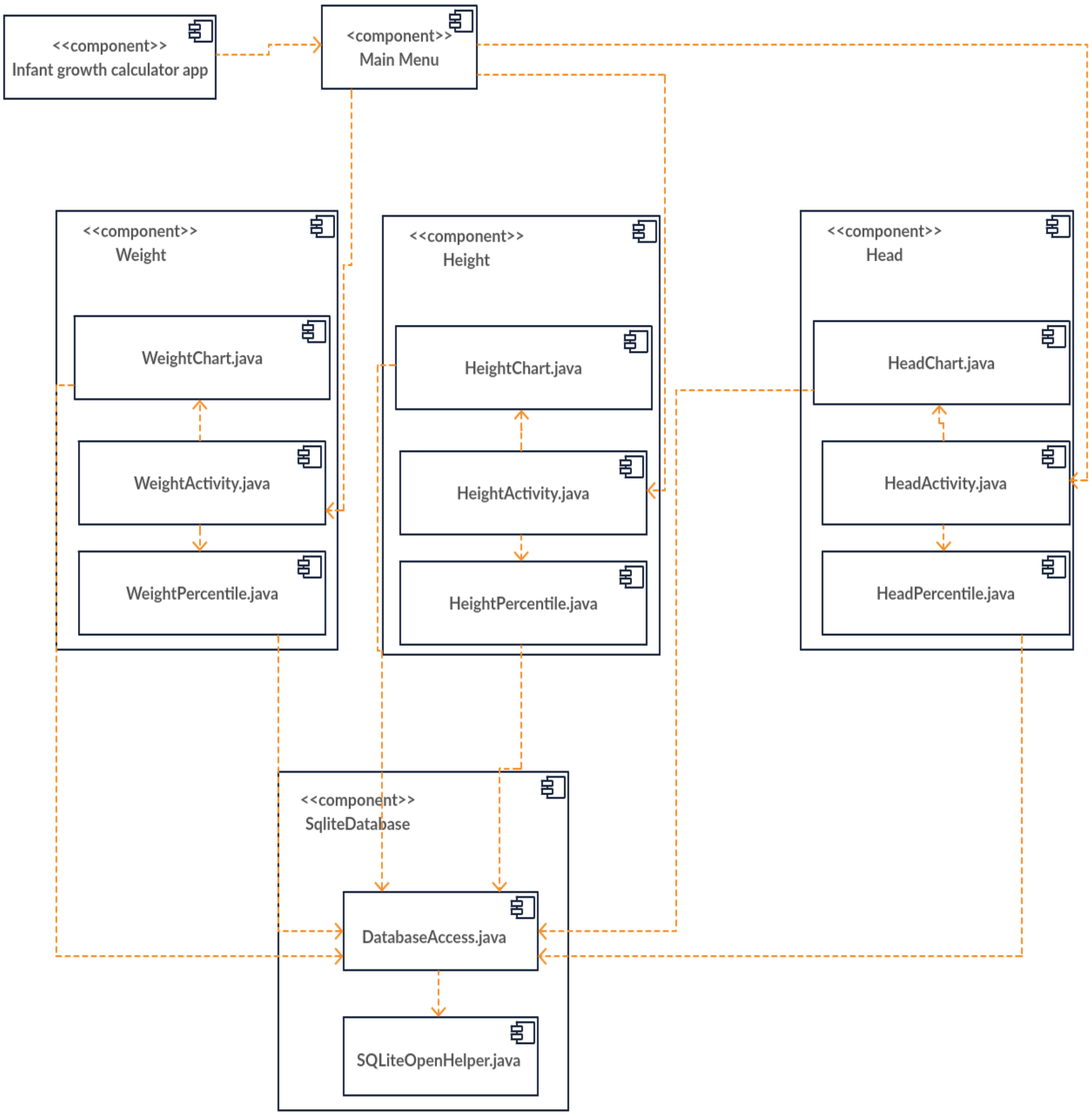


**Figure 13**. Component diagram.

### 3.6 Architectural diagram

The Architectural diagram (Figure 14) is made based on the three-layer structure of the application and the layers are classified based on their functionalities. User interface layer, logic layer and data layer are the three layers. User interface layer displays data and users interact with the application using the activities in the application.  The logic layer contains all the application logic that are used to make the growth rate calculation. It contains classes which have methods used for writing queries to get data from the database, use the data in the formulas, make the calculation and send the result to the user interface layer. The Data layer manages the local data in SQLite database. It contains classes which are responsible for making a connection between the database and the logic layer.

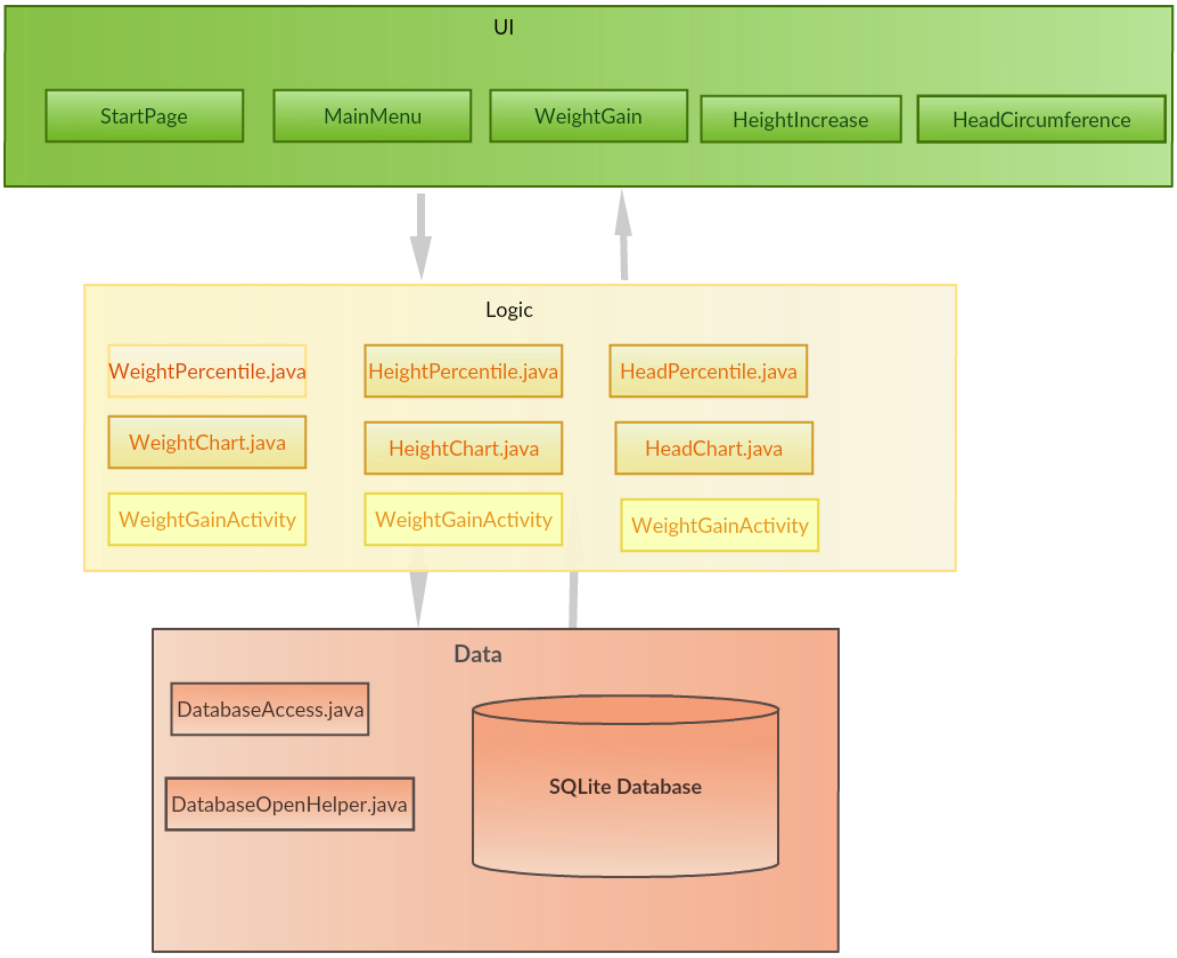


**Figure 14.** Architectural Diagram

# 4. DESIGN

Design is the crucial part of an application development. In this project the design has two parts, database design and the user interface design.

## 4.1. Database design

The database is designed in such a way that the application doesn’t store user input data in the database. It only contains pre-populated world health organization standard tables and stores them in the internal storage. Android SQLite Asset Helper, an open source library found in GitHub /12/ is used to copy a pre-populated existing SQLite database tables from the database browser into the application.

The database design (Figure 15) is made for  12 tables of world health organization child growth rate standards. The tables in the database don’t have relationships with each other as each table has its own specific prepopulated standard values for the application to use. Each table has 7 columns (Figure 16). These columns are, column age type integer, column p1st type numeric, column p3rd type numeric, column p15 type numeric, column p50th type numeric, column p85th type numeric and column p97th type numeric. The contents of the tables are explained as follow:

- Table “*Boysweightmonths”* table has 1%,3%,15%,50%,85%,97% weight-for-age child growth standard table boy’s percentiles from birth to 12 months. values in each row show the standard weight in kilogram. /2/
- Table *“Boysweightweeks”* table has 1%,3%,15%,50%,85%,97% weight-for-age child growth standard table boys’ percentiles from birth to 13 weeks. The values in each column shows the standard weight in kilogram. /2/
- Table “*Girlsweightmonths”* table has 1%,3%,15%,50%,85%,97% weight-for-age child growth standard table girls’ percentiles from birth to 12 months. The values in each column show the standard weight in kilogram. /3/

- Table *"Girlsweightweeks"* table has 1%,3%,15%,50%,85%,97% weight-for-age child growth standard table girls' percentiles from birth to 13 weeks. The values in each column show the standard weight in kilogram. /3/
- Table *"Hightmonthsboys"* table has 1%,3%,15%,50%,85%,97% height-for-age child growth standard table boys' percentiles from birth to 12 months. The values in each column show the standard height in centimetre. /5/
- Table "*Hightweeksboy"* table has 1%,3%,15%,50%,85%,97% height-for-age child growth standard tables boys' percentiles from birth to 13 weeks. The values in each column show the standard height in centimetre. /5/
- Table "*Hightmonthsgirl"* table has 1%, 3%, 15% ,50% ,85%, 97% height per age child growth standard percentiles for girls from birth to 12 months. The values in each column shows standard height in centimetre. /4/
- Table *"Hightweeksgirls*" table has 1%,3%,15%,50%,85%,97% height-for-age child growth standard table girls' percentiles from birth to 13 weeks. The values in each column show the standard height in centimetre. /4/
- Table *"Headboysmonths*" table has 1%,3%,15%,50%,85%,97% head circumference per age child growth standard percentiles for boys from birth to 12 months. The values in each column shows standard head circumference in centimetre. /6/
- Table "*Headboysweeks*" table has 1%,3%,15%,50%,85%,97% head circumference-for-age child growth standard table boys' percentiles from birth to 13 weeks. The values in each column shows standard head circumference in centimetre. /6/
- Table "*Headgirlsmonths*" table has 1%,3%,15%,50%,85%,97% head circumference-for-age child growth standard table girls' percentiles from birth to 12 months. The values in each column shows standard head circumference in centimetre. /7/
- Table "H*eadgirlsweeks"* table has 1%,3%,15%,50%,85%,97% head circumference-for-age child growth standard table girls' percentiles from birth to 13

weeks. The values in each column shows standard head circumference in centimetre. /7/

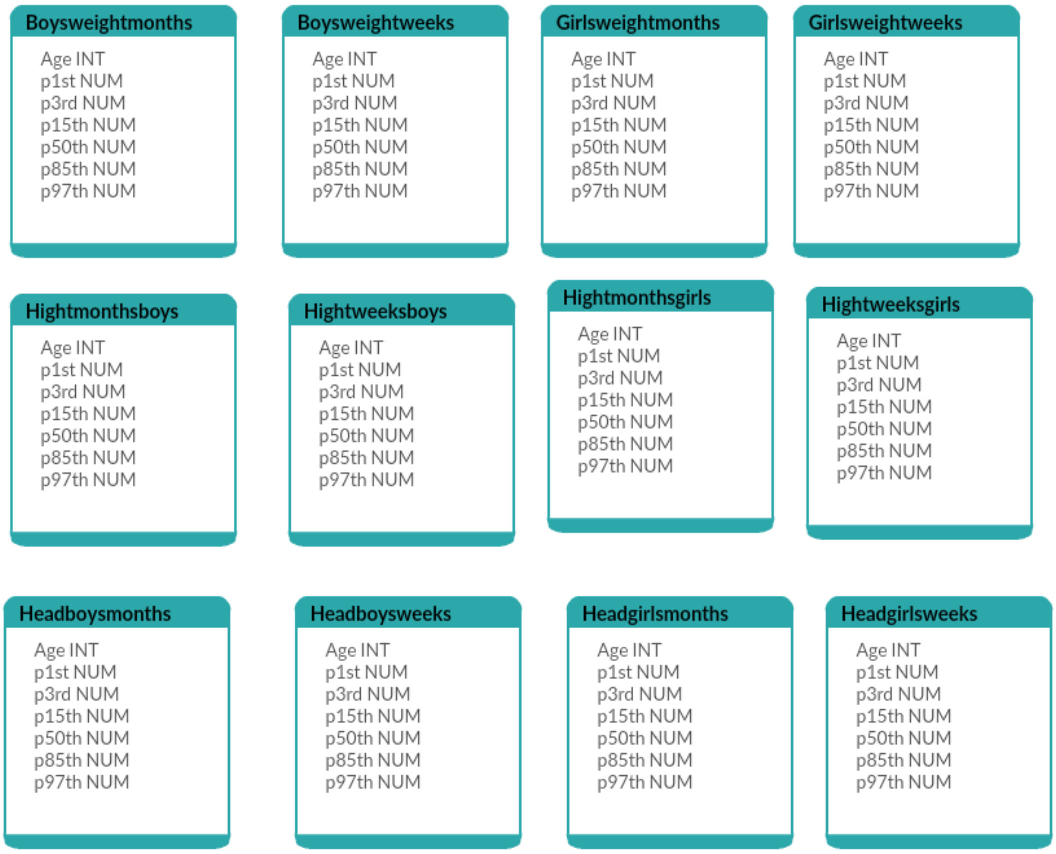
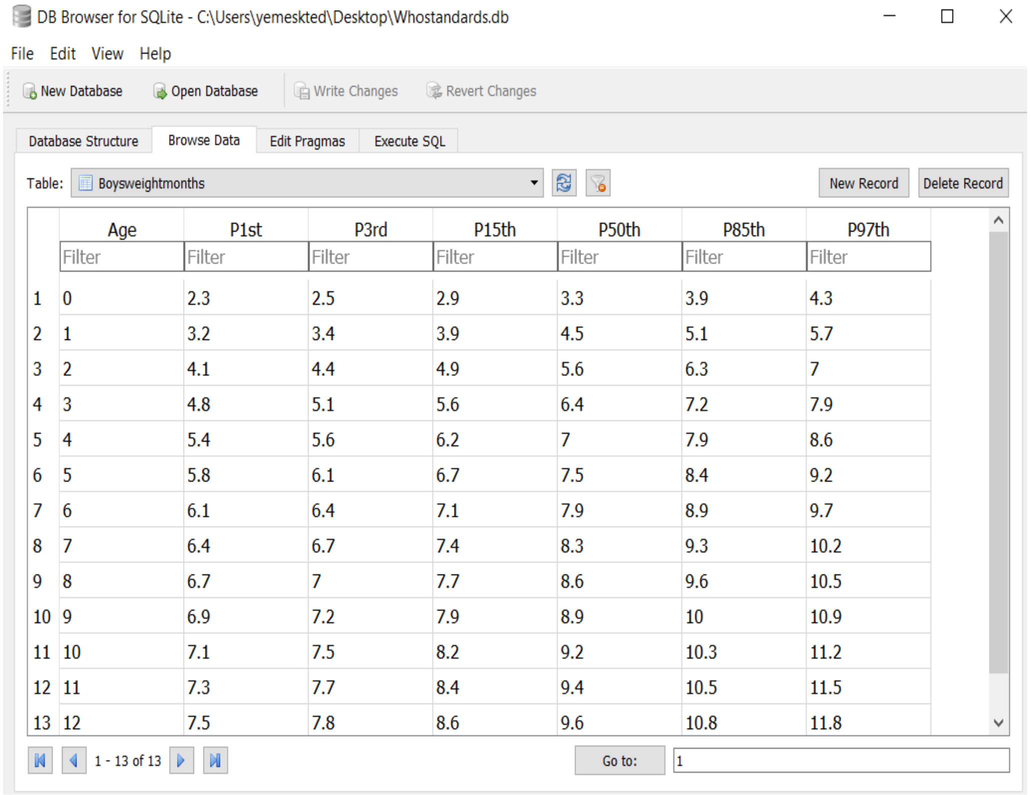


**Figure 15.** Database tables schema.

Each table in the database has 1%, 3%, 15%, 50%,85%, and 97% standard percentile values of weight-for-age or  height-for-age or head circumference-for age. Age is given in weeks or months for boys and girls and each category has its own WHO standard table separately /1/.



DB Browser for SQLite - C:\Users\yemeskted\Desktop\Whostandards.db

Table: Boysweightmonths

| | Age | P1st | P3rd | P15th | P50th | P85th | P97th |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 2.3 | 2.5 | 2.9 | 3.3 | 3.9 | 4.3 |
| 2 | 1 | 3.2 | 3.4 | 3.9 | 4.5 | 5.1 | 5.7 |
| 3 | 2 | 4.1 | 4.4 | 4.9 | 5.6 | 6.3 | 7 |
| 4 | 3 | 4.8 | 5.1 | 5.6 | 6.4 | 7.2 | 7.9 |
| 5 | 4 | 5.4 | 5.6 | 6.2 | 7 | 7.9 | 8.6 |
| 6 | 5 | 5.8 | 6.1 | 6.7 | 7.5 | 8.4 | 9.2 |
| 7 | 6 | 6.1 | 6.4 | 7.1 | 7.9 | 8.9 | 9.7 |
| 8 | 7 | 6.4 | 6.7 | 7.4 | 8.3 | 9.3 | 10.2 |
| 9 | 8 | 6.7 | 7 | 7.7 | 8.6 | 9.6 | 10.5 |
| 10 | 9 | 6.9 | 7.2 | 7.9 | 8.9 | 10 | 10.9 |
| 11 | 10 | 7.1 | 7.5 | 8.2 | 9.2 | 10.3 | 11.2 |
| 12 | 11 | 7.3 | 7.7 | 8.4 | 9.4 | 10.5 | 11.5 |
| 13 | 12 | 7.5 | 7.8 | 8.6 | 9.6 | 10.8 | 11.8 |

1 - 13 of 13

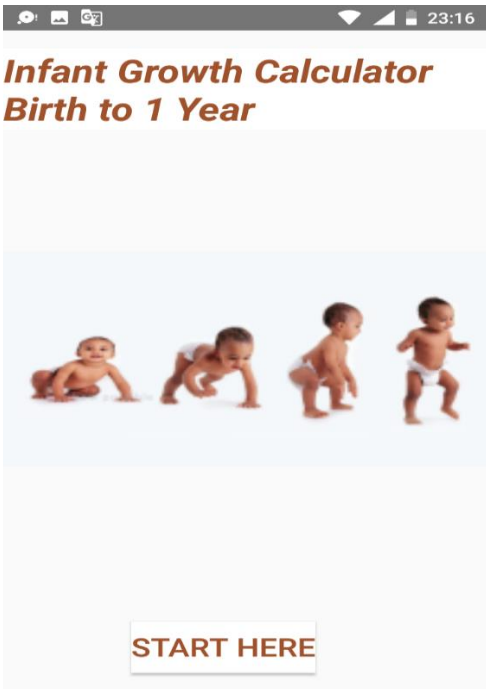
Go to: 1

**Figure 16.** Example of database table.

## 4.2. User interface design

The layouts for different parts of user interface (UI) were built on the layout editor by drugging user interface elements into a visual design editor. /19/ There are six different parts of UI in this application. Below is their description of the design.

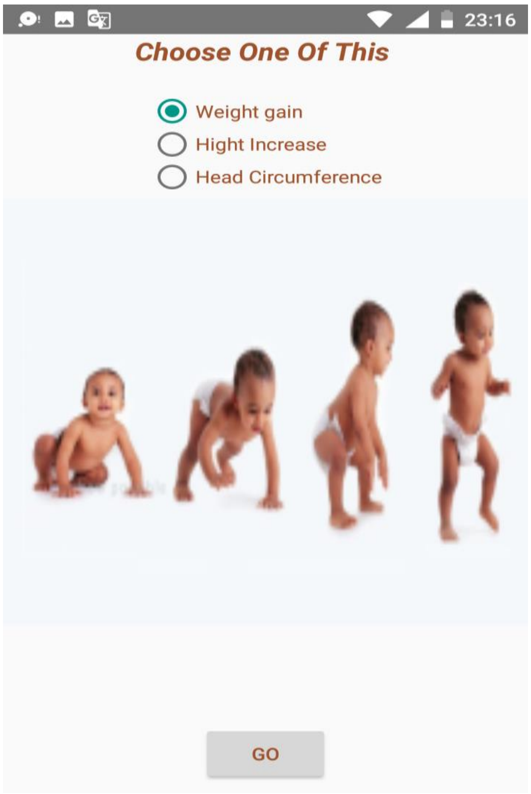
*Starting screen UI* (Figure 17) is the first screen the user gets when the application loads on the android phone. It has a text, a picture and a button. The layout design is built on relative layout view group under which there are child views (text view, Image view and button) positioned relative to the parent and each other specified by id.



Infant Growth Calculator
Birth to 1 Year

**Figure 17.** Starting screen layout design

*Main menu UI* (Figure 18) is the second screen where a user chooses what they want to calculate. It shows “choose one of this” text, a radio group of three radio buttons weight gain, Height increase and head circumference, a background Image and a “go” button. The layout design is built on a constraint layout view group under which there are text view, button and radio group (specified by Id) positioned in relative to one another.



23:16

Choose One Of This

● Weight gain

○ Hight Increase

○ Head Circumference

**Figure 18**. Main menu screen layout design.

*Weight gain rate calculator UI* (Figure 19) contains "weight gain rate" text, a "gender" text, a radio group of two radio buttons male and female, "birth weight" text, a decimal number input text field, "current weight" text, a decimal number input text field, "age" text, a second radio group of 2 radio buttons "weeks" and "months", an integer number input text field and a "calculate" button. The layout design is built on a constraint layout view group under which there are 5 text views, a button, 2 radio groups and 3 edit text views positioned in relative to one another.

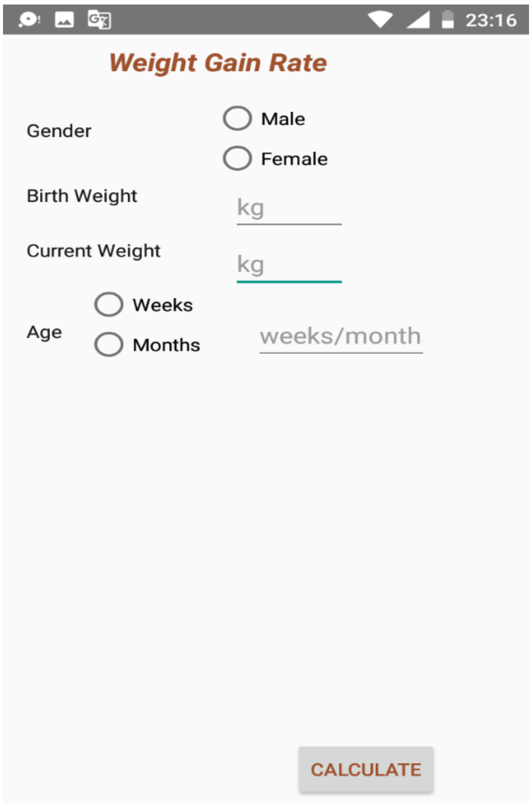


**Figure 19.** Weight gain rate screen layout design.

*Height increase rate calculator UI* (Figure 20) contains “height increase rate” text, a “gender” text, a radio group of two radio buttons male and female, “birth height” text, a decimal number input text field, ”current height” text, a decimal number input text field, “age” text, a second radio group of 2 radio buttons “weeks” and “months”, an integer number input text field and  a “calculate” button. The layout design is built on a constraint layout view group under which there are 5 text views, a button, 2 radio groups and 3 edit text views positioned in relative to one another.

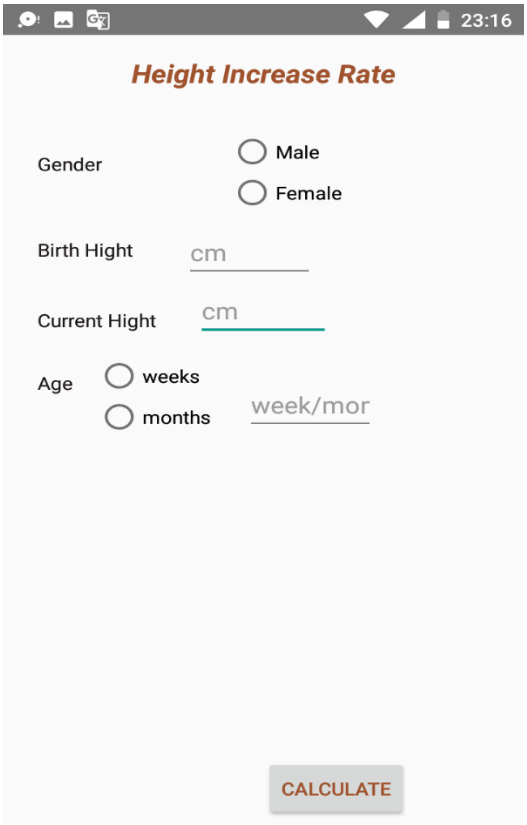
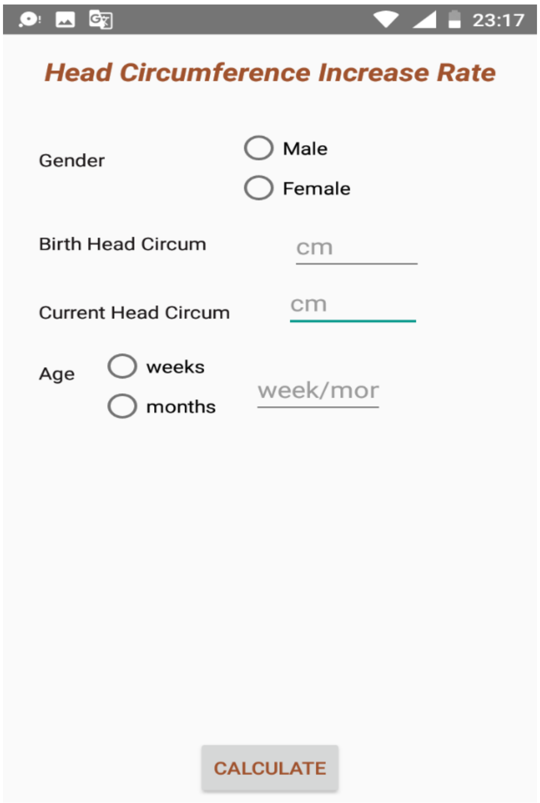


**Figure 20.** Height increase rate screen layout design.

*Head circumference rate calculation UI* (Figure 21) contains “head circumference increase rate” text, a “gender” , a radio group of two radio buttons male and female, “birth head circumference” text, a decimal number input text field, ”current head circumference” text, a decimal number input text field, “age” text, a second radio group of 2 radio buttons “weeks” and “months”, an integer number input text field and  a “calculate” button. The layout design is built on a constraint layout view group under which there are 5 text views, a button, 2 radio groups and 3 edit text views positioned in relative to one another.



23:17

Head Circumference Increase Rate

Gender ○ Male ○ Female

Birth Head Circum cm

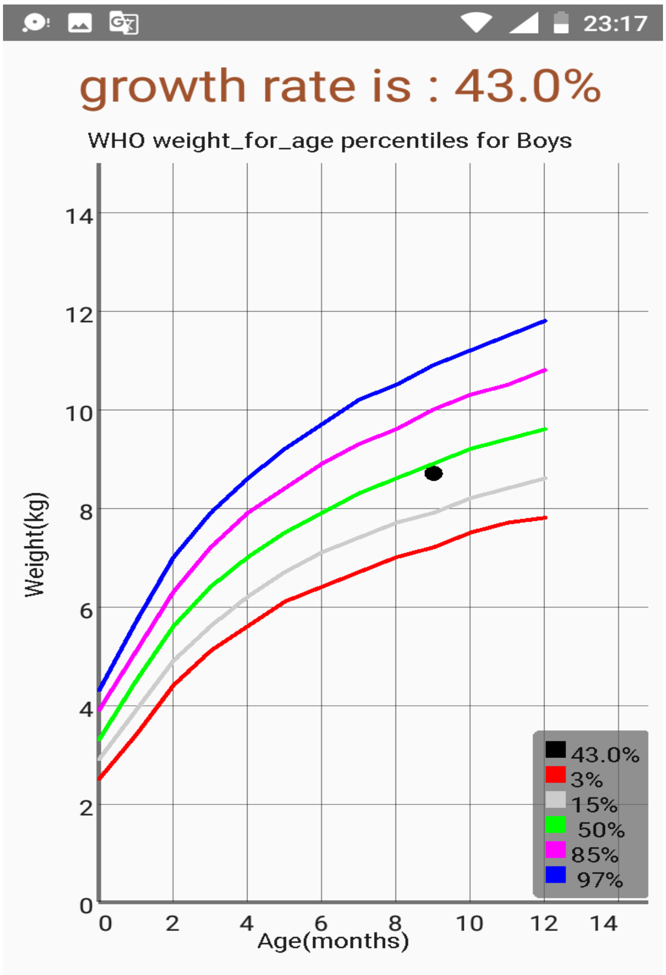
Current Head Circum cm

Age ○ weeks ○ months week/mor

CALCULATE

**Figure 21.** Head circumference increase rate screen layout design

*Result UI* (Figure 22) contains the result in text like “growth rate is” and a graph of world health organization child growth chart of 3%, 15%, 50%,85% and 97% growth standards plus the calculated growth rate result. The graph has a title, a legend, age on the x axis and weight or height or head circumference on the y axis. The layout design is built on a constraint layout view group under which there is a text view and a graph view.



growth rate is : 43.0%

**Figure 22.** Result screen layout design.

# 5. IMPLEMENTATION

The implementation has two important parts, the frontend part and backend part. Implementation of the front-end part is shown using an example code snippet of the xml lay out of the different UI elements of a screen and its implementation in the activity's java code. The back-end part shows how the application was implemented through activities and classes using the driven formulas and code snippets.

## 5.1. Frontend

Weight gain rate calculator screen (Figure 23) is taken as an example in this report to show how the user interface is implemented in the code for each part of the user interface in the xml file. The implementation of the UI elements takes place in the Activity java files of the relative layout. The implementation of the height and head circumference calculator user interfaces and the result UI are similar with the weight gain rate calculator screen, there for only weight gain rate calculator UI code snippets are shown in this report as an example.

The user interface elements are dragged in a visual design editor then the lay out XML file is written automatically without writing it by hand. In the XML file each UI element (Figure 23) is defined using a unique “id”, and specification of the looks are also defined which includes colour, its position, width, height, input type, text etc (code Snippet 6).

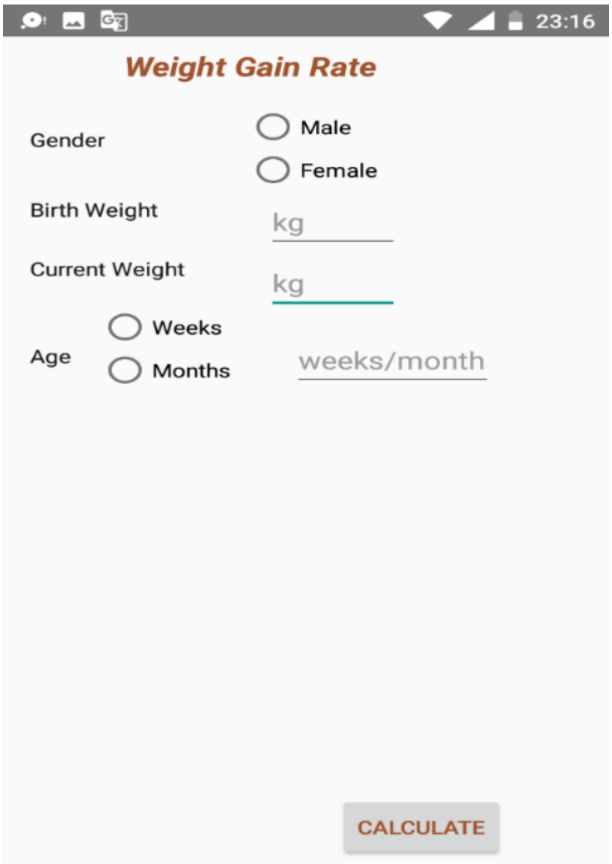


**Figure 23**. Example UI elements on the layout

Below is the code snippet for each UI element shown in Figure 23. It is the xml layout that defines each UI element's id, size, colour, position, title, input type etc.

```
<TextView        // text view for the text at the top
    android:id="@+id/textView_weight"
    android:textColor="#A0522D"
    android:textSize="20sp"
    android:textStyle="normal|bold|italic"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toTopOf="parent" />


<TextView      //text view for the text current weight
    android:id="@+id/textView_weightcurrent"
    android: text="Current Weight"
    android:textColor="@color/colorAccent"
```

```
   android:textSize="14sp"
   app:layout_constraintStart_toStartOf="parent"
   app:layout_constraintTop_toBottomOf="@+id/textView_weightbirth" />


<EditText        // current weight user input field
   android:id="@+id/editText_currentWight"

   android:hint="kg"
   android:inputType="numberDecimal"
   app:layout_constraintStart_toEndOf="@+id/textView_weightcurrent"
   app:layout_constraintTop_toBottomOf="@+id/editText_BirthWight" />

<EditText   //birth weight user input field
   android:id="@+id/editText_BirthWight"
   android:hint="kg"
   android:inputType="numberDecimal"
   android:textColor="@color/colorAccent"
   app:layout_constraintStart_toEndOf="@+id/textView_weightbirth"
   app:layout_constraintTop_toBottomOf="@+id/Radiogroupe_W_gender" />

<Button      // calculate button
   android:id="@+id/calcButton_weight"
   android:text="Calculate"
   android:textColor="#A0522D" />

<TextView    //birth weight text view
   android:id="@+id/textView_weightbirth"
   android:text="Birth Weight"
   android:textColor="@color/colorAccent"
   app:layout_constraintTop_toBottomOf="@+id/textView_weightGender" />

<TextView       // Age text view
   android:id="@+id/textView_weightage"
   android:text="Age"
   android:textColor="@color/colorAccent"
   app:layout_constraintTop_toBottomOf="@+id/textView_weightcurrent" />

<TextView      // Gender text view
   android:id="@+id/textView_weightGender"
   android:text="Gender"
   android:textColor="@color/colorAccent"
   app:layout_constraintTop_toBottomOf="@+id/textView_weight" />

<RadioGroup   // gender radio group
   android:id="@+id/Radiogroupe_W_gender"
   app:layout_constraintStart_toEndOf="@+id/textView_weightGender"
   app:layout_constraintTop_toBottomOf="@+id/textView_weight">

   <RadioButton    // Male radio button
      android:id="@+id/radioButton_Wmale"
      android:text="Male" />
```

```
    <RadioButton    // female radio button
      android:id="@+id/radioButton_wfemale"
      android:text="Female" />

  </RadioGroup>

  <EditText     // Age input field
    android:id="@+id/editText_wAge"
    android:hint="weeks/months"
    android:inputType="numberDecimal"
    app:layout_constraintStart_toEndOf="@+id/radiogroup_age"
    app:layout_constraintTop_toBottomOf="@+id/editText_currentWight" />

  <RadioGroup
    android:id="@+id/radiogroup_age"
    app:layout_constraintStart_toEndOf="@+id/textView_weightage"
    app:layout_constraintTop_toBottomOf="@+id/textView_weightcurrent">

    <RadioButton        // Weeks radio button
      android:id="@+id/radioButton_weeks_w"
      android:text="Weeks" />

    <RadioButton   //months radio button
      android:id="@+id/radioButton_months_w"
      android:text="Months" />
  </RadioGroup>
```

**Code snippet 6.** An Example of the UI elements’ xml file

The UI elements of the layout xml file are declared in Activity java class like shown in the code snippet 7.

```
public class WeightActivity extends AppCompatActivity {
    Button bCalc_w;          //button for calculate
    EditText etC_w;        //current weight input text editor
    EditText etB_w;      //birth weight input text editor
    EditText etAge_w;  //age input text editor
    RadioGroup rgGender_w;   //radio group for gender
    RadioButton rbMale_w;  //radio button for gender male
    RadioButton rbFemale_w;  //radio button for  gender female
    RadioGroup rgAge_w;     //radio group for age
    RadioButton rbweeks_w;           //radio button for weeks
    RadioButton rbmonths_w;      //radio button for months
```

**Code Snippet 7.** Example of declaring UI elements in Activity java file.

For implementing the UI elements of the layout xml file in the "on create" method of the Activity java class , first the "Content View" must be set to the specific layout and then the UI elements of that layout need to be assigned to the declared variables by using "findViewById" and their "id" (Code snippet 8).

```
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_weight);

    rgGender_w =  findViewById(R.id.Radiogroupe_W_gender);
    etB_w = findViewById(R.id.editText_BirthWight);
    etC_w = findViewById(R.id.editText_currentWight);
    etAge_w = findViewById(R.id.editText_wAge);
    rbMale_w =  findViewById(R.id.radioButton_Wmale);
    rbFemale_w = findViewById(R.id.radioButton_wfemale);
    bCalc_w = findViewById(R.id.calcButton_weight);
    rgAge_w = findViewById(R.id.radiogroup_age);
    rbweeks_w = findViewById(R.id.radioButton_weeks_w);
    rbmonths_w =  findViewById(R.id.radioButton_months_w);
```

**Code snippet 8.** Example of Implementing UI elements

## 5.2 Backend

The backend part of the application was implemented through activities and classes. These classes and activities are: “weightActivity", “weightChart”, “weightPercentile”, “heightActivity”, “heightChart”, “heightPercentile”, “headActivity” , “headChart”, “headPercentile” and “databaseAccess” which are used to calculate weight-for-age percentiles, height-for-age percentiles, head circumference-for-age percentiles and get the world health organization standard values from the database. Each activity and class have constructors and methods which will be shown in detail. In order to make weight gain, height increase and head circumference growth rate calculations, the following formulas needed to be created and implemented for each type of growth calculation. The world health organization standard values of the variables in the formula are found in the database.

For calculating weight-for-age growth rate percentile, we used the following formulas. The world health organization weight-for- age standard percentiles used for this calculation are 1%, 3%, 15%, 50%, 85% and 97%.

$$AG = (CW - pn) \tag{1}$$

$$AGPW = pm - pn \tag{2}$$

$$GPW = \frac{(AG)}{AGPW} \tag{3}$$

$$Percentw = (GPW * (\frac{(Pmth\% - Pnth\%)}{100})) + (\frac{Pnth\%}{100}) \tag{4}$$

*CW* = current weight in kilogram user input.

*Pn* = the nearest smaller percentile world health organization standard value weight in kilogram relative to the given CW in the database.

*AG* = the weight difference between the nearest smaller percentile world health organization standard value Pn & the current weight CW.

*Pm* = the nearest larger WHO standard value weight in kilogram relative to the given CW in the database.

*AGPW* == the weight difference between the nearest smaller percentile world health organization standard value Pn & the nearest larger WHO standard value *Pm.*

*GPW* = the ratio of AG per AGPW.

*Pnth%* = the nearest smaller percentile of world health organization growth rate standard of a given age

*Pmth%* = the nearest larger percentile of world health organization growth rate standard of a given age

*Percentw* = the calculated weight per age percentile

Weight percentile at birth or at 0 week or at 0 month the following formula is used. The world health organization weight per age standard percentiles used for this calculation are 1%, 3%, 15%, 50%, 85% and 97%

$$AG = (BW - pn) \tag{5}$$

$$AGPW = pm - pn \tag{6}$$

$$GPW = \frac{(AG)}{AGPW} \tag{7}$$

$$Percentw = (GPW * (\frac{(Pmth\% - Pnth\%)}{100})) + (\frac{Pnth\%}{100}) \tag{8}$$

*BW* = birth weight in kilogram user input.

*Pn* = the nearest smaller percentile world health organization standard value weight in kilogram relative to the given BW in the database.

*AG* = the weight difference between the nearest smaller percentile world health organization standard value Pn & the birth weight BW.

*Pm* = the nearest larger world health organization standard value weight in kilogram relative to the given BW in the database.

*AGPW* == the weight difference between the nearest smaller percentile WHO standard value Pn & the nearest larger world health organization standard value *Pm*.

*GPW* = the ratio of AG per AGPW.

*Pnth%* = the nearest smaller percentile of world health organization growth rate standard of a given age.

*Pmth%* = the nearest larger percentile of world health organization growth rate standard of a given age.

*Percentw* = the calculated weight per age percentile.

For calculating height per age growth rate percentile, the following formulas are used. The world health organization height per age standard percentiles used for this calculation are 1%, 3%, 15%, 50%, 85%97%.

$$AG = (CH - pn) \tag{9}$$

$$AGPW = pm - pn \tag{10}$$

$$GPW = \frac{(AG)}{AGPW} \tag{11}$$

$$PercentH = (GPW * (\frac{(Pmth\% - Pnth\%)}{100})) + (\frac{Pnth\%}{100}) \qquad (12)$$

*CH* = current height in centimetres user input.

*Pn* = the nearest smaller percentile world health organization standard value height in centimetres relative to the given CH in the database.

*AG* = the height difference between the nearest smaller percentile world health organization standard value Pn & the current height CH.

*Pm* = the nearest larger world health organization standard value height in centimetres relative to the given CH in the database.

*AGPW* == the height difference between the nearest smaller percentile world health organization standard value Pn & the nearest larger world health organization standard value *Pm.*

*GPW* = the ratio of AG per AGPW.

*Pnth%* = the nearest smaller percentile of world health organization growth rate standard of a given age

*Pmth%* = the nearest larger percentile of world health organization growth rate standard of a given age

*PercentH* = the calculated height per age percentile.

For calculating height percentile at birth or at 0 week or at 0 month the following formula is used. The world health organization height-for-age standard percentiles used for this calculation are 1%, 3%, 15%, 50%, 85% and 97%.

$$AG = (BH - pn) \qquad (13)$$

$$AGPW \ = \ pm - pn \tag{14}$$

$$GPW \ = \frac{(AG)}{AGPW} \tag{15}$$

$$PercentH \ = \ (GPW \ * (\frac{(Pmth\% - Pnth\%)}{100})) + (\frac{Pnth\%}{100}) \tag{16}$$

*BH* = birth height in centimetres user input.

*Pn* = the nearest smaller percentile world health organization standard value height in centimetres relative to the given BH in the database.

*AG* = the height difference between the nearest smaller percentile world health organization standard value Pn & the birth height BH.

*Pm* = the nearest larger world health organization standard value height in centimetres relative to the given BH in the database.

*AGPW* = = the height difference between the nearest smaller percentile world health organization standard value Pn & the nearest larger world health organization standard value *Pm.*

*GPW* = the ratio of AG per AGPW.

*Pnth%* = the nearest smaller percentile of world health organization growth rate standard of a given age.

*Pmth%* = the nearest larger percentile of world health organization growth rate standard of a given age.

*PercentH* = the calculated height per age percentile.

For calculating head circumference-for-age growth rate percentile, the following formulas are used. The world health organization head circumference-for-age standard percentiles used for this calculation are 1%, 3%, 15%, 50%, 85% and 97%.

$$AG = (CHC - pn) \tag{17}$$

$$AGPW = pm - pn \tag{18}$$

$$GPW = \frac{(AG)}{AGPW} \tag{19}$$

$$PercentHC = (GPW * (\frac{(Pmth\% - Pnth\%)}{100})) + (\frac{Pnth\%}{100}) \tag{20}$$

*CHC* = head circumference in centimetres user input.

*Pn* = the nearest smaller percentile world health organization standard value head circumference in centimetres relative to the given CHC in the database.

*AG* = the height difference between the nearest smaller percentile world health organization standard value Pn & the current head circumference CHC.

*Pm* = the nearest larger world health organization standard value head circumference in centimetres relative to the given CHC in the database.

*AGPW* = the head circumference difference between the nearest smaller percentile world health organization standard value Pn & the nearest larger world health organization standard value *Pm.*

*GPW* = the ratio of AG per AGPW.

*Pnth%* = the nearest smaller percentile of world health organization growth rate standard of a given age.

*Pmth%* = the nearest larger percentile of world health organization growth rate standard of a given age.

*PercentHC* = the calculated head circumference per age percentile.

For calculating head circumference percentile at birth or at 0 week or at 0 month the following formula is used. The world health organization head circumference-for-age standard percentiles used for this calculation are 1%, 3%, 15%, 50%, 85% and 97%.

$$AG \ = \ (BHC \ - \ pn) \tag{21}$$

$$AGPW \ = \ pm - pn \tag{22}$$

$$GPW \ = \frac{(AG)}{AGPW} \tag{23}$$

$$PercentHC \ = \ (GPW \ * (\frac{(Pmth\% - Pnth\%)}{100})) + (\frac{Pnth\%}{100}) \tag{24}$$

*BHC* = birth head circumference in centimetres user input.

*Pn* = the nearest smaller percentile world health organization standard value head circumference in centimetres relative to the given BHC in the database.

*AG* = the head circumference difference between the nearest smaller percentile world health organization standard value Pn & the birth head circumference BHC.

*Pm* = the nearest larger world health organization standard value head circumference in centimetres relative to the given BHC in the database.

*AGPW* == the head circumference difference between the nearest smaller percentile world health organization standard value Pn & the nearest larger world health organization standard value *Pm.*

*GPW* = the ratio of AG per AGPW.

*Pnth%* = the nearest smaller percentile of world health organization growth rate standard of a given age relative to the given BHC

*Pmth%* = the nearest larger percentile of world health organization growth rate standard of a given age.

*PercentHC* = the calculated head circumference per age percentile.

The logic part is implemented in the weight gain activity, height increase activity, head circumference activity classes. A user fills in gender, birth weight, current weight, age in weeks or months and then clicks the "calculate" button to calculate the growth rate percentile and displays the result on another layout. Each activity uses 2 other classes with similar logic to carry out the implementation.

In this report, weight gain activity is used as an example to show how the implementation looks like. Since the logic and codding is similar with all the activities and to avoid redundancy, only the implementation for weight gain rate calculation code snippets are taken as an example in this report. The methods are explained below.

- The *"MaleWeightWeeks"* method does the calculation for boys' weight per age in weeks growth rate and displays the result on another layout.
- The *"maleWeightMonths*" this method does the calculation for boys' weight per age in months growth rate and displays the result on another layout
- The *"femaleweightMonths"* method does the calculation for girls' weight per age in months growth rate and displays the result on another layout

- The *"femaleWeightWeeks"* method does the calculation for girls' weight per age in weeks growth rate and displays the result on another layout
- The *"graph"* this is the method used to draw a world health organization growth chart for boys displaying 3%, 15 %,50%,85% and 97% growth rate percentile standard curves. /10/
- The "*graphGirls*" this is the method used to draw a world health organization child growth standard chart for girls displaying 3%, 15 %,50%,85% and 97% growth rate percentile standard curves. /9/

The code snippet 9 shows the if statement to check if none of the radio buttons for gender is not checked or any of the text input fields is empty or none of the age radio buttons are not checked or if there is an empty field which a user must put values in and should not be left unfilled.

```
if((!rbMale_w.isChecked()&&!rbFemale_w.isChecked())||(etB_w.getText().toString().equals(""))||
(etC_w.getText().toString().equals(""))||(!rbweeks_w.isChecked()&&!rbmonths_w.isChecked())||
(etAge_w.getText().toString().equals("")))

{
 Toast.makeText(getApplicationContext(),"ENTER ALL FIELDS !!!",Toast.LENGTH_LONG).show();

 }
```

**Code snippet 9.** Example of input field validation.

Next is the code snippet for an example of calling the methods to calculate boys' growth rate percentile when age is given in weeks or in months. It shows that gender "male" radio button and the age radio button "weeks" are checked then the method "MaleWeightWeeks" is called. Else if gender "male" radio button and the age radio button "months" are checked then the method "maleWeightMonths" is called.

```
else if ((rbMale_w.isChecked() && rbweeks_w.isChecked()))

 {
   MaleWeightWeeks();

} else if((rbMale_w.isChecked()&& rbmonths_w.isChecked()))

{

maleWeightMonths();

  }
```

**Code snippet 10.** Example of boys' growth rate calculations.

Below is the code snippet example for calling the methods to calculate girls' growth rate percentile when age is given in weeks or in months otherwise shows a pop-up error message. If gender "Female" radio button and the age radio button "months" are checked then the method "femaleweightMonths" is called. Else if gender "Female" radio button and the age radio button "weeks" are checked then the method "femaleWeightWeeks" is called otherwise pop-up an "Error" message.

```
 if(rbFemale_w.isChecked()&& rbmonths_w.isChecked()){
   femaleweightMonths();
}

else if (rbFemale_w.isChecked()&&rbweeks_w.isChecked())

{
     femaleWeightWeeks();
}

else {

Toast.makeText(getApplicationContext()," ERORR TRY      AGAIN!!!!!!!!!!!",

Toast.LENGTH_LONG).show();
}
```

**Code snippet 11.** Example of girls’ growth rate calculation methods.

Here is the part where an explanation on how the formulas are used for the calculation and how the logic for the calculation is written in the code takes place. The “Femaleweightmonths” method is taken as an example in this report. It does the calculation for girls’ weight per age growth rate percentile when age is given in months and compares the result with world health organization child growth rate standard chart by showing the result on the chart.

In the java code “switch” is used to make the calculation using the “age” as parameter and the cases are the number of months/weeks given. For example, if the age is 0 month the application will start making the calculation at case “0”, then finds the given current weight in the world health organization standard table using if else statement. Then compares it with the standard growth rate percentile values of p1(1%), p3(3%), p15(15%), p50(50%), p85(85%) and p97(97%).

```
switch (Age_month) // using age as a parameter

 {
   case "0":                // when age is 0 month
      if (CW <= p1)       //if current weight given is less than 1%

    {
         setContentView(R.layout.activity_result);    // display the result in a result layout

         TextView tv = findViewById(R.id.result_h);
         tv.setText(" growth rate is : 0 %"
         GraphView g = findViewById(R.id.graph);    //plot line graph for the result

        LineGraphSeries<DataPoint> series4 = new LineGraphSeries<>(new DataPoint[] {
                new DataPoint(Age_m, CW)});          // x and y data points for the graph
         g.addSeries(series4);                          //add the datapoints
         series4.setColor(Color.BLACK);           // set the color to black
         series4.setDrawDataPoints(true);     // datapoints are shown in the graph
         series4.setTitle(String.valueOf(rate.format(Percentw)));       // set the result as title
         graphGirls();               // a method for girls' WHO standard chart.

         }
```

**Code snippet 12**. Example of using age as parameter.

Below is the code snippet that shows what happens if the given current weight is less than or greater than 1% and less than 3% as an example. If it is less than 1%, then automatically the growth rate will be 0% without the need of using the formula or else the formula will be applied to calculate the growth rate percentile.

```
String p1st = WeightPercentile.getGwm1p(Age_week);

// the getGwm1p method in the WeightPercentile class is used to get 1%

String p3rd = WeightPercentile.getGwm3p(Age_week);

// thegetgetGwm3p method in the WeightPercentile  class is used to get 3%
  p1 = Double.parseDouble(p1st);

// the string value of 1st % weight in kg is changed to double type

p3 = Double.parseDouble(p3rd);

//changes the string value of 3% weight in kg to double type
 if (CW >p1 &&CW <= p3)      //if current weight is greater than 1% and less than 3%

          {

               AG = (CW - p1);       // the difference between current value and  1% value
                AGPW = p3-p1;        //the  difference between 3% value  and 1% value
                 GPW = (AG) / AGPW;     // take ratio
                  Percentw = (GPW * 0.02) +0.01;    // the  calculated  growth rate result
                   setContentView(R.layout.activity_result);   // the result displaying layout
                   TextView tv = findViewById(R.id.result_h);   //the result in  text
                     tv.setText(" growth rate is : " + String.valueOf(rate.format(Percentw)));

                  }
```

**Code snippet 13**. Example of implementation of the formula

After the calculation, it displays the result in the form of a text and graph, then compares the result on the standard chart using the “age” and the “current weight” as x and y data points in the chart.

```
    setContentView(R.layout.activity_result);    // display the result in a different layout
    GraphView g = findViewById(R.id.graph);    //plot line graph for the result

   LineGraphSeries<DataPoint> series4 = new LineGraphSeries<>(new DataPoint[] {
        new DataPoint(Age_m, CW)});          //  set age x-axis and  cw y-axis
    g.addSeries(series4);                          //add the datapoints
    series4.setColor(Color.BLACK);            // set the color to black
    series4.setDrawDataPoints(true);       // datapoints are shown in the graph
    series4.setTitle(String.valueOf(rate.format(Percentw)));       // set the result as title
    graphGirls();              // a method for girls' WHO standard chart is called.

    }
```

**Code snippet 14**. Example of plotting the result on a graph.

The case continues until 12 months using the same logic and it's also applicable for the age given in weeks, only the variables and the table names in the query of the database class is changing according to which table the standard value is fetched. World health organization standards are available only for up to 13 weeks age given in weeks and 12 months for age in months. The logic and the codes are similar for all the methods that are used to calculate weight gain rate, height increase rate and head circumference increase rate. It an example of the implementation of queries used to get the standard values for the 1%, 3%,15%,50%,85% and 97% from the world health organization standard table in the database which is used in the formula for the calculation.

```
//this is   the method to get the value of 1 percentile at a given age

public String getGwm1p(String age)

{
 c=db.rawQuery("select P1st from Girlsweightmonths where Age = '"+age+"'",new String[]{});
//it will query the 1 percentile from the table Girlsweightmonths where age is     equal to the given
//input age

StringBuffer buffer = new StringBuffer();   // create string objects
while (c.moveToNext())                        // move the cursor to the next row

{
String wage = c.getString(0);
buffer.append(""+wage);
}
return buffer.toString(); //return the result as string
}
```

**Code snippet 15.** Example of WHO standard percentiles implementation.

The next part of the code snippet from the “WeghtChart” class shows a method which is used to get the datapoints for the 3% girls weight gain per month curve on the world health organization child growth standard chart. For the chart’s datapoints of 'x' and 'y' axis, columns Age and p3rd (the value of 3% growth rate percentile) are used to get the values from the Standard table “girlsweightmonths “in the database. The logic of the coding is also similar for getting the datapoints of 1%,15%,50%,85% and 97%. Standard chart curves.

```
protected   DataPoint[] getDatawmg3p()

{
   String[] columns = {"Age", "P3rd"}; // column names Age and P3rd
   c = db.query("Girlsweightmonths", columns, null, null, null,null,null,null);

//create a new temporary table with columns Age and P3rd table Girlsweightmonths"

   DataPoint[] dp = new DataPoint[c.getCount()]; // get the datapoints from the new table
   for(int i = 0;i<c.getCount(); i++){
    c.moveToNext();
    dp[i]=new DataPoint(c.getInt(0), c.getDouble(1));
   }
   return dp; // return the datapoint
};
```

**Code snippet 16**. Example of the implementation datapoints for WHO charts.

world health organization child growth rate charts are implemented using different methods for each category of the calculation. There are 6 different standard charts. These charts are Child growth standard chart from birth to two years weight-per-age percentile for boys, weight-per-age percentile chart for girls, height-per-age percentile chart for boys, height-per-age percentile chart for girls, head circumference per age percentile chart for boys and head circumference percentile chart for girls. For this report, only one method’s code snippet is shown just to explain the implementation. This method is used to draw the world health organization growth chart for girls displaying 3%, growth rate standard percentile curve on the chart. The code snippet below shows how the 3% curve on the chart is implemented. It uses the methods in the WeightChart class to access it’s datapoints from the standard values stored in the database tables.

The code shows how to draw line graph for 3 percent growth rate. It also shows how to get the datapoints from world health organization standard weight-for-age values from the database. The method  getDatawmg3p() in the WeightChart class gets the id of the graph in a view, adds the datapoints series to the line graph, sets the line graph title, set the line graph color to red, sets legend visibility true, legend at the bottom, sets the x axis minimum value 0, sets x axis maximum value 15,sets y axis minimum value 0,sets y axis maximum value to 12,sets chart title, allows the axis bound to be set manually, allows the x axis bound to be set manually, allows grid label, sets x axis title and sets y axis title.

```
public void graphGirls()

{
    GraphView graph = (GraphView) findViewById(R.id.graph);
    LineGraphSeries<DataPoint> series = new LineGraphSeries<>(databaseAccess.getDatawmg3p());
    graph.addSeries(series);
   series.setTitle("3%");
   series.setColor(Color.RED);
   graph.getLegendRenderer().setVisible(true);
   graph.getLegendRenderer().setAlign(LegendRenderer.LegendAlign.BOTTOM);
   graph.getViewport().setMinX(0);

   graph.getViewport().setMaxX(15);
   graph.getViewport().setMinY(0);
   graph.getViewport().setMaxY(15);
   graph.setTitle("WHO weight_for_age percentiles for Girls ");
   graph.getViewport().setYAxisBoundsManual(true);

   graph.getViewport().setXAxisBoundsManual(true);
   GridLabelRenderer gridLabel = graph.getGridLabelRenderer();
   gridLabel.setHorizontalAxisTitle("Age(months)");
   gridLabel.setVerticalAxisTitle("Weight(kg)");
}
```

**Code snippet 17.** Example of plotting WHO standard chart.

# 6. TESTING

Testing has graphical user interface part and functional part of the application. Mainly android emulator virtual devices and real android mobile phone devices are used to test and monitor the app. Huawei honor 7 light with android version 7 and Nokia TA-1032 with android version 8.1 devices and also, virtual devices nexus 4 API 27 target Android 8, nexus one API 22 target android 5.1, Nexus S API 28 target Android 9.0 and Nexus 6 API 24 target Android 7.0 virtual devices are used for Testing the graphical user interface, the performance and reliability of the app.

World health organization growth rate standard percentile tables of weight per age, height per age and head circumference per age for boys and girls separately were used to test the application calculation and the result was compared with the values in the world health organization standard percentiles tables and charts. The tables are found in the Appendices part of this project.

# 7. SUMMARY

Infant Growth Calculator is a simple and user-friendly child growth rate calculator. It is an android mobile application which calculates the growth rate of infant babies aged from birth up to one year using world health organization (WHO) standards. It is Intended to help parents with infant babies who usually worry wondering how well the baby is growing. This application will help parents to calculate their infant baby's growth rate instantly using their mobile phones so that they don't have to wait to their child's health care unite appointment to see where their baby's growth rate lies on the world health organization (WHO) child growth rate standard curves.

It calculates weight per age, height per age and head circumference per age growth rate percentiles for babies based on weight-for-age, height-for-age and head circumference-for-age child growth rate percentile tables of the world health organization's standards. /1/

The tables are stored in the database using internal storage. They are used to generate the application's calculation formula and to draw charts for world health organization standard percentiles and the calculation result.

The calculator receives birth weight, current weight, birth height, current height, birth head circumference, current head circumference, gender and age from the user and calculates the percentile growth rate. Each selected calculation has its own screen with user input information of gender, birth weight/height/head circumference, current weight/height/head circumference and age. The application uses the formula created for the calculation by putting the user input values and WHO standard values from the database.

The result displays a text showing how much the calculated growth rate percentile is and draws the result on the WHO growth rate standard chart to show where the growth rate lies in the standard curves for comparison.

## 8. CONCLUSIONS

The project was implemented well so that the goals are achieved as it calculates the growth rate percentiles for weight, height, and head circumferences from birth up to 12 months and the results are shown in the accurate place on the WHO standard charts.

The calculation has some deviation of 0.5% to 2.5 % from the WHO standard table of some values between the standard percentiles used for the calculation, but this doesn’t affect the overall growth rate percentile result on the standard chart as it is a very small deviation. The cause for this deviation is that only the growth chart percentile values of (3%,15%,50%,85% &97%) are stored in the data base from the standard tables for the calculation .There for, the deviation can be corrected by using all the percentile values of the standard tables in the calculation.

The most challenging part of this project was generating the formulas for the calculations. The solutions were found by carefully studying the standard values of the WHO child growth rate percentile tables, how the values change from one percentile to the other and taking the ratio of the difference. Improvements can be made on the formula itself by providing easily understandable and meaningful variable names. This app can be improved in the future by adding additional functionalities. Some of the future works are listed below.

- The application can be improved to make the calculation for infant babies age up to 2 years.
- It can be improved to store user input data in the database and show the child’s growth curve on the WHO standard chart.
- It can include a registration form so that users can use the app for 2 or more children.
- It can include body mass index (BMI) for age calculation.

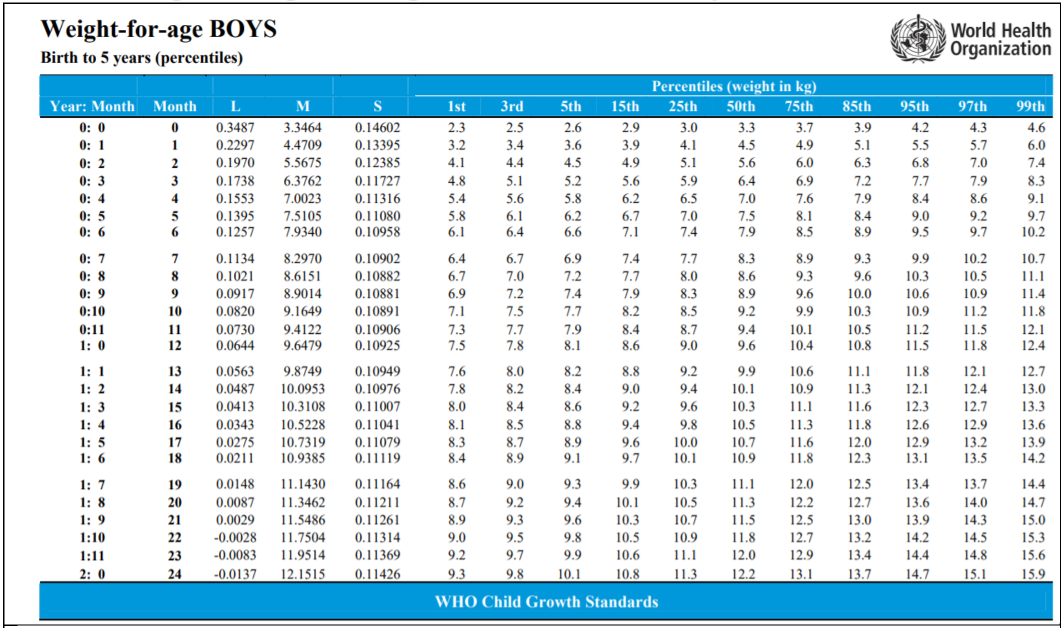
# REFERENCES

1. World health organization child growth standards. Accessed 15.4.2019. https://www.who.int/childgrowth/standards/en/
2. World health organization child growth standard weight-for-age tables boys' percentiles. Accessed 15.4.2019. https://www.who.int/childgrowth/standards/w_f_a_tables_p_boys/en/
3. World health organization child growth standard weight-for-age tables girls' percentiles. Accessed 15.4.2019. https://www.who.int/childgrowth/standards/w_f_a_tables_p_girls/en/
4. World health organization child growth standard height-for-age tables girls' percentiles. Accessed 14.4.2019. https://www.who.int/childgrowth/standards/h_f_a_tables_p_girls/en/
5. World health organization child growth standard height-for-age tables boys' percentiles . Accessed 14.4.2019 . https://www.who.int/childgrowth/standards/h_f_a_tables_p_boys/en/
6. World health organization child growth standard head circumference-for-age tables boys' percentiles. Accessed 15.4.2019. https://www.who.int/childgrowth/standards/hcfa_tables_p_boys/en/
7. World health organization child growth standard head circumference-for-age tables girls' percentiles. Accessed 15.4.2019. https://www.who.int/childgrowth/standards/hcfa_tables_p_girls/en/
8. World health organization child growth standard weight-for-age charts boys' percentiles. Accessed 15.4.2019. https://www.who.int/childgrowth/standards/chts_wfa_boys_p/en/
9. World health organization child growth standard weight-for-age charts girls' percentiles. Accessed 15.4.2019. https://www.who.int/childgrowth/standards/chts_wfa_girls_p/en/

10. World health organization child growth standard weight-for-age charts boys' percentiles. Accessed 15.4.2019.
https://www.who.int/childgrowth/standards/chts_wfa_boys_p/en/
11. Android-graph view open source library. Accessed 15.5.2019.
https://github.com/jjoe64/GraphView
12. Android-SQLite-asset-helper open source library. Accessed 10.5.2019.
https://github.com/jgilfelt/android-sqlite-asset-helper
13. Android developer guide. Accessed 16.4.2019.
https://developer.android.com/guide
14. Android Studio Features. Accesses 17.5.2019
https://developer.android.com/studio
15. Android studio review. Accessed 17.5.2019
https://developer.android.com/studio/intro/
16. Java review. Accessed 17.5.2019.
https://www.w3schools.com/java/java_intro.asp
17. Introduction to JDK. Accessed 17.5.2019.
https://www.javaworld.com/article/3296360/what-is-the-jdk-introduction-to-the-java-development-kit.html
18. DB browser for SQLite (DB4S) .Accesses 17.5.2019.
https://sqlitebrowser.org/
19. Android studio layout editor. Accessed 17.5.2019.
https://developer.android.com/studio/write/layout-editor.html

APPENDIX 1

Table 2. Weight-for-age WHO growth standards for boys.



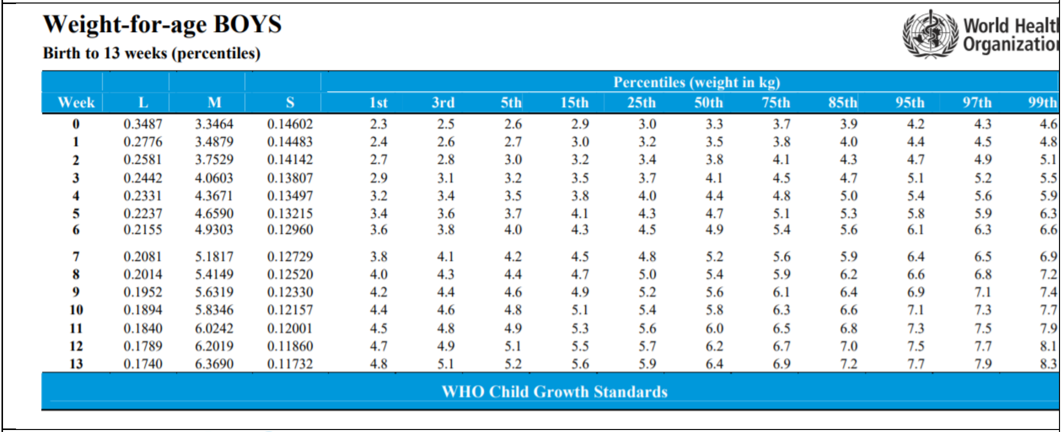
## Weight-for-age BOYS

**Birth to 5 years (percentiles)**

World Health Organization

| | | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year: Month | Month | L | M | S | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| 0: 0 | 0 | 0.3487 | 3.3464 | 0.14602 | 2.3 | 2.5 | 2.6 | 2.9 | 3.0 | 3.3 | 3.7 | 3.9 | 4.2 | 4.3 | 4.6 |
| 0: 1 | 1 | 0.2297 | 4.4709 | 0.13395 | 3.2 | 3.4 | 3.6 | 3.9 | 4.1 | 4.5 | 4.9 | 5.1 | 5.5 | 5.7 | 6.0 |
| 0: 2 | 2 | 0.1970 | 5.5675 | 0.12385 | 4.1 | 4.4 | 4.5 | 4.9 | 5.1 | 5.6 | 6.0 | 6.3 | 6.8 | 7.0 | 7.4 |
| 0: 3 | 3 | 0.1738 | 6.3762 | 0.11727 | 4.8 | 5.1 | 5.2 | 5.6 | 5.9 | 6.4 | 6.9 | 7.2 | 7.7 | 7.9 | 8.3 |
| 0: 4 | 4 | 0.1553 | 7.0023 | 0.11316 | 5.4 | 5.6 | 5.8 | 6.2 | 6.5 | 7.0 | 7.6 | 7.9 | 8.4 | 8.6 | 9.1 |
| 0: 5 | 5 | 0.1395 | 7.5105 | 0.11080 | 5.8 | 6.1 | 6.2 | 6.7 | 7.0 | 7.5 | 8.1 | 8.4 | 9.0 | 9.2 | 9.7 |
| 0: 6 | 6 | 0.1257 | 7.9340 | 0.10958 | 6.1 | 6.4 | 6.6 | 7.1 | 7.4 | 7.9 | 8.5 | 8.9 | 9.5 | 9.7 | 10.2 |
| 0: 7 | 7 | 0.1134 | 8.2970 | 0.10902 | 6.4 | 6.7 | 6.9 | 7.4 | 7.7 | 8.3 | 8.9 | 9.3 | 9.9 | 10.2 | 10.7 |
| 0: 8 | 8 | 0.1021 | 8.6151 | 0.10882 | 6.7 | 7.0 | 7.2 | 7.7 | 8.0 | 8.6 | 9.3 | 9.6 | 10.3 | 10.5 | 11.1 |
| 0: 9 | 9 | 0.0917 | 8.9014 | 0.10881 | 6.9 | 7.2 | 7.4 | 7.9 | 8.3 | 8.9 | 9.6 | 10.0 | 10.6 | 10.9 | 11.4 |
| 0:10 | 10 | 0.0820 | 9.1649 | 0.10891 | 7.1 | 7.5 | 7.7 | 8.2 | 8.5 | 9.2 | 9.9 | 10.3 | 10.9 | 11.2 | 11.8 |
| 0:11 | 11 | 0.0730 | 9.4122 | 0.10906 | 7.3 | 7.7 | 7.9 | 8.4 | 8.7 | 9.4 | 10.1 | 10.5 | 11.2 | 11.5 | 12.1 |
| 1: 0 | 12 | 0.0644 | 9.6479 | 0.10925 | 7.5 | 7.8 | 8.1 | 8.6 | 9.0 | 9.6 | 10.4 | 10.8 | 11.5 | 11.8 | 12.4 |
| 1: 1 | 13 | 0.0563 | 9.8749 | 0.10949 | 7.6 | 8.0 | 8.2 | 8.8 | 9.2 | 9.9 | 10.6 | 11.1 | 11.8 | 12.1 | 12.7 |
| 1: 2 | 14 | 0.0487 | 10.0953 | 0.10976 | 7.8 | 8.2 | 8.4 | 9.0 | 9.4 | 10.1 | 10.9 | 11.3 | 12.1 | 12.4 | 13.0 |
| 1: 3 | 15 | 0.0413 | 10.3108 | 0.11007 | 8.0 | 8.4 | 8.6 | 9.2 | 9.6 | 10.3 | 11.1 | 11.6 | 12.3 | 12.7 | 13.3 |
| 1: 4 | 16 | 0.0343 | 10.5228 | 0.11041 | 8.1 | 8.5 | 8.8 | 9.4 | 9.8 | 10.5 | 11.3 | 11.8 | 12.6 | 12.9 | 13.6 |
| 1: 5 | 17 | 0.0275 | 10.7319 | 0.11079 | 8.3 | 8.7 | 8.9 | 9.6 | 10.0 | 10.7 | 11.6 | 12.0 | 12.9 | 13.2 | 13.9 |
| 1: 6 | 18 | 0.0211 | 10.9385 | 0.11119 | 8.4 | 8.9 | 9.1 | 9.7 | 10.1 | 10.9 | 11.8 | 12.3 | 13.1 | 13.5 | 14.2 |
| 1: 7 | 19 | 0.0148 | 11.1430 | 0.11164 | 8.6 | 9.0 | 9.3 | 9.9 | 10.3 | 11.1 | 12.0 | 12.5 | 13.4 | 13.7 | 14.4 |
| 1: 8 | 20 | 0.0087 | 11.3462 | 0.11211 | 8.7 | 9.2 | 9.4 | 10.1 | 10.5 | 11.3 | 12.2 | 12.7 | 13.6 | 14.0 | 14.7 |
| 1: 9 | 21 | 0.0029 | 11.5486 | 0.11261 | 8.9 | 9.3 | 9.6 | 10.3 | 10.7 | 11.5 | 12.5 | 13.0 | 13.9 | 14.3 | 15.0 |
| 1:10 | 22 | -0.0028 | 11.7504 | 0.11314 | 9.0 | 9.5 | 9.8 | 10.5 | 10.9 | 11.8 | 12.7 | 13.2 | 14.2 | 14.5 | 15.3 |
| 1:11 | 23 | -0.0083 | 11.9514 | 0.11369 | 9.2 | 9.7 | 9.9 | 10.6 | 11.1 | 12.0 | 12.9 | 13.4 | 14.4 | 14.8 | 15.6 |
| 2: 0 | 24 | -0.0137 | 12.1515 | 0.11426 | 9.3 | 9.8 | 10.1 | 10.8 | 11.3 | 12.2 | 13.1 | 13.7 | 14.7 | 15.1 | 15.9 |

WHO Child Growth Standards



## Weight-for-age BOYS

**Birth to 13 weeks (percentiles)**

World Health Organization

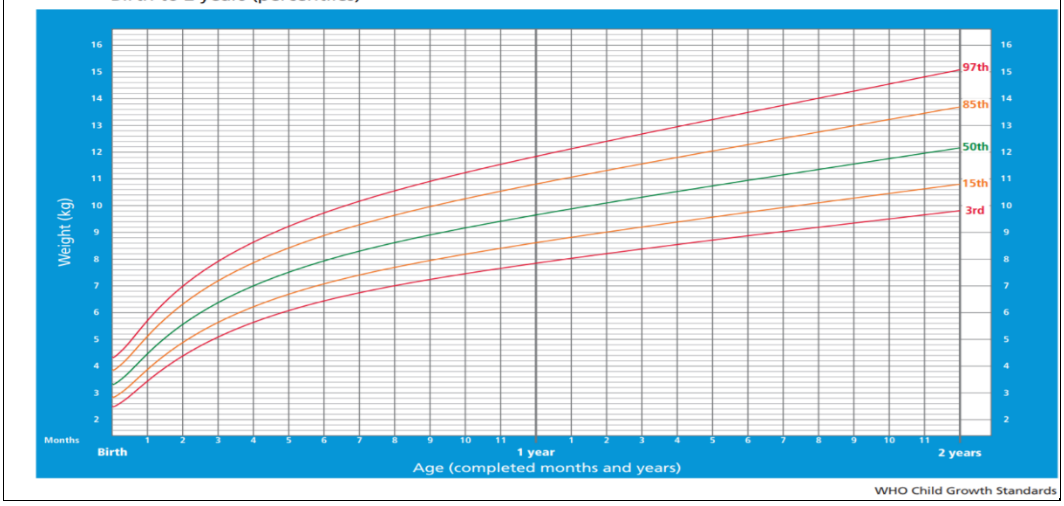
| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | L | M | S | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| 0 | 0.3487 | 3.3464 | 0.14602 | 2.3 | 2.5 | 2.6 | 2.9 | 3.0 | 3.3 | 3.7 | 3.9 | 4.2 | 4.3 | 4.6 |
| 1 | 0.2776 | 3.4879 | 0.14483 | 2.4 | 2.6 | 2.7 | 3.0 | 3.2 | 3.5 | 3.8 | 4.0 | 4.4 | 4.5 | 4.8 |
| 2 | 0.2581 | 3.7529 | 0.14142 | 2.7 | 2.8 | 3.0 | 3.2 | 3.4 | 3.8 | 4.1 | 4.3 | 4.7 | 4.9 | 5.1 |
| 3 | 0.2442 | 4.0603 | 0.13807 | 2.9 | 3.1 | 3.2 | 3.5 | 3.7 | 4.1 | 4.5 | 4.7 | 5.1 | 5.2 | 5.5 |
| 4 | 0.2331 | 4.3671 | 0.13497 | 3.2 | 3.4 | 3.5 | 3.8 | 4.0 | 4.4 | 4.8 | 5.0 | 5.4 | 5.6 | 5.9 |
| 5 | 0.2237 | 4.6590 | 0.13215 | 3.4 | 3.6 | 3.7 | 4.1 | 4.3 | 4.7 | 5.1 | 5.3 | 5.8 | 5.9 | 6.3 |
| 6 | 0.2155 | 4.9303 | 0.12960 | 3.6 | 3.8 | 4.0 | 4.3 | 4.5 | 4.9 | 5.4 | 5.6 | 6.1 | 6.3 | 6.6 |
| 7 | 0.2081 | 5.1817 | 0.12729 | 3.8 | 4.1 | 4.2 | 4.5 | 4.8 | 5.2 | 5.6 | 5.9 | 6.4 | 6.5 | 6.9 |
| 8 | 0.2014 | 5.4149 | 0.12520 | 4.0 | 4.3 | 4.4 | 4.7 | 5.0 | 5.4 | 5.9 | 6.2 | 6.6 | 6.8 | 7.2 |
| 9 | 0.1952 | 5.6319 | 0.12330 | 4.2 | 4.4 | 4.6 | 4.9 | 5.2 | 5.6 | 6.1 | 6.4 | 6.9 | 7.1 | 7.4 |
| 10 | 0.1894 | 5.8346 | 0.12157 | 4.4 | 4.6 | 4.8 | 5.1 | 5.4 | 5.8 | 6.3 | 6.6 | 7.1 | 7.3 | 7.7 |
| 11 | 0.1840 | 6.0242 | 0.12001 | 4.5 | 4.8 | 4.9 | 5.3 | 5.6 | 6.0 | 6.5 | 6.8 | 7.3 | 7.5 | 7.9 |
| 12 | 0.1789 | 6.2019 | 0.11860 | 4.7 | 4.9 | 5.1 | 5.5 | 5.7 | 6.2 | 6.7 | 7.0 | 7.5 | 7.7 | 8.1 |
| 13 | 0.1740 | 6.3690 | 0.11732 | 4.8 | 5.1 | 5.2 | 5.6 | 5.9 | 6.4 | 6.9 | 7.2 | 7.7 | 7.9 | 8.3 |

WHO Child Growth Standards

## Weight-for-age BOYS

Birth to 2 years (percentiles)

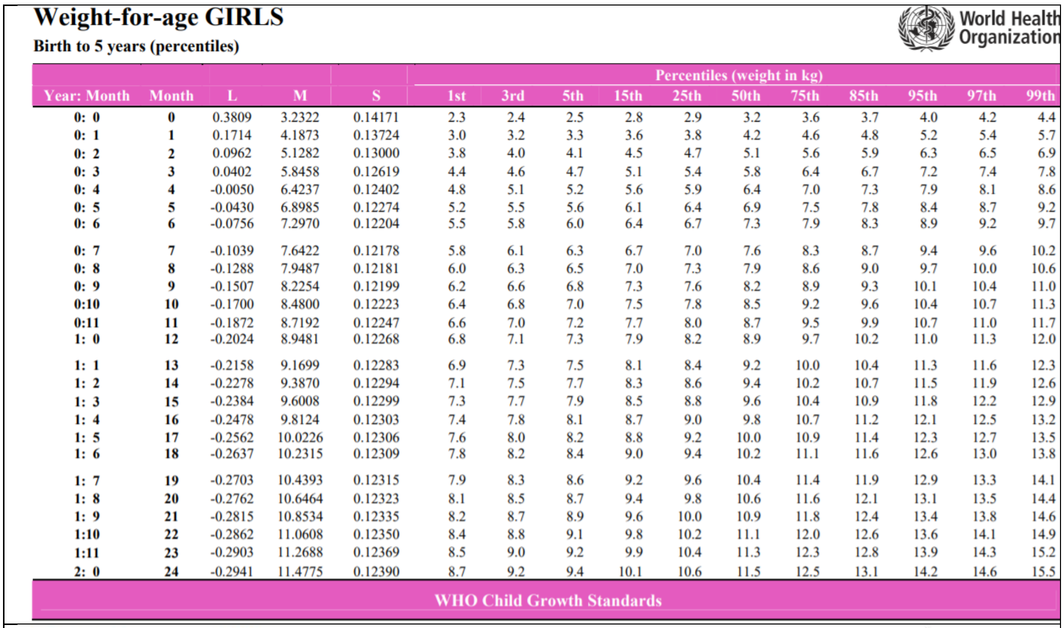
World Health Organization



WHO Child Growth Standards

APPENDIX 2

Table 3. Weight-for-age WHO growth standards for girls.

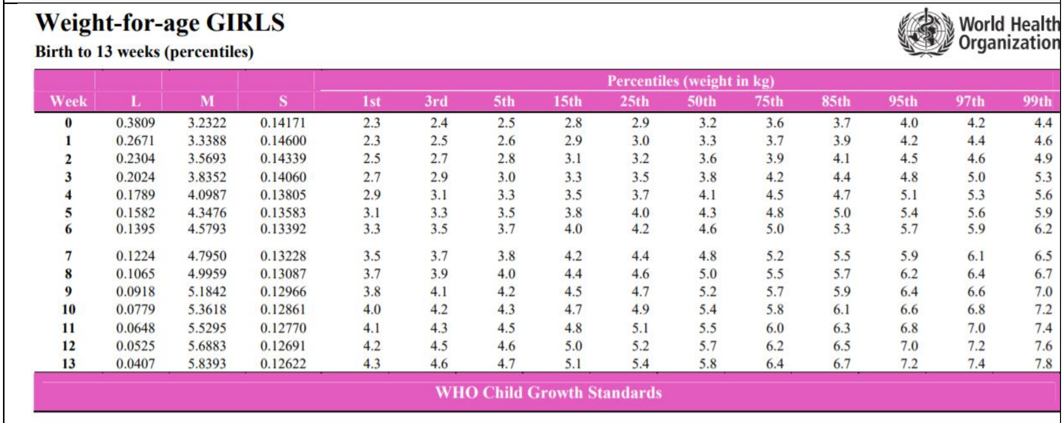


## Weight-for-age GIRLS

**Birth to 5 years (percentiles)**

| | | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year: Month | Month | L | M | S | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| 0: 0 | 0 | 0.3809 | 3.2322 | 0.14171 | 2.3 | 2.4 | 2.5 | 2.8 | 2.9 | 3.2 | 3.6 | 3.7 | 4.0 | 4.2 | 4.4 |
| 0: 1 | 1 | 0.1714 | 4.1873 | 0.13724 | 3.0 | 3.2 | 3.3 | 3.6 | 3.8 | 4.2 | 4.6 | 4.8 | 5.2 | 5.4 | 5.7 |
| 0: 2 | 2 | 0.0962 | 5.1282 | 0.13000 | 3.8 | 4.0 | 4.1 | 4.5 | 4.7 | 5.1 | 5.6 | 5.9 | 6.3 | 6.5 | 6.9 |
| 0: 3 | 3 | 0.0402 | 5.8458 | 0.12619 | 4.4 | 4.6 | 4.7 | 5.1 | 5.4 | 5.8 | 6.4 | 6.7 | 7.2 | 7.4 | 7.8 |
| 0: 4 | 4 | -0.0050 | 6.4237 | 0.12402 | 4.8 | 5.1 | 5.2 | 5.6 | 5.9 | 6.4 | 7.0 | 7.3 | 7.9 | 8.1 | 8.6 |
| 0: 5 | 5 | -0.0430 | 6.8985 | 0.12274 | 5.2 | 5.5 | 5.6 | 6.1 | 6.4 | 6.9 | 7.5 | 7.8 | 8.4 | 8.7 | 9.2 |
| 0: 6 | 6 | -0.0756 | 7.2970 | 0.12204 | 5.5 | 5.8 | 6.0 | 6.4 | 6.7 | 7.3 | 7.9 | 8.3 | 8.9 | 9.2 | 9.7 |
| 0: 7 | 7 | -0.1039 | 7.6422 | 0.12178 | 5.8 | 6.1 | 6.3 | 6.7 | 7.0 | 7.6 | 8.3 | 8.7 | 9.4 | 9.6 | 10.2 |
| 0: 8 | 8 | -0.1288 | 7.9487 | 0.12181 | 6.0 | 6.3 | 6.5 | 7.0 | 7.3 | 7.9 | 8.6 | 9.0 | 9.7 | 10.0 | 10.6 |
| 0: 9 | 9 | -0.1507 | 8.2254 | 0.12199 | 6.2 | 6.6 | 6.8 | 7.3 | 7.6 | 8.2 | 8.9 | 9.3 | 10.1 | 10.4 | 11.0 |
| 0:10 | 10 | -0.1700 | 8.4800 | 0.12223 | 6.4 | 6.8 | 7.0 | 7.5 | 7.8 | 8.5 | 9.2 | 9.6 | 10.4 | 10.7 | 11.3 |
| 0:11 | 11 | -0.1872 | 8.7192 | 0.12247 | 6.6 | 7.0 | 7.2 | 7.7 | 8.0 | 8.7 | 9.5 | 9.9 | 10.7 | 11.0 | 11.7 |
| 1: 0 | 12 | -0.2024 | 8.9481 | 0.12268 | 6.8 | 7.1 | 7.3 | 7.9 | 8.2 | 8.9 | 9.7 | 10.2 | 11.0 | 11.3 | 12.0 |
| 1: 1 | 13 | -0.2158 | 9.1699 | 0.12283 | 6.9 | 7.3 | 7.5 | 8.1 | 8.4 | 9.2 | 10.0 | 10.4 | 11.3 | 11.6 | 12.3 |
| 1: 2 | 14 | -0.2278 | 9.3870 | 0.12294 | 7.1 | 7.5 | 7.7 | 8.3 | 8.6 | 9.4 | 10.2 | 10.7 | 11.5 | 11.9 | 12.6 |
| 1: 3 | 15 | -0.2384 | 9.6008 | 0.12299 | 7.3 | 7.7 | 7.9 | 8.5 | 8.8 | 9.6 | 10.4 | 10.9 | 11.8 | 12.2 | 12.9 |
| 1: 4 | 16 | -0.2478 | 9.8124 | 0.12303 | 7.4 | 7.8 | 8.1 | 8.7 | 9.0 | 9.8 | 10.7 | 11.2 | 12.1 | 12.5 | 13.2 |
| 1: 5 | 17 | -0.2562 | 10.0226 | 0.12306 | 7.6 | 8.0 | 8.2 | 8.8 | 9.2 | 10.0 | 10.9 | 11.4 | 12.3 | 12.7 | 13.5 |
| 1: 6 | 18 | -0.2637 | 10.2315 | 0.12309 | 7.8 | 8.2 | 8.4 | 9.0 | 9.4 | 10.2 | 11.1 | 11.6 | 12.6 | 13.0 | 13.8 |
| 1: 7 | 19 | -0.2703 | 10.4393 | 0.12315 | 7.9 | 8.3 | 8.6 | 9.2 | 9.6 | 10.4 | 11.4 | 11.9 | 12.9 | 13.3 | 14.1 |
| 1: 8 | 20 | -0.2762 | 10.6464 | 0.12323 | 8.1 | 8.5 | 8.7 | 9.4 | 9.8 | 10.6 | 11.6 | 12.1 | 13.1 | 13.5 | 14.4 |
| 1: 9 | 21 | -0.2815 | 10.8534 | 0.12335 | 8.2 | 8.7 | 8.9 | 9.6 | 10.0 | 10.9 | 11.8 | 12.4 | 13.4 | 13.8 | 14.6 |
| 1:10 | 22 | -0.2862 | 11.0608 | 0.12350 | 8.4 | 8.8 | 9.1 | 9.8 | 10.2 | 11.1 | 12.0 | 12.6 | 13.6 | 14.1 | 14.9 |
| 1:11 | 23 | -0.2903 | 11.2688 | 0.12369 | 8.5 | 9.0 | 9.2 | 9.9 | 10.4 | 11.3 | 12.3 | 12.8 | 13.9 | 14.3 | 15.2 |
| 2: 0 | 24 | -0.2941 | 11.4775 | 0.12390 | 8.7 | 9.2 | 9.4 | 10.1 | 10.6 | 11.5 | 12.5 | 13.1 | 14.2 | 14.6 | 15.5 |

WHO Child Growth Standards



## Weight-for-age GIRLS

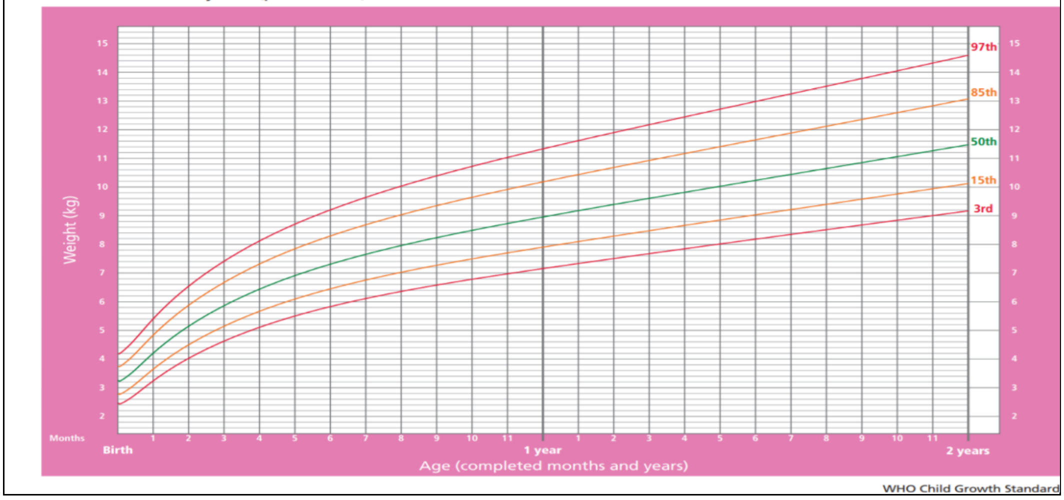
**Birth to 13 weeks (percentiles)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | L | M | S | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| 0 | 0.3809 | 3.2322 | 0.14171 | 2.3 | 2.4 | 2.5 | 2.8 | 2.9 | 3.2 | 3.6 | 3.7 | 4.0 | 4.2 | 4.4 |
| 1 | 0.2671 | 3.3388 | 0.14600 | 2.3 | 2.5 | 2.6 | 2.9 | 3.0 | 3.3 | 3.7 | 3.9 | 4.2 | 4.4 | 4.6 |
| 2 | 0.2304 | 3.5693 | 0.14339 | 2.5 | 2.7 | 2.8 | 3.1 | 3.2 | 3.6 | 3.9 | 4.1 | 4.5 | 4.6 | 4.9 |
| 3 | 0.2024 | 3.8352 | 0.14060 | 2.7 | 2.9 | 3.0 | 3.3 | 3.5 | 3.8 | 4.2 | 4.4 | 4.8 | 5.0 | 5.3 |
| 4 | 0.1789 | 4.0987 | 0.13805 | 2.9 | 3.1 | 3.3 | 3.5 | 3.7 | 4.1 | 4.5 | 4.7 | 5.1 | 5.3 | 5.6 |
| 5 | 0.1582 | 4.3476 | 0.13583 | 3.1 | 3.3 | 3.5 | 3.8 | 4.0 | 4.3 | 4.8 | 5.0 | 5.4 | 5.6 | 5.9 |
| 6 | 0.1395 | 4.5793 | 0.13392 | 3.3 | 3.5 | 3.7 | 4.0 | 4.2 | 4.6 | 5.0 | 5.3 | 5.7 | 5.9 | 6.2 |
| 7 | 0.1224 | 4.7950 | 0.13228 | 3.5 | 3.7 | 3.8 | 4.2 | 4.4 | 4.8 | 5.2 | 5.5 | 5.9 | 6.1 | 6.5 |
| 8 | 0.1065 | 4.9959 | 0.13087 | 3.7 | 3.9 | 4.0 | 4.4 | 4.6 | 5.0 | 5.5 | 5.7 | 6.2 | 6.4 | 6.7 |
| 9 | 0.0918 | 5.1842 | 0.12966 | 3.8 | 4.1 | 4.2 | 4.5 | 4.7 | 5.2 | 5.7 | 5.9 | 6.4 | 6.6 | 7.0 |
| 10 | 0.0779 | 5.3618 | 0.12861 | 4.0 | 4.2 | 4.3 | 4.7 | 4.9 | 5.4 | 5.8 | 6.1 | 6.6 | 6.8 | 7.2 |
| 11 | 0.0648 | 5.5295 | 0.12770 | 4.1 | 4.3 | 4.5 | 4.8 | 5.1 | 5.5 | 6.0 | 6.3 | 6.8 | 7.0 | 7.4 |
| 12 | 0.0525 | 5.6883 | 0.12691 | 4.2 | 4.5 | 4.6 | 5.0 | 5.2 | 5.7 | 6.2 | 6.5 | 7.0 | 7.2 | 7.6 |
| 13 | 0.0407 | 5.8393 | 0.12622 | 4.3 | 4.6 | 4.7 | 5.1 | 5.4 | 5.8 | 6.4 | 6.7 | 7.2 | 7.4 | 7.8 |

WHO Child Growth Standards

## Weight-for-age GIRLS

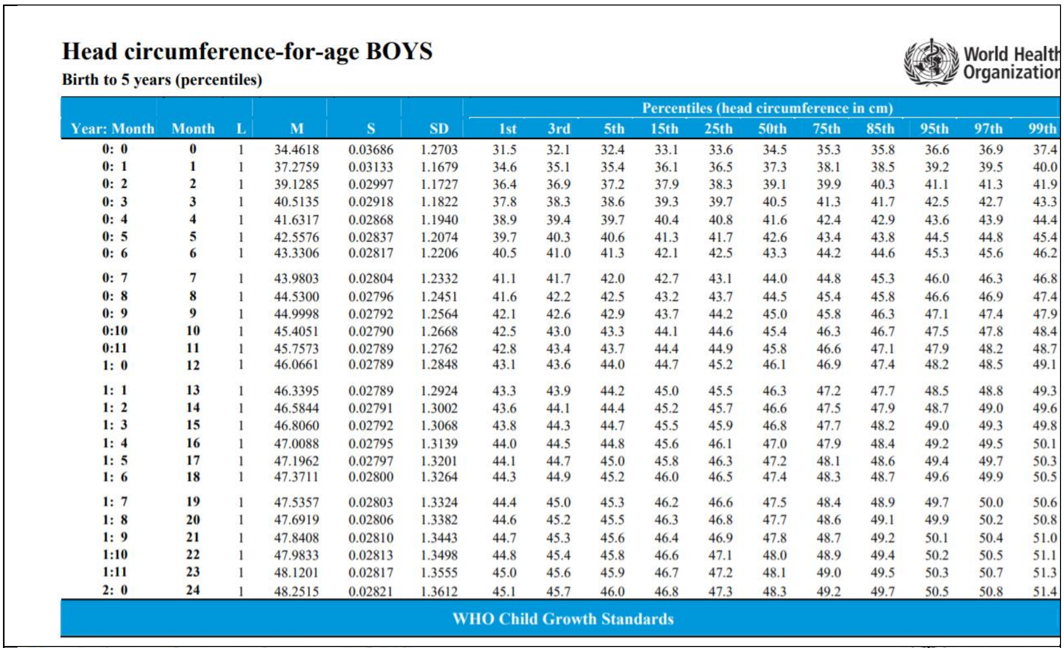
Birth to 2 years (percentiles)



WHO Child Growth Standard

APPENDIX 3

Table 4. Head circumference-for-age WHO growth standards for boys.



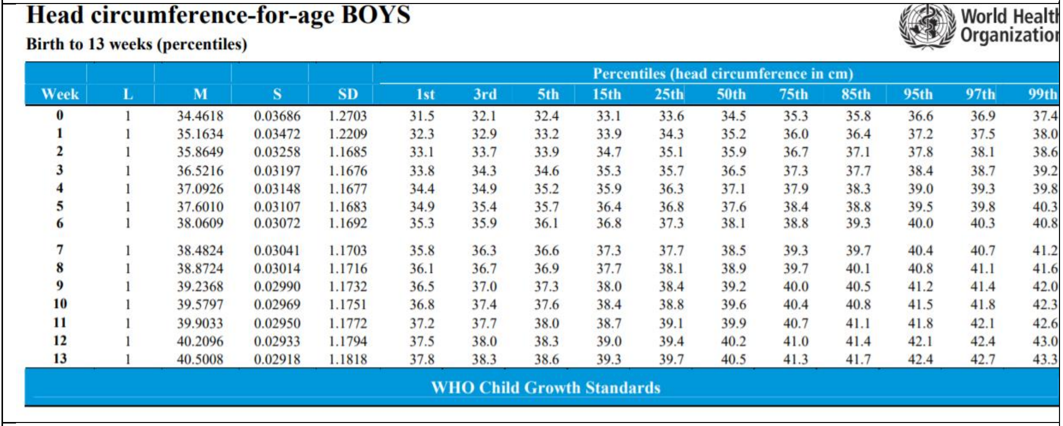
## Head circumference-for-age BOYS

Birth to 5 years (percentiles)

World Health Organization

| | | | | | | Percentiles (head circumference in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year: Month | Month | L | M | S | SD | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| 0: 0 | 0 | 1 | 34.4618 | 0.03686 | 1.2703 | 31.5 | 32.1 | 32.4 | 33.1 | 33.6 | 34.5 | 35.3 | 35.8 | 36.6 | 36.9 | 37.4 |
| 0: 1 | 1 | 1 | 37.2759 | 0.03133 | 1.1679 | 34.6 | 35.1 | 35.4 | 36.1 | 36.5 | 37.3 | 38.1 | 38.5 | 39.2 | 39.5 | 40.0 |
| 0: 2 | 2 | 1 | 39.1285 | 0.02997 | 1.1727 | 36.4 | 36.9 | 37.2 | 37.9 | 38.3 | 39.1 | 39.9 | 40.3 | 41.1 | 41.3 | 41.9 |
| 0: 3 | 3 | 1 | 40.5135 | 0.02918 | 1.1822 | 37.8 | 38.3 | 38.6 | 39.3 | 39.7 | 40.5 | 41.3 | 41.7 | 42.5 | 42.7 | 43.3 |
| 0: 4 | 4 | 1 | 41.6317 | 0.02868 | 1.1940 | 38.9 | 39.4 | 39.7 | 40.4 | 40.8 | 41.6 | 42.4 | 42.9 | 43.6 | 43.9 | 44.4 |
| 0: 5 | 5 | 1 | 42.5576 | 0.02837 | 1.2074 | 39.7 | 40.3 | 40.6 | 41.3 | 41.7 | 42.6 | 43.4 | 43.8 | 44.5 | 44.8 | 45.4 |
| 0: 6 | 6 | 1 | 43.3306 | 0.02817 | 1.2206 | 40.5 | 41.0 | 41.3 | 42.1 | 42.5 | 43.3 | 44.2 | 44.6 | 45.3 | 45.6 | 46.2 |
| 0: 7 | 7 | 1 | 43.9803 | 0.02804 | 1.2332 | 41.1 | 41.7 | 42.0 | 42.7 | 43.1 | 44.0 | 44.8 | 45.3 | 46.0 | 46.3 | 46.8 |
| 0: 8 | 8 | 1 | 44.5300 | 0.02796 | 1.2451 | 41.6 | 42.2 | 42.5 | 43.2 | 43.7 | 44.5 | 45.4 | 45.8 | 46.6 | 46.9 | 47.4 |
| 0: 9 | 9 | 1 | 44.9998 | 0.02792 | 1.2564 | 42.1 | 42.6 | 42.9 | 43.7 | 44.2 | 45.0 | 45.8 | 46.3 | 47.1 | 47.4 | 47.9 |
| 0:10 | 10 | 1 | 45.4051 | 0.02790 | 1.2668 | 42.5 | 43.0 | 43.3 | 44.1 | 44.6 | 45.4 | 46.3 | 46.7 | 47.5 | 47.8 | 48.4 |
| 0:11 | 11 | 1 | 45.7573 | 0.02789 | 1.2762 | 42.8 | 43.4 | 43.7 | 44.4 | 44.9 | 45.8 | 46.6 | 47.1 | 47.9 | 48.2 | 48.7 |
| 1: 0 | 12 | 1 | 46.0661 | 0.02789 | 1.2848 | 43.1 | 43.6 | 44.0 | 44.7 | 45.2 | 46.1 | 46.9 | 47.4 | 48.2 | 48.5 | 49.1 |
| 1: 1 | 13 | 1 | 46.3395 | 0.02789 | 1.2924 | 43.3 | 43.9 | 44.2 | 45.0 | 45.5 | 46.3 | 47.2 | 47.7 | 48.5 | 48.8 | 49.3 |
| 1: 2 | 14 | 1 | 46.5844 | 0.02791 | 1.3002 | 43.6 | 44.1 | 44.4 | 45.2 | 45.7 | 46.6 | 47.5 | 47.9 | 48.7 | 49.0 | 49.6 |
| 1: 3 | 15 | 1 | 46.8060 | 0.02792 | 1.3068 | 43.8 | 44.3 | 44.7 | 45.5 | 45.9 | 46.8 | 47.7 | 48.2 | 49.0 | 49.3 | 49.8 |
| 1: 4 | 16 | 1 | 47.0088 | 0.02795 | 1.3139 | 44.0 | 44.5 | 44.8 | 45.6 | 46.1 | 47.0 | 47.9 | 48.4 | 49.2 | 49.5 | 50.1 |
| 1: 5 | 17 | 1 | 47.1962 | 0.02797 | 1.3201 | 44.1 | 44.7 | 45.0 | 45.8 | 46.3 | 47.2 | 48.1 | 48.6 | 49.4 | 49.7 | 50.3 |
| 1: 6 | 18 | 1 | 47.3711 | 0.02800 | 1.3264 | 44.3 | 44.9 | 45.2 | 46.0 | 46.5 | 47.4 | 48.3 | 48.7 | 49.6 | 49.9 | 50.5 |
| 1: 7 | 19 | 1 | 47.5357 | 0.02803 | 1.3324 | 44.4 | 45.0 | 45.3 | 46.2 | 46.6 | 47.5 | 48.4 | 48.9 | 49.7 | 50.0 | 50.6 |
| 1: 8 | 20 | 1 | 47.6919 | 0.02806 | 1.3382 | 44.6 | 45.2 | 45.5 | 46.3 | 46.8 | 47.7 | 48.6 | 49.1 | 49.9 | 50.2 | 50.8 |
| 1: 9 | 21 | 1 | 47.8408 | 0.02810 | 1.3443 | 44.7 | 45.3 | 45.6 | 46.4 | 46.9 | 47.8 | 48.7 | 49.2 | 50.1 | 50.4 | 51.0 |
| 1:10 | 22 | 1 | 47.9833 | 0.02813 | 1.3498 | 44.8 | 45.4 | 45.8 | 46.6 | 47.1 | 48.0 | 48.9 | 49.4 | 50.2 | 50.5 | 51.1 |
| 1:11 | 23 | 1 | 48.1201 | 0.02817 | 1.3555 | 45.0 | 45.6 | 45.9 | 46.7 | 47.2 | 48.1 | 49.0 | 49.5 | 50.3 | 50.7 | 51.3 |
| 2: 0 | 24 | 1 | 48.2515 | 0.02821 | 1.3612 | 45.1 | 45.7 | 46.0 | 46.8 | 47.3 | 48.3 | 49.2 | 49.7 | 50.5 | 50.8 | 51.4 |

WHO Child Growth Standards



## Head circumference-for-age BOYS

Birth to 13 weeks (percentiles)

World Health Organization

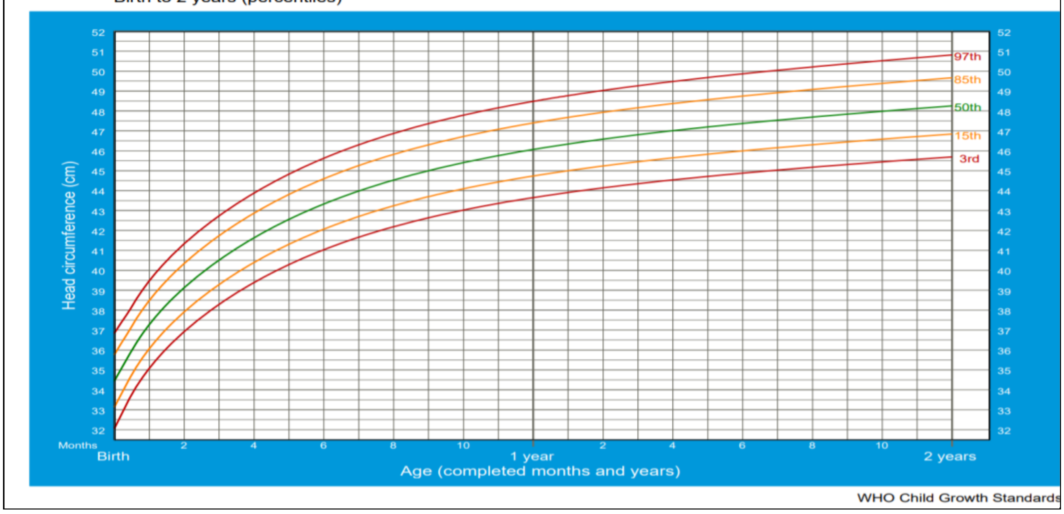
| | | | | | Percentiles (head circumference in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | L | M | S | SD | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| 0 | 1 | 34.4618 | 0.03686 | 1.2703 | 31.5 | 32.1 | 32.4 | 33.1 | 33.6 | 34.5 | 35.3 | 35.8 | 36.6 | 36.9 | 37.4 |
| 1 | 1 | 35.1634 | 0.03472 | 1.2209 | 32.3 | 32.9 | 33.2 | 33.9 | 34.3 | 35.2 | 36.0 | 36.4 | 37.2 | 37.5 | 38.0 |
| 2 | 1 | 35.8649 | 0.03258 | 1.1685 | 33.1 | 33.7 | 33.9 | 34.7 | 35.1 | 35.9 | 36.7 | 37.1 | 37.8 | 38.1 | 38.6 |
| 3 | 1 | 36.5216 | 0.03197 | 1.1676 | 33.8 | 34.3 | 34.6 | 35.3 | 35.7 | 36.5 | 37.3 | 37.7 | 38.4 | 38.7 | 39.2 |
| 4 | 1 | 37.0926 | 0.03148 | 1.1677 | 34.4 | 34.9 | 35.2 | 35.9 | 36.3 | 37.1 | 37.9 | 38.3 | 39.0 | 39.3 | 39.8 |
| 5 | 1 | 37.6010 | 0.03107 | 1.1683 | 34.9 | 35.4 | 35.7 | 36.4 | 36.8 | 37.6 | 38.4 | 38.8 | 39.5 | 39.8 | 40.3 |
| 6 | 1 | 38.0609 | 0.03072 | 1.1692 | 35.3 | 35.9 | 36.1 | 36.8 | 37.3 | 38.1 | 38.8 | 39.3 | 40.0 | 40.3 | 40.8 |
| 7 | 1 | 38.4824 | 0.03041 | 1.1703 | 35.8 | 36.3 | 36.6 | 37.3 | 37.7 | 38.5 | 39.3 | 39.7 | 40.4 | 40.7 | 41.2 |
| 8 | 1 | 38.8724 | 0.03014 | 1.1716 | 36.1 | 36.7 | 36.9 | 37.7 | 38.1 | 38.9 | 39.7 | 40.1 | 40.8 | 41.1 | 41.6 |
| 9 | 1 | 39.2368 | 0.02990 | 1.1732 | 36.5 | 37.0 | 37.3 | 38.0 | 38.4 | 39.2 | 40.0 | 40.5 | 41.2 | 41.4 | 42.0 |
| 10 | 1 | 39.5797 | 0.02969 | 1.1751 | 36.8 | 37.4 | 37.6 | 38.4 | 38.8 | 39.6 | 40.4 | 40.8 | 41.5 | 41.8 | 42.3 |
| 11 | 1 | 39.9033 | 0.02950 | 1.1772 | 37.2 | 37.7 | 38.0 | 38.7 | 39.1 | 39.9 | 40.7 | 41.1 | 41.8 | 42.1 | 42.6 |
| 12 | 1 | 40.2096 | 0.02933 | 1.1794 | 37.5 | 38.0 | 38.3 | 39.0 | 39.4 | 40.2 | 41.0 | 41.4 | 42.1 | 42.4 | 43.0 |
| 13 | 1 | 40.5008 | 0.02918 | 1.1818 | 37.8 | 38.3 | 38.6 | 39.3 | 39.7 | 40.5 | 41.3 | 41.7 | 42.4 | 42.7 | 43.3 |

WHO Child Growth Standards

## Head circumference-for-age BOYS

Birth to 2 years (percentiles)

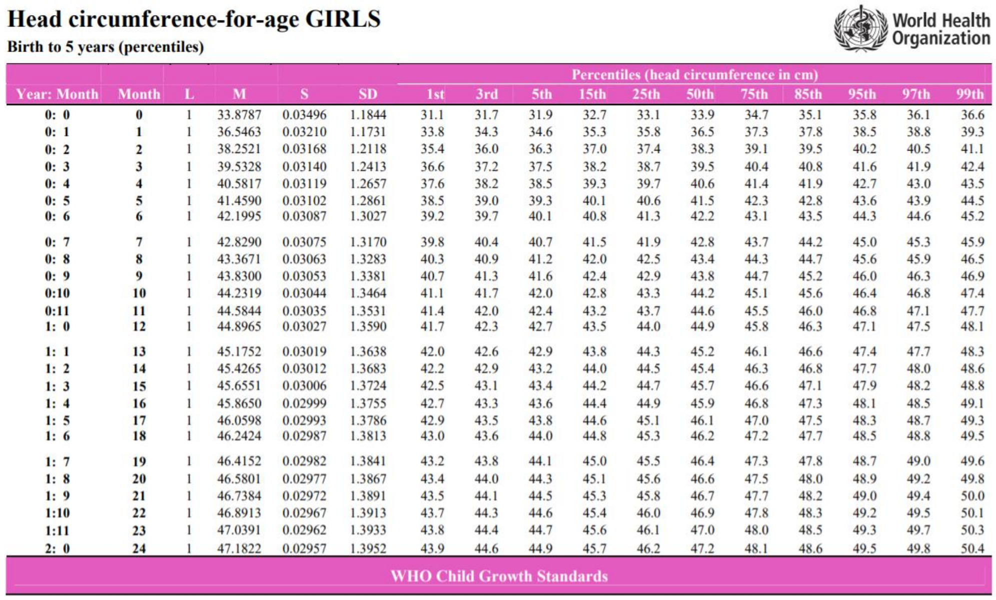
World Health Organization



WHO Child Growth Standards

APPENDIX 4

Table 5. Head circumference-for-age WHO growth standards for girls



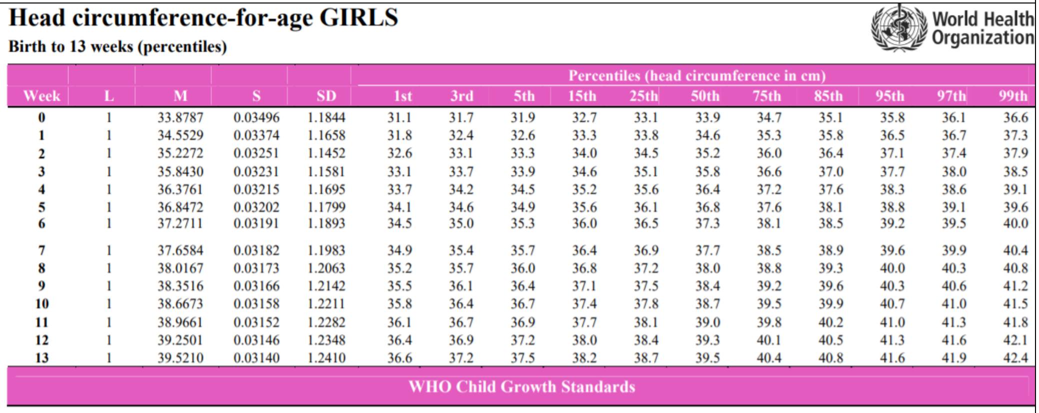
## Head circumference-for-age GIRLS

**Birth to 5 years (percentiles)**

World Health Organization

| | | | | | | Percentiles (head circumference in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year: Month | Month | L | M | S | SD | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| 0: 0 | 0 | 1 | 33.8787 | 0.03496 | 1.1844 | 31.1 | 31.7 | 31.9 | 32.7 | 33.1 | 33.9 | 34.7 | 35.1 | 35.8 | 36.1 | 36.6 |
| 0: 1 | 1 | 1 | 36.5463 | 0.03210 | 1.1731 | 33.8 | 34.3 | 34.6 | 35.3 | 35.8 | 36.5 | 37.3 | 37.8 | 38.5 | 38.8 | 39.3 |
| 0: 2 | 2 | 1 | 38.2521 | 0.03168 | 1.2118 | 35.4 | 36.0 | 36.3 | 37.0 | 37.4 | 38.3 | 39.1 | 39.5 | 40.2 | 40.5 | 41.1 |
| 0: 3 | 3 | 1 | 39.5328 | 0.03140 | 1.2413 | 36.6 | 37.2 | 37.5 | 38.2 | 38.7 | 39.5 | 40.4 | 40.8 | 41.6 | 41.9 | 42.4 |
| 0: 4 | 4 | 1 | 40.5817 | 0.03119 | 1.2657 | 37.6 | 38.2 | 38.5 | 39.3 | 39.7 | 40.6 | 41.4 | 41.9 | 42.7 | 43.0 | 43.5 |
| 0: 5 | 5 | 1 | 41.4590 | 0.03102 | 1.2861 | 38.5 | 39.0 | 39.3 | 40.1 | 40.6 | 41.5 | 42.3 | 42.8 | 43.6 | 43.9 | 44.5 |
| 0: 6 | 6 | 1 | 42.1995 | 0.03087 | 1.3027 | 39.2 | 39.7 | 40.1 | 40.8 | 41.3 | 42.2 | 43.1 | 43.5 | 44.3 | 44.6 | 45.2 |
| 0: 7 | 7 | 1 | 42.8290 | 0.03075 | 1.3170 | 39.8 | 40.4 | 40.7 | 41.5 | 41.9 | 42.8 | 43.7 | 44.2 | 45.0 | 45.3 | 45.9 |
| 0: 8 | 8 | 1 | 43.3671 | 0.03063 | 1.3283 | 40.3 | 40.9 | 41.2 | 42.0 | 42.5 | 43.4 | 44.3 | 44.7 | 45.6 | 45.9 | 46.5 |
| 0: 9 | 9 | 1 | 43.8300 | 0.03053 | 1.3381 | 40.7 | 41.3 | 41.6 | 42.4 | 42.9 | 43.8 | 44.7 | 45.2 | 46.0 | 46.3 | 46.9 |
| 0:10 | 10 | 1 | 44.2319 | 0.03044 | 1.3464 | 41.1 | 41.7 | 42.0 | 42.8 | 43.3 | 44.2 | 45.1 | 45.6 | 46.4 | 46.8 | 47.4 |
| 0:11 | 11 | 1 | 44.5844 | 0.03035 | 1.3531 | 41.4 | 42.0 | 42.4 | 43.2 | 43.7 | 44.6 | 45.5 | 46.0 | 46.8 | 47.1 | 47.7 |
| 1: 0 | 12 | 1 | 44.8965 | 0.03027 | 1.3590 | 41.7 | 42.3 | 42.7 | 43.5 | 44.0 | 44.9 | 45.8 | 46.3 | 47.1 | 47.5 | 48.1 |
| 1: 1 | 13 | 1 | 45.1752 | 0.03019 | 1.3638 | 42.0 | 42.6 | 42.9 | 43.8 | 44.3 | 45.2 | 46.1 | 46.6 | 47.4 | 47.7 | 48.3 |
| 1: 2 | 14 | 1 | 45.4265 | 0.03012 | 1.3683 | 42.2 | 42.9 | 43.2 | 44.0 | 44.5 | 45.4 | 46.3 | 46.8 | 47.7 | 48.0 | 48.6 |
| 1: 3 | 15 | 1 | 45.6551 | 0.03006 | 1.3724 | 42.5 | 43.1 | 43.4 | 44.2 | 44.7 | 45.7 | 46.6 | 47.1 | 47.9 | 48.2 | 48.8 |
| 1: 4 | 16 | 1 | 45.8650 | 0.02999 | 1.3755 | 42.7 | 43.3 | 43.6 | 44.4 | 44.9 | 45.9 | 46.8 | 47.3 | 48.1 | 48.5 | 49.1 |
| 1: 5 | 17 | 1 | 46.0598 | 0.02993 | 1.3786 | 42.9 | 43.5 | 43.8 | 44.6 | 45.1 | 46.1 | 47.0 | 47.5 | 48.3 | 48.7 | 49.3 |
| 1: 6 | 18 | 1 | 46.2424 | 0.02987 | 1.3813 | 43.0 | 43.6 | 44.0 | 44.8 | 45.3 | 46.2 | 47.2 | 47.7 | 48.5 | 48.8 | 49.5 |
| 1: 7 | 19 | 1 | 46.4152 | 0.02982 | 1.3841 | 43.2 | 43.8 | 44.1 | 45.0 | 45.5 | 46.4 | 47.3 | 47.8 | 48.7 | 49.0 | 49.6 |
| 1: 8 | 20 | 1 | 46.5801 | 0.02977 | 1.3867 | 43.4 | 44.0 | 44.3 | 45.1 | 45.6 | 46.6 | 47.5 | 48.0 | 48.9 | 49.2 | 49.8 |
| 1: 9 | 21 | 1 | 46.7384 | 0.02972 | 1.3891 | 43.5 | 44.1 | 44.5 | 45.3 | 45.8 | 46.7 | 47.7 | 48.2 | 49.0 | 49.4 | 50.0 |
| 1:10 | 22 | 1 | 46.8913 | 0.02967 | 1.3913 | 43.7 | 44.3 | 44.6 | 45.4 | 46.0 | 46.9 | 47.8 | 48.3 | 49.2 | 49.5 | 50.1 |
| 1:11 | 23 | 1 | 47.0391 | 0.02962 | 1.3933 | 43.8 | 44.4 | 44.7 | 45.6 | 46.1 | 47.0 | 48.0 | 48.5 | 49.3 | 49.7 | 50.3 |
| 2: 0 | 24 | 1 | 47.1822 | 0.02957 | 1.3952 | 43.9 | 44.6 | 44.9 | 45.7 | 46.2 | 47.2 | 48.1 | 48.6 | 49.5 | 49.8 | 50.4 |

WHO Child Growth Standards



## Head circumference-for-age GIRLS

**Birth to 13 weeks (percentiles)**

World Health Organization

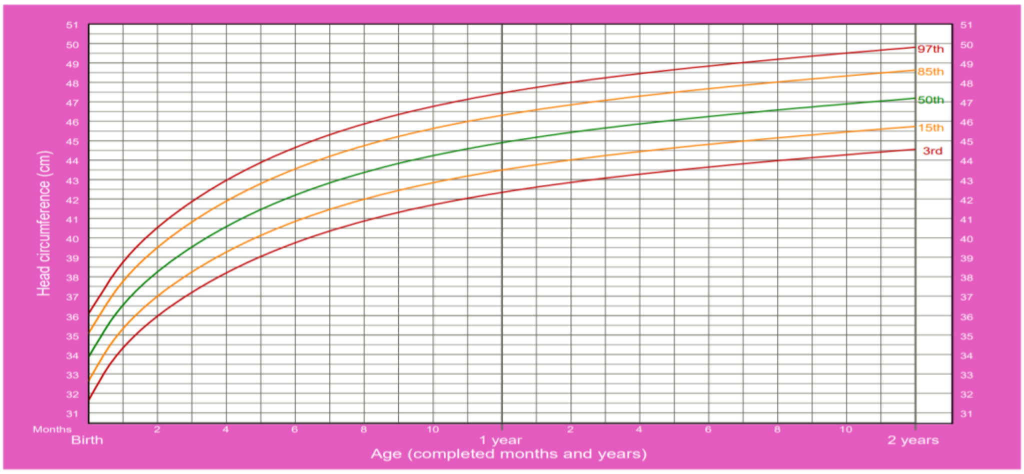
| | | | | | Percentiles (head circumference in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | L | M | S | SD | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| 0 | 1 | 33.8787 | 0.03496 | 1.1844 | 31.1 | 31.7 | 31.9 | 32.7 | 33.1 | 33.9 | 34.7 | 35.1 | 35.8 | 36.1 | 36.6 |
| 1 | 1 | 34.5529 | 0.03374 | 1.1658 | 31.8 | 32.4 | 32.6 | 33.3 | 33.8 | 34.6 | 35.3 | 35.8 | 36.5 | 36.7 | 37.3 |
| 2 | 1 | 35.2272 | 0.03251 | 1.1452 | 32.6 | 33.1 | 33.3 | 34.0 | 34.5 | 35.2 | 36.0 | 36.4 | 37.1 | 37.4 | 37.9 |
| 3 | 1 | 35.8430 | 0.03231 | 1.1581 | 33.1 | 33.7 | 33.9 | 34.6 | 35.1 | 35.8 | 36.6 | 37.0 | 37.7 | 38.0 | 38.5 |
| 4 | 1 | 36.3761 | 0.03215 | 1.1695 | 33.7 | 34.2 | 34.5 | 35.2 | 35.6 | 36.4 | 37.2 | 37.6 | 38.3 | 38.6 | 39.1 |
| 5 | 1 | 36.8472 | 0.03202 | 1.1799 | 34.1 | 34.6 | 34.9 | 35.6 | 36.1 | 36.8 | 37.6 | 38.1 | 38.8 | 39.1 | 39.6 |
| 6 | 1 | 37.2711 | 0.03191 | 1.1893 | 34.5 | 35.0 | 35.3 | 36.0 | 36.5 | 37.3 | 38.1 | 38.5 | 39.2 | 39.5 | 40.0 |
| 7 | 1 | 37.6584 | 0.03182 | 1.1983 | 34.9 | 35.4 | 35.7 | 36.4 | 36.9 | 37.7 | 38.5 | 38.9 | 39.6 | 39.9 | 40.4 |
| 8 | 1 | 38.0167 | 0.03173 | 1.2063 | 35.2 | 35.7 | 36.0 | 36.8 | 37.2 | 38.0 | 38.8 | 39.3 | 40.0 | 40.3 | 40.8 |
| 9 | 1 | 38.3516 | 0.03166 | 1.2142 | 35.5 | 36.1 | 36.4 | 37.1 | 37.5 | 38.4 | 39.2 | 39.6 | 40.3 | 40.6 | 41.2 |
| 10 | 1 | 38.6673 | 0.03158 | 1.2211 | 35.8 | 36.4 | 36.7 | 37.4 | 37.8 | 38.7 | 39.5 | 39.9 | 40.7 | 41.0 | 41.5 |
| 11 | 1 | 38.9661 | 0.03152 | 1.2282 | 36.1 | 36.7 | 36.9 | 37.7 | 38.1 | 39.0 | 39.8 | 40.2 | 41.0 | 41.3 | 41.8 |
| 12 | 1 | 39.2501 | 0.03146 | 1.2348 | 36.4 | 36.9 | 37.2 | 38.0 | 38.4 | 39.3 | 40.1 | 40.5 | 41.3 | 41.6 | 42.1 |
| 13 | 1 | 39.5210 | 0.03140 | 1.2410 | 36.6 | 37.2 | 37.5 | 38.2 | 38.7 | 39.5 | 40.4 | 40.8 | 41.6 | 41.9 | 42.4 |

WHO Child Growth Standards

## Head circumference-for-age GIRLS

Birth to 2 years (percentiles)

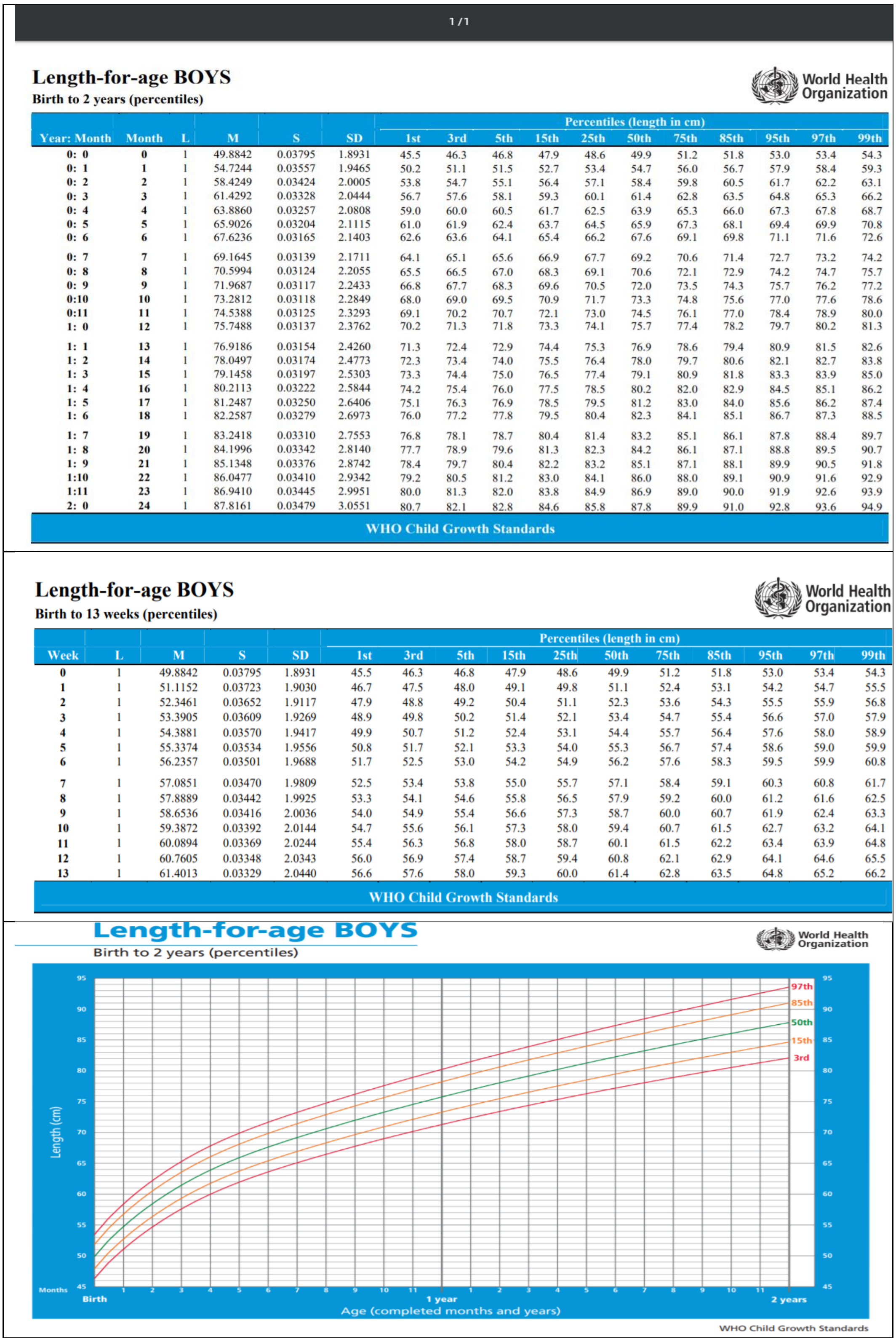
World Health Organization



WHO Child Growth Standards

APPENDIX 5

Table 6. Height-for-age WHO growth standards for boys



1 / 1

## Length-for-age BOYS

**Birth to 2 years (percentiles)**

World Health Organization

| | | | | | | Percentiles (length in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0: 0** | **0** | 1 | 49.8842 | 0.03795 | 1.8931 | 45.5 | 46.3 | 46.8 | 47.9 | 48.6 | 49.9 | 51.2 | 51.8 | 53.0 | 53.4 | 54.3 |
| **0: 1** | **1** | 1 | 54.7244 | 0.03557 | 1.9465 | 50.2 | 51.1 | 51.5 | 52.7 | 53.4 | 54.7 | 56.0 | 56.7 | 57.9 | 58.4 | 59.3 |
| **0: 2** | **2** | 1 | 58.4249 | 0.03424 | 2.0005 | 53.8 | 54.7 | 55.1 | 56.4 | 57.1 | 58.4 | 59.8 | 60.5 | 61.7 | 62.2 | 63.1 |
| **0: 3** | **3** | 1 | 61.4292 | 0.03328 | 2.0444 | 56.7 | 57.6 | 58.1 | 59.3 | 60.1 | 61.4 | 62.8 | 63.5 | 64.8 | 65.3 | 66.2 |
| **0: 4** | **4** | 1 | 63.8860 | 0.03257 | 2.0808 | 59.0 | 60.0 | 60.5 | 61.7 | 62.5 | 63.9 | 65.3 | 66.0 | 67.3 | 67.8 | 68.7 |
| **0: 5** | **5** | 1 | 65.9026 | 0.03204 | 2.1115 | 61.0 | 61.9 | 62.4 | 63.7 | 64.5 | 65.9 | 67.3 | 68.1 | 69.4 | 69.9 | 70.8 |
| **0: 6** | **6** | 1 | 67.6236 | 0.03165 | 2.1403 | 62.6 | 63.6 | 64.1 | 65.4 | 66.2 | 67.6 | 69.1 | 69.8 | 71.1 | 71.6 | 72.6 |
| **0: 7** | **7** | 1 | 69.1645 | 0.03139 | 2.1711 | 64.1 | 65.1 | 65.6 | 66.9 | 67.7 | 69.2 | 70.6 | 71.4 | 72.7 | 73.2 | 74.2 |
| **0: 8** | **8** | 1 | 70.5994 | 0.03124 | 2.2055 | 65.5 | 66.5 | 67.0 | 68.3 | 69.1 | 70.6 | 72.1 | 72.9 | 74.2 | 74.7 | 75.7 |
| **0: 9** | **9** | 1 | 71.9687 | 0.03117 | 2.2433 | 66.8 | 67.7 | 68.3 | 69.6 | 70.5 | 72.0 | 73.5 | 74.3 | 75.7 | 76.2 | 77.2 |
| **0:10** | **10** | 1 | 73.2812 | 0.03118 | 2.2849 | 68.0 | 69.0 | 69.5 | 70.9 | 71.7 | 73.3 | 74.8 | 75.6 | 77.0 | 77.6 | 78.6 |
| **0:11** | **11** | 1 | 74.5388 | 0.03125 | 2.3293 | 69.1 | 70.2 | 70.7 | 72.1 | 73.0 | 74.5 | 76.1 | 77.0 | 78.4 | 78.9 | 80.0 |
| **1: 0** | **12** | 1 | 75.7488 | 0.03137 | 2.3762 | 70.2 | 71.3 | 71.8 | 73.3 | 74.1 | 75.7 | 77.4 | 78.2 | 79.7 | 80.2 | 81.3 |
| **1: 1** | **13** | 1 | 76.9186 | 0.03154 | 2.4260 | 71.3 | 72.4 | 72.9 | 74.4 | 75.3 | 76.9 | 78.6 | 79.4 | 80.9 | 81.5 | 82.6 |
| **1: 2** | **14** | 1 | 78.0497 | 0.03174 | 2.4773 | 72.3 | 73.4 | 74.0 | 75.5 | 76.4 | 78.0 | 79.7 | 80.6 | 82.1 | 82.7 | 83.8 |
| **1: 3** | **15** | 1 | 79.1458 | 0.03197 | 2.5303 | 73.3 | 74.4 | 75.0 | 76.5 | 77.4 | 79.1 | 80.9 | 81.8 | 83.3 | 83.9 | 85.0 |
| **1: 4** | **16** | 1 | 80.2113 | 0.03222 | 2.5844 | 74.2 | 75.4 | 76.0 | 77.5 | 78.5 | 80.2 | 82.0 | 82.9 | 84.5 | 85.1 | 86.2 |
| **1: 5** | **17** | 1 | 81.2487 | 0.03250 | 2.6406 | 75.1 | 76.3 | 76.9 | 78.5 | 79.5 | 81.2 | 83.0 | 84.0 | 85.6 | 86.2 | 87.4 |
| **1: 6** | **18** | 1 | 82.2587 | 0.03279 | 2.6973 | 76.0 | 77.2 | 77.8 | 79.5 | 80.4 | 82.3 | 84.1 | 85.1 | 86.7 | 87.3 | 88.5 |
| **1: 7** | **19** | 1 | 83.2418 | 0.03310 | 2.7553 | 76.8 | 78.1 | 78.7 | 80.4 | 81.4 | 83.2 | 85.1 | 86.1 | 87.8 | 88.4 | 89.7 |
| **1: 8** | **20** | 1 | 84.1996 | 0.03342 | 2.8140 | 77.7 | 78.9 | 79.6 | 81.3 | 82.3 | 84.2 | 86.1 | 87.1 | 88.8 | 89.5 | 90.7 |
| **1: 9** | **21** | 1 | 85.1348 | 0.03376 | 2.8742 | 78.4 | 79.7 | 80.4 | 82.2 | 83.2 | 85.1 | 87.1 | 88.1 | 89.9 | 90.5 | 91.8 |
| **1:10** | **22** | 1 | 86.0477 | 0.03410 | 2.9342 | 79.2 | 80.5 | 81.2 | 83.0 | 84.1 | 86.0 | 88.0 | 89.1 | 90.9 | 91.6 | 92.9 |
| **1:11** | **23** | 1 | 86.9410 | 0.03445 | 2.9951 | 80.0 | 81.3 | 82.0 | 83.8 | 84.9 | 86.9 | 89.0 | 90.0 | 91.9 | 92.6 | 93.9 |
| **2: 0** | **24** | 1 | 87.8161 | 0.03479 | 3.0551 | 80.7 | 82.1 | 82.8 | 84.6 | 85.8 | 87.8 | 89.9 | 91.0 | 92.8 | 93.6 | 94.9 |

WHO Child Growth Standards

## Length-for-age BOYS

**Birth to 13 weeks (percentiles)**

World Health Organization

| | | | | | Percentiles (length in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0** | 1 | 49.8842 | 0.03795 | 1.8931 | 45.5 | 46.3 | 46.8 | 47.9 | 48.6 | 49.9 | 51.2 | 51.8 | 53.0 | 53.4 | 54.3 |
| **1** | 1 | 51.1152 | 0.03723 | 1.9030 | 46.7 | 47.5 | 48.0 | 49.1 | 49.8 | 51.1 | 52.4 | 53.1 | 54.2 | 54.7 | 55.5 |
| **2** | 1 | 52.3461 | 0.03652 | 1.9117 | 47.9 | 48.8 | 49.2 | 50.4 | 51.1 | 52.3 | 53.6 | 54.3 | 55.5 | 55.9 | 56.8 |
| **3** | 1 | 53.3905 | 0.03609 | 1.9269 | 48.9 | 49.8 | 50.2 | 51.4 | 52.1 | 53.4 | 54.7 | 55.4 | 56.6 | 57.0 | 57.9 |
| **4** | 1 | 54.3881 | 0.03570 | 1.9417 | 49.9 | 50.7 | 51.2 | 52.4 | 53.1 | 54.4 | 55.7 | 56.4 | 57.6 | 58.0 | 58.9 |
| **5** | 1 | 55.3374 | 0.03534 | 1.9556 | 50.8 | 51.7 | 52.1 | 53.3 | 54.0 | 55.3 | 56.7 | 57.4 | 58.6 | 59.0 | 59.9 |
| **6** | 1 | 56.2357 | 0.03501 | 1.9688 | 51.7 | 52.5 | 53.0 | 54.2 | 54.9 | 56.2 | 57.6 | 58.3 | 59.5 | 59.9 | 60.8 |
| **7** | 1 | 57.0851 | 0.03470 | 1.9809 | 52.5 | 53.4 | 53.8 | 55.0 | 55.7 | 57.1 | 58.4 | 59.1 | 60.3 | 60.8 | 61.7 |
| **8** | 1 | 57.8889 | 0.03442 | 1.9925 | 53.3 | 54.1 | 54.6 | 55.8 | 56.5 | 57.9 | 59.2 | 60.0 | 61.2 | 61.6 | 62.5 |
| **9** | 1 | 58.6536 | 0.03416 | 2.0036 | 54.0 | 54.9 | 55.4 | 56.6 | 57.3 | 58.7 | 60.0 | 60.7 | 61.9 | 62.4 | 63.3 |
| **10** | 1 | 59.3872 | 0.03392 | 2.0144 | 54.7 | 55.6 | 56.1 | 57.3 | 58.0 | 59.4 | 60.7 | 61.5 | 62.7 | 63.2 | 64.1 |
| **11** | 1 | 60.0894 | 0.03369 | 2.0244 | 55.4 | 56.3 | 56.8 | 58.0 | 58.7 | 60.1 | 61.5 | 62.2 | 63.4 | 63.9 | 64.8 |
| **12** | 1 | 60.7605 | 0.03348 | 2.0343 | 56.0 | 56.9 | 57.4 | 58.7 | 59.4 | 60.8 | 62.1 | 62.9 | 64.1 | 64.6 | 65.5 |
| **13** | 1 | 61.4013 | 0.03329 | 2.0440 | 56.6 | 57.6 | 58.0 | 59.3 | 60.0 | 61.4 | 62.8 | 63.5 | 64.8 | 65.2 | 66.2 |

WHO Child Growth Standards

## Length-for-age BOYS

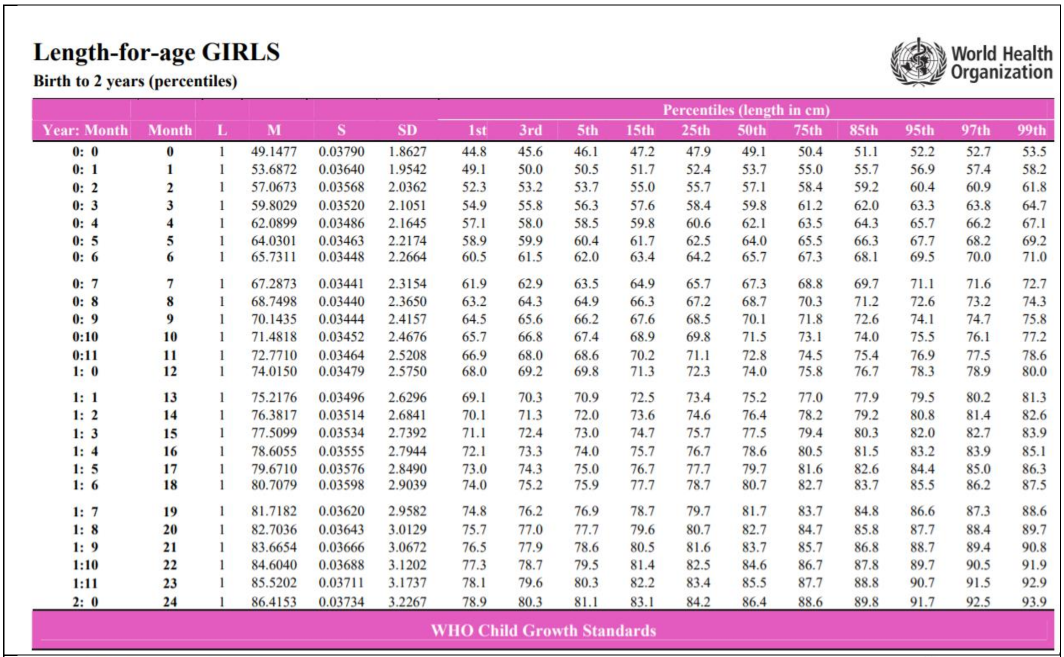
Birth to 2 years (percentiles)

World Health Organization

WHO Child Growth Standards

APPENDIX 6

Table 7. Height-for-age WHO growth standards for girls



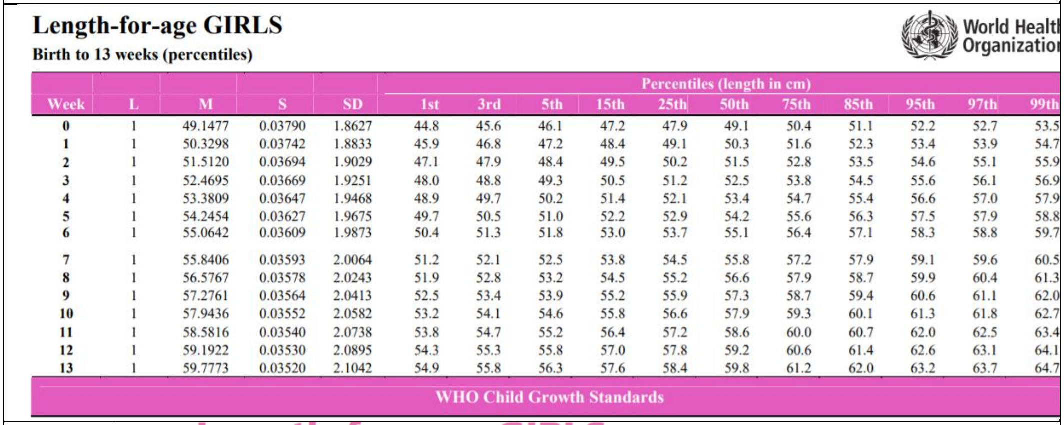
## Length-for-age GIRLS

**Birth to 2 years (percentiles)**

World Health Organization

| | | | | | | Percentiles (length in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0: 0** | **0** | 1 | 49.1477 | 0.03790 | 1.8627 | 44.8 | 45.6 | 46.1 | 47.2 | 47.9 | 49.1 | 50.4 | 51.1 | 52.2 | 52.7 | 53.5 |
| **0: 1** | **1** | 1 | 53.6872 | 0.03640 | 1.9542 | 49.1 | 50.0 | 50.5 | 51.7 | 52.4 | 53.7 | 55.0 | 55.7 | 56.9 | 57.4 | 58.2 |
| **0: 2** | **2** | 1 | 57.0673 | 0.03568 | 2.0362 | 52.3 | 53.2 | 53.7 | 55.0 | 55.7 | 57.1 | 58.4 | 59.2 | 60.4 | 60.9 | 61.8 |
| **0: 3** | **3** | 1 | 59.8029 | 0.03520 | 2.1051 | 54.9 | 55.8 | 56.3 | 57.6 | 58.4 | 59.8 | 61.2 | 62.0 | 63.3 | 63.8 | 64.7 |
| **0: 4** | **4** | 1 | 62.0899 | 0.03486 | 2.1645 | 57.1 | 58.0 | 58.5 | 59.8 | 60.6 | 62.1 | 63.5 | 64.3 | 65.7 | 66.2 | 67.1 |
| **0: 5** | **5** | 1 | 64.0301 | 0.03463 | 2.2174 | 58.9 | 59.9 | 60.4 | 61.7 | 62.5 | 64.0 | 65.5 | 66.3 | 67.7 | 68.2 | 69.2 |
| **0: 6** | **6** | 1 | 65.7311 | 0.03448 | 2.2664 | 60.5 | 61.5 | 62.0 | 63.4 | 64.2 | 65.7 | 67.3 | 68.1 | 69.5 | 70.0 | 71.0 |
| **0: 7** | **7** | 1 | 67.2873 | 0.03441 | 2.3154 | 61.9 | 62.9 | 63.5 | 64.9 | 65.7 | 67.3 | 68.8 | 69.7 | 71.1 | 71.6 | 72.7 |
| **0: 8** | **8** | 1 | 68.7498 | 0.03440 | 2.3650 | 63.2 | 64.3 | 64.9 | 66.3 | 67.2 | 68.7 | 70.3 | 71.2 | 72.6 | 73.2 | 74.3 |
| **0: 9** | **9** | 1 | 70.1435 | 0.03444 | 2.4157 | 64.5 | 65.6 | 66.2 | 67.6 | 68.5 | 70.1 | 71.8 | 72.6 | 74.1 | 74.7 | 75.8 |
| **0:10** | **10** | 1 | 71.4818 | 0.03452 | 2.4676 | 65.7 | 66.8 | 67.4 | 68.9 | 69.8 | 71.5 | 73.1 | 74.0 | 75.5 | 76.1 | 77.2 |
| **0:11** | **11** | 1 | 72.7710 | 0.03464 | 2.5208 | 66.9 | 68.0 | 68.6 | 70.2 | 71.1 | 72.8 | 74.5 | 75.4 | 76.9 | 77.5 | 78.6 |
| **1: 0** | **12** | 1 | 74.0150 | 0.03479 | 2.5750 | 68.0 | 69.2 | 69.8 | 71.3 | 72.3 | 74.0 | 75.8 | 76.7 | 78.3 | 78.9 | 80.0 |
| **1: 1** | **13** | 1 | 75.2176 | 0.03496 | 2.6296 | 69.1 | 70.3 | 70.9 | 72.5 | 73.4 | 75.2 | 77.0 | 77.9 | 79.5 | 80.2 | 81.3 |
| **1: 2** | **14** | 1 | 76.3817 | 0.03514 | 2.6841 | 70.1 | 71.3 | 72.0 | 73.6 | 74.6 | 76.4 | 78.2 | 79.2 | 80.8 | 81.4 | 82.6 |
| **1: 3** | **15** | 1 | 77.5099 | 0.03534 | 2.7392 | 71.1 | 72.4 | 73.0 | 74.7 | 75.7 | 77.5 | 79.4 | 80.3 | 82.0 | 82.7 | 83.9 |
| **1: 4** | **16** | 1 | 78.6055 | 0.03555 | 2.7944 | 72.1 | 73.3 | 74.0 | 75.7 | 76.7 | 78.6 | 80.5 | 81.5 | 83.2 | 83.9 | 85.1 |
| **1: 5** | **17** | 1 | 79.6710 | 0.03576 | 2.8490 | 73.0 | 74.3 | 75.0 | 76.7 | 77.7 | 79.7 | 81.6 | 82.6 | 84.4 | 85.0 | 86.3 |
| **1: 6** | **18** | 1 | 80.7079 | 0.03598 | 2.9039 | 74.0 | 75.2 | 75.9 | 77.7 | 78.7 | 80.7 | 82.7 | 83.7 | 85.5 | 86.2 | 87.5 |
| **1: 7** | **19** | 1 | 81.7182 | 0.03620 | 2.9582 | 74.8 | 76.2 | 76.9 | 78.7 | 79.7 | 81.7 | 83.7 | 84.8 | 86.6 | 87.3 | 88.6 |
| **1: 8** | **20** | 1 | 82.7036 | 0.03643 | 3.0129 | 75.7 | 77.0 | 77.7 | 79.6 | 80.7 | 82.7 | 84.7 | 85.8 | 87.7 | 88.4 | 89.7 |
| **1: 9** | **21** | 1 | 83.6654 | 0.03666 | 3.0672 | 76.5 | 77.9 | 78.6 | 80.5 | 81.6 | 83.7 | 85.7 | 86.8 | 88.7 | 89.4 | 90.8 |
| **1:10** | **22** | 1 | 84.6040 | 0.03688 | 3.1202 | 77.3 | 78.7 | 79.5 | 81.4 | 82.5 | 84.6 | 86.7 | 87.8 | 89.7 | 90.5 | 91.9 |
| **1:11** | **23** | 1 | 85.5202 | 0.03711 | 3.1737 | 78.1 | 79.6 | 80.3 | 82.2 | 83.4 | 85.5 | 87.7 | 88.8 | 90.7 | 91.5 | 92.9 |
| **2: 0** | **24** | 1 | 86.4153 | 0.03734 | 3.2267 | 78.9 | 80.3 | 81.1 | 83.1 | 84.2 | 86.4 | 88.6 | 89.8 | 91.7 | 92.5 | 93.9 |

WHO Child Growth Standards



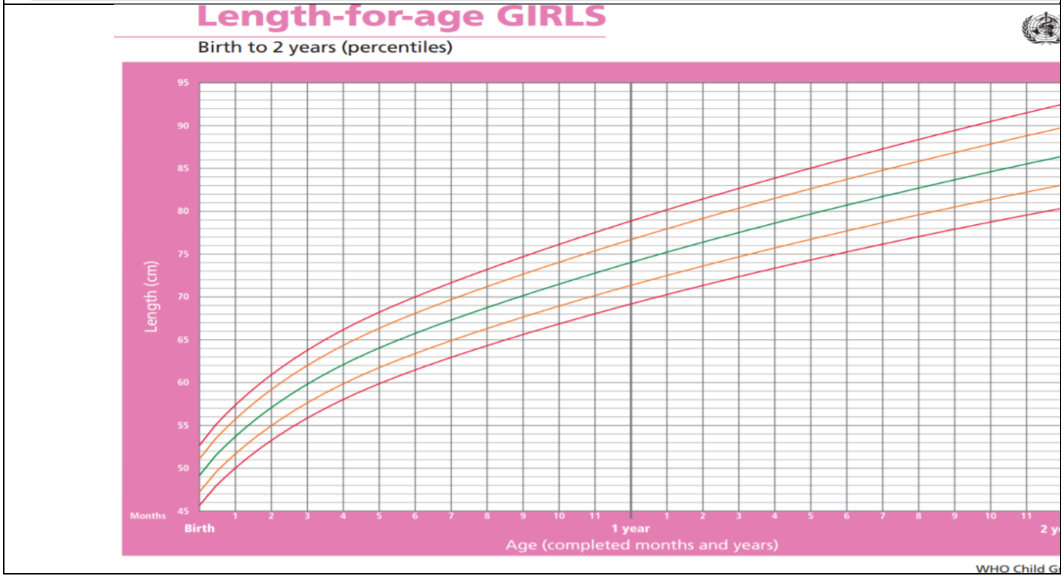
## Length-for-age GIRLS

**Birth to 13 weeks (percentiles)**

World Healt Organizatio

| | | | | | Percentiles (length in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0** | 1 | 49.1477 | 0.03790 | 1.8627 | 44.8 | 45.6 | 46.1 | 47.2 | 47.9 | 49.1 | 50.4 | 51.1 | 52.2 | 52.7 | 53.5 |
| **1** | 1 | 50.3298 | 0.03742 | 1.8833 | 45.9 | 46.8 | 47.2 | 48.4 | 49.1 | 50.3 | 51.6 | 52.3 | 53.4 | 53.9 | 54.7 |
| **2** | 1 | 51.5120 | 0.03694 | 1.9029 | 47.1 | 47.9 | 48.4 | 49.5 | 50.2 | 51.5 | 52.8 | 53.5 | 54.6 | 55.1 | 55.9 |
| **3** | 1 | 52.4695 | 0.03669 | 1.9251 | 48.0 | 48.8 | 49.3 | 50.5 | 51.2 | 52.5 | 53.8 | 54.5 | 55.6 | 56.1 | 56.9 |
| **4** | 1 | 53.3809 | 0.03647 | 1.9468 | 48.9 | 49.7 | 50.2 | 51.4 | 52.1 | 53.4 | 54.7 | 55.4 | 56.6 | 57.0 | 57.9 |
| **5** | 1 | 54.2454 | 0.03627 | 1.9675 | 49.7 | 50.5 | 51.0 | 52.2 | 52.9 | 54.2 | 55.6 | 56.3 | 57.5 | 57.9 | 58.8 |
| **6** | 1 | 55.0642 | 0.03609 | 1.9873 | 50.4 | 51.3 | 51.8 | 53.0 | 53.7 | 55.1 | 56.4 | 57.1 | 58.3 | 58.8 | 59.7 |
| **7** | 1 | 55.8406 | 0.03593 | 2.0064 | 51.2 | 52.1 | 52.5 | 53.8 | 54.5 | 55.8 | 57.2 | 57.9 | 59.1 | 59.6 | 60.5 |
| **8** | 1 | 56.5767 | 0.03578 | 2.0243 | 51.9 | 52.8 | 53.2 | 54.5 | 55.2 | 56.6 | 57.9 | 58.7 | 59.9 | 60.4 | 61.3 |
| **9** | 1 | 57.2761 | 0.03564 | 2.0413 | 52.5 | 53.4 | 53.9 | 55.2 | 55.9 | 57.3 | 58.7 | 59.4 | 60.6 | 61.1 | 62.0 |
| **10** | 1 | 57.9436 | 0.03552 | 2.0582 | 53.2 | 54.1 | 54.6 | 55.8 | 56.6 | 57.9 | 59.3 | 60.1 | 61.3 | 61.8 | 62.7 |
| **11** | 1 | 58.5816 | 0.03540 | 2.0738 | 53.8 | 54.7 | 55.2 | 56.4 | 57.2 | 58.6 | 60.0 | 60.7 | 62.0 | 62.5 | 63.4 |
| **12** | 1 | 59.1922 | 0.03530 | 2.0895 | 54.3 | 55.3 | 55.8 | 57.0 | 57.8 | 59.2 | 60.6 | 61.4 | 62.6 | 63.1 | 64.1 |
| **13** | 1 | 59.7773 | 0.03520 | 2.1042 | 54.9 | 55.8 | 56.3 | 57.6 | 58.4 | 59.8 | 61.2 | 62.0 | 63.2 | 63.7 | 64.7 |

WHO Child Growth Standards


Length-for-age GIRLS
Birth to 2 years (percentiles)
Length (cm)
Months
Birth
1 year
2 y
Age (completed months and years)
WHO Child G