Analysis of Walking Patterns Based on Weather Conditions

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January 10, 2025

Abstract

This study analyzes the relationship between weather conditions and daily walking patterns using data collected from the Apple Health app and historical weather records in Istanbul, Turkey. The analysis spans multiple years and reveals significant correlations between environmental factors and physical activity levels. Key findings indicate that temperature has the strongest positive correlation with step count, while precipitation shows a slight negative impact. The study provides insights for optimizing daily physical activity based on weather conditions.

1 Introduction

1.1 Motivation

Understanding how environmental factors influence daily physical activity is crucial for maintaining a healthy lifestyle. This project emerged from a personal interest in analyzing walking habits in Istanbul, specifically focusing on:

- The impact of weather conditions on daily step counts
- Identification of patterns that could optimize daily activity
- Understanding seasonal variations in movement patterns
- Developing strategies to maintain consistent activity despite weather changes

1.2 Research Question

The primary research question driving this analysis is: *How do different weather conditions influence walking behavior and habits?* This question encompasses several sub-aspects:

- What is the correlation between temperature and daily step count?
- How do precipitation and wind speed affect walking patterns?
- Are there significant seasonal variations in walking behavior?
- What are the optimal weather conditions for maximizing physical activity?

2 Methodology

2.1 Data Collection

The study utilizes two primary data sources:

2.1.1 Walking Data

- Source: Apple Health app export (XML format)
- Metrics: Steps, duration, timestamps
- Period: Multiple years of daily records
- Total days analyzed: 2,893

2.1.2 Weather Data

- Source: Meteostat API
- Location: Istanbul (41.0082°N, 28.9784°E)
- Parameters: Temperature, precipitation, wind speed, pressure
- Temporal resolution: Daily measurements

2.2 Data Processing Pipeline

The analysis involved three main processing steps:

1. **Step Data Extraction:**
    - XML parsing of health data
    - Daily step aggregation
    - Statistical calculations
2. **Weather Data Collection:**
    - Historical weather retrieval
    - Data matching with step dates
    - Missing value handling
3. **Data Analysis:**
    - Data merging and cleaning
    - Visualization generation
    - Statistical analysis

3 Results

3.1 Overall Statistics

Key statistical findings from the analysis:

- Average daily steps: 6,148
- Highest recorded: 28,430 steps
- Lowest recorded: 1 step
- Total days analyzed: 2,893

3.2 Temperature Impact

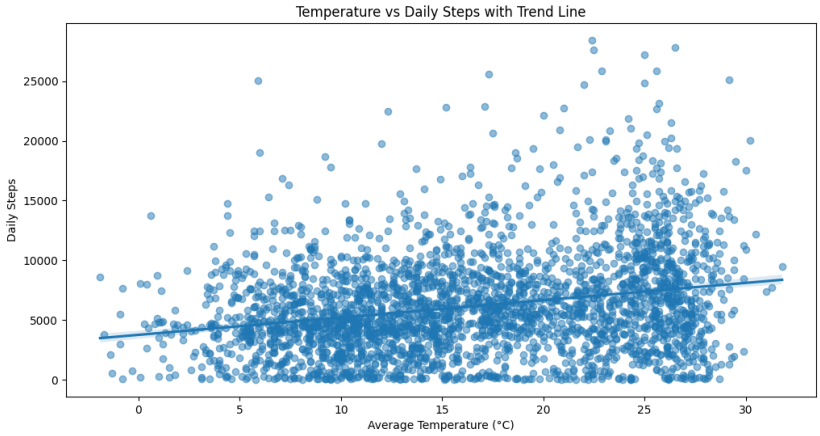

Figure 1: Temperature vs Daily Steps with Trend Line

Temperature shows a clear positive correlation with step count:

- Cold (¡5°C): 4,678 steps/day
- Mild (5-15°C): 5,112 steps/day
- Warm (15-25°C): 6,811 steps/day
- Hot (¿25°C): 7,610 steps/day

3.3 Daily Patterns

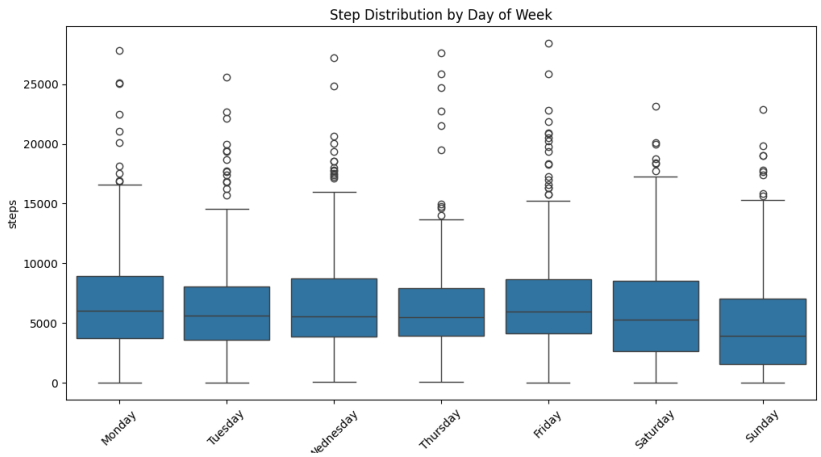

Figure 2: Step Distribution by Day of Week

Average steps by weekday show clear patterns:

- Highest: Monday (6,652 steps)
- Lowest: Sunday (4,813 steps)
- Weekdays consistently show higher activity

3.4 Seasonal Trends

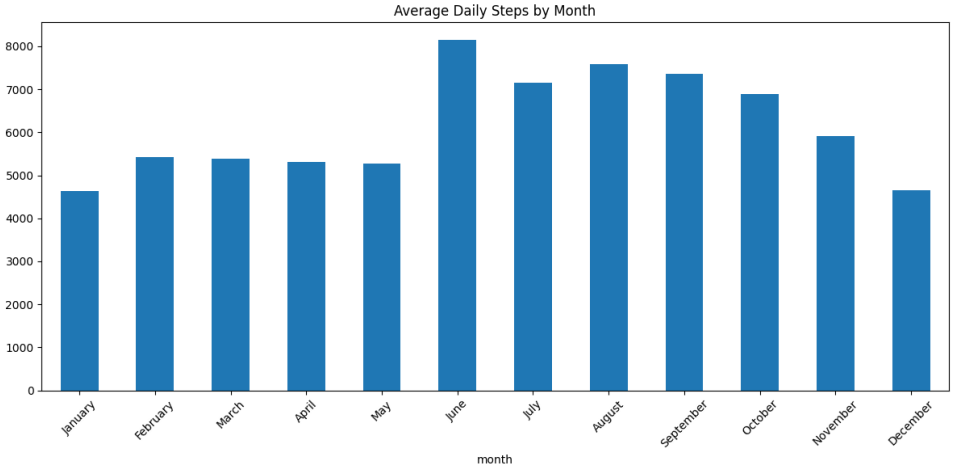

Figure 3: Average Daily Steps by Month

Monthly averages reveal distinct seasonal patterns:

- Peak month: June (8,149 steps)
- Lowest month: January (4,637 steps)
- Summer months show consistently higher activity

3.5 Weather Correlations

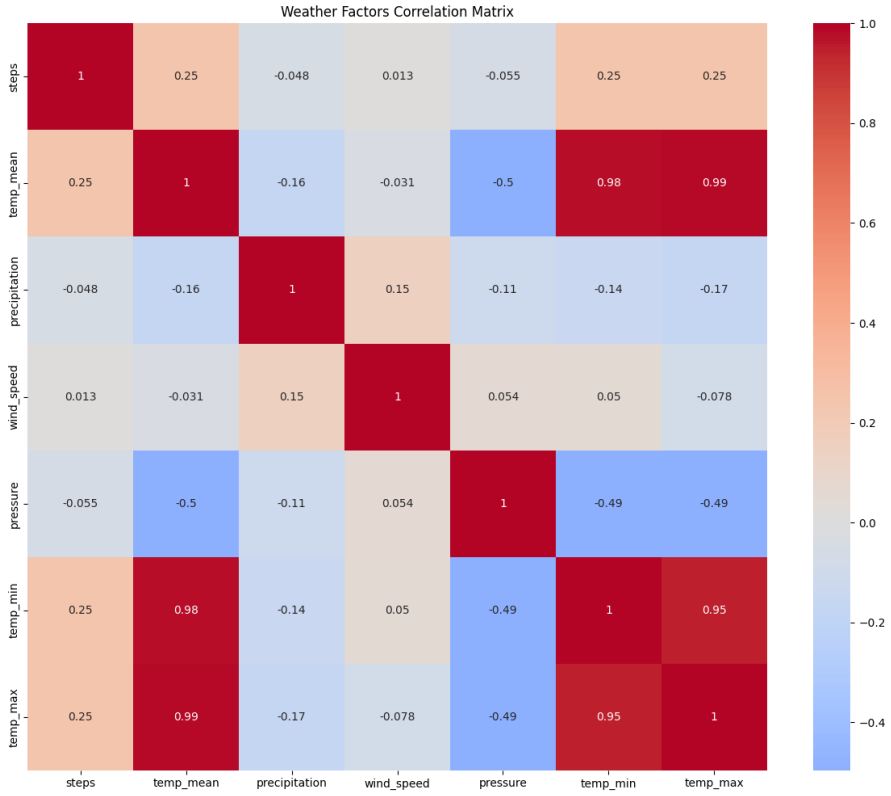

Figure 4: Weather Factors Correlation Matrix

Correlation coefficients with daily steps:

- Temperature: +0.250 (strongest positive)
- Precipitation: -0.048 (slight negative)
- Wind speed: +0.013 (negligible)
- Pressure: -0.055 (slight negative)

3.6 Weather Impact Analysis

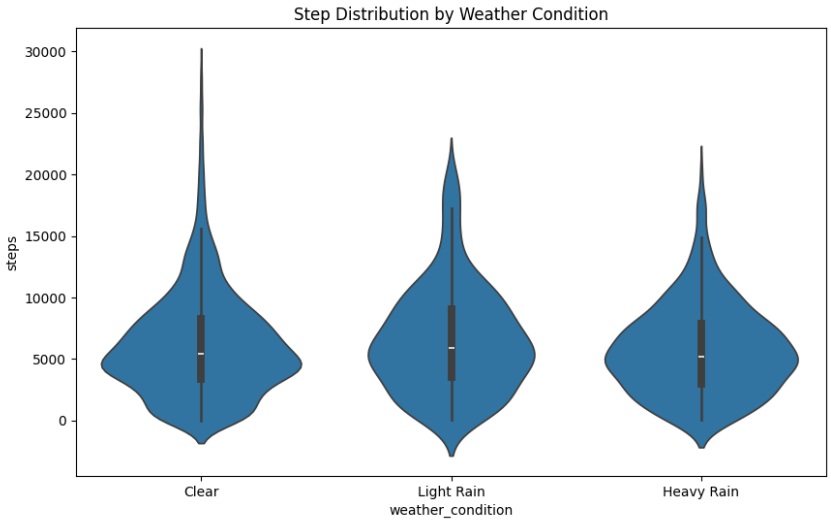

Figure 5: Average Steps by Weather Condition

Average steps by weather condition show interesting patterns:

- Light Rain: 6,564 steps (highest average)
- Clear: 6,167 steps
- Heavy Rain: 5,783 steps (lowest average)

3.7 Hourly Activity Distribution

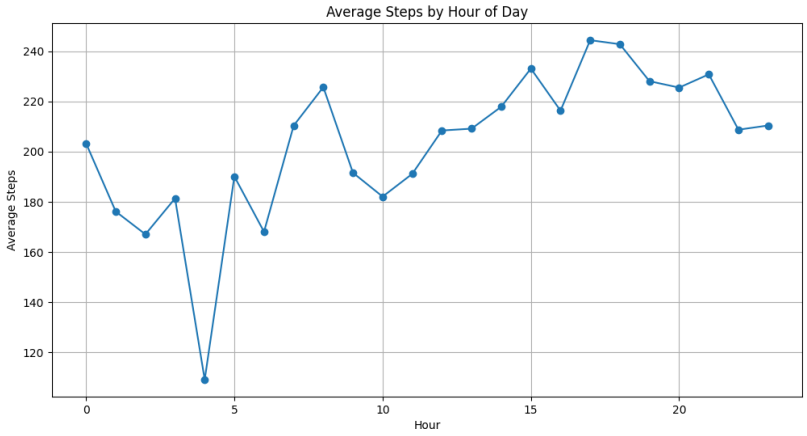

Figure 6: Distribution of Steps Throughout the Day

3.8 Combined Weather Effects

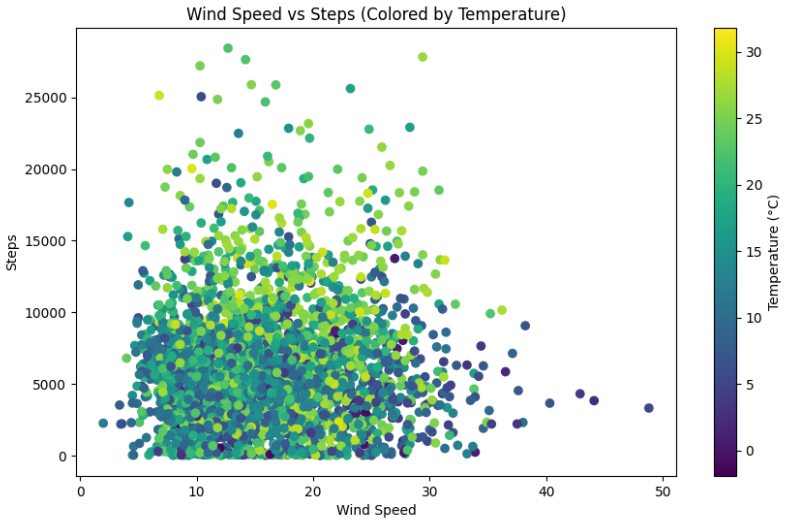

Figure 7: Combined Effect of Wind Speed and Temperature on Step Count

3.9 Long-term Trends

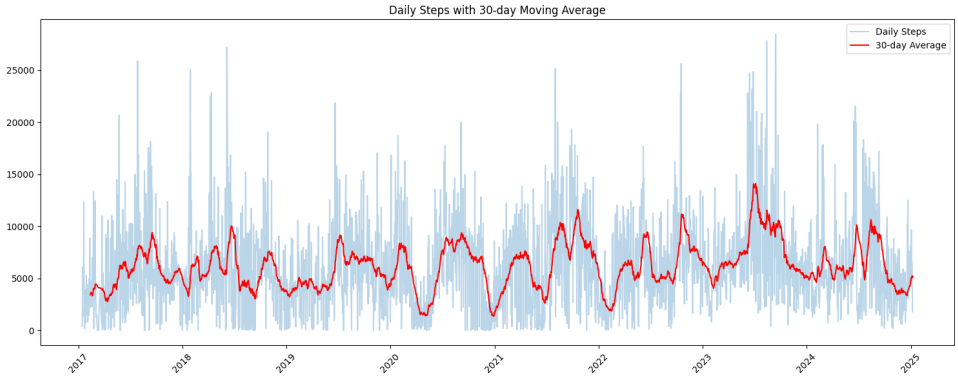

Figure 8: 30-Day Moving Average of Step Count

3.10 Temperature-Day Relationship

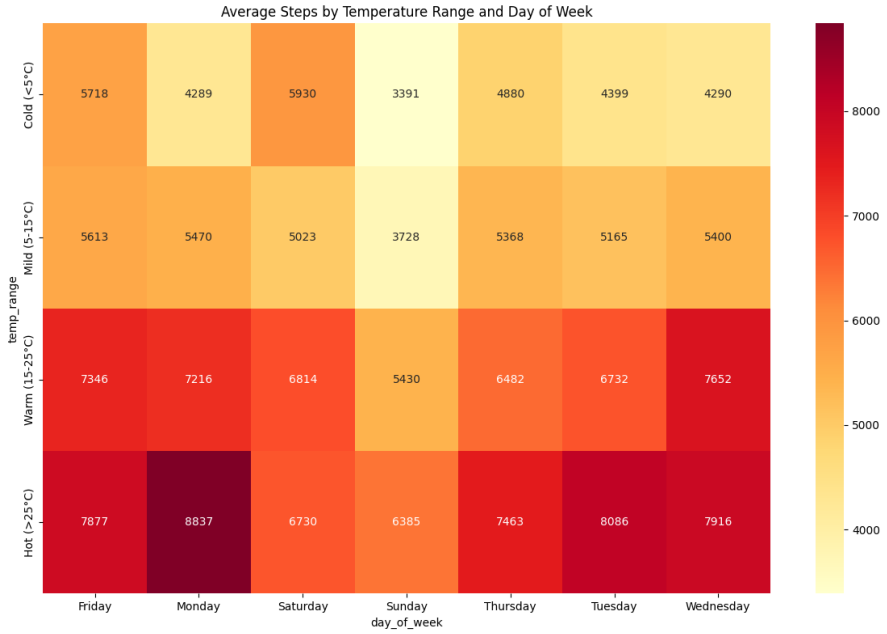

Figure 9: Heat Map of Steps by Temperature Range and Day of Week

4 Detailed Statistical Analysis

4.1 Monthly Breakdown

Monthly step averages reveal clear seasonal patterns:

- June: 8,149 steps (highest)
- August: 7,578 steps
- September: 7,361 steps
- July: 7,154 steps
- October: 6,885 steps
- November: 5,904 steps
- February: 5,417 steps
- March: 5,391 steps
- April: 5,316 steps
- May: 5,274 steps
- December: 4,652 steps
- January: 4,637 steps (lowest)

4.2 Temperature Range Analysis

Detailed breakdown by temperature range:

Temperature Range	Mean Steps	Sample Count
Cold (¡5°C)	4,678.16	132
Mild (5-15°C)	5,112.37	1,197
Warm (15-25°C)	6,810.66	1,066
Hot (¿25°C)	7,609.98	498

Table 1: Step Count Distribution by Temperature Range

4.3 Notable Records

Top walking days and their conditions:

1. 2023-09-15: 28,430 steps (22.4°C, Clear)
2. 2023-08-14: 27,817 steps (26.5°C, Clear)
3. 2023-09-14: 27,635 steps (22.5°C, Clear)
4. 2018-06-06: 27,200 steps (25.0°C, Clear)
5. 2018-06-07: 25,885 steps (25.6°C, Clear)

5 Discussion

5.1 Key Findings

The analysis reveals several significant patterns:

- Temperature has the strongest influence on walking behavior
- Weekday/weekend patterns are consistent regardless of weather
- Seasonal variations show clear impact on activity levels
- Light rain doesn't significantly deter walking

5.2 Optimal Conditions

Based on the data, optimal conditions for walking are:

- Temperature: Above 15°C
- Day of Week: Monday-Friday
- Season: Summer months
- Weather: Clear or light rain

6 Conclusions

The study provides valuable insights into the relationship between weather conditions and walking patterns. Key recommendations include:

- Developing winter-specific strategies to maintain activity
- Planning outdoor activities during optimal temperature periods
- Focusing on increasing weekend activity levels
- Not letting light rain deter walking activities

7 Technical Implementation

The analysis was implemented using Python, with key libraries including:

- pandas for data manipulation
- matplotlib and seaborn for visualization
- Meteostat API for weather data
- XML processing for health data

The complete code and data processing pipeline is available in the project repository, structured in three main components:

- date_extractor.py: Step data processing
- weather_fetcher.py: Weather data collection
- data_analyzer.py: Analysis and visualization