

## Introduction

Physical activity monitoring is crucial to many chronic conditions such as heart failure, diabetes, and cancer. One of the simplest approaches to measure the physical activities that people perform daily, is to **count the number of the steps** they take during a day. Our goal in this study is:

- Investigating the step count accuracy on multiple activity monitor devices under various circumstances, e.g. with walker, cane, and shopping cart.
- Developing our own step count algorithm to detect steps from the smart phone accelerometer signals.

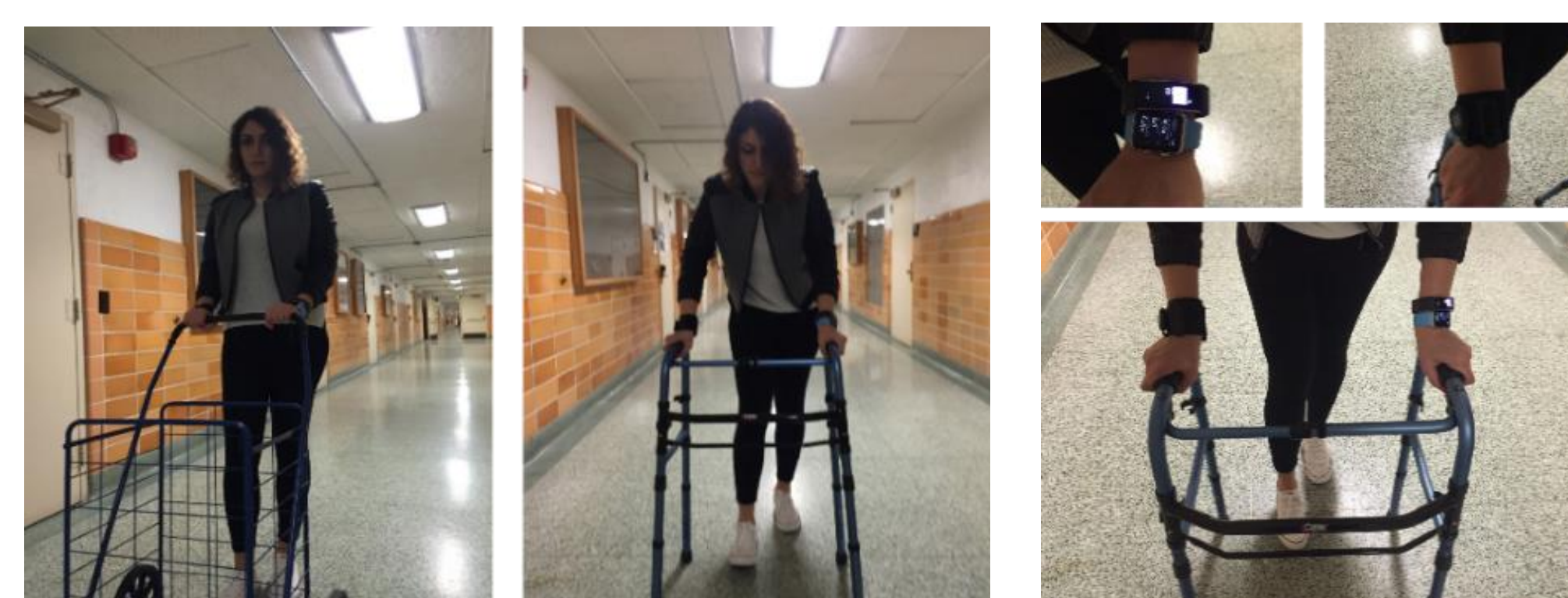
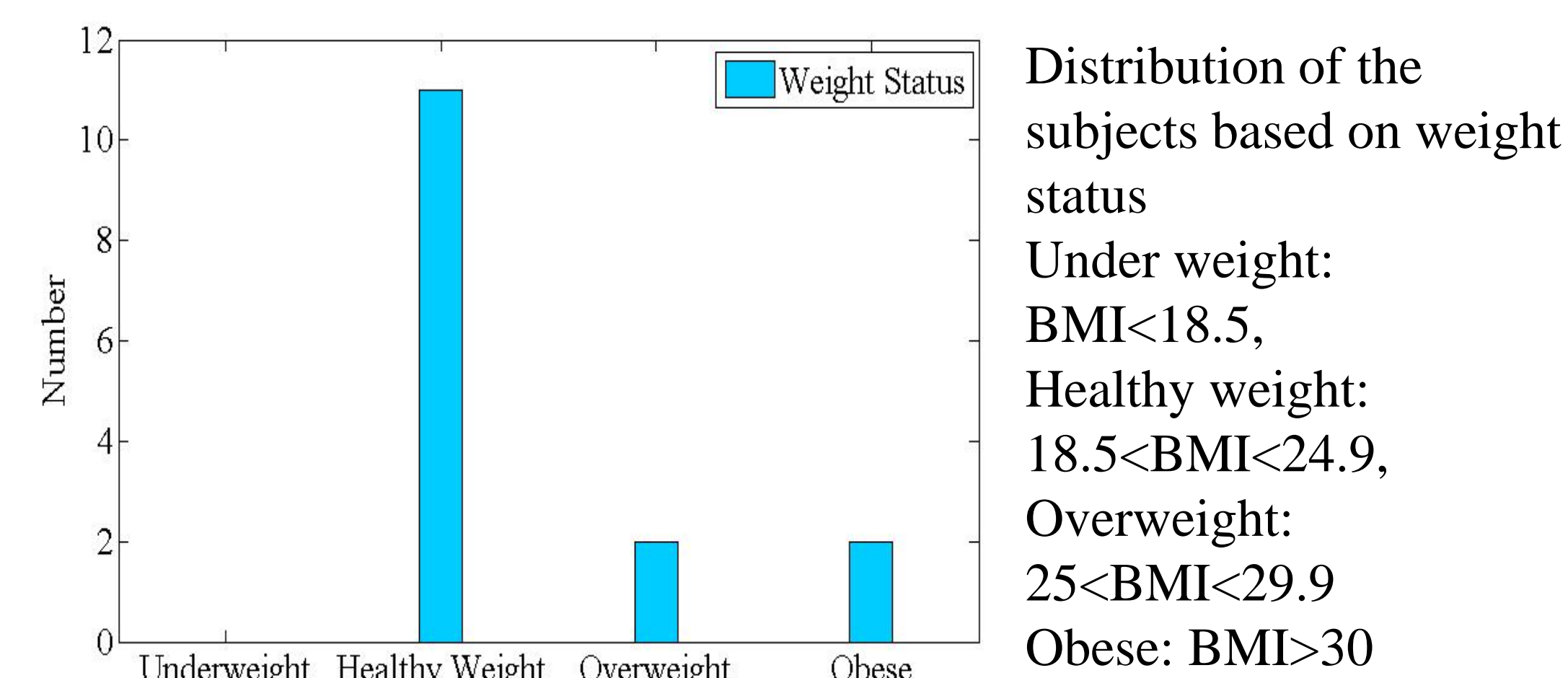
## Methods and Data Analysis

### Participants:

- 14 young adults, 1 old adult

Physical and demographic features of the participants in the primary experiment

Feature	All Subjects	Female	Male
Age (y)	21-44	21-44	23-31
Height (cm)	161-187	161-185	170-187
Weight (kg)	56-113	56-113	65-99
BMI ( $kgm^{-2}$ )	20.3-32.8	20.3-32.8	20.7-30.8
Stride Length	66.7-77.6	66.7-76.7	70.5-77.6



A participant while doing the shopping cart and walker experiments

### Activity Trackers

- Fitbit Charge (right hand)
- Misfit (right hand)
- Apple watch (left hand)
- Microsoft band (left hand)



Physical activities performed in the experiment (Each was conducted for almost 100 steps)

Activity#	Description
1	Normal Walking
2	Walking with gaps
3	Walking with hands in the pockets
4	Walking with a shopping cart
5	Walking with a walker
6	Walking with a cane

### 1 smart phone

- Samsung Galaxy S4 (waist)

### Camera

- Records video of the subjects

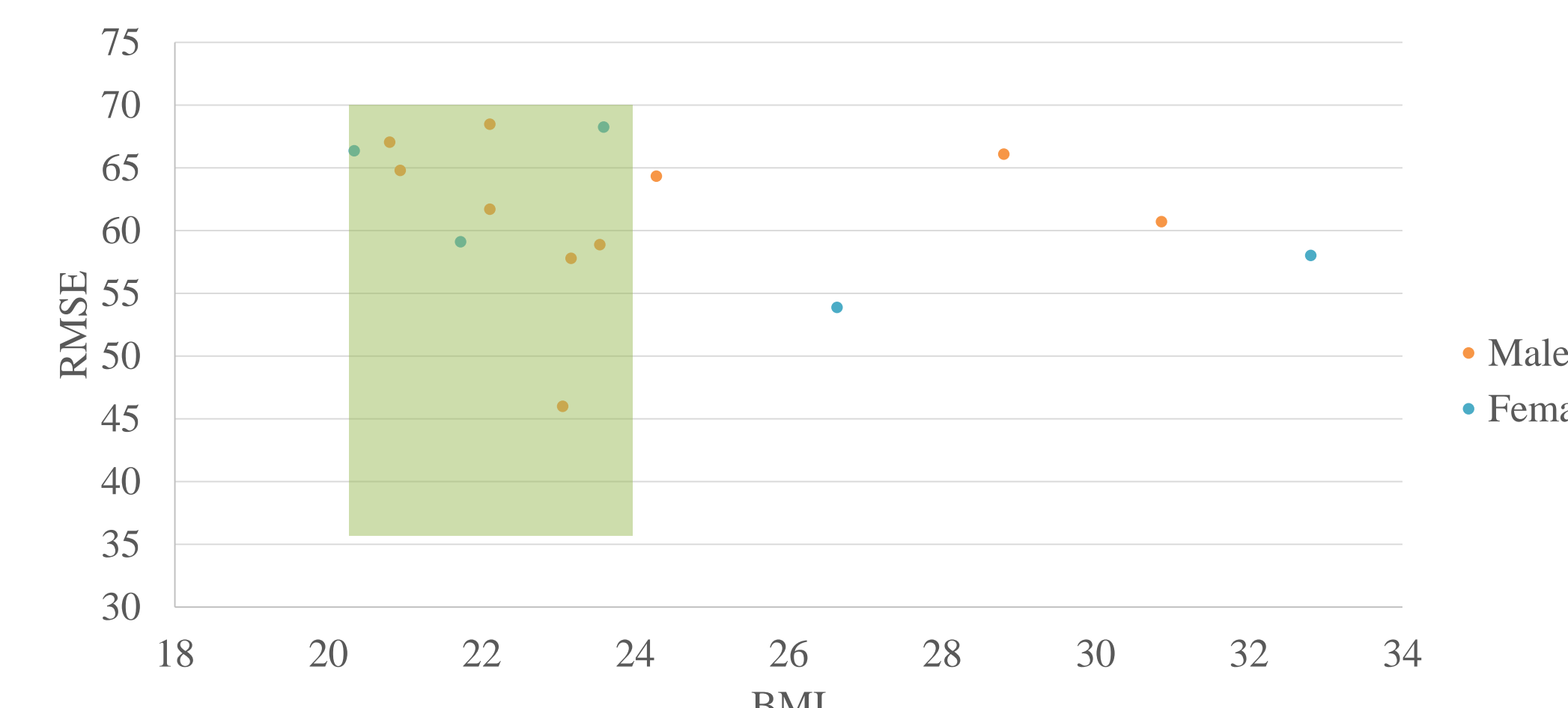
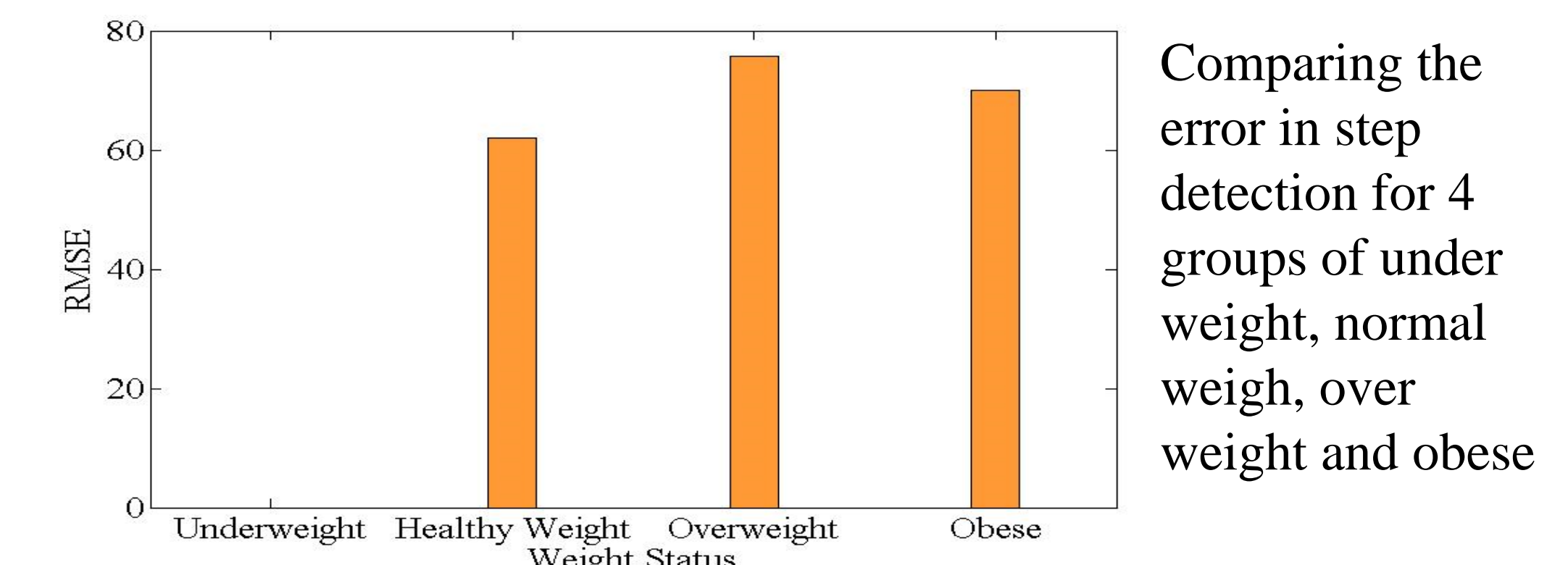
### Assistive Technologies

- Walker
- Pouch
- Cain
- Shopping Cart

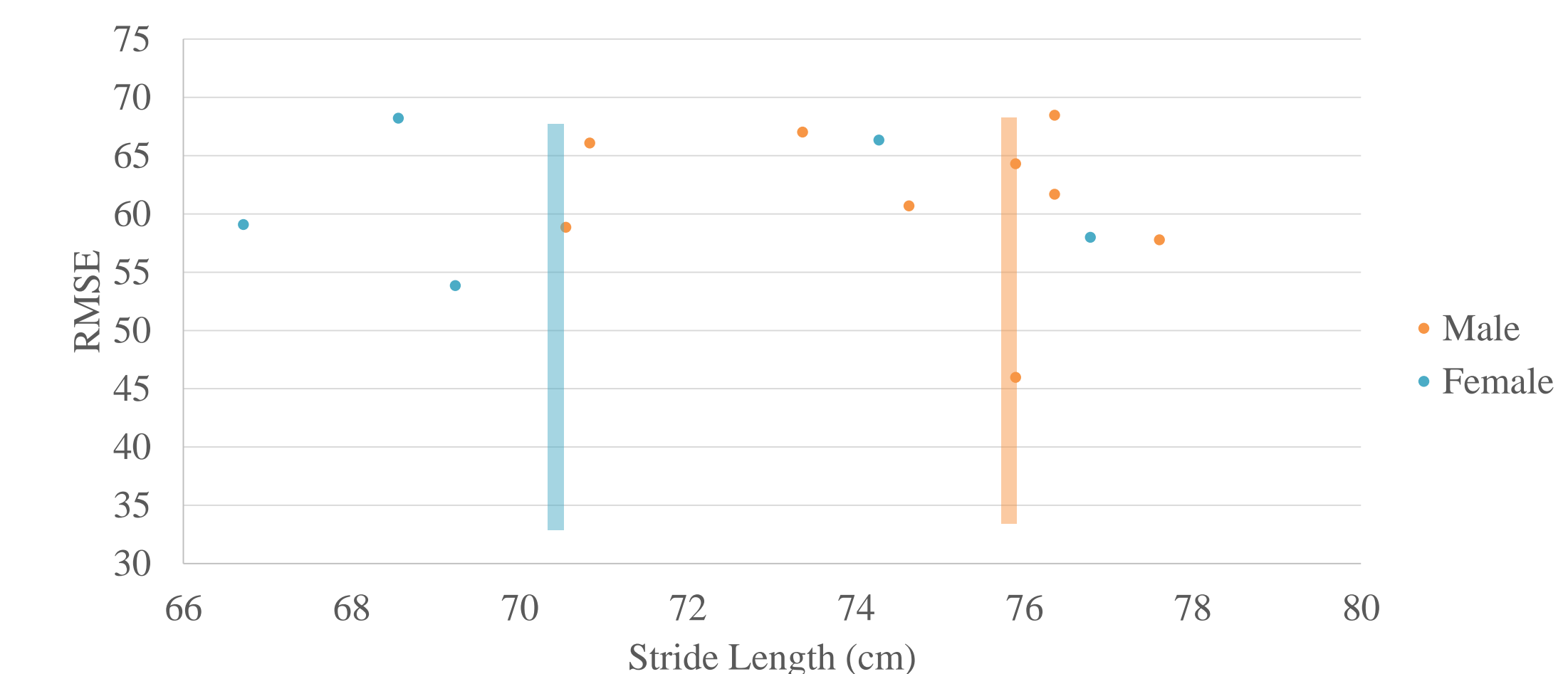


Activity Trackers	RMSE
Misfit	63.43
Fitbit Charge	62.80
Microsoft Band	64.91
Apple Watch	60.19

Average performance of each tracker in counting steps over all the activities



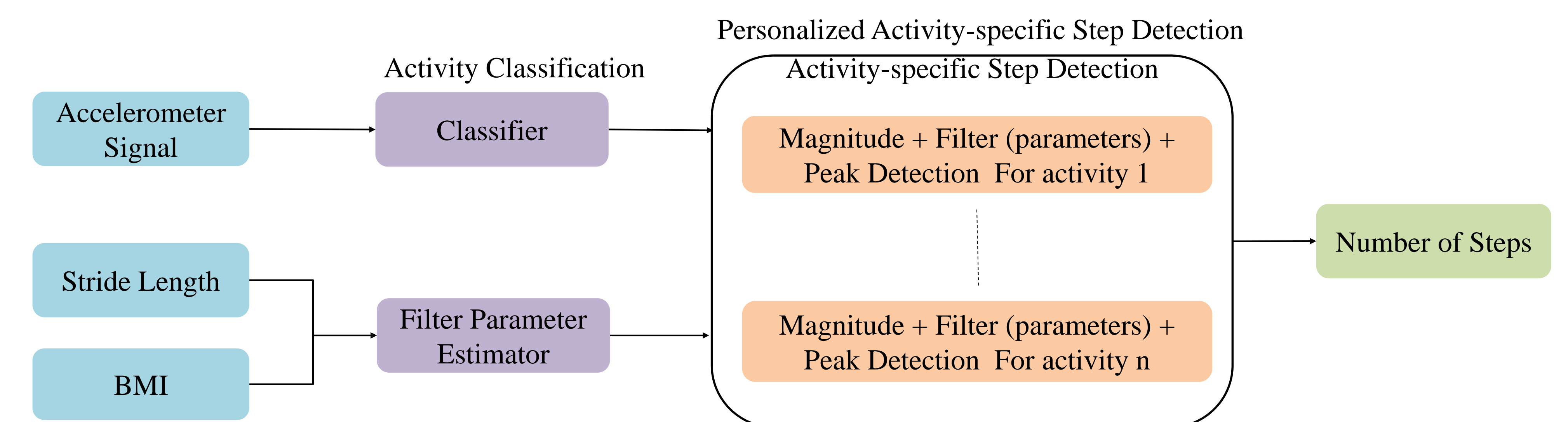
Effect of the BMI and stride length of the participants in RMSE of detecting steps



## Conclusion and Discussion

- The overall performance of the trackers wasn't satisfying in the experiment ( $60.19 < RMSE < 64.19$ ).
- The trackers were least accurate in the activities 4, 5 and 6, as hands are not involved in walking pattern.
- Misfit demonstrated a poor performance in all the physical activities.
- The steps were more accurately detected during the physical activities with pattern close to normal walking (activities 1, 2 and 3), as the trackers showed less error while walking normally, with gaps and while hands in the pockets.
- RMSE for the individuals with stride length close to average stride length tends to be less.
- RMSE for the individuals with BMI close to average healthy BMI value tends to be less.

These results demonstrate the requirement for more advanced algorithms to detect the steps. **Idea:** Taking the **type of the activity** (intensity) into account and is normalized based on the **BMI** and **stride length**.



## Acknowledgement

Research reported here was supported by the National Institutes of Health under award number R25AG046114.. We acknowledge Dr. Hassan Ghasemzadeh for helping during the process of this project, .

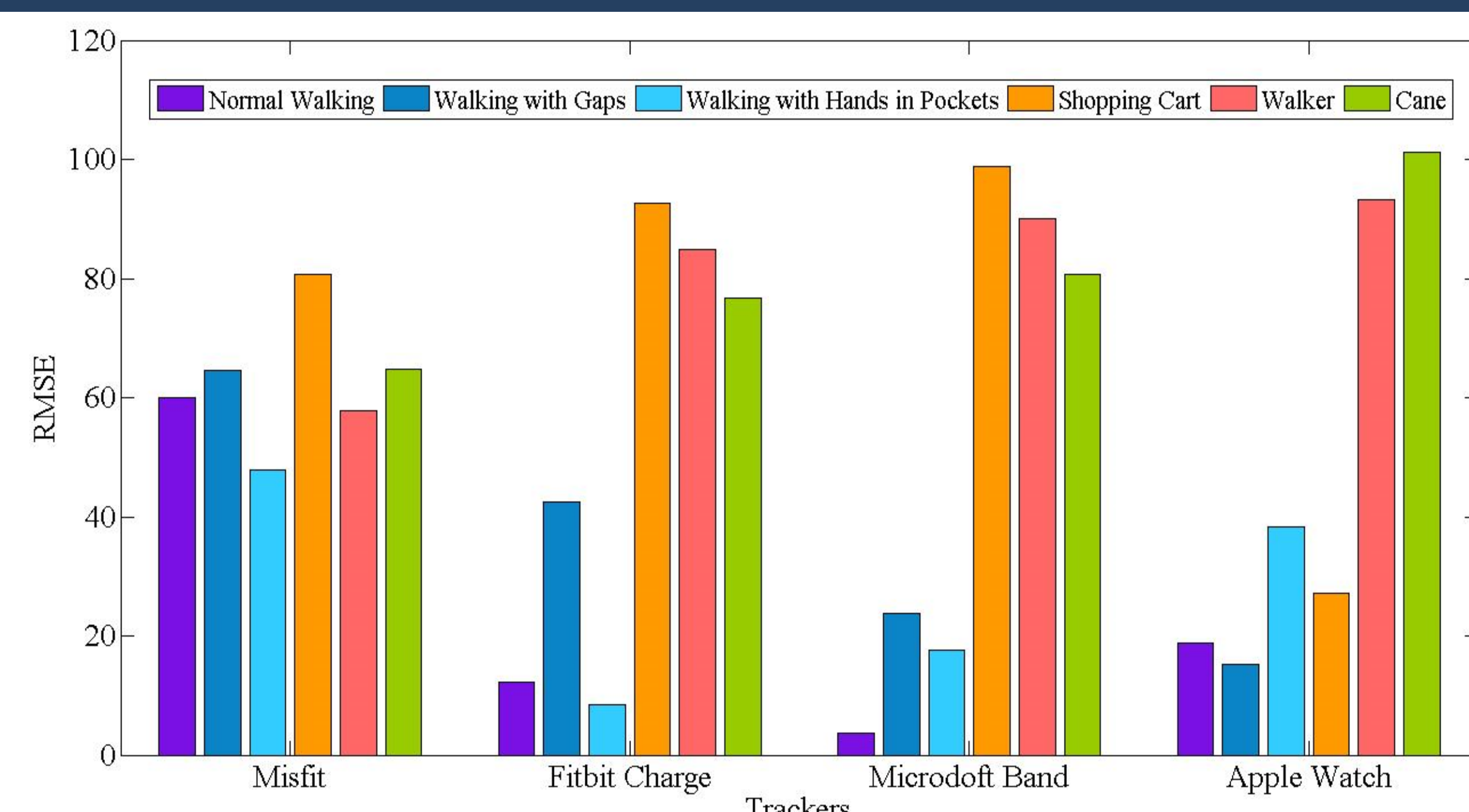
## References

A Comparative Review – 28 Days with the Fitbit One, Jawbone UP, Nike+ Fuel Band, and Body Media LINK  
 The validity of consumer-level, activity monitors in healthy adults worn in free-living conditions: a cross-sectional study, Ty Ferguson, Alex V Rowlands, Tim Olds and Carol Maher  
 Validation of the Fitbit One activity monitor device during treadmill walking, Takacs J, Pollock CL, Guenther JR, Bahar M, Napier C, Hunt MA  
 Validity of the *Fitbit* activity tracker for measuring steps in community-dwelling older adults ,Serene S Paul,Anne Tiedemann,Leanne M Hassett,Elisabeth Ramsay,Catherine Kirkham,Sakina Chagpar  
 Step Detection and Activity Recognition Accuracy of Seven Physical Activity Monitors, Fabio A. Storm, Ben W. Heller, and Claudia Mazzà

## Results

Performance of the trackers (except misfit) in counting steps for each activity

Activities	RMSE
Normal Walking	11.56
Walking with gaps	27.18
Walking with hands in the pocket	21.46
Walking with a shopping cart	72.82
Walking with a walker	89.42
Walking with a cane	86.14



RMSE of recording steps for each tracker during various physical activities