THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

CONSECRATE THEM IN THE TRUTH

HEALTH AND FITNESS TRACKER APP

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INTRODUCTION

OVERVIEW

The **Health and Fitness Tracker** is an innovative mobile application designed to empower users to take control of their health and wellness journey. By integrating advanced tracking features, the app allows users to monitor their physical health and daily activities, such as step count, calorie intake, and exercise routines.

The app aims to simplify personal health management by offering a user-friendly interface and personalized insights. Users can set fitness goals, receive tailored workout and diet recommendations, and track their progress with detailed analytics. The tracker includes features like reminders, gamified, and community support to ensure user engagement to foster motivation.

RATIONALE

In today's world, maintaining a healthy lifestyle is challenging due to time constraints, bad habits, and a lack of accessible tools for self-monitoring. The rise of lifestyle-related health issues, such as obesity, stress, and poor sleep quality, outlines the need for user-friendly solutions that encourage good health management.

The Health and Fitness Tracker addresses these challenges by leveraging technology to make health monitoring convenient and effective. The app bridges the gap between individual health awareness and actionable steps. Its design aligns with the growing demand for health-focused tech solutions, empowering users to prioritize their well-being in an increasingly digital age.

OBJECTIVES

(i) **Promote Health Awareness:** Enable users to monitor their physical activity, and nutrition, to develop a greater awareness of their well-being.

(ii)**Encourage a Healthy Lifestyle:** Provide tools and resources to support users in establishing and maintaining healthy habits, such as regular exercise, balanced diets, and adequate rest.
(iii)**Personalize User Experience:** Offer tailored fitness plans, activity suggestions, and dietary recommendations based on user preferences, goals, and tracked health data.

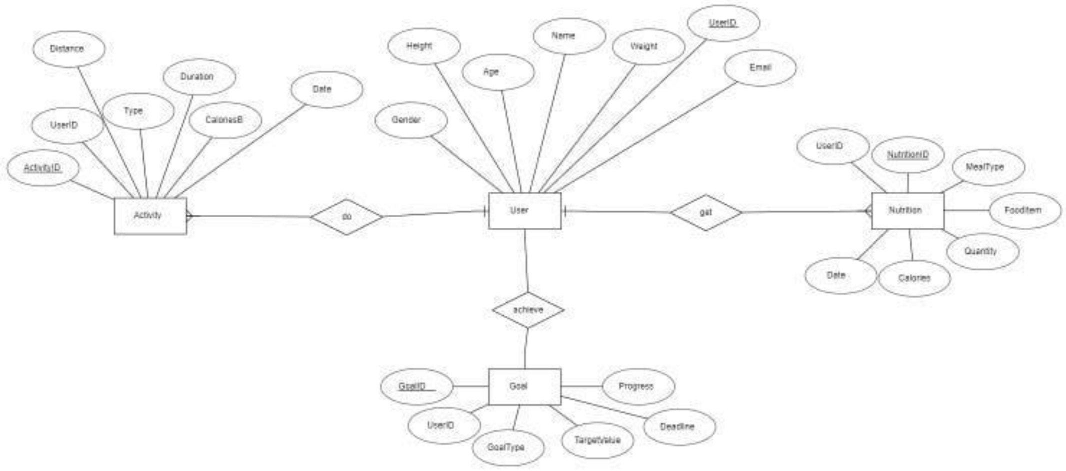
(iv)**Track (iv)Progress Over Time:** Deliver detailed reports and visualizations to help users monitor their progress toward fitness and health goals effectively.

(v)**Facilitate Accessibility:** Design a user-friendly interface that is accessible to individuals of varying fitness levels, ensuring inclusivity.

(vi)**Support Long-Term Health Goals:** Encourage sustainable practices by focusing on long-term health improvements rather than short-term results.

SYSTEM DESIGN

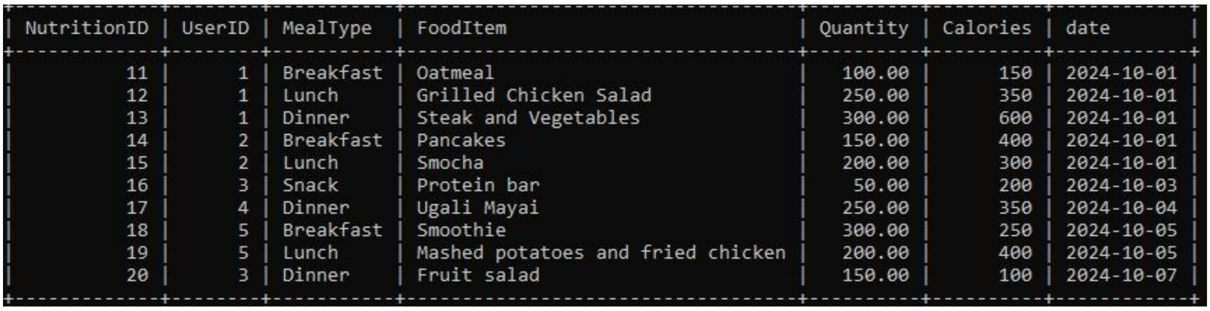
ER-DIAGRAM



The ER diagram for the health and fitness tracker app illustrates the entities, their attributes, and relationships that form the app's database structure. Key entities include User, Activity, Nutrition, and Goals. Relationships link users to their tracked data, such as recorded workouts, nutrition (e.g., meal type), and personalized goals. The diagram ensures a clear understanding of how user data is stored, retrieved, and analysed, forming the backbone of the app's functionality for tracking progress and providing actionable insights.

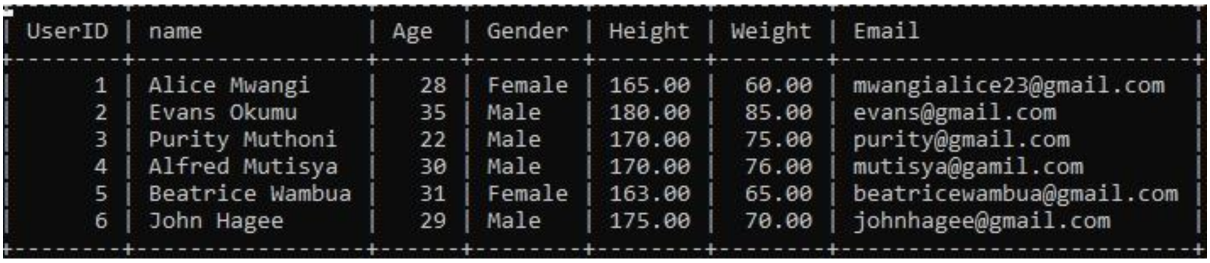
Table Structures

Nutrition table



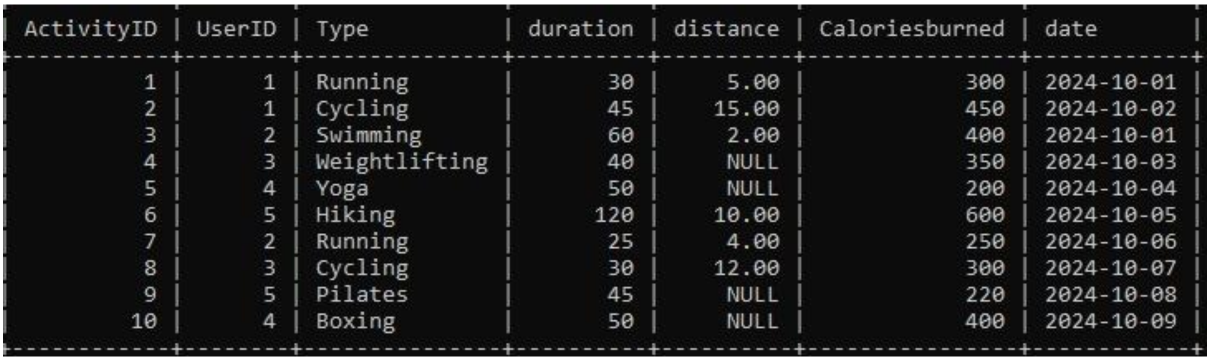
```
+-------------+--------+-----------+-----------------------------------+----------+----------+------------+
| NutritionID | UserID | MealType  | FoodItem                          | Quantity | Calories | date       |
+-------------+--------+-----------+-----------------------------------+----------+----------+------------+
|          11 |      1 | Breakfast | Oatmeal                           |   100.00 |      150 | 2024-10-01 |
|          12 |      1 | Lunch     | Grilled Chicken Salad             |   250.00 |      350 | 2024-10-01 |
|          13 |      1 | Dinner    | Steak and Vegetables              |   300.00 |      600 | 2024-10-01 |
|          14 |      2 | Breakfast | Pancakes                          |   150.00 |      400 | 2024-10-01 |
|          15 |      2 | Lunch     | Smocha                            |   200.00 |      300 | 2024-10-01 |
|          16 |      3 | Snack     | Protein bar                       |    50.00 |      200 | 2024-10-03 |
|          17 |      4 | Dinner    | Ugali Mayai                       |   250.00 |      350 | 2024-10-04 |
|          18 |      5 | Breakfast | Smoothie                          |   300.00 |      250 | 2024-10-05 |
|          19 |      5 | Lunch     | Mashed potatoes and fried chicken |   200.00 |      400 | 2024-10-05 |
|          20 |      3 | Dinner    | Fruit salad                       |   150.00 |      100 | 2024-10-07 |
+-------------+--------+-----------+-----------------------------------+----------+----------+------------+
```

Users table



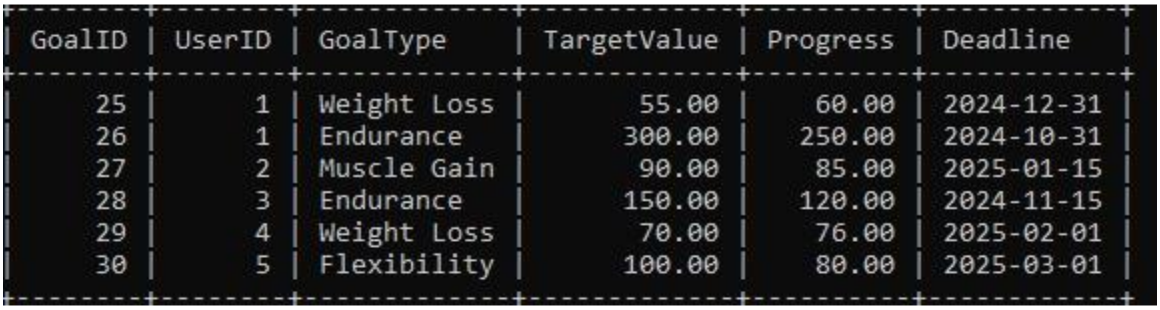
```
+--------+------------------+-----+--------+--------+--------+---------------------------+
| UserID | name             | Age | Gender | Height | Weight | Email                     |
+--------+------------------+-----+--------+--------+--------+---------------------------+
|      1 | Alice Mwangi     |  28 | Female | 165.00 |  60.00 | mwangialice23@gmail.com   |
|      2 | Evans Okumu      |  35 | Male   | 180.00 |  85.00 | evans@gmail.com           |
|      3 | Purity Muthoni   |  22 | Male   | 170.00 |  75.00 | purity@gmail.com          |
|      4 | Alfred Mutisya   |  30 | Male   | 170.00 |  76.00 | mutisya@gamil.com         |
|      5 | Beatrice Wambua  |  31 | Female | 163.00 |  65.00 | beatricewambua@gmail.com  |
|      6 | John Hagee       |  29 | Male   | 175.00 |  70.00 | johnhagee@gmail.com       |
+--------+------------------+-----+--------+--------+--------+---------------------------+
```

Activity table



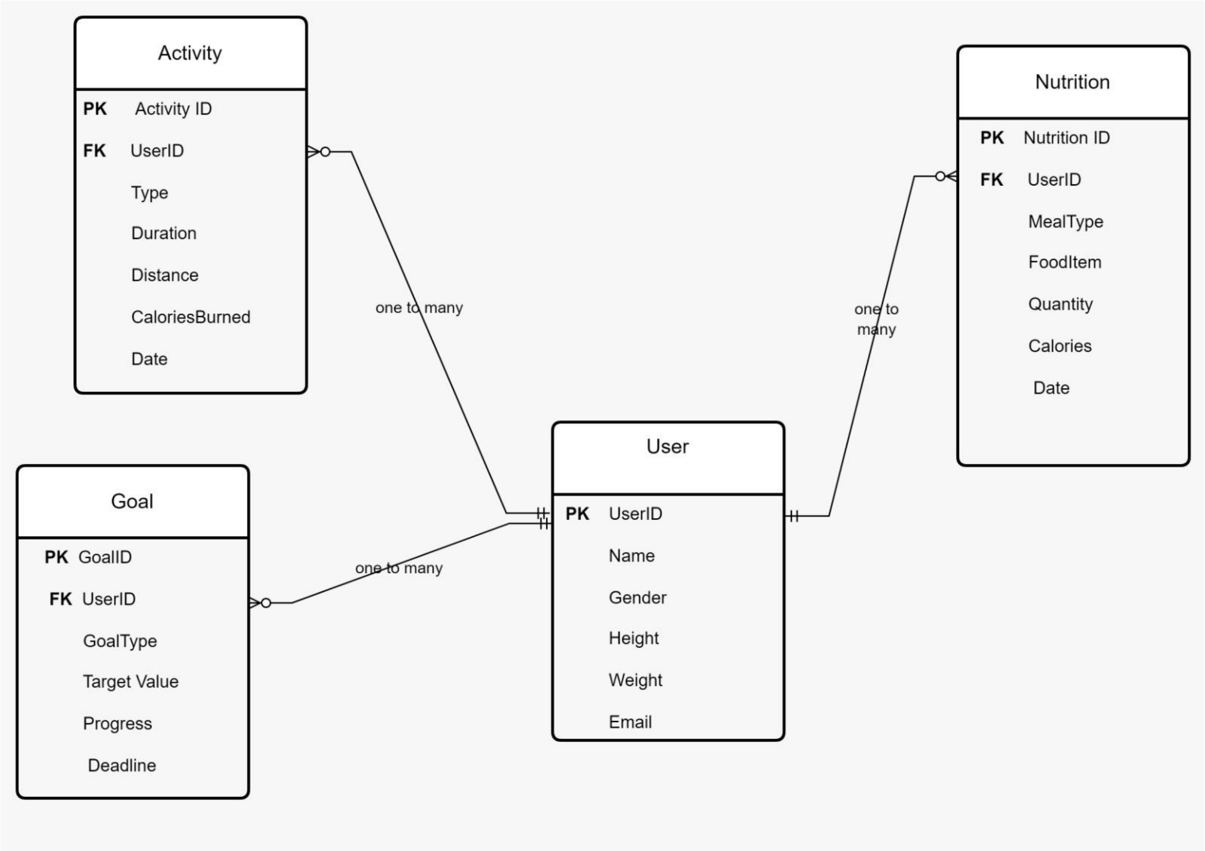
```
| ActivityID | UserID | Type          | duration | distance | Caloriesburned | date       |
+------------+--------+---------------+----------+----------+----------------+------------+
|          1 |      1 | Running       |       30 |     5.00 |            300 | 2024-10-01 |
|          2 |      1 | Cycling       |       45 |    15.00 |            450 | 2024-10-02 |
|          3 |      2 | Swimming      |       60 |     2.00 |            400 | 2024-10-01 |
|          4 |      3 | Weightlifting |       40 |     NULL |            350 | 2024-10-03 |
|          5 |      4 | Yoga          |       50 |     NULL |            200 | 2024-10-04 |
|          6 |      5 | Hiking        |      120 |    10.00 |            600 | 2024-10-05 |
|          7 |      2 | Running       |       25 |     4.00 |            250 | 2024-10-06 |
|          8 |      3 | Cycling       |       30 |    12.00 |            300 | 2024-10-07 |
|          9 |      5 | Pilates       |       45 |     NULL |            220 | 2024-10-08 |
|         10 |      4 | Boxing        |       50 |     NULL |            400 | 2024-10-09 |
+------------+--------+---------------+----------+----------+----------------+------------+
```

Goal table



```
+--------+--------+-------------+-------------+----------+------------+
| GoalID | UserID | GoalType    | TargetValue | Progress | Deadline   |
+--------+--------+-------------+-------------+----------+------------+
|     25 |      1 | Weight Loss |       55.00 |    60.00 | 2024-12-31 |
|     26 |      1 | Endurance   |      300.00 |   250.00 | 2024-10-31 |
|     27 |      2 | Muscle Gain |       90.00 |    85.00 | 2025-01-15 |
|     28 |      3 | Endurance   |      150.00 |   120.00 | 2024-11-15 |
|     29 |      4 | Weight Loss |       70.00 |    76.00 | 2025-02-01 |
|     30 |      5 | Flexibility |      100.00 |    80.00 | 2025-03-01 |
+--------+--------+-------------+-------------+----------+------------+
```

SQL SCHEMA



The **table structures for the Health and Fitness Tracker app** define the organization of data within its database. Key tables include:

1. **Users Table** – Defines user attributes such as user ID (primary key), name, age, gender, height, weight, and email.
2. **Activities Table** – Tracks fitness activities with fields for activity ID (primary key), user ID (foreign key) duration, calories burned, and distance.
3. **Nutrition Table** – Records nutrition ID (primary key), user ID (foreign key) meal types, food items, quantity, calories, and date.
4. **Goal Table** – Contains user-specific goals, including goal Id(primary key), user ID(foreign key) target value, progress, and deadline.

These tables are interconnected to ensure efficient data organization, normalization, and seamless relationships between tables

Implementation

Crud operations

CRUD Operations

```
-- 1. Create: Add a new user

INSERT INTO `user` (`name`, `Age`, `Gender`, `Height`, `Weight`, `Email`)

VALUES ('John Hagee', 29, 'Male', 175.00, 70.00, 'johnhagee@gmail.com');
```

```
-- 2. Read: Get all activities of a specific user
SELECT * FROM `activity` WHERE `UserID` = 1;


-- 3. Update: Update a user's email
UPDATE `user` SET `Email` = 'mwangialice23@gmail.com' WHERE `UserID` = 1;


-- 4. Delete: Remove an activity
DELETE FROM `activity` WHERE `ActivityID` = 1;
```

Explanation

The SQL queries above demonstrate basic CRUD (Create, Read, Update, Delete) operations essential for managing the backend of the Health and Fitness Tracker app:

1. **Create**:

The `INSERT INTO` query adds a new user, John Hagee, to the `user` table. It includes personal details such as name, age, gender, height, weight, and email address.

2. **Read**

The `SELECT` query retrieves all activities for a specific user, identified by their `UserID` (e.g., `UserID = 1`). This fetches relevant data from the `activity` table, such as workout types, durations, or timestamps.

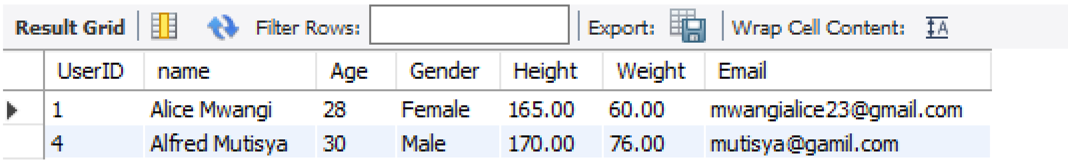
3. **Update**:

The `UPDATE` query modifies the email address of a user in the `user` table, targeting the record where `UserID = 1`. It replaces the existing email with a new one, ensuring user information remains current.

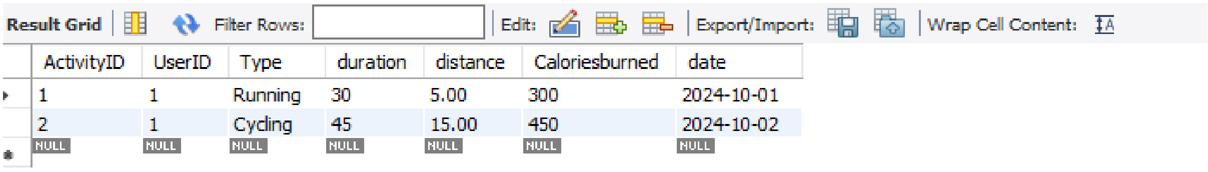
4**. Delete**

The `DELETE` query removes a specific activity from the `activity` table, identified by its `ActivityID` (e.g., `ActivityID = 1`). This operation helps manage and clean outdated or unnecessary records.

These queries showcase the core database operations required for efficient backend functionality, enabling the app to manage user and activity data seamlessly.



UserID	name	Age	Gender	Height	Weight	Email
1	Alice Mwangi	28	Female	165.00	60.00	mwangialice23@gmail.com
4	Alfred Mutisya	30	Male	170.00	76.00	mutisya@gamil.com



ActivityID	UserID	Type	duration	distance	Caloriesburned	date
1	1	Running	30	5.00	300	2024-10-01
2	1	Cycling	45	15.00	450	2024-10-02
NULL	NULL	NULL	NULL	NULL	NULL	NULL

Advanced SQL queries

```
-- Advanced Query: Users consuming more calories than burning

WITH CaloriesConsumed AS (

  SELECT UserID, SUM(Calories) AS TotalIntake FROM nutrition GROUP BY UserID

),

CaloriesBurned AS (

  SELECT UserID, SUM(Caloriesburned) AS TotalBurned FROM activity GROUP BY UserID

)

SELECT

  c.UserID,

  c.TotalIntake,

  b.TotalBurned

FROM CaloriesConsumed c

LEFT JOIN CaloriesBurned b ON c.UserID = b.UserID

WHERE c.TotalIntake > b.TotalBurned;
```

Explanation

The SQL query identifies users whose calorie intake exceeds their calories burned using **Common Table Expressions (CTEs)** and a final comparison.

Step 1: Calories Consumed (**CaloriesConsumed** CTE)

```
SELECT

  c.UserID,

  c.TotalIntake,

  b.TotalBurned

FROM CaloriesConsumed c

LEFT JOIN CaloriesBurned b ON c.UserID = b.UserID

WHERE c.TotalIntake > b.TotalBurned;
```

The explanation for the code above is :

UserID: Identifies each user uniquely.

SUM(Calories): Adds up all the calories consumed by the user.

GROUP BY UserID: Ensures the total is calculated for each user separately.

Step 2: Calories Burned (**CaloriesBurned** CTE)

This CTE computes the total calories burned by each user based on the `activity` table:

```
CaloriesBurned AS (

  SELECT UserID, SUM(Caloriesburned) AS TotalBurned FROM activity GROUP BY UserID

)
```

SUM(Caloriesburned): Adds up all the calories burned by the user during recorded activities.

Similar to the first CTE, the total is calculated for each user by grouping results by UserID.

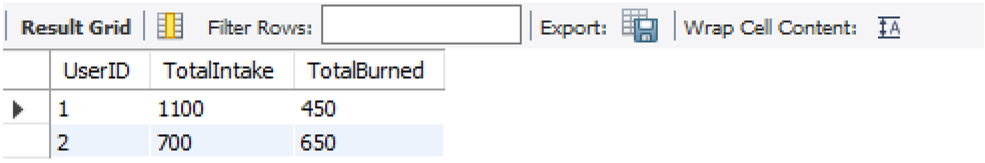
Step 3: Combine and Filter Results

The main query combines the two CTEs to compare calorie intake with calories burned:

```
SELECT

  c.UserID,

  c.TotalIntake,

  b.TotalBurned
```

```
FROM CaloriesConsumed c
LEFT JOIN CaloriesBurned b ON c.UserID = b.UserID
WHERE c.TotalIntake > b.TotalBurned;
```

LEFT JOIN: Merges data from CaloriesConsumed and CaloriesBurned, ensuring that all users from CaloriesConsumed are included, even if they have no activities logged in CaloriesBurned.
WHERE c.TotalIntake > b.TotalBurned: Filters the results to show only users whose total calorie intake exceeds the total calories they burned.



UserID	TotalIntake	TotalBurned
1	1100	450
2	700	650

TESTING AND VALIDATION

The **backend testing** of the Health and Fitness Tracker application focused on ensuring database integrity, and accurate data processing. The testing process was conducted in stages, including unit testing, integration testing, and performance testing.

Unit Testing:

(i)Verified CRUD operations for each table (Users, Activities, Nutrition, Goals,).

(ii) Ensured constraints (e.g., primary and foreign keys, data types, null checks) functioned correctly.

Integration Testing:

(i)Assessed the relationships between tables to confirm correct joins and foreign key dependencies.

(ii)Tested for retrieving, updating, and deleting user data, ensuring proper interaction with the database.

iii)Validated error handling for invalid inputs, duplicate data, or broken relationships.

Performance Testing:

(i)Evaluated query execution times to ensure the backend handles large datasets efficiently.

(ii)Simulated concurrent user requests to test database performance under high load.

Results:

> (i)All CRUD operations executed successfully, with appropriate data validations and constraints enforced.
>
> (ii)Database queries performed well under simulated load, maintaining consistent response times.
>
> (iii)No issues were found with table relationships or data integrity, ensuring the backend is robust and scalable.

These results demonstrate that the backend infrastructure is reliable, optimized, and ready to support the app's front-end development.

Conclusion and Recommendations

Conclusion:
The backend development of the Health and Fitness Tracker app successfully established a robust database and API to support the application's core functionality. Comprehensive testing ensured data integrity, reliable CRUD operations, and efficient performance under simulated load conditions. The current structure provides a strong foundation for storing, retrieving, and managing user health and fitness data while supporting scalability for future needs.

Recommendations for Future Improvements:

Advanced Analytics Integration: Incorporate machine learning algorithms for predictive analytics, such as forecasting user progress and recommending personalized health plans based on trends.

Enhanced Data Security: Implement advanced encryption protocols and role-based access controls to safeguard sensitive health data, ensuring compliance with data privacy regulations like GDPR or HIPAA.

Scalability Features: Upgrade the backend to handle increased user traffic and larger datasets as the app's user base grows. Database partitioning or cloud-based solutions like AWS RDS could be explored.

API Optimization: Refine API endpoints to reduce latency further, using techniques such as caching and pagination for large data sets.

Integration with Wearables: Extend compatibility to sync data from fitness devices like smartwatches, enabling real-time data updates and enriched user experiences.

By incorporating these enhancements, the Health and Fitness Tracker can evolve into a comprehensive health management platform, staying competitive and meeting the dynamic needs of users.

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