Mikayla Karkoski and Hannah Wimpy

karkoski.m@northeastern.edu & wimpy.h@northeastern.edu

DS2001 – Programming With Data Practicum

Professor Felix Muzny

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Can ADHD Be Objectively Diagnosed in Both Genders Using Movement Data?

Problem Statement and Background

Attention-Deficit Hyperactivity Disorder (ADHD) affects a significant portion of the adult population, impacting daily functioning and quality of life (Hicks et al., 2021). Despite being commonly associated with males, ADHD equally affects both genders. However, underdiagnosis in females remains a challenge due to varying symptom presentation, with males generally displaying more hyperactive symptoms than females (Martin, 2024; Gaub & Carlson, 1997).

ADHD research has historically focused on male subjects, potentially overlooking critical insights into female experiences (Mizuno et al., 2023). To address this gap, we investigate whether movement data can objectively contribute to ADHD diagnosis in both genders, with a particular focus on the lack of hyperactive symptoms in females and its implications for diagnostic accuracy.

Introduction and Description of the Data

By understanding ADHD better, we can enhance diagnosis, treatment, and overall well-being. Despite the common perception that ADHD primarily affects males, research indicates that it impacts both genders equally. However, females often go undiagnosed due to atypical symptom presentation. Investigating ADHD from a gender-inclusive perspective is crucial. The availability of the HYPERAKTIV dataset provides a unique opportunity. Our aim was to investigate whether the absence of hyperactive symptoms in females affects the utility of activity data for diagnosing ADHD. We sought to determine if activity data might primarily contribute to diagnosing ADHD in males rather than improving diagnosis overall. By analyzing movement data, we aim to contribute to more objective and accurate ADHD diagnosis methods, particularly regarding hyperactivity in males and the nuanced presentation of symptoms in females.

We obtained the HYPERAKTIV dataset, which includes health, activity, neuropsychological testing, and heart rate data. This dataset comprises information from adult patients both with and without ADHD. Our study centers on movement data collected using wrist-worn actigraph devices. These devices measure acceleration in a 3D space (Hicks et al., 2021).

The dataset contains records from 51 patients diagnosed with ADHD and 52 clinical controls. Alongside movement data, it includes patient demographics, health-related information, and neuropsychological assessments. The combination of activity data, heart rate measurements, and other variables provides a comprehensive view of patients' daily lives.

By examining movement patterns, we can gain insights into how ADHD manifests differently in males and females. This understanding informs better diagnostic criteria and personalized interventions. Accurate diagnosis validates the experiences of females with ADHD,

reducing stigma and misconceptions associated with the condition. Objective data from movement patterns can enhance diagnostic accuracy, leading to timely interventions and improved outcomes. Addressing underdiagnosis has broader implications for public health.

Methods

The dataset consisted of a participant demographics file and a heart rate variability (HRV) and activity file for each participant. We utilized the participant demographics file and the participant activity files for our investigation. The first thing we did was download the dataset. Next, we extracted movement data from each file and found the average movement of each participant. We then utilized the patient demographics file, extracted the participant ID and gender information from it and sorted the data such that each participant ID is linked with the participant's gender and average activity. The sorted data was then used to create four CSV files containing of the movement averages, with the data sorted in files based on gender and ADHD status (e.g. one CSV file contains female control movement averages).

After the CSV files were created, the average of the averages was found for each group (e.g. an average of the movement averages of female control participants was calculated). A scatterplot of average movement of each participant versus participant was then created with each group assigned a different color. Custom standard error bars and horizontal lines representing the average of the averages for each group was added to the plot. The scatterplot allows us to visualize the spread and variability of data.

Bar graphs comparing average movement of ADHD participants and that of control participants for each gender were then created. Each group was given a different color. Standard error of each group's list of averages was then calculated and the graphs were given custom

standard error bars. The variance of each group's list of averages was calculated and the variance ratio between the experimental and control groups was found. The variance ratios were less than 4:1, so equal variance could be assumed in t tests. T tests comparing the experimental and control were then performed for each gender using an alpha value of 0.2, yielding the p values. Finally, the significance of the bar graphs was appropriately labeled based on the calculated p values.

Results, Conclusions, and Future Work

Our investigation focused on using movement data to diagnose ADHD objectively. We found a significant difference of approximately 50 ($p = 0.112$, $p < 0.2$) in movement patterns between males with ADHD and control subjects, aligning with existing research highlighting hyperactivity as a prominent symptom in males (Figure 1).

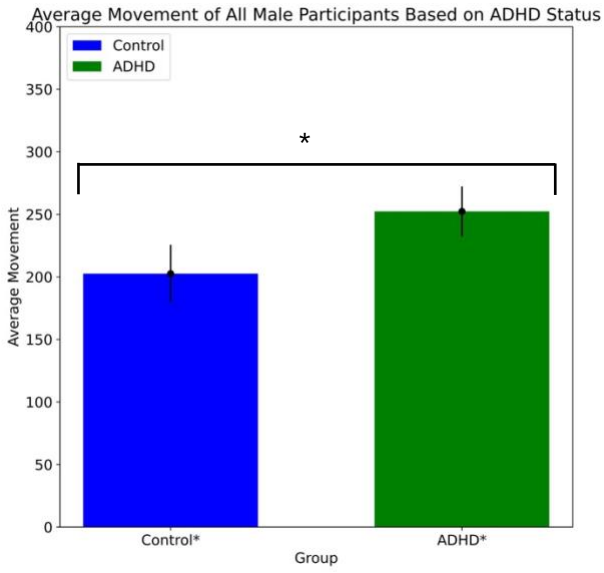

Figure 1: Average Movement of All Male Participants Based on ADHD Status

However, we did not observe significant movement average difference ($p = 0.68$, $p > 0.2$) between females with ADHD and controls, indicating the complexity of ADHD diagnosis in females where symptoms may manifest differently (Figure 2).

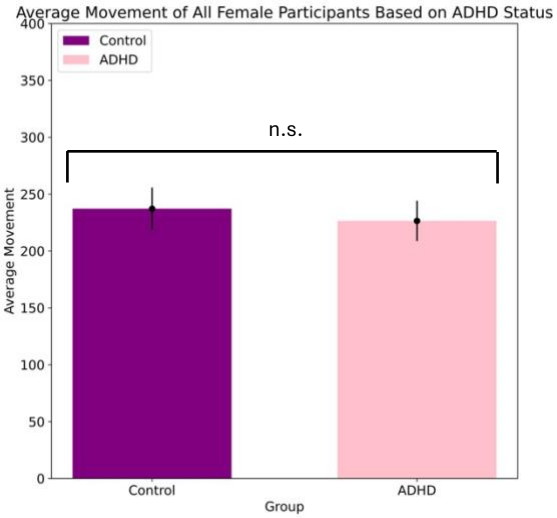

Figure 2: Average Movement of All Female Participants Based on ADHD Status

High variability in movement data within both groups posed challenges, compounded by our relatively small sample size, which limited statistical power. The absence of recorded previous activity levels introduced confounding effects, and other unmeasured factors like sleep patterns and stress could also impact movement data.

Strengths of our study include the gender-inclusive approach, explicitly considering both genders to address the underdiagnosis issue in females and contribute to a more holistic understanding of ADHD. Leveraging the HYPERAKTIV dataset provided authentic patient data, enhancing the relevance of our findings. However, our study had shortcomings, notably the sample size limitations, restricting the generalizability of results. Future studies should aim for larger samples to improve statistical power. Additionally, the lack of information on previous

activity levels, gender rather than solely sex, and other confounders limited our analysis, suggesting that collecting comprehensive data on lifestyle factors would enhance accuracy.

In terms of future work, longitudinal studies could investigate movement patterns over time to capture dynamic changes, revealing trends and individual variations. Integrating movement data with other modalities like heart rate and sleep patterns may enhance diagnostic accuracy through a holistic approach. Further refinement of machine learning models, including exploration of advanced techniques and fine-tuning hyperparameters, could improve performance. Recording additional lifestyle variables such as stress levels and physical activity would address confounding effects more comprehensively.

In conclusion, while our study sheds light on gender-related differences in ADHD diagnosis using movement data, further research is essential to address limitations and expand methods, contributing to more accurate and equitable ADHD assessments.

Sources

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