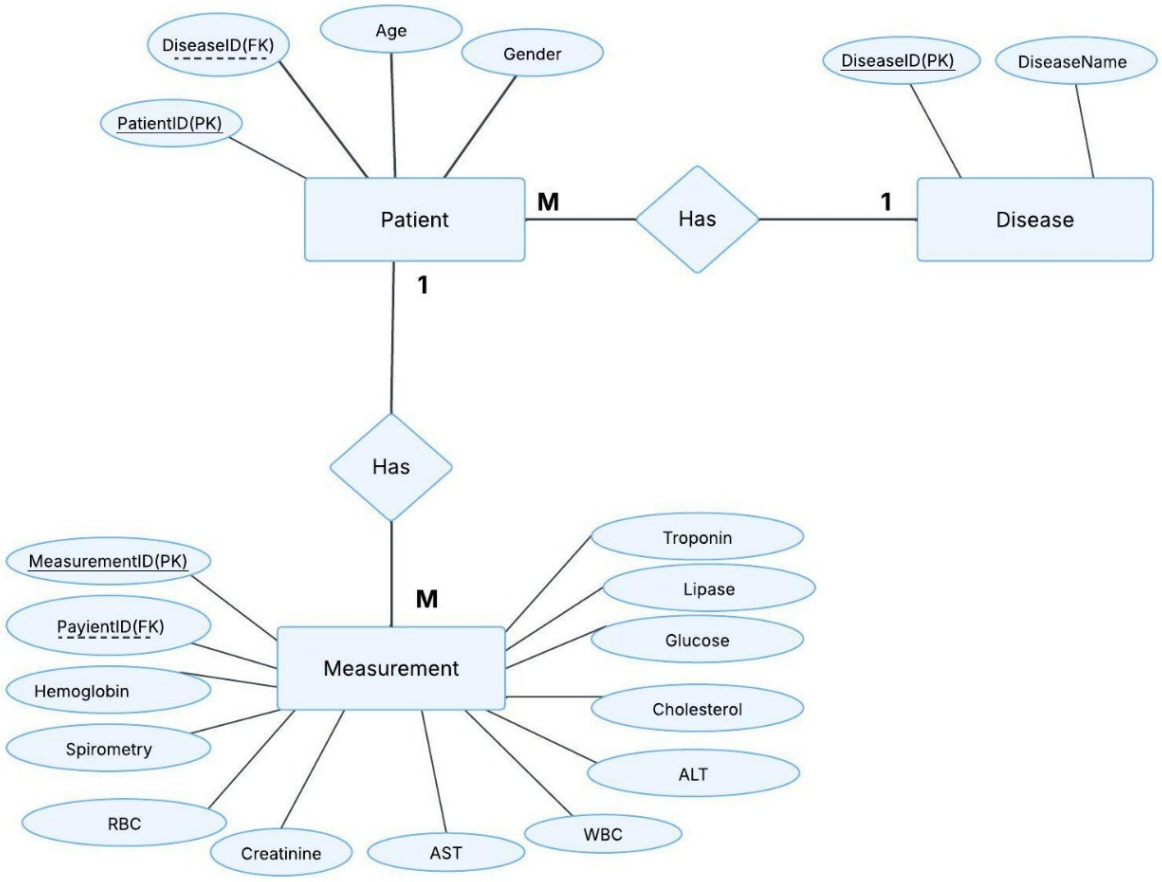
Data warehouse final project

DB source name: laboratory__data

Team members:

- Rawan Elsayed Hisham 42110142 (42110142.Rawan@acu.edu.eg)
- Salma Abdrabo Abdelbary 42110089
- Omar Esam Shokry 42110192
- Yassa khalil naguip 42110348
- Mustafa Safwat 42110304
- Abdelwahab Ashraf 42110375

Source ERD:

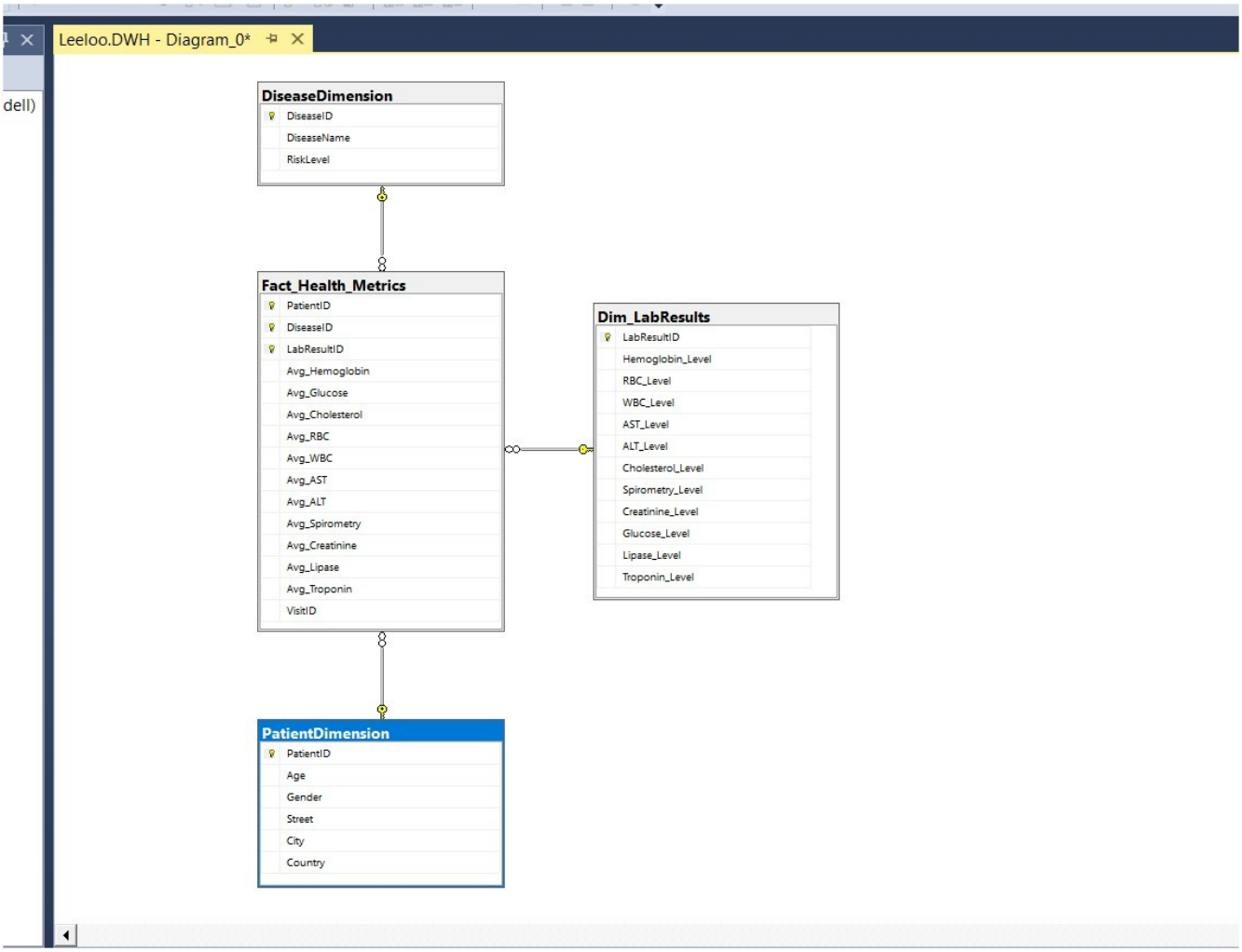


Motivation:

We are creating the Patient Health **Star Schema** & **Snowflake Schema** to analyze average medical measurements (such as Hemoglobin, Glucose, and Cholesterol) across patient demographics (Gender and Age), diseases (e.g., Anemia, Asthma), and raw measurement values. This will enable healthcare professionals to identify health trends, detect patterns in medical conditions, and assess risk factors for specific diseases, ultimately supporting better diagnosis and treatment decisions.

Star schema

Star schema model:



Schema description:

Fact Table (`Fact_Health_Metrics`)

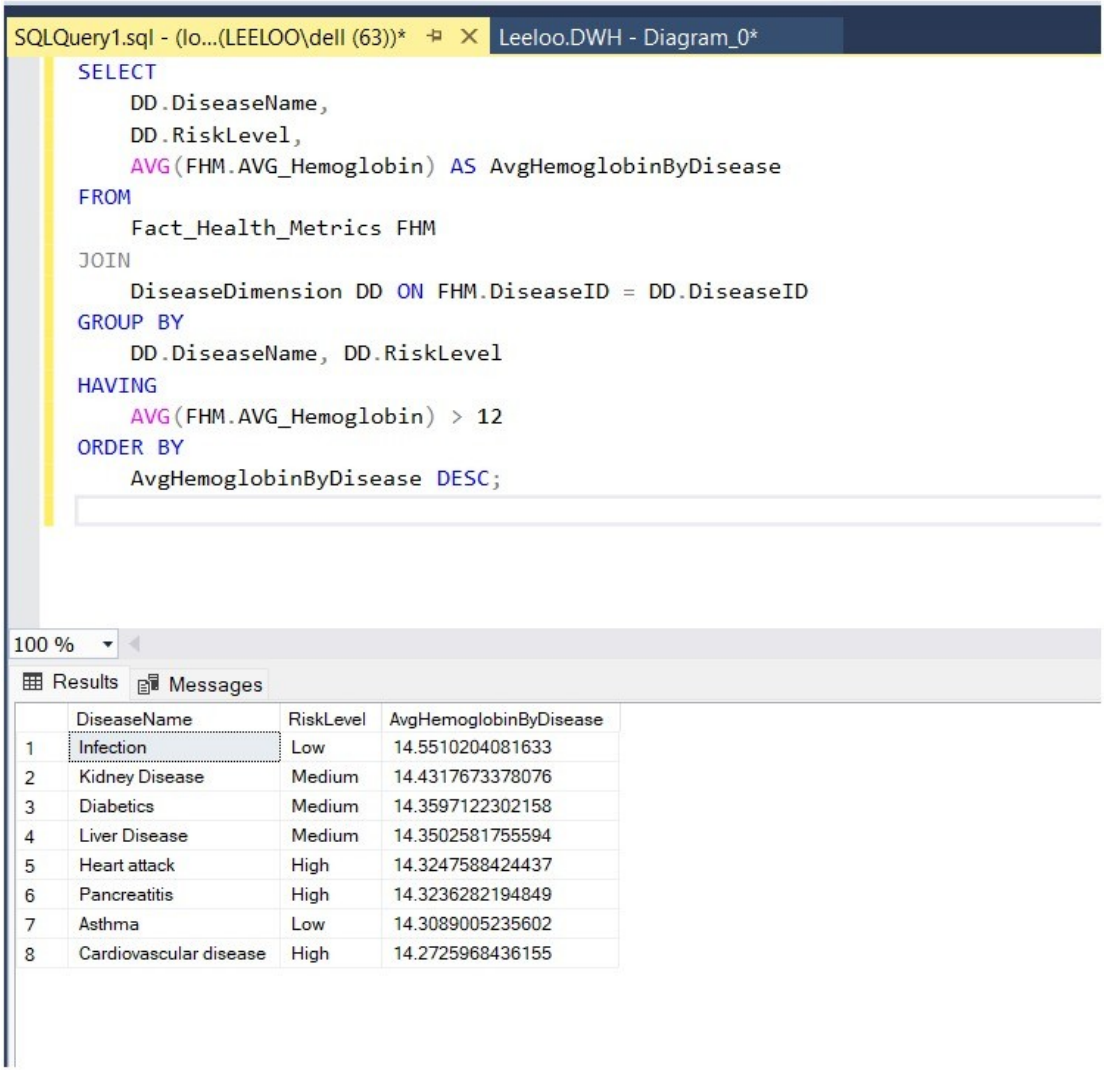
- Contains aggregated health metrics (averages of lab results) for patients.
- Foreign keys:
  - `PatientID` (links to `PatientDimension`)
  - `DiseaseID` (links to `DiseaseDimension`)
  - `LabResultID` (links to `Dim_LabResults`)
- Metrics include averages for hemoglobin, glucose, cholesterol, RBC, WBC, AST, ALT, spirometry, creatinine, lipase, and troponin.

2. **Dimension Tables:**
   - **`DiseaseDimension`**
     - Stores disease-related data (`DiseaseID`, `DiseaseName`, `RiskLevel`).

- **`Dim_LabResults`**
  - Contains raw lab test results (e.g., hemoglobin level, glucose level, cholesterol level).
- **`PatientDimension`**
  - Holds patient demographics (`PatientID`, `Age`, `Gender`, `Street`, `City`, `Country`).

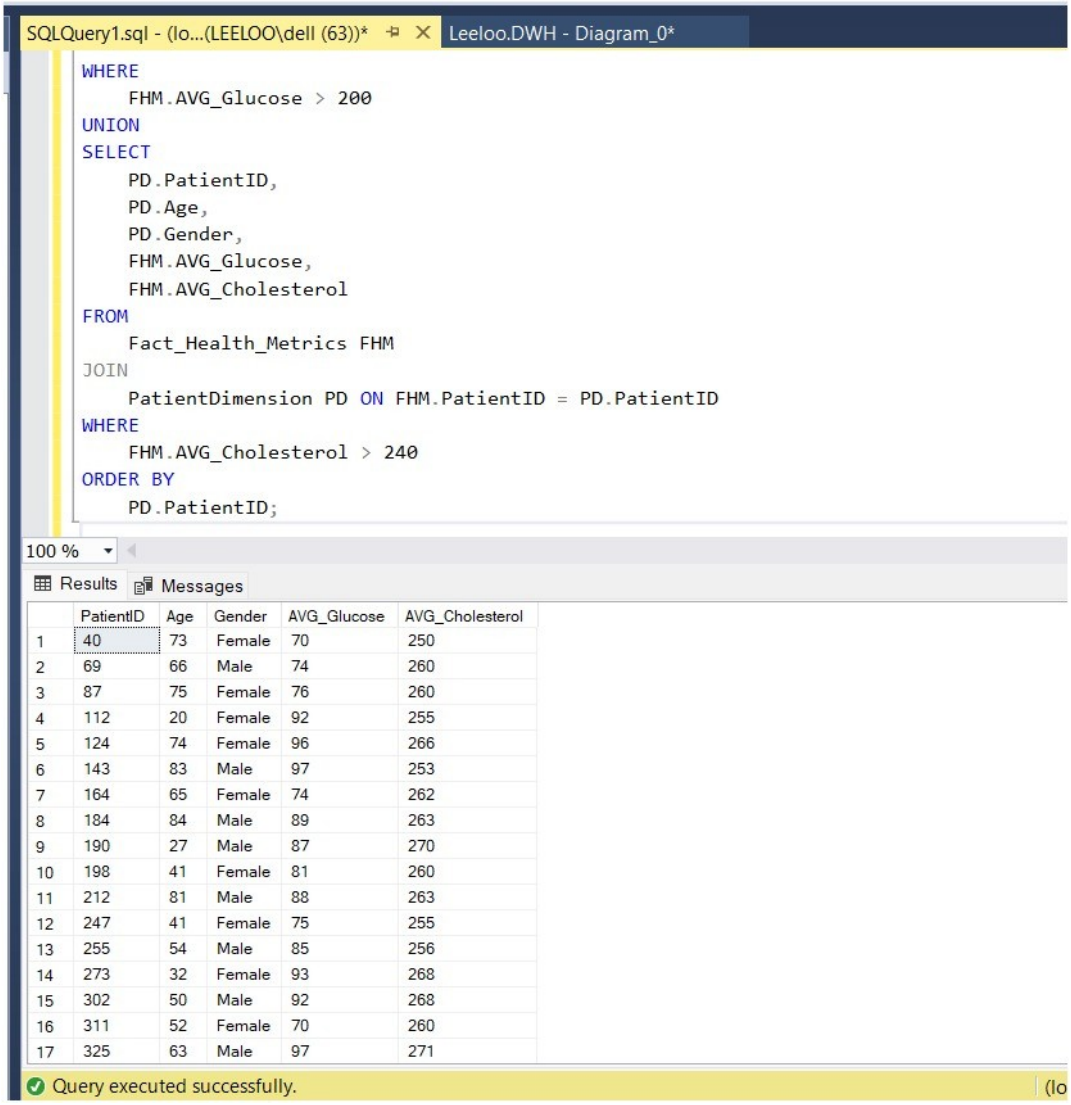
Transformation process queries:

Query 1: Average Hemoglobin by Disease Risk Level



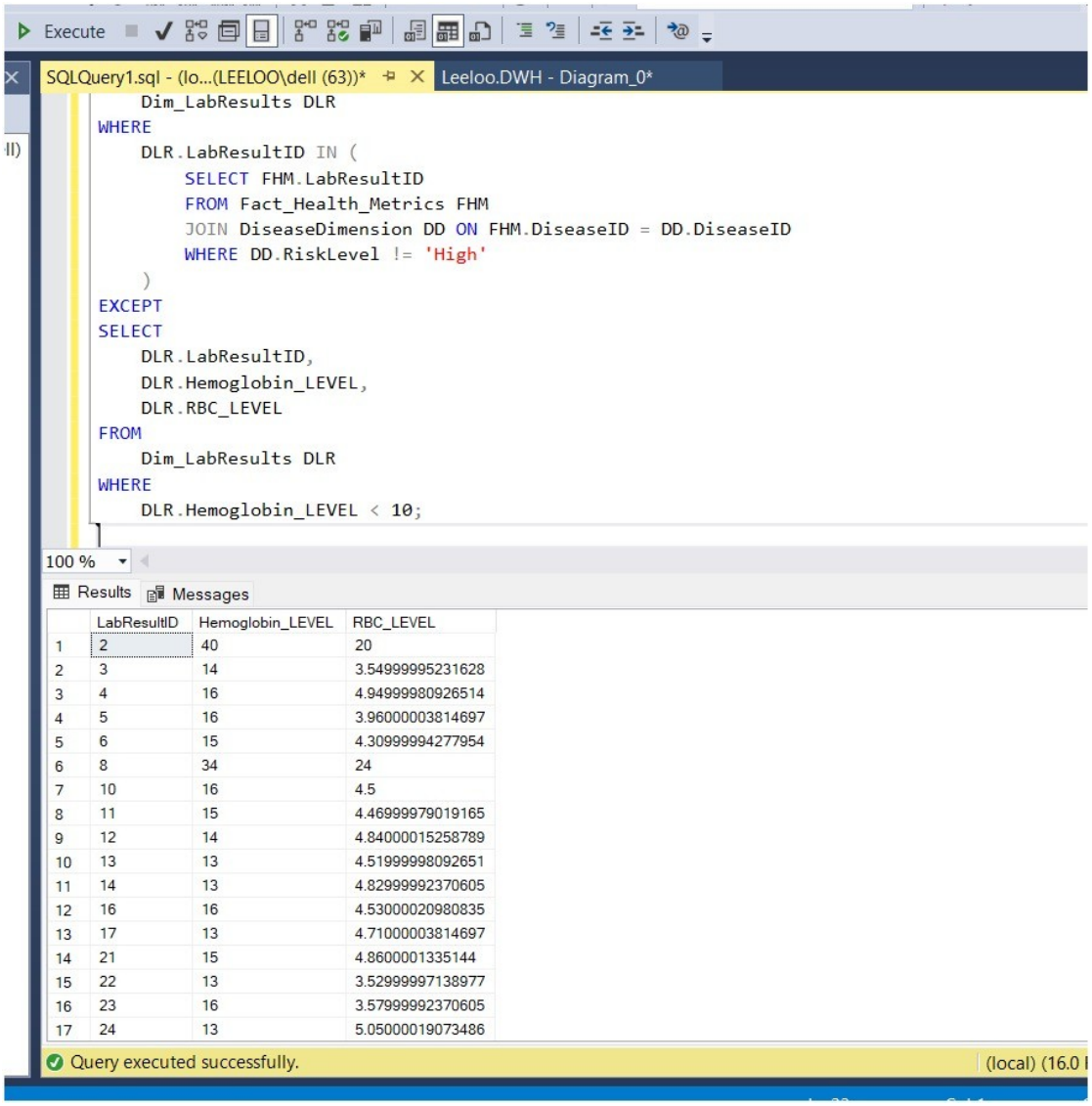
	DiseaseName	RiskLevel	AvgHemoglobinByDisease
1	Infection	Low	14.5510204081633
2	Kidney Disease	Medium	14.4317673378076
3	Diabetics	Medium	14.3597122302158
4	Liver Disease	Medium	14.3502581755594
5	Heart attack	High	14.3247588424437
6	Pancreatitis	High	14.3236282194849
7	Asthma	Low	14.3089005235602
8	Cardiovascular disease	High	14.2725968436155

Query 2: Patients with High Glucose or High Cholesterol



	PatientID	Age	Gender	AVG_Glucose	AVG_Cholesterol
1	40	73	Female	70	250
2	69	66	Male	74	260
3	87	75	Female	76	260
4	112	20	Female	92	255
5	124	74	Female	96	266
6	143	83	Male	97	253
7	164	65	Female	74	262
8	184	84	Male	89	263
9	190	27	Male	87	270
10	198	41	Female	81	260
11	212	81	Male	88	263
12	247	41	Female	75	255
13	255	54	Male	85	256
14	273	32	Female	93	268
15	302	50	Male	92	268
16	311	52	Female	70	260
17	325	63	Male	97	271

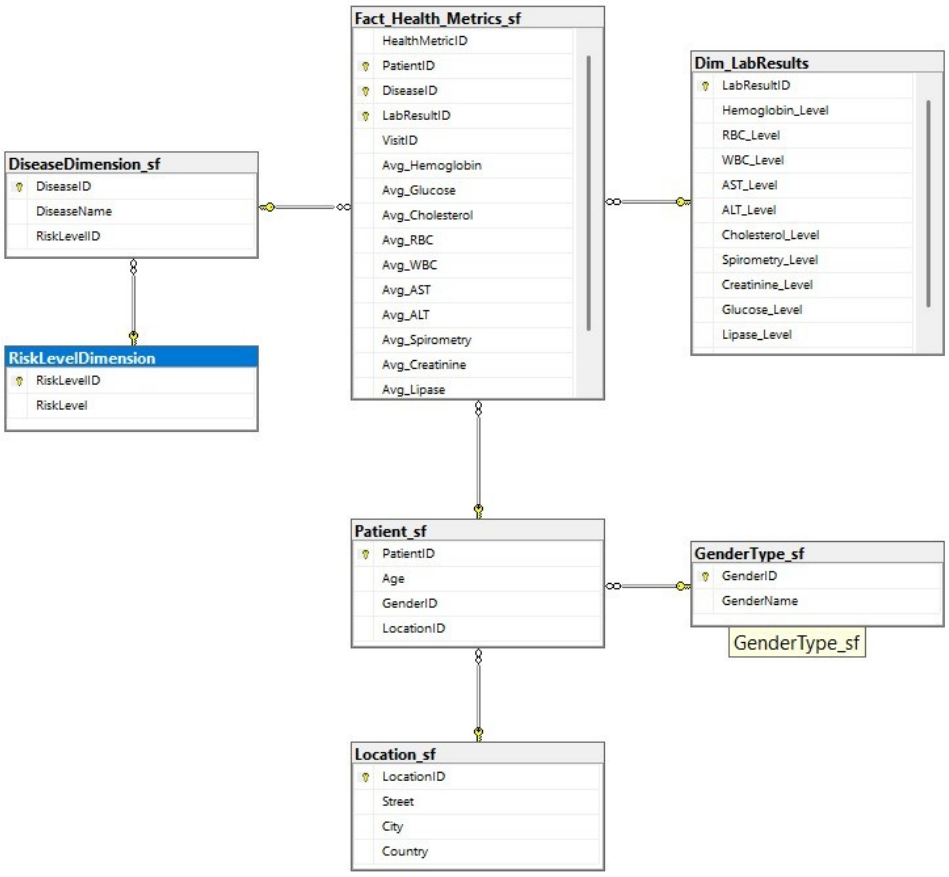
Query 3: Lab Results Not Associated with High Risk Diseases



	LabResultID	Hemoglobin_LEVEL	RBC_LEVEL
1	2	40	20
2	3	14	3.54999995231628
3	4	16	4.94999980926514
4	5	16	3.96000003814697
5	6	15	4.30999994277954
6	8	34	24
7	10	16	4.5
8	11	15	4.46999979019165
9	12	14	4.84000015258789
10	13	13	4.51999998092651
11	14	13	4.82999992370605
12	16	16	4.53000020980835
13	17	13	4.71000003814697
14	21	15	4.8600001335144
15	22	13	3.52999997138977
16	23	16	3.57999992370605
17	24	13	5.05000019073486

Snowflake schema

Snowflake schema model:



Schema description:

`Fact Table (Fact_Health_Metrics_sf)`

- Contains aggregated health metrics (averages of lab results) linked to patients, diseases, and lab tests.
- Foreign keys:
  - `PatientID` → `Patient_sf`
  - `DiseaseID` → `DiseaseDimension_sf`
  - `LabResultID` → `Dim_LabResults`
  - `VisitID` (tracks patient visits)

- Metrics include averages for hemoglobin, glucose, cholesterol, RBC, WBC, AST, ALT, spirometry, creatinine, lipase, and troponin.

Dimension Tables (Normalized Structure):

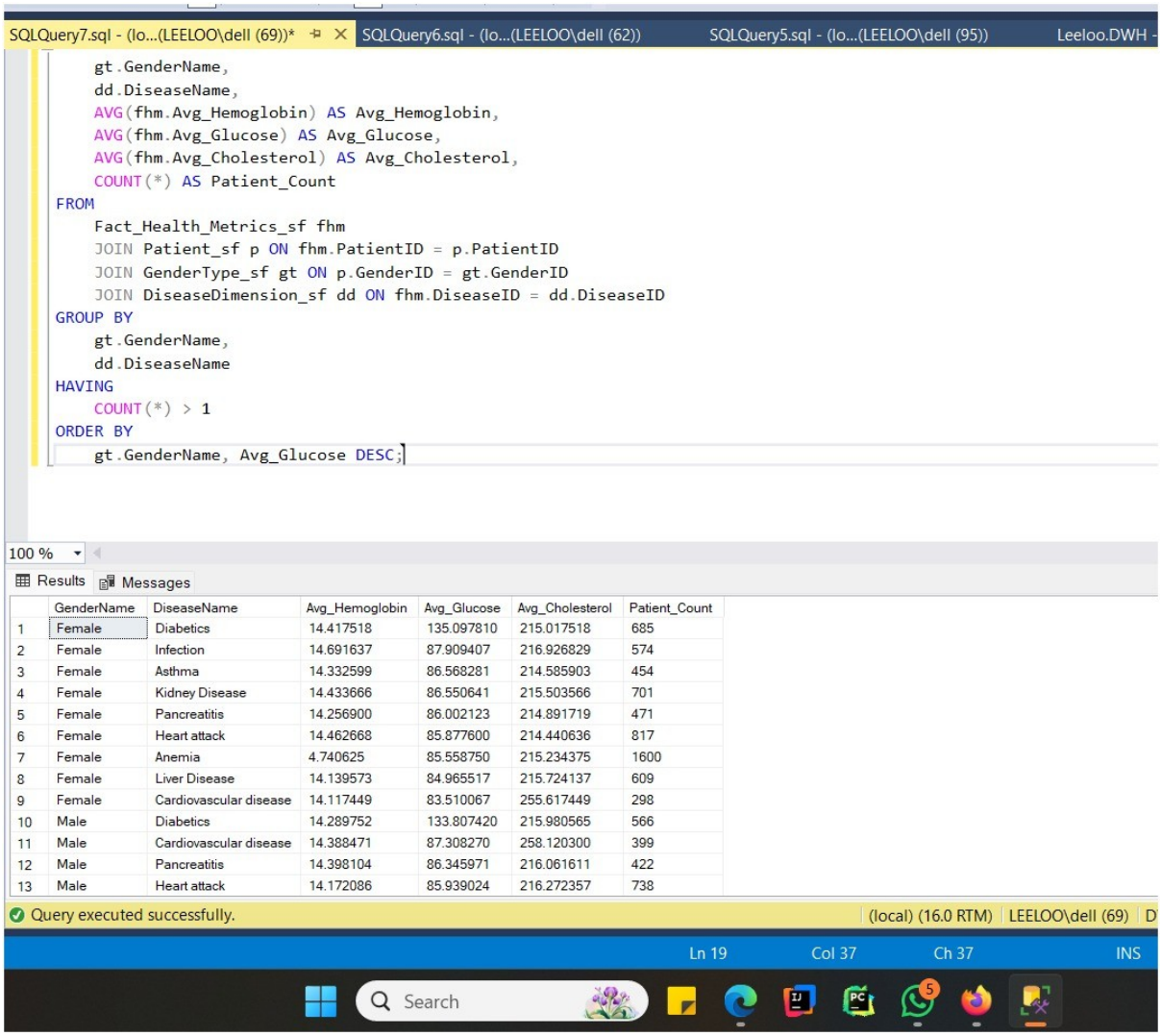
1. **`DiseaseDimension_sf`**
    - Stores disease data (`DiseaseID`, `DiseaseName`, `RiskLevelID`).
    - Linked to **`RiskLevelDimension`** (`RiskLevelID`, `RiskLevel`) for risk categorization.
2. **`Dim_LabResults`**
    - Contains raw lab test results (e.g., hemoglobin level, glucose level, cholesterol level).
3. **`Patient_sf`**
    - Holds patient data (`PatientID`, `Age`, `GenderID`, `LocationID`).
    - Linked to:
        - **`GenderType_sf`** (`GenderID`, `GenderName`) for gender classification.
        - **`Location_sf`** (`LocationID`, `Street`, `City`, `Country`) for address details.

Comparison to Star Schema :

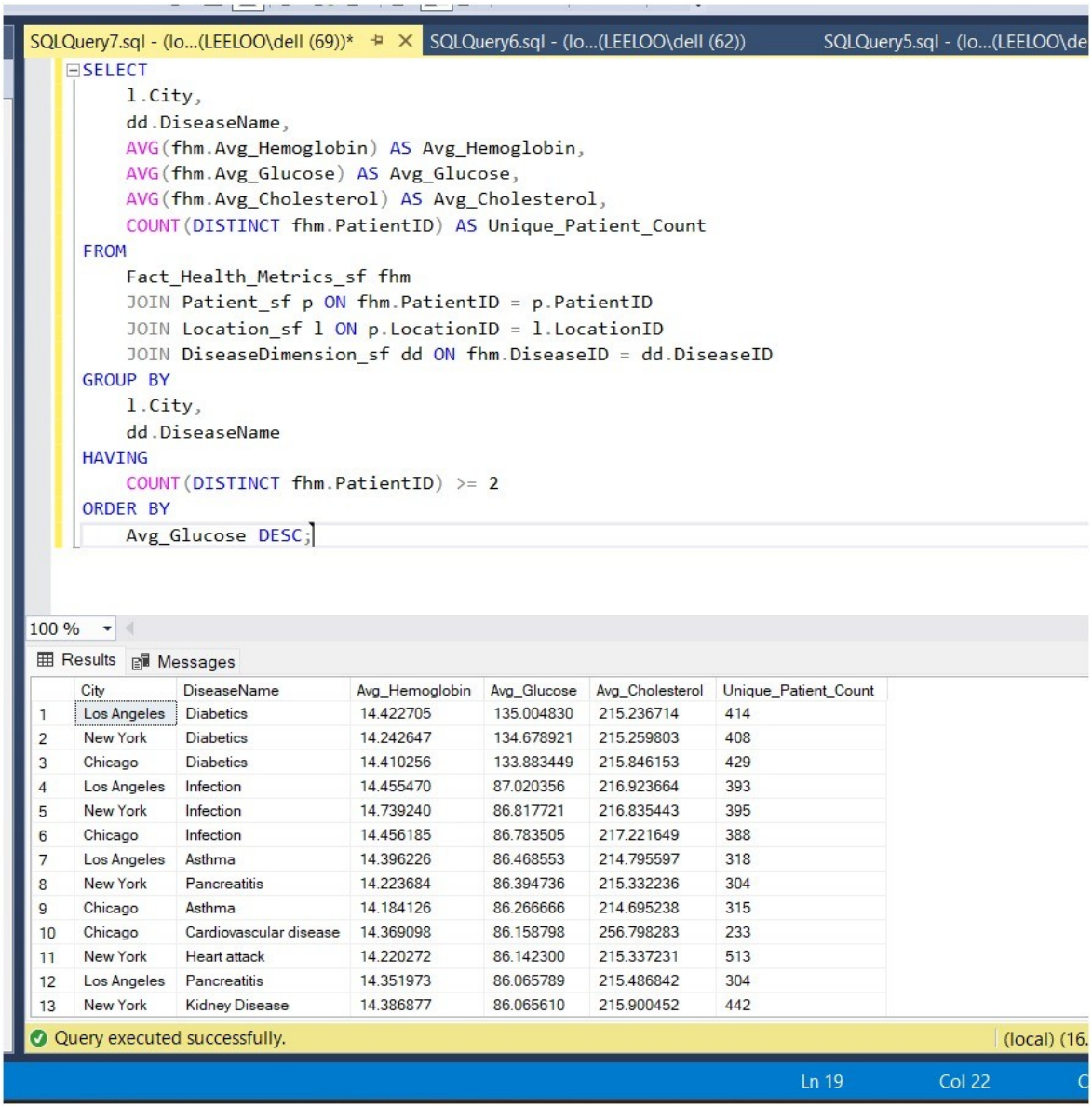
- **Snowflake**: More normalized (e.g., Patient_sf links to GenderType_sf and Location_sf, DiseaseDimension_sf Linked to RiskLevelDimension).
- **Star**: Simpler, with denormalized dimensions (e.g., PatientDimension included gender and location directly, DiseaseDimension_sf included RiskLevel directly).

Transformation process queries:

Q*: This query calculates the average health metrics grouped by gender and disease:



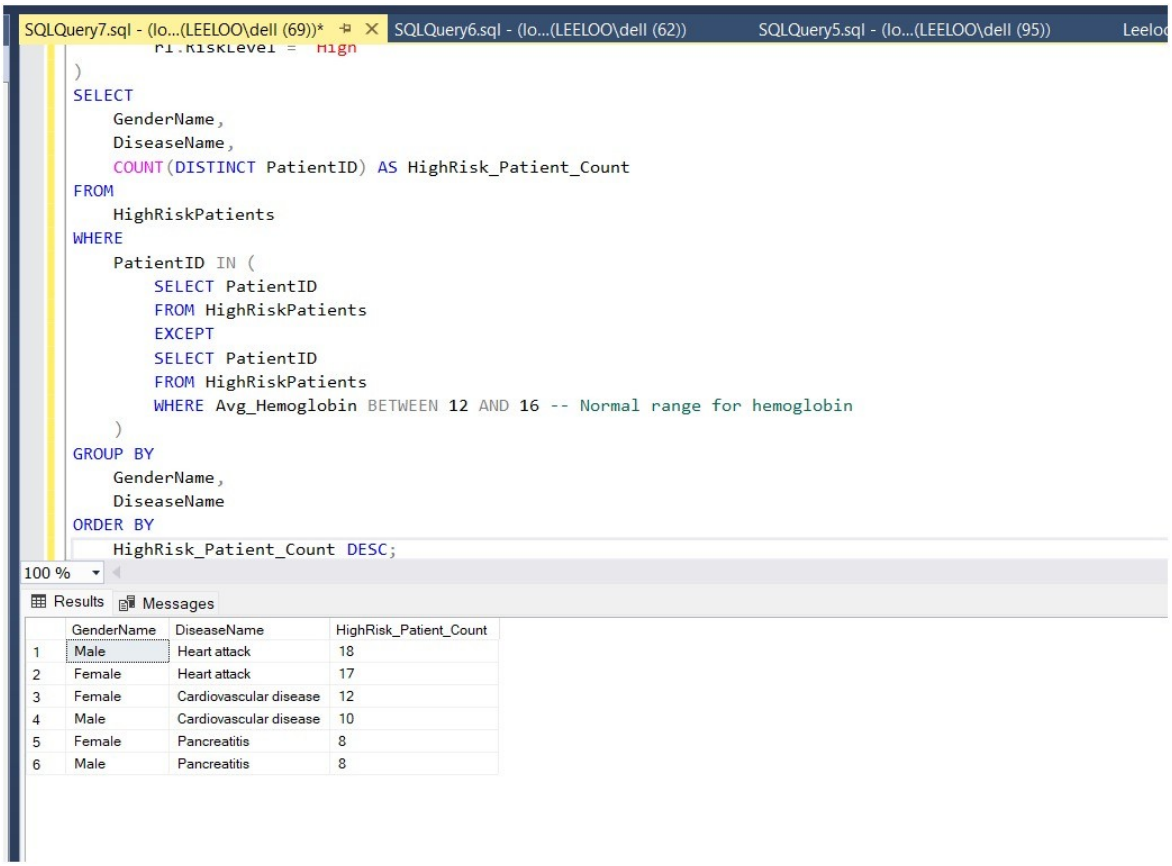
Query 1: Average Health Metrics by Location and Disease



Query 2: High-Risk Patients by Gender

```
WITH HighRiskPatients AS (
    SELECT
        p.PatientID,
        gt.GenderName,
        dd.DiseaseName,
        fhm.Avg_Hemoglobin
    FROM
        Fact_Health_Metrics_sf fhm
        JOIN Patient_sf p ON fhm.PatientID = p.PatientID
        JOIN GenderType_sf gt ON p.GenderID = gt.GenderID
        JOIN DiseaseDimension_sf dd ON fhm.DiseaseID = dd.DiseaseID
        JOIN RiskLevelDimension rl ON dd.RiskLevelID = rl.RiskLevelID
```

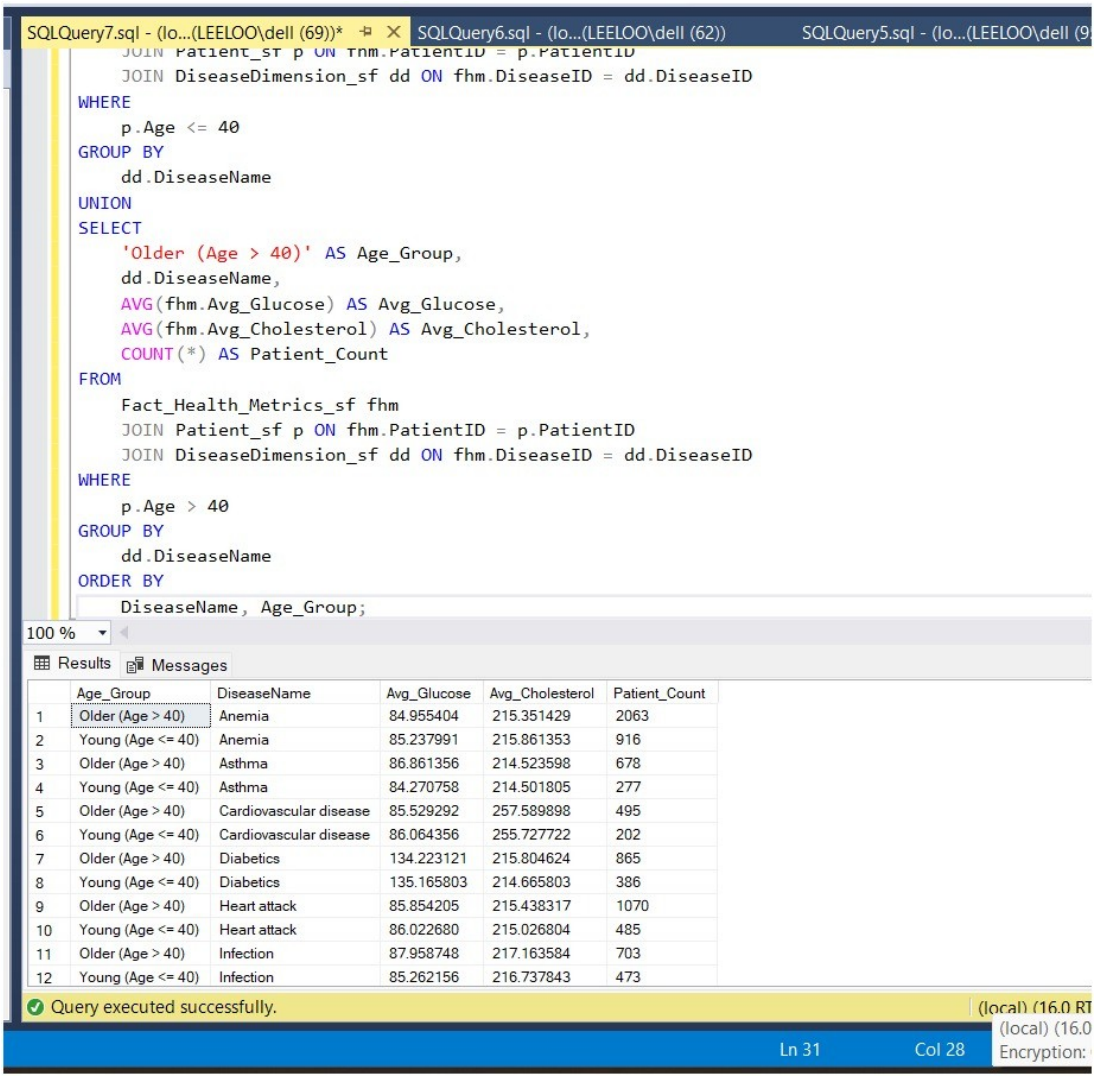
```
    WHERE
        rl.RiskLevel = 'High'
)
SELECT
    GenderName,
    DiseaseName,
    COUNT(DISTINCT PatientID) AS HighRisk_Patient_Count
FROM
    HighRiskPatients
WHERE
    PatientID IN (
        SELECT PatientID
        FROM HighRiskPatients
        EXCEPT
        SELECT PatientID
        FROM HighRiskPatients
        WHERE Avg_Hemoglobin BETWEEN 12 AND 16 -- Normal range for hemoglobin
    )
GROUP BY
    GenderName,
    DiseaseName
ORDER BY
    HighRisk_Patient_Count DESC;
```



Query 3: Compare Lab Metrics for Young vs. Older Patients

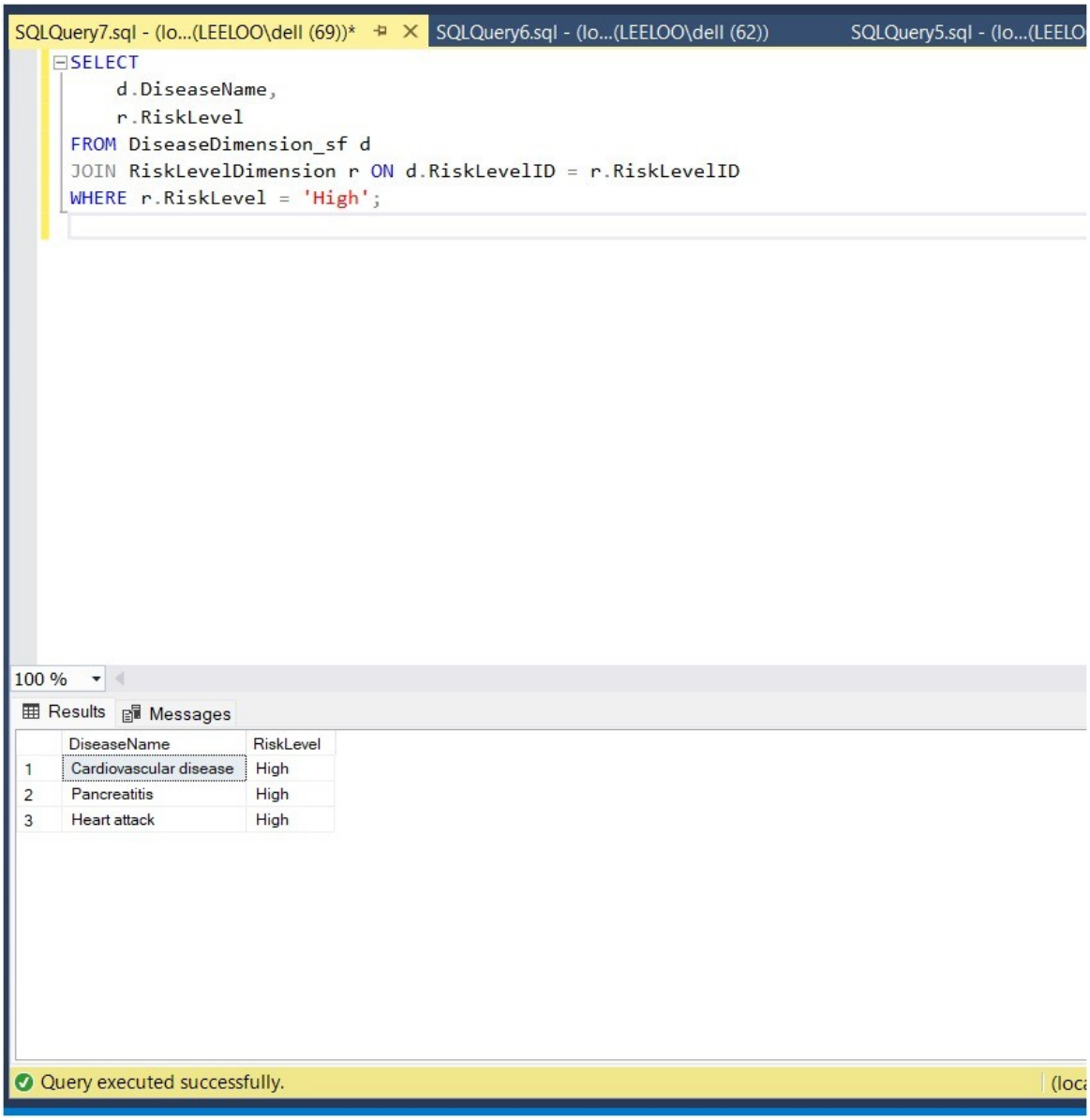
```
SELECT
   'Young (Age <= 40)' AS Age_Group,
   dd.DiseaseName,
   AVG(fhm.Avg_Glucose) AS Avg_Glucose,
   AVG(fhm.Avg_Cholesterol) AS Avg_Cholesterol,
   COUNT(*) AS Patient_Count
FROM
   Fact_Health_Metrics_sf fhm
   JOIN Patient_sf p ON fhm.PatientID = p.PatientID
   JOIN DiseaseDimension_sf dd ON fhm.DiseaseID = dd.DiseaseID
WHERE
   p.Age <= 40
GROUP BY
   dd.DiseaseName
UNION
SELECT
   'Older (Age > 40)' AS Age_Group,
   dd.DiseaseName,
   AVG(fhm.Avg_Glucose) AS Avg_Glucose,
   AVG(fhm.Avg_Cholesterol) AS Avg_Cholesterol,
```

```
    COUNT(*) AS Patient_Count
FROM
    Fact_Health_Metrics_sf fhm
    JOIN Patient_sf p ON fhm.PatientID = p.PatientID
    JOIN DiseaseDimension_sf dd ON fhm.DiseaseID = dd.DiseaseID
WHERE
    p.Age > 40
GROUP BY
    dd.DiseaseName
ORDER BY
    DiseaseName, Age_Group;
```

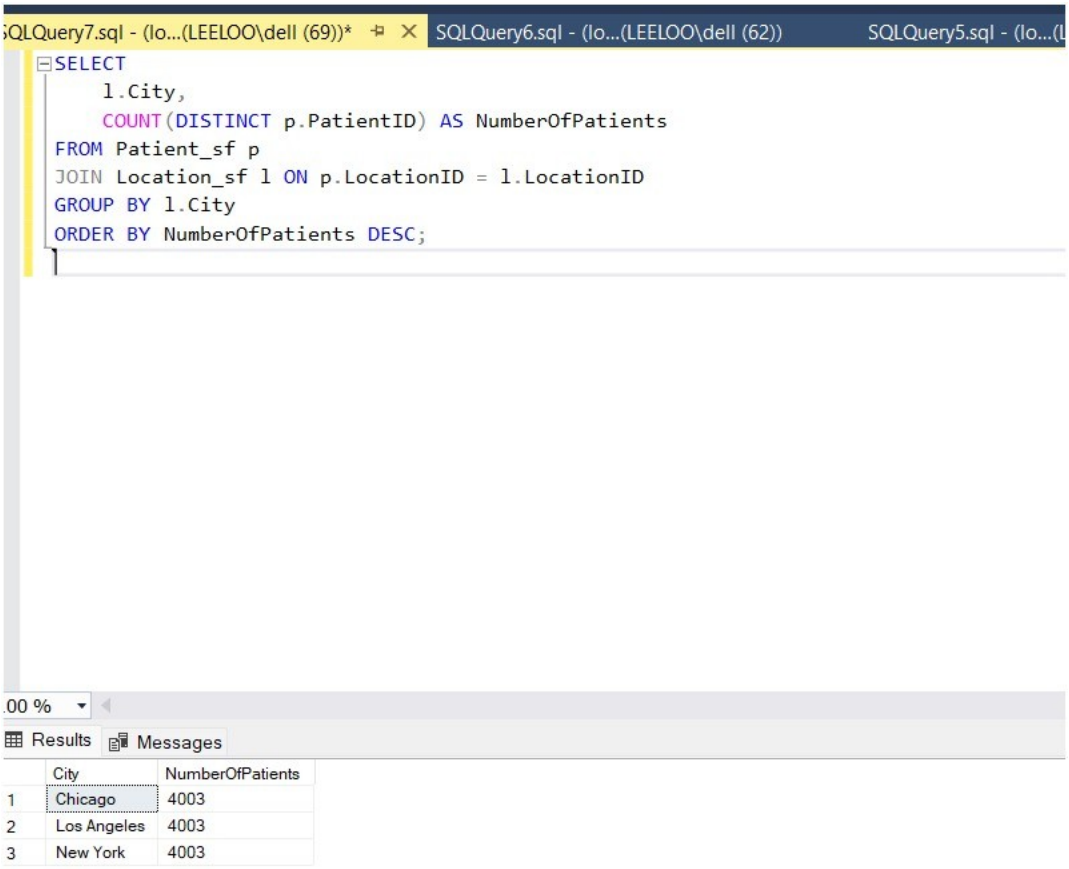


	Age_Group	DiseaseName	Avg_Glucose	Avg_Cholesterol	Patient_Count
1	Older (Age > 40)	Anemia	84.955404	215.351429	2063
2	Young (Age <= 40)	Anemia	85.237991	215.861353	916
3	Older (Age > 40)	Asthma	86.861356	214.523598	678
4	Young (Age <= 40)	Asthma	84.270758	214.501805	277
5	Older (Age > 40)	Cardiovascular disease	85.529292	257.589898	495
6	Young (Age <= 40)	Cardiovascular disease	86.064356	255.727722	202
7	Older (Age > 40)	Diabetics	134.223121	215.804624	865
8	Young (Age <= 40)	Diabetics	135.165803	214.665803	386
9	Older (Age > 40)	Heart attack	85.854205	215.438317	1070
10	Young (Age <= 40)	Heart attack	86.022680	215.026804	485
11	Older (Age > 40)	Infection	87.958748	217.163584	703
12	Young (Age <= 40)	Infection	85.262156	216.737843	473

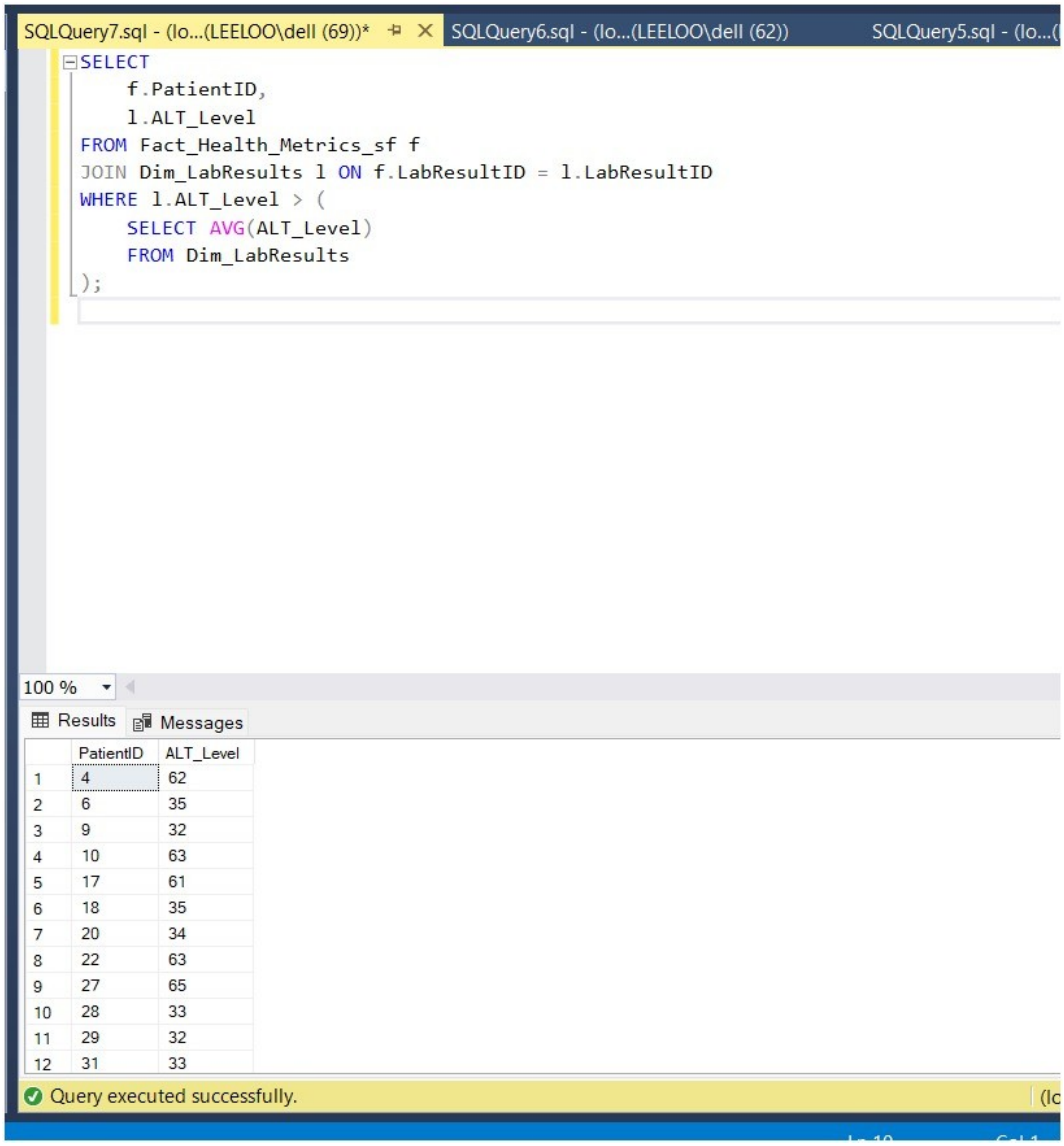
Q4: Dangerous diseases only



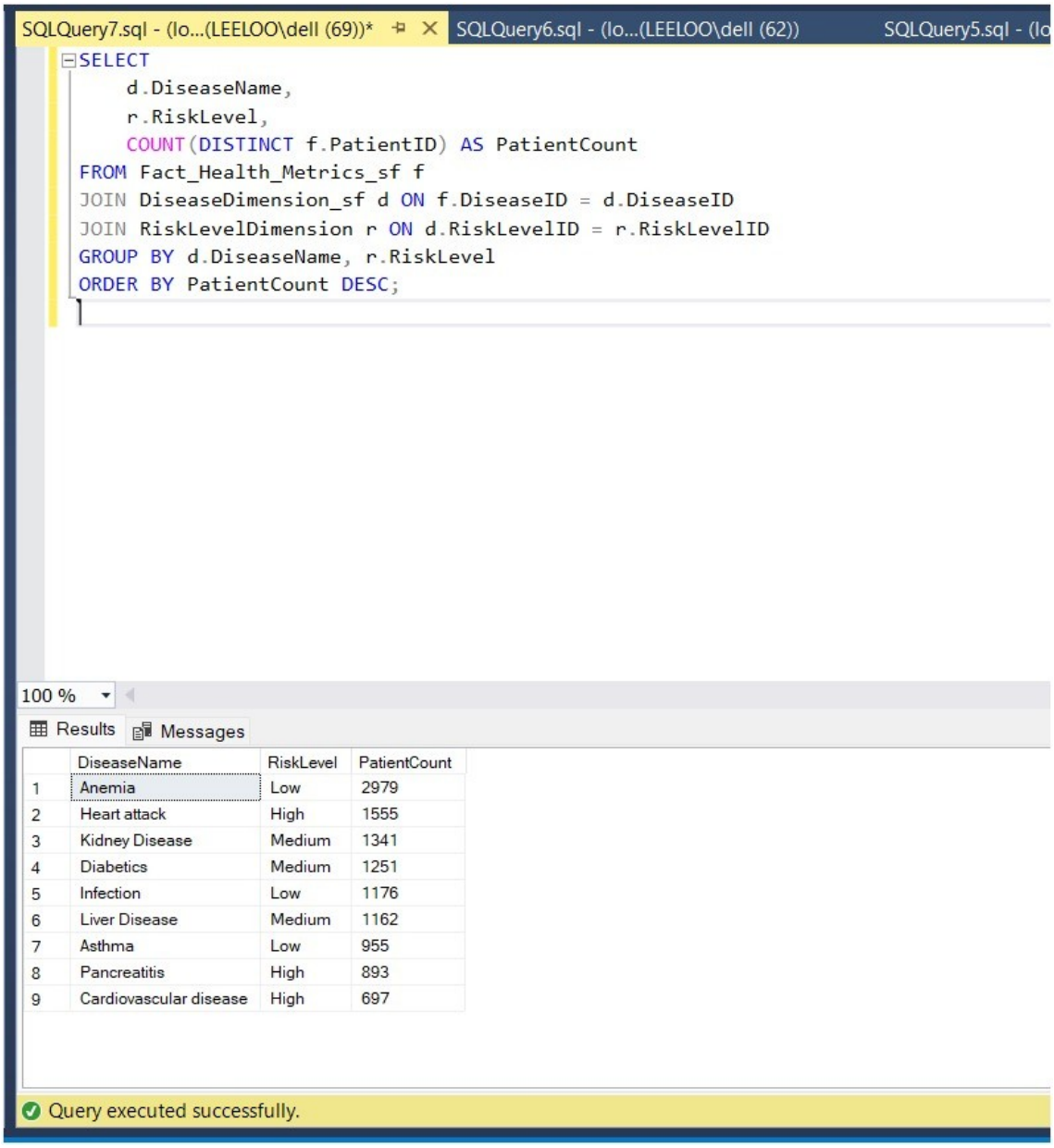
Q5: Patients number in each city



Q6: Patients with ALT levels higher than the general average


SQLQuery7.sql - (lo...(LEELOO\dell (69))*
SQLQuery6.sql - (lo...(LEELOO\dell (62))
SQLQuery5.sql - (lo...(
SELECT
f.PatientID,
l.ALT_Level
FROM Fact_Health_Metrics_sf f
JOIN Dim_LabResults l ON f.LabResultID = l.LabResultID
WHERE l.ALT_Level > (
SELECT AVG(ALT_Level)
FROM Dim_LabResults
);
100 %
Results
Messages
PatientID ALT_Level
1 4 62
2 6 35
3 9 32
4 10 63
5 17 61
6 18 35
7 20 34
8 22 63
9 27 65
10 28 33
11 29 32
12 31 33
Query executed successfully.

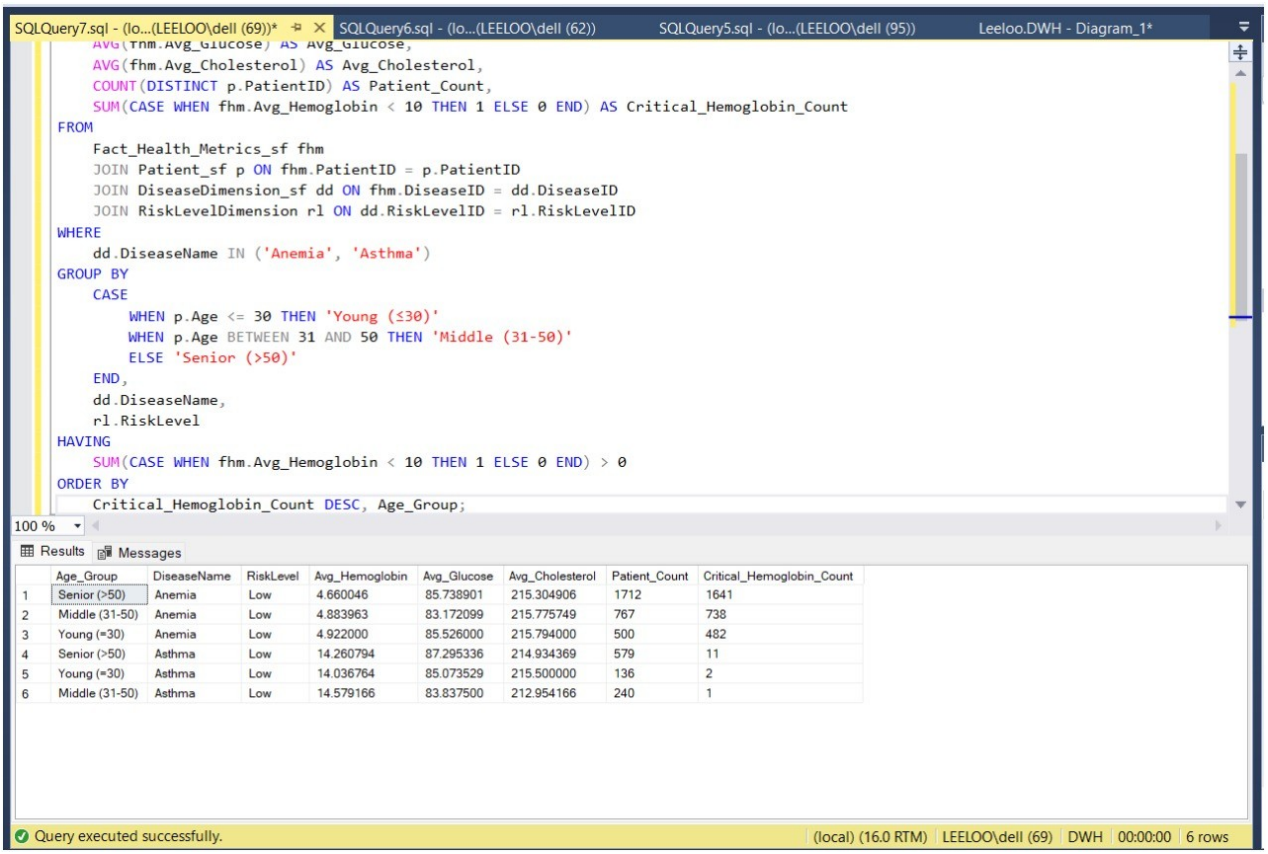
Q7: Analysis of the number of patients by disease type and severity



Query 8: Analyzes average measurements by age group and disease with risk level

```
SELECT
  CASE
    WHEN p.Age <= 30 THEN 'Young (≤30)'
    WHEN p.Age BETWEEN 31 AND 50 THEN 'Middle (31-50)'
    ELSE 'Senior (>50)'
  END AS Age_Group,
  dd.DiseaseName,
  rl.RiskLevel,
  AVG(fhm.Avg_Hemoglobin) AS Avg_Hemoglobin,
  AVG(fhm.Avg_Glucose) AS Avg_Glucose,
```

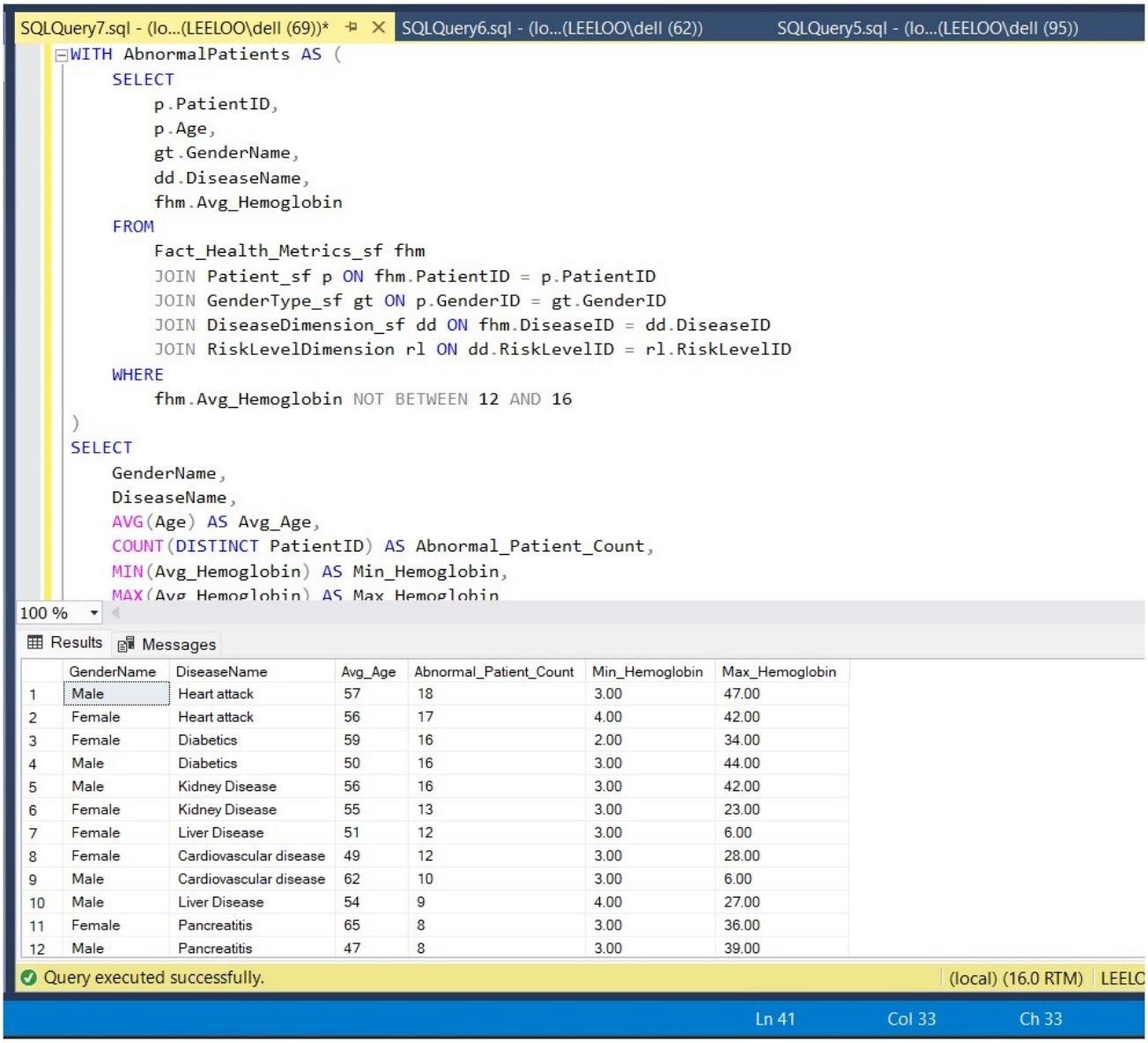
```
    AVG(fhm.Avg_Cholesterol) AS Avg_Cholesterol,
    COUNT(DISTINCT p.PatientID) AS Patient_Count,
    SUM(CASE WHEN fhm.Avg_Hemoglobin < 10 THEN 1 ELSE 0 END) AS
Critical_Hemoglobin_Count
FROM
    Fact_Health_Metrics_sf fhm
    JOIN Patient_sf p ON fhm.PatientID = p.PatientID
    JOIN DiseaseDimension_sf dd ON fhm.DiseaseID = dd.DiseaseID
    JOIN RiskLevelDimension rl ON dd.RiskLevelID = rl.RiskLevelID
WHERE
    dd.DiseaseName IN ('Anemia', 'Asthma')
GROUP BY
    CASE
        WHEN p.Age <= 30 THEN 'Young (≤30)'
        WHEN p.Age BETWEEN 31 AND 50 THEN 'Middle (31-50)'
        ELSE 'Senior (>50)'
    END,
    dd.DiseaseName,
    rl.RiskLevel
HAVING
    SUM(CASE WHEN fhm.Avg_Hemoglobin < 10 THEN 1 ELSE 0 END) > 0
ORDER BY
    Critical_Hemoglobin_Count DESC, Age_Group;
```



Query 9: Identify Patients with Abnormal Measurements Excluding Low-Risk Diseases

```
WITH AbnormalPatients AS (
    SELECT
        p.PatientID,
        p.Age,
        gt.GenderName,
        dd.DiseaseName,
        fhm.Avg_Hemoglobin
    FROM
        Fact_Health_Metrics_sf fhm
        JOIN Patient_sf p ON fhm.PatientID = p.PatientID
        JOIN GenderType_sf gt ON p.GenderID = gt.GenderID
        JOIN DiseaseDimension_sf dd ON fhm.DiseaseID = dd.DiseaseID
        JOIN RiskLevelDimension rl ON dd.RiskLevelID = rl.RiskLevelID
    WHERE
        fhm.Avg_Hemoglobin NOT BETWEEN 12 AND 16
)
SELECT
    GenderName,
    DiseaseName,
```

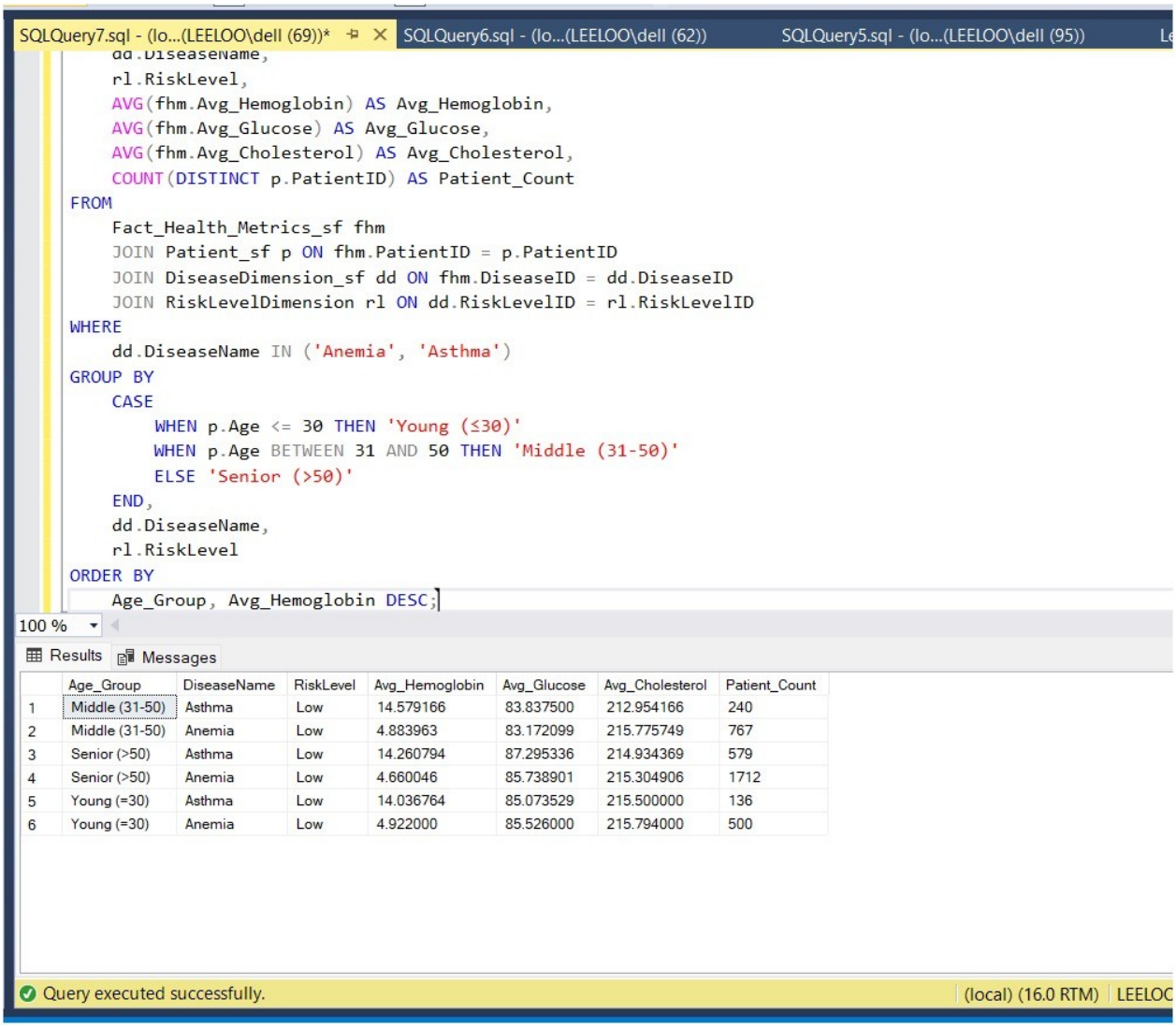
```
    AVG(Age) AS Avg_Age,
    COUNT(DISTINCT PatientID) AS Abnormal_Patient_Count,
    MIN(Avg_Hemoglobin) AS Min_Hemoglobin,
    MAX(Avg_Hemoglobin) AS Max_Hemoglobin
FROM
    AbnormalPatients
WHERE
    PatientID IN (
        SELECT PatientID
        FROM AbnormalPatients
        EXCEPT
        SELECT PatientID
        FROM AbnormalPatients ap
        JOIN DiseaseDimension_sf dd ON ap.DiseaseName = dd.DiseaseName
        JOIN RiskLevelDimension rl ON dd.RiskLevelID = rl.RiskLevelID
        WHERE rl.RiskLevel = 'Low'
    )
GROUP BY
    GenderName,
    DiseaseName
ORDER BY
    Abnormal_Patient_Count DESC;
```



Query 10: Average Measurements by Age Group and Disease with Risk Level

```
SELECT
  CASE
    WHEN p.Age <= 30 THEN 'Young (≤30)'
    WHEN p.Age BETWEEN 31 AND 50 THEN 'Middle (31-50)'
    ELSE 'Senior (>50)'
  END AS Age_Group,
  dd.DiseaseName,
  rl.RiskLevel,
  AVG(fhm.Avg_Hemoglobin) AS Avg_Hemoglobin,
  AVG(fhm.Avg_Glucose) AS Avg_Glucose,
  AVG(fhm.Avg_Cholesterol) AS Avg_Cholesterol,
  COUNT(DISTINCT p.PatientID) AS Patient_Count
FROM
```

```
    Fact_Health_Metrics_sf fhm
    JOIN Patient_sf p ON fhm.PatientID = p.PatientID
    JOIN DiseaseDimension_sf dd ON fhm.DiseaseID = dd.DiseaseID
    JOIN RiskLevelDimension rl ON dd.RiskLevelID = rl.RiskLevelID
WHERE
    dd.DiseaseName IN ('Anemia', 'Asthma')
GROUP BY
    CASE
        WHEN p.Age <= 30 THEN 'Young (≤30)'
        WHEN p.Age BETWEEN 31 AND 50 THEN 'Middle (31-50)'
        ELSE 'Senior (>50)'
    END,
    dd.DiseaseName,
    rl.RiskLevel
ORDER BY
    Age_Group, Avg_Hemoglobin DESC;
```



	Age_Group	DiseaseName	RiskLevel	Avg_Hemoglobin	Avg_Glucose	Avg_Cholesterol	Patient_Count
1	Middle (31-50)	Asthma	Low	14.579166	83.837500	212.954166	240
2	Middle (31-50)	Anemia	Low	4.883963	83.172099	215.775749	767
3	Senior (>50)	Asthma	Low	14.260794	87.295336	214.934369	579
4	Senior (>50)	Anemia	Low	4.660046	85.738901	215.304906	1712
5	Young (=30)	Asthma	Low	14.036764	85.073529	215.500000	136
6	Young (=30)	Anemia	Low	4.922000	85.526000	215.794000	500