NHANES 2013-14 Data Analysis Research Presentation

Rameen Saeed

PRESENTATION OUTLINE

1. Introduction

   a. Background + Project Goals

   b. NHANES Dataset

   c. Summary of Contributions

2. Preliminary Visualizations

3. Activity Level Analysis

4. Linear Model Analysis

5. Summary of Conclusions

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Background

- NHANES = National Health & Nutritional Examination Surveys
    - Conducted every year by CDC
    - ~ 5000 people
    - each person represented by a unique ID called "SEQN"
    - Oversampling: hispanics, black persons, white persons below poverty level, & white persons 80+

- Focus: 2013 - 2014 Cycle
    - Data: Demographics, Examination, Laboratory

Project Goals

- Visualizing + analyzing physical activity trends at the hour, day, & week levels

- Viewing physical activity breakdowns between different age groups & comparing them

- Observing how trends in physical activity and other demographic data affect the following 3 health indicators:

  1. Waist Circumference (cm)

  2. BMI (kg/m^2)

  3. Total Cholesterol (mg/DL)

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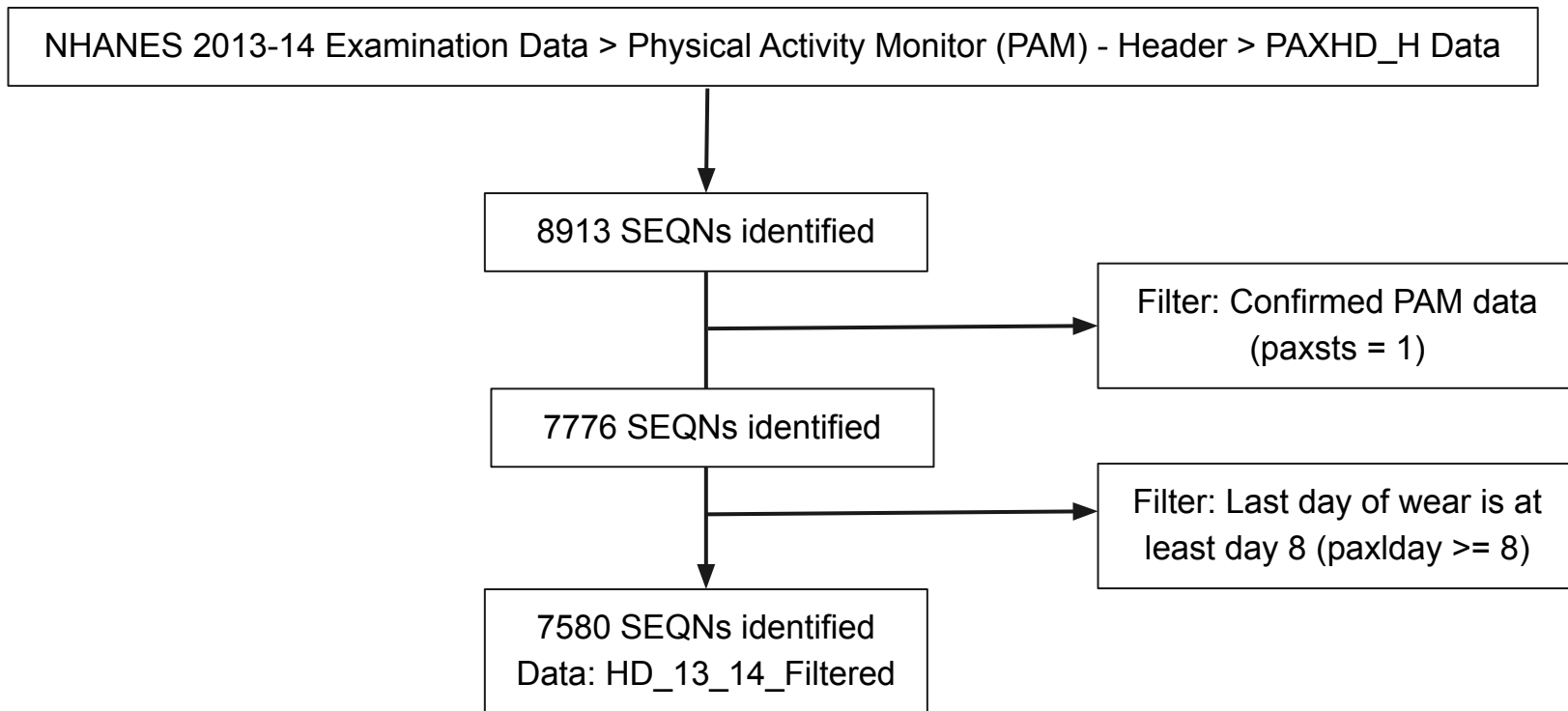
5. Summary of Conclusions

Main Datasets:

1. Examination Data > Physical Activity Monitor - Header (PAXHD_H)
   - Participants told to wear physical activity monitor (PAM) for 9 days (days 1 & 9 have partial data)

2. Examination Data > Physical Activity Monitor - Day (PAXDAY_H)

3. Examination Data > Physical Activity Monitor - Hour (PAXHR_H)

4. Examination Data > Body Measures (BMX_H)

5. Demographics Data > Demographic Variables and Sample Weights (DEMO_H)

6. Laboratory Data > Cholesterol - Total (TCHOL_H)

MIMS:

- Purpose: develop a universal open source acceleration summary metric that is not dependent on device specifications

- Derived from raw acceleration data (in g):
  - interpolation, extrapolation, bandpass filtering, and aggregation conducted independently using empirically determined time and frequency-domain parameters -> software algorithm

- Our dataset:
  - PAM worn on wrist
  - Measure x,y,z acceleration every 1/80th sec (80 Hz)
  - Measure lux light vals every sec (1 Hz)

Header Flowchart

NHANES 2013-14 Examination Data > Physical Activity Monitor (PAM) - Header > PAXHD_H Data

↓

8913 SEQNs identified

→ Filter: Confirmed PAM data (paxsts = 1)

7776 SEQNs identified

→ Filter: Last day of wear is at least day 8 (paxlday >= 8)

7580 SEQNs identified
Data: HD_13_14_Filtered

Day Flowchart

NHANES 2013-14 Examination Data > Physical Activity Monitor (PAM) - Day > PAXDAY_H Data

7776 SEQNs identified

Filter: Full day's worth of data only (paxvmd >= 1440)

7659 SEQNs identified
Data: Day_13_14_Filtered

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CONTRIBUTIONS

- Created visualizations to highlight differences in activity levels between the day of the week & age groups

- Converted between the MIMS acceleration summary metric to 1 of 5 activity levels

- Viewed breakdown of activity levels according to each age group

- Performed linear regression to examine how activity levels & other demographic variables affect waist circumference, BMI, & total cholesterol levels

MAIN FINDINGS

- Activity Levels:

  - Weekdays vs. Weekends

  - Decrease with Age

- Age, height, and vigorous physical activity appear as most statistically significant variables affecting waist circumference & BMI

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2. **Preliminary Visualizations**

3. Activity Level Analysis

4. Linear Model Analysis
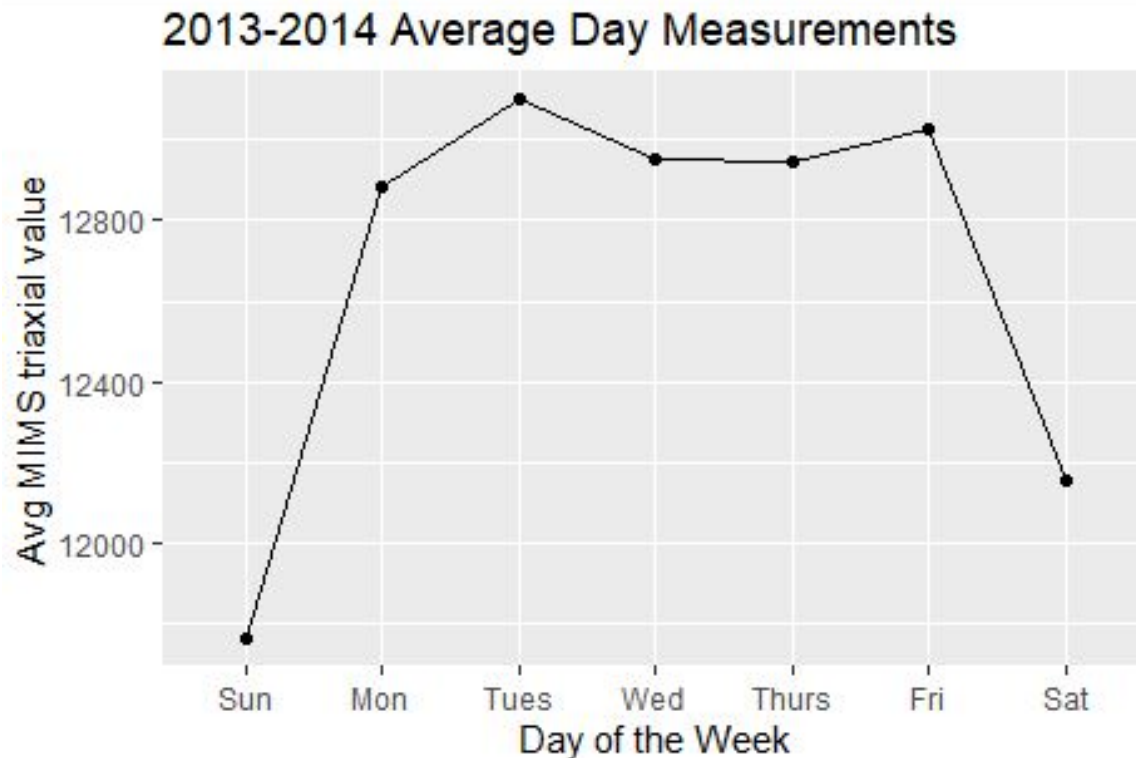
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Header Visualization

2013-14 Day Measurements Started
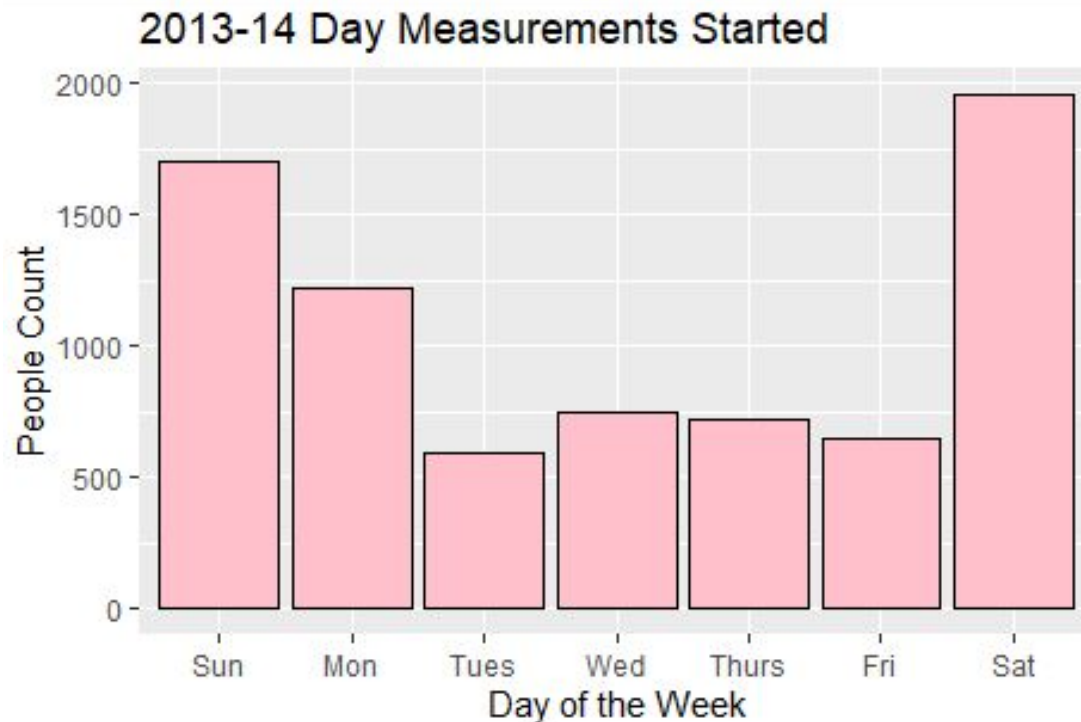
- Day of week conversion: 1(Sun).....7(Sat)

- Most measurements started on weekend

Day Visualization

2013-2014 Day Measurements
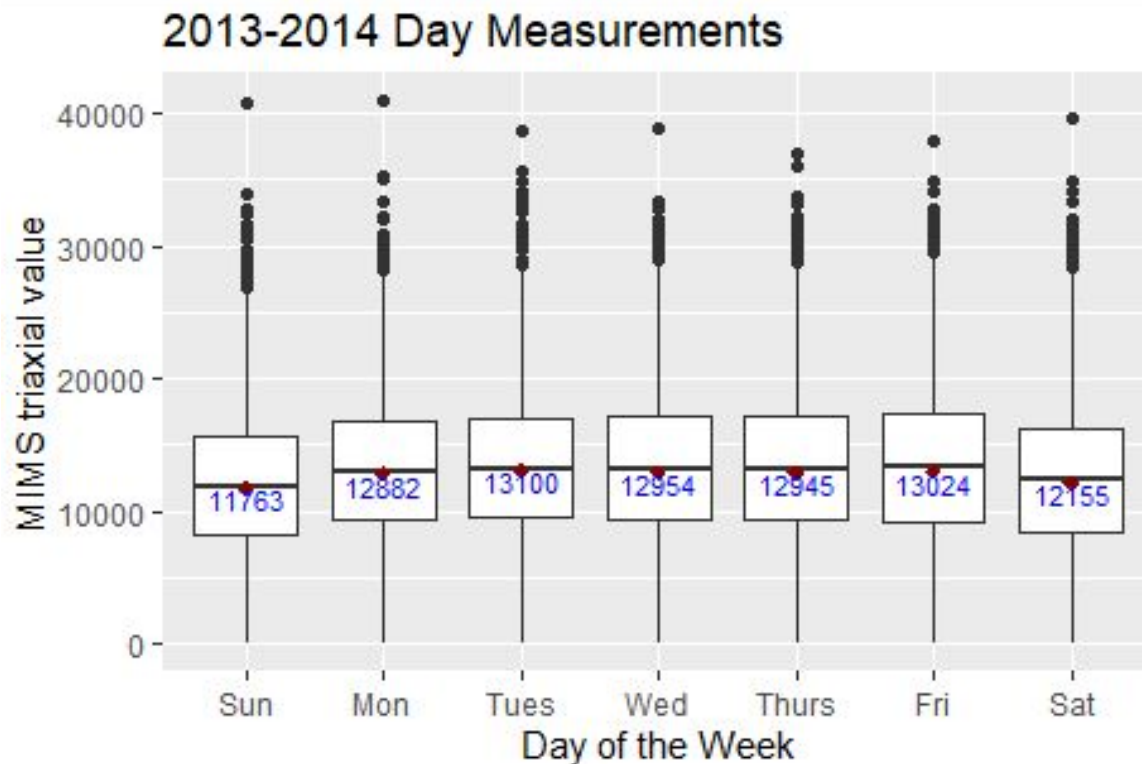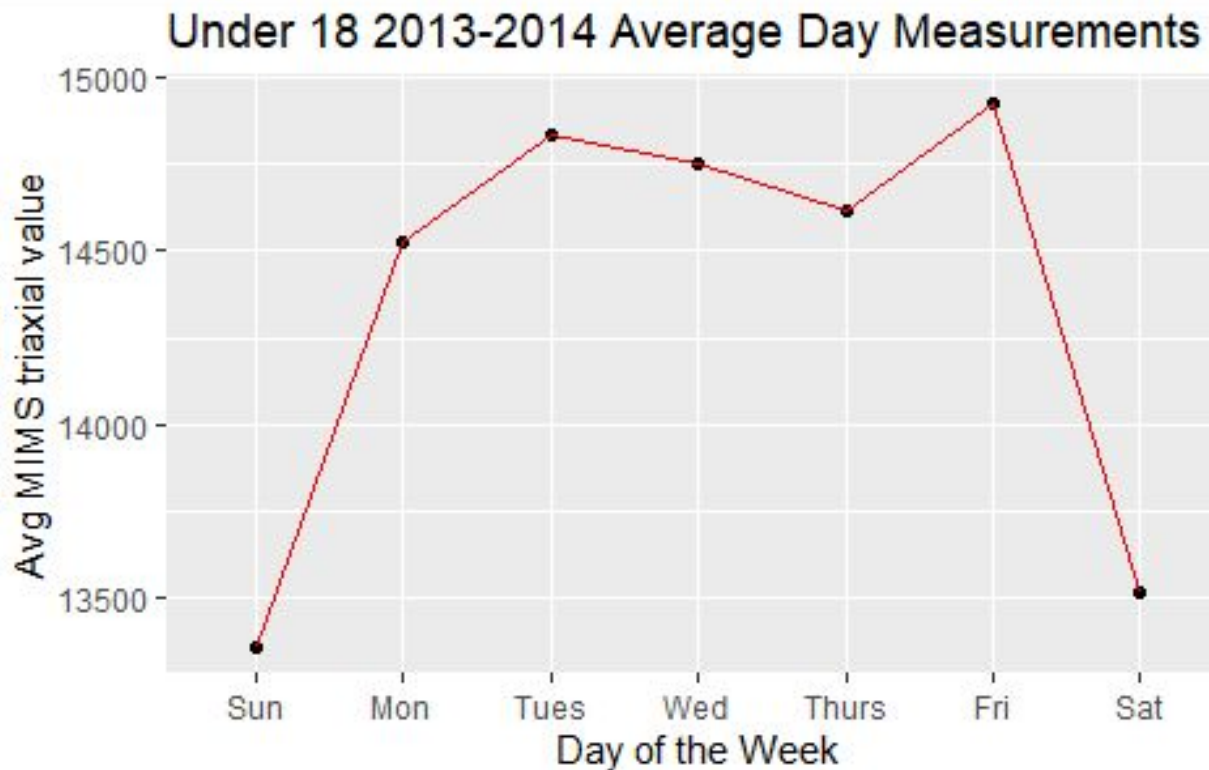
- Day of week conversion: 1(Sun).....7(Sat)

- Avg MIMS value for all SEQNs based on day of the week

Day Visualization

2013-2014 Average Day Measurements
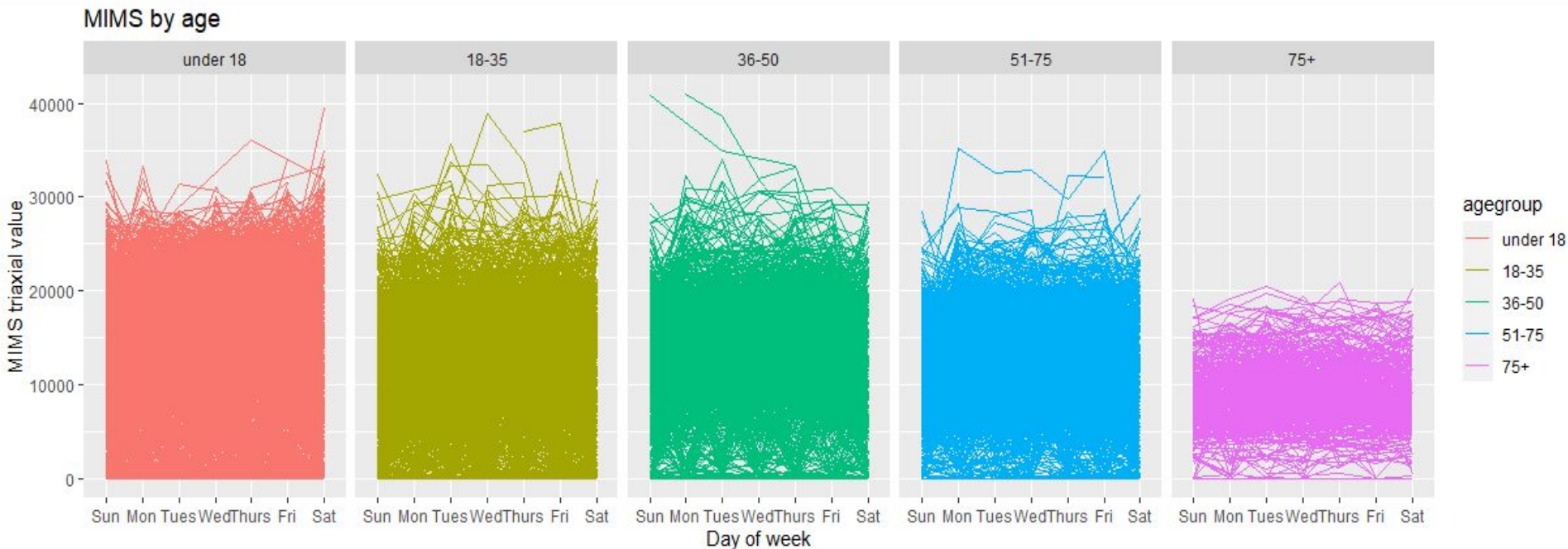
- Weekends have lower activity measures while Tuesday has the highest

Under 18 Day Visualization

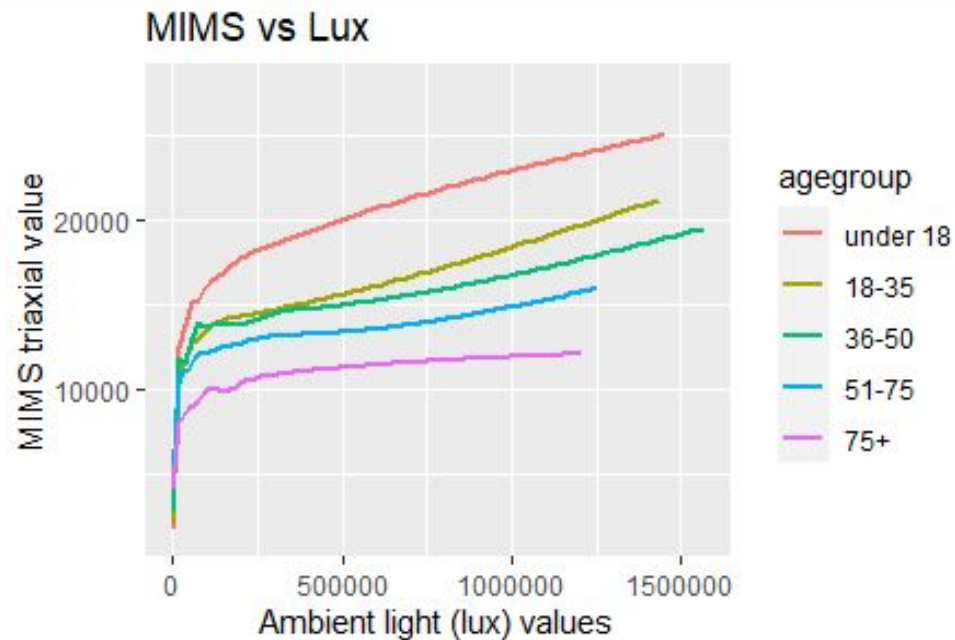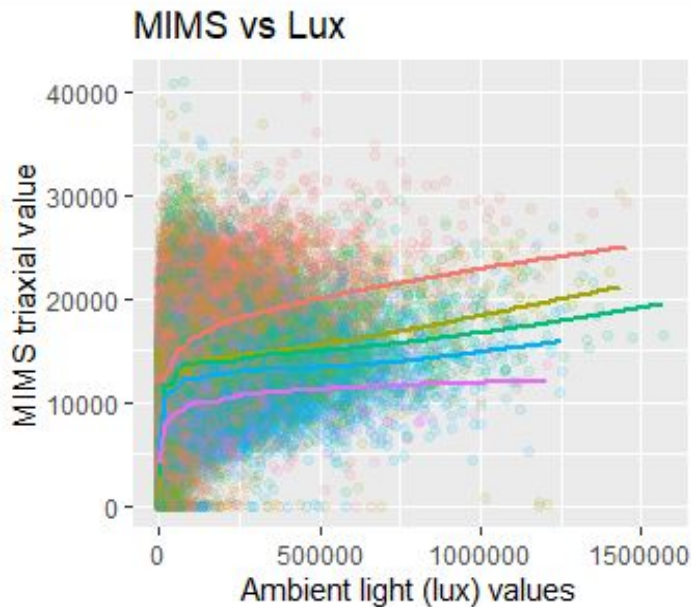Under 18 2013-2014 Average Day Measurements

- Study showed children accumulate significantly more activity on the structured weekdays than the weekends

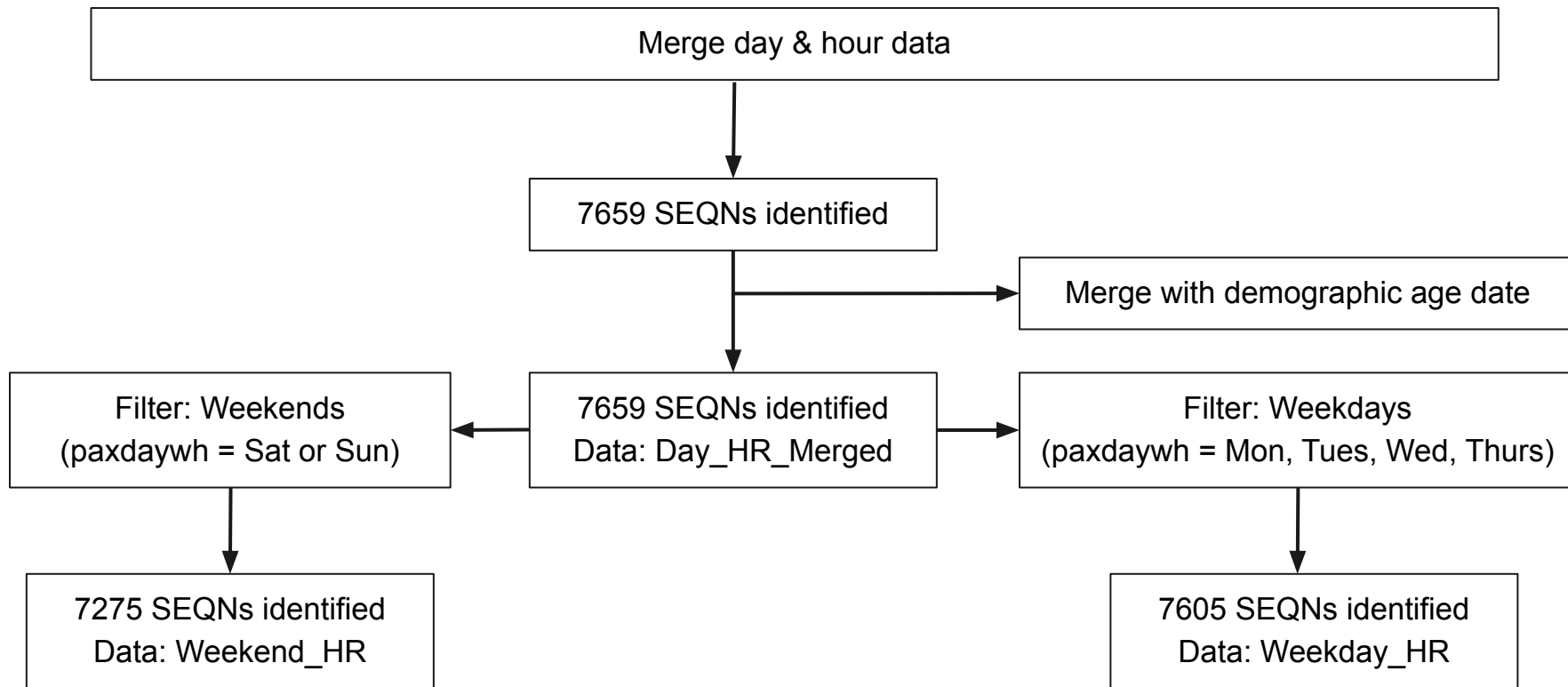- Important to provide more opportunities for activity on the weekends

Merged: Day & Age

MIMS by age

Merged: Day & Age

Merged Flowchart: Day, Hour, & Age

```
                    Merge day & hour data
                            |
                            v
                   7659 SEQNs identified
                            |
                            |-------------------> Merge with demographic age date
                            v
  Filter: Weekends  <--  7659 SEQNs identified  -->  Filter: Weekdays
  (paxdaywh = Sat or Sun)   Data: Day_HR_Merged      (paxdaywh = Mon, Tues, Wed, Thurs)
        |                                                    |
        v                                                    v
  7275 SEQNs identified                              7605 SEQNs identified
  Data: Weekend_HR                                   Data: Weekday_HR
```
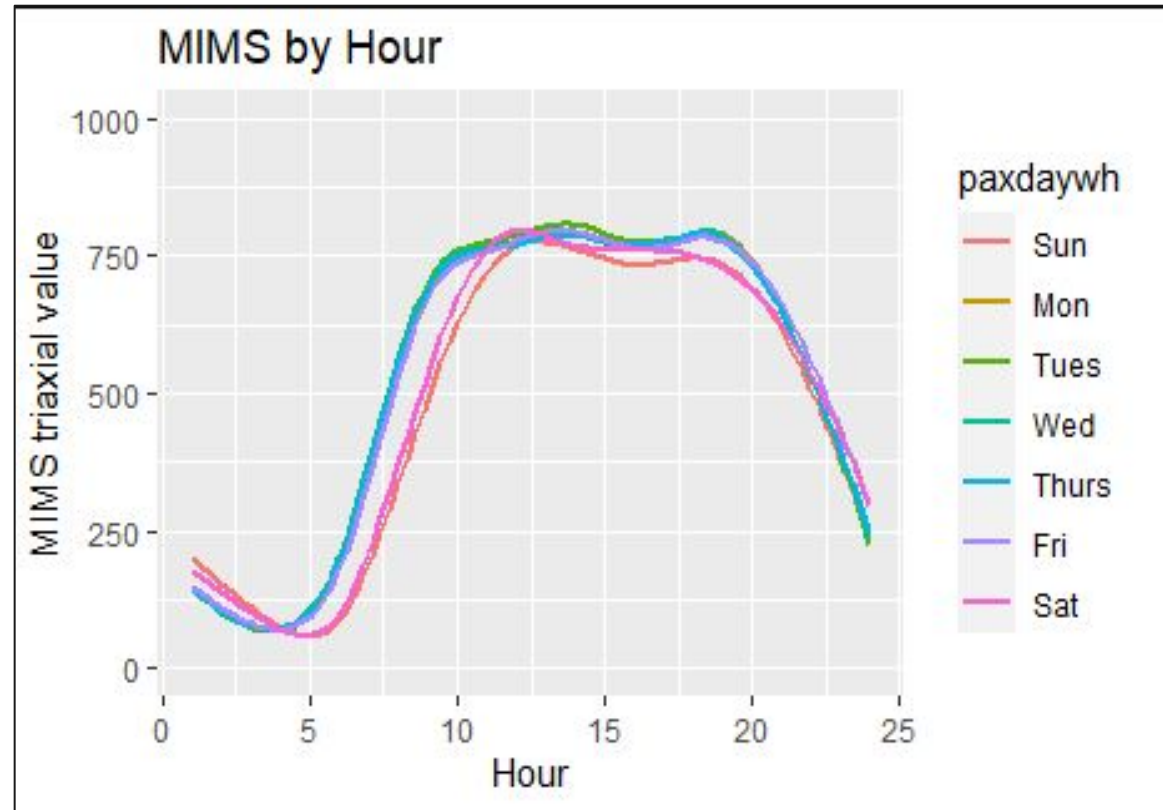
Filter

|	seqn	wtmec2yr Full sample 2 year MEC exam weight	hour	paxdayh Day of PAM measurements for this hour	paxdaywh Day of the week for this hour
1	73557	13481.04	1	2	Wed
2	73557	13481.04	2	2	Wed
3	73557	13481.04	3	2	Wed
4	73557	13481.04	4	2	Wed
5	73557	13481.04	5	2	Wed
6	73557	13481.04	6	2	Wed
7	73557	13481.04	7	2	Wed
8	73557	13481.04	8	2	Wed
9	73557	13481.04	9	2	Wed
10	73557	13481.04	10	2	Wed
11	73557	13481.04	11	2	Wed
12	73557	13481.04	12	2	Wed
13	73557	13481.04	13	2	Wed
14	73557	13481.04	14	2	Wed
15	73557	13481.04	15	2	Wed
16	73557	13481.04	16	2	Wed

Daily Hour Visualization

Graphed each hour vs MIMS pair for every SEQN & created smooth lines based on day of week
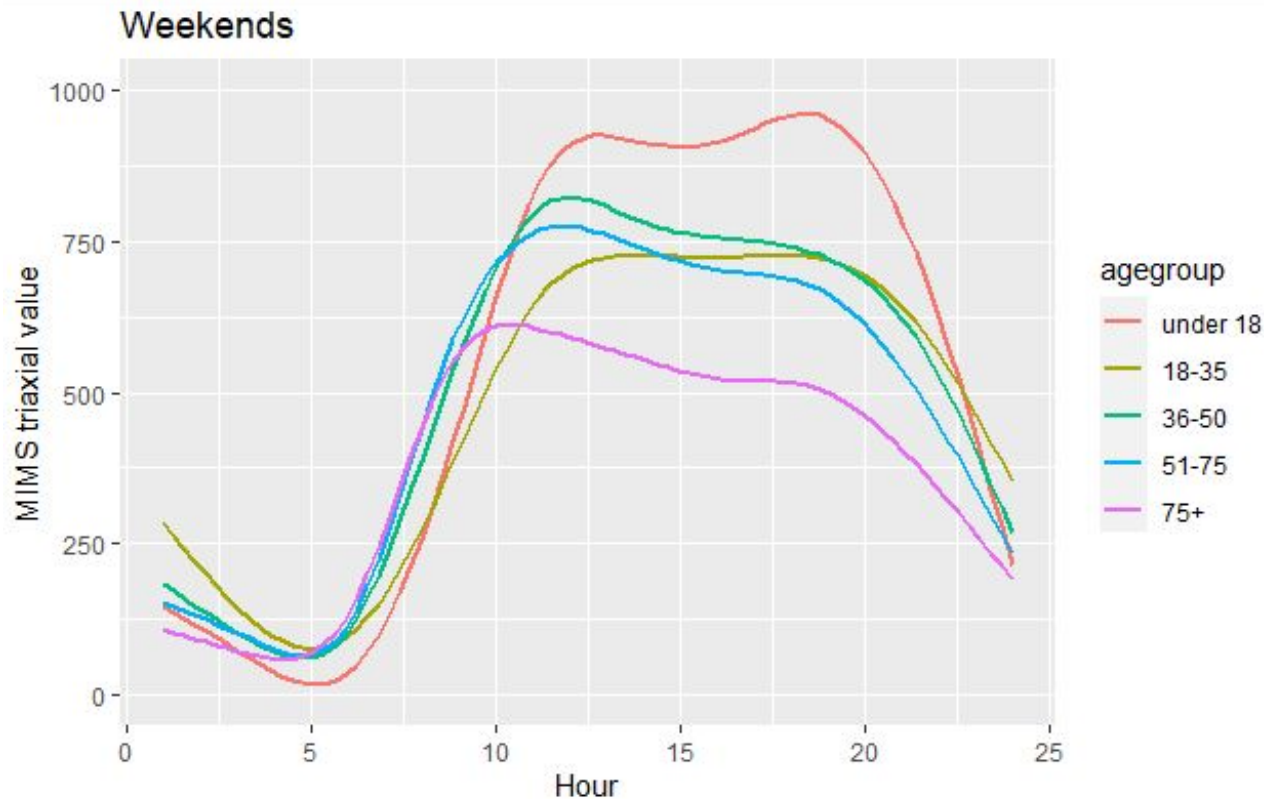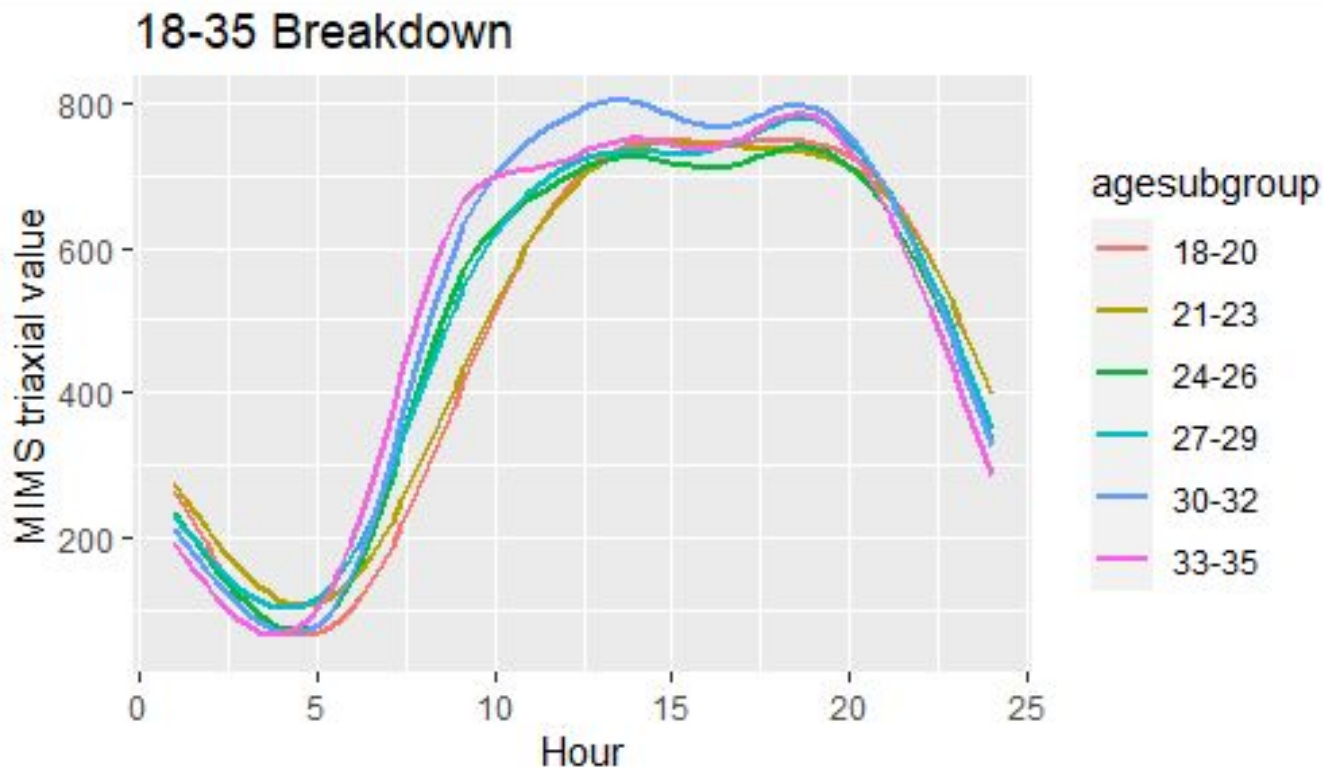
Same trend with lower activities for weekends

Weekday Hours
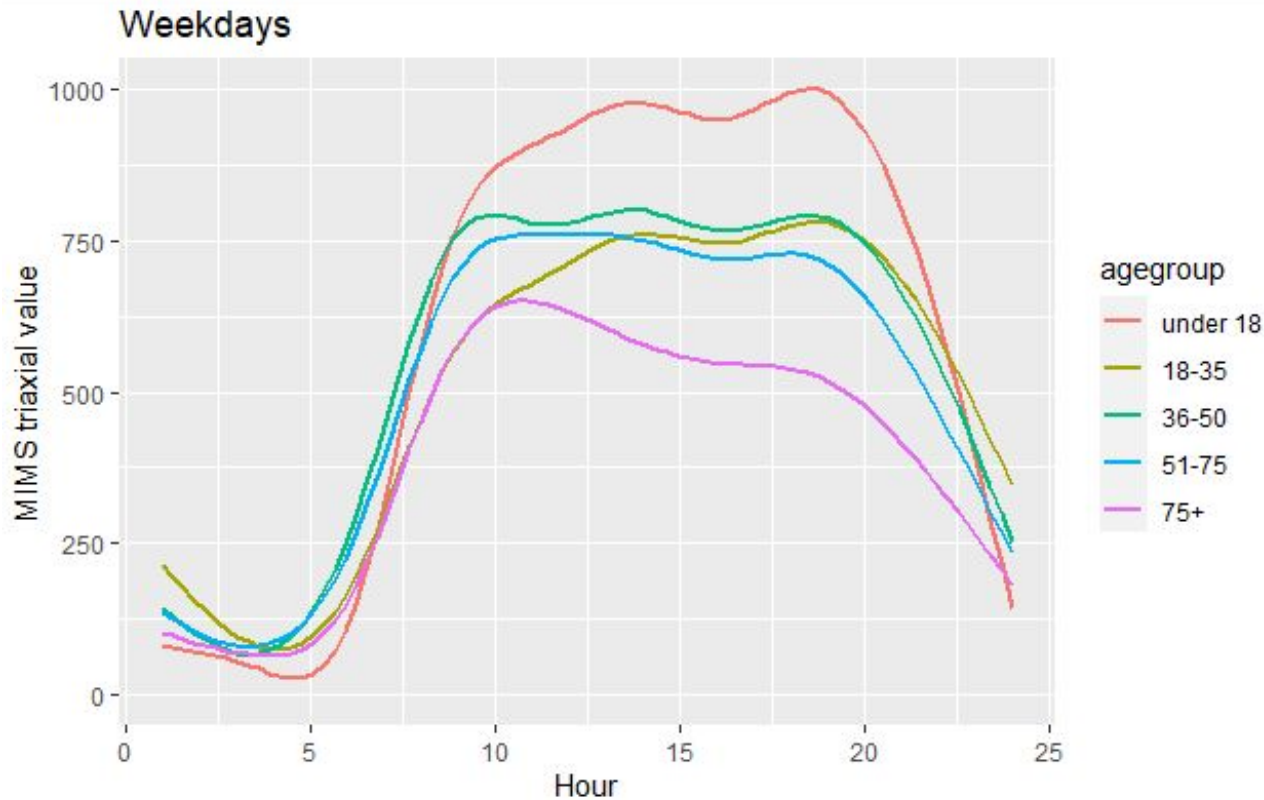
Weekend Hours

18-35 Analysis

18-35 Breakdown

Merged Flowchart: Header, Hour, & Age

Merge header & hour data

↓

7580 SEQNs identified

Merge with demographic data

Filter: exclude day 1 & 9 observations
(paxdayh != 1 & paxdayh != 9)

7580 SEQNs identified

Filter: Grab SEQN that have full week
of **valid** minutes
(paxvmh= 10080 mins)

3654 SEQNs identified
Data: Week_13_14

Weekly Hour Visualization

Day of week conversion: 1(Sun).....7(Sat)

Equation =

minimim_positive(24*(firstday-1) + firstday timestamp + paxssnhp/288000 , 24*(firstday-1) + firstday timestamp + paxssnhp/288000 **- 168**)

Week_13_14 | merged_ageday_13_14

Filter

ridageyr Age in years at screening	riagendr	dmdeduc3	dmdeduc2	indhhin2	agegroup	hrsincesun
69	1	NA	3	4	51-75	72
69	1	NA	3	4	51-75	73
69	1	NA	3	4	51-75	74
69	1	NA	3	4	51-75	75
69	1	NA	3	4	51-75	76
69	1	NA	3	4	51-75	77
69	1	NA	3	4	51-75	78
69	1	NA	3	4	51-75	79
69	1	NA	3	4	51-75	80
69	1	NA	3	4	51-75	81
69	1	NA	3	4	51-75	82

Day	"Hours Since Sunday"
Sunday	0-23
Monday	24-47
Tuesday	48-71
Wednesday	72-95
Thursday	96-119
Friday	120-143
Saturday	144-167

Weekly Hour Visualization

Seqn 73557

Weekly Hour Visualization

Seqn 74176

Weekly Hour Visualization

Seqn 74176
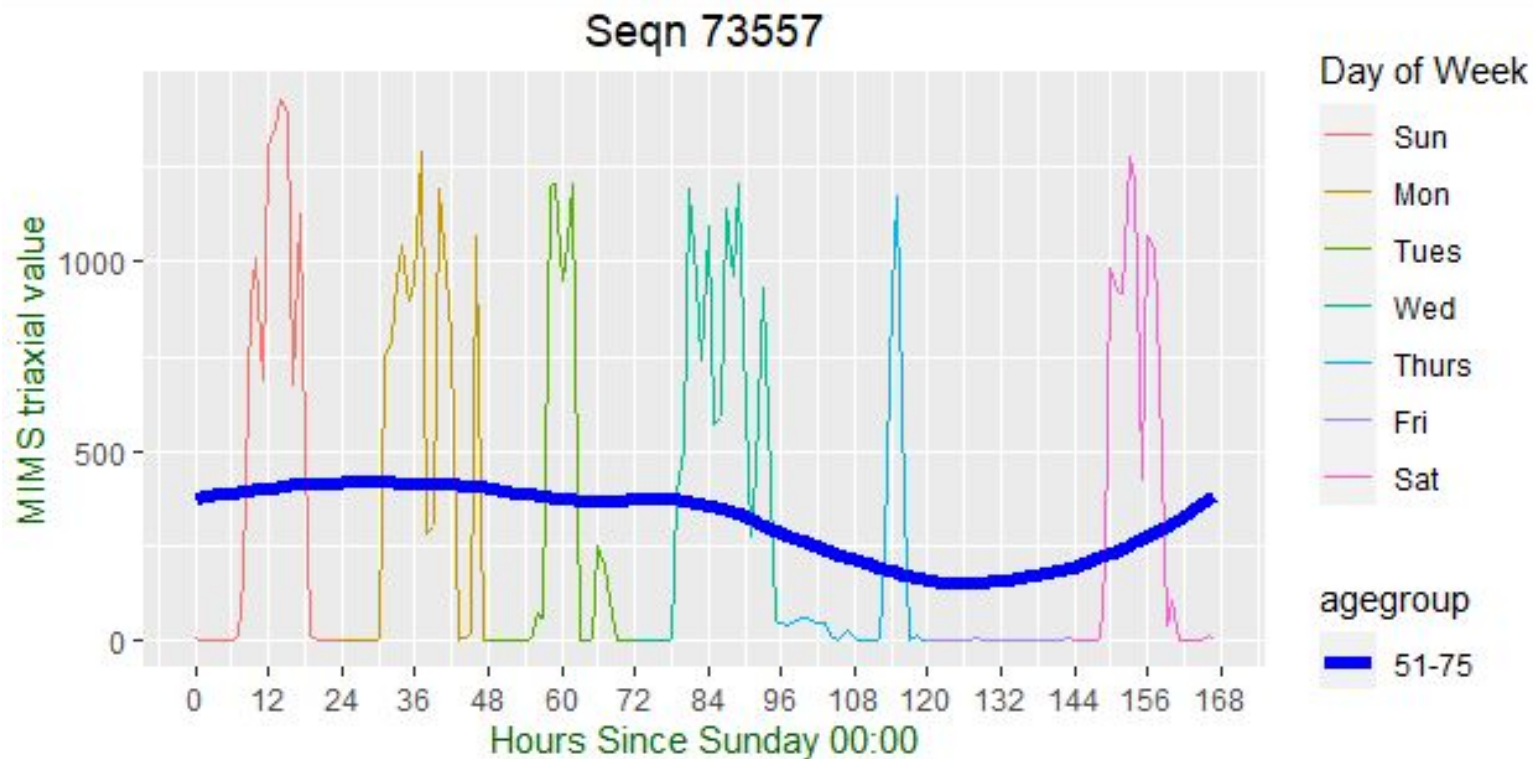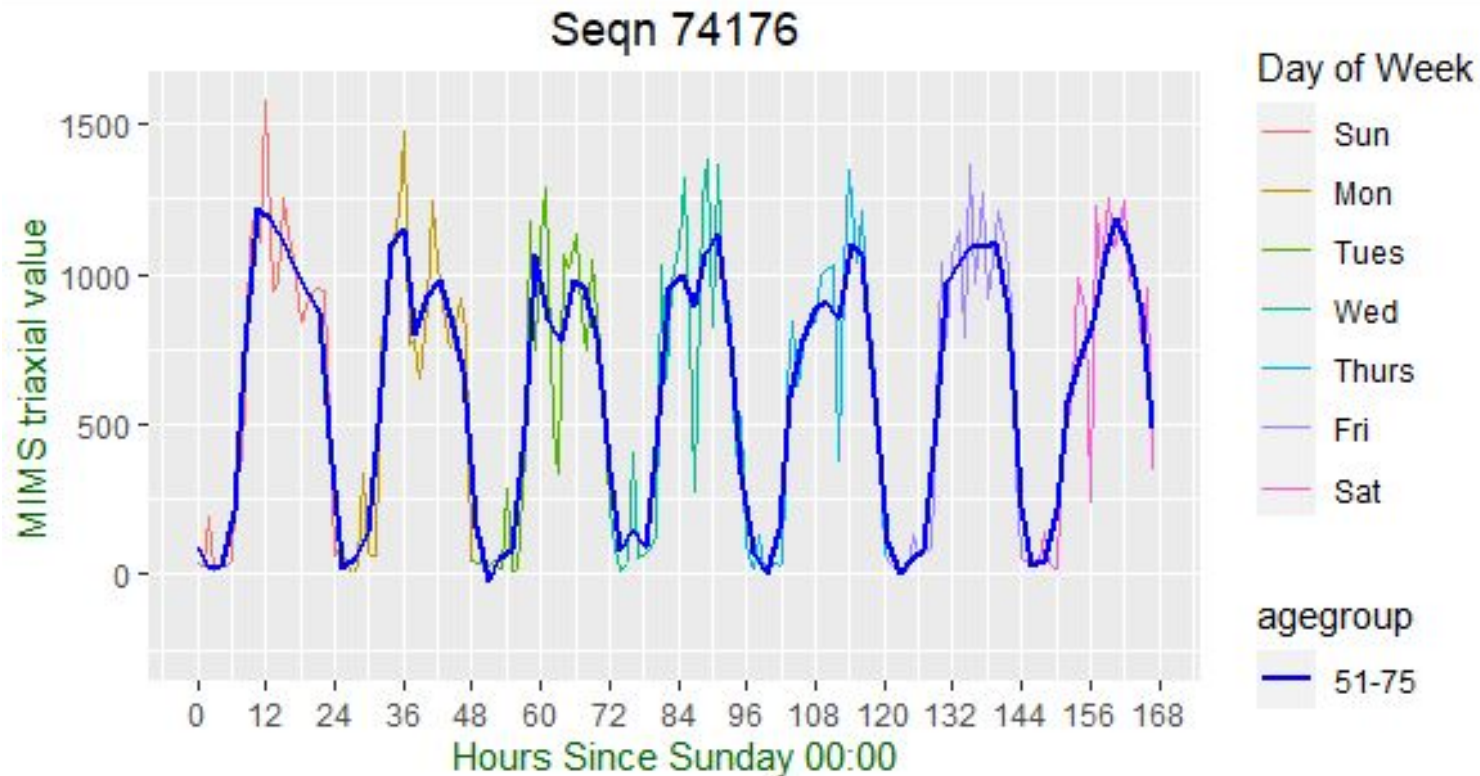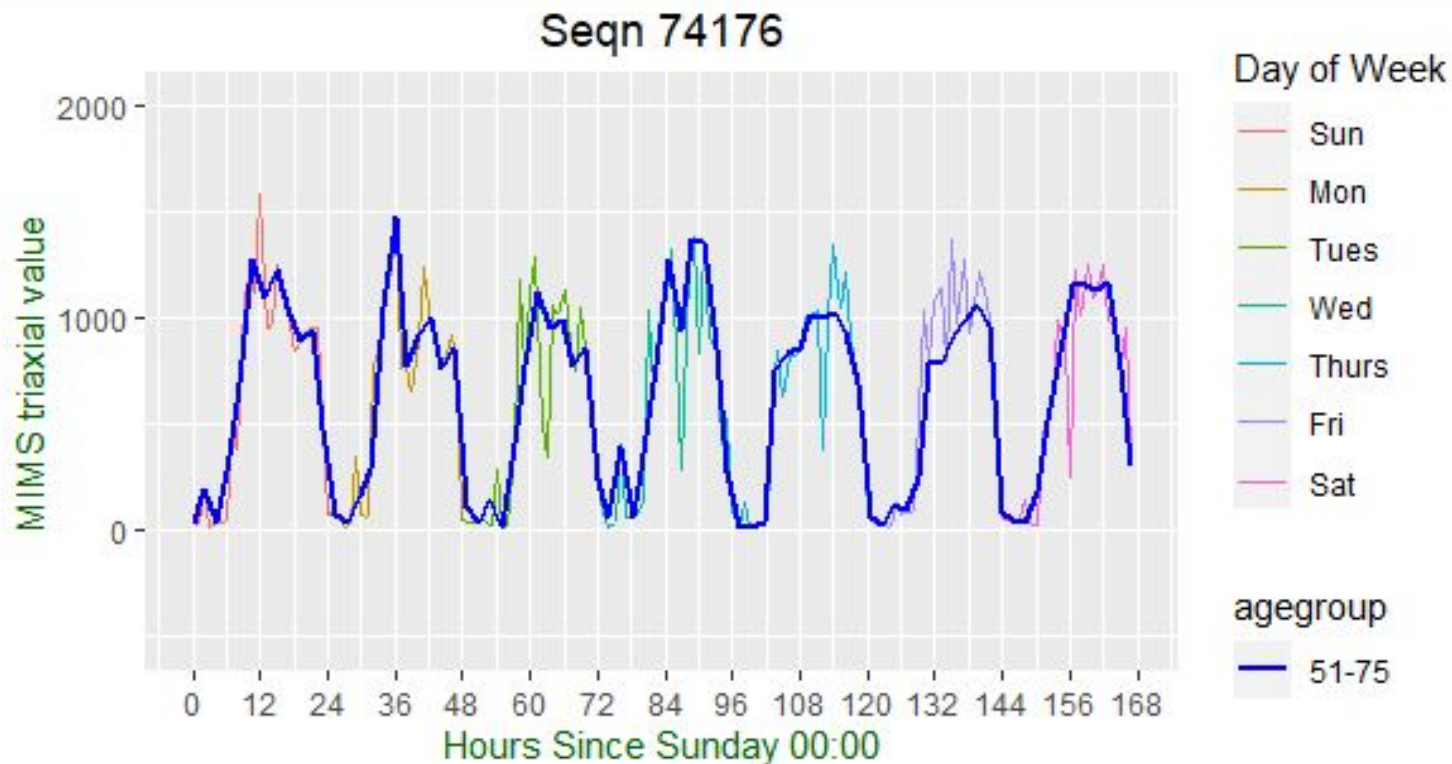
Weekly Hour Visualization

Physical Activity over the Week

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- Purpose: develop a universal open source acceleration summary metric that is not dependent on device specifications

- Derived from raw acceleration data (in g):
  - interpolation, extrapolation, bandpass filtering, and aggregation conducted independently using empirically determined time and frequency-domain parameters -> software algorithm

- Our dataset:
  - PAM worn on wrist
  - Measure x,y,z acceleration every 1/80th sec (80 Hz)
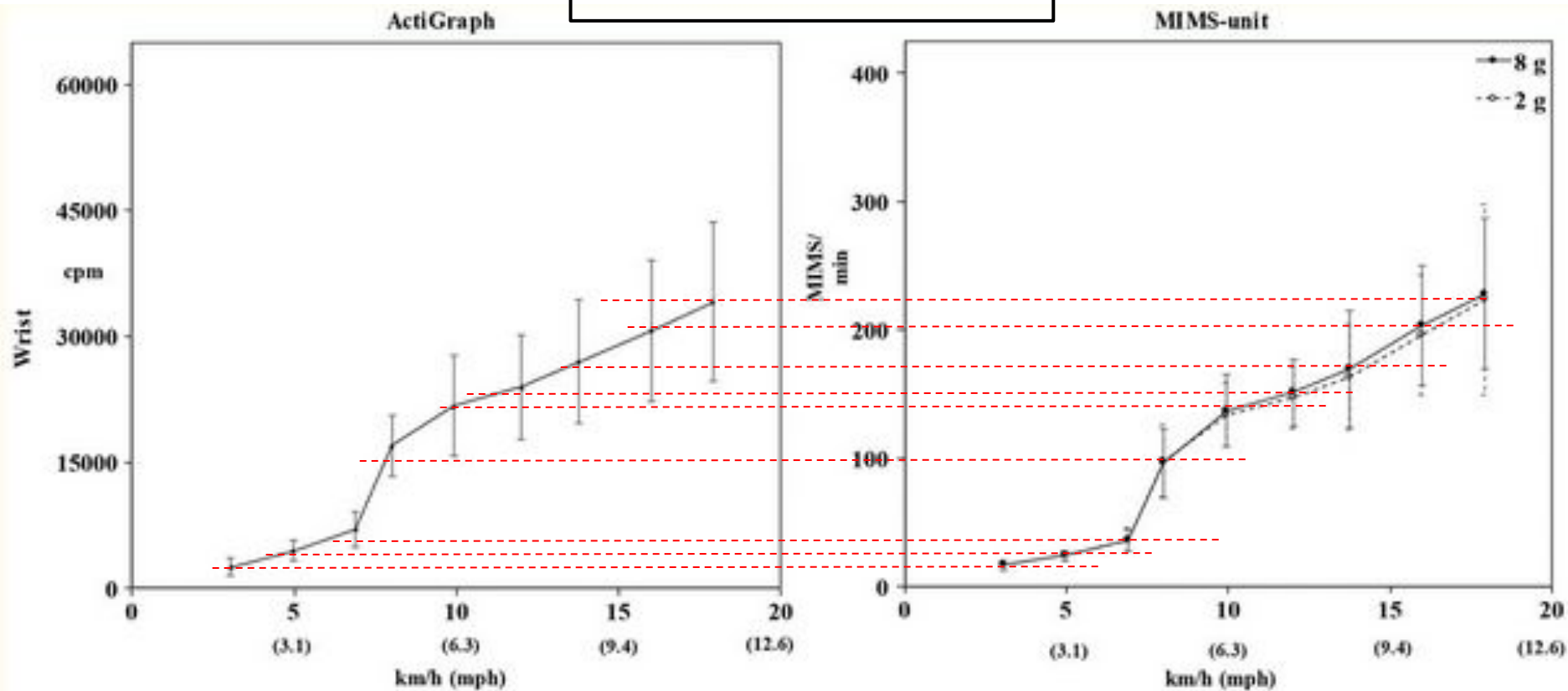 - Measure lux light vals every sec (1 Hz)

1 MIMS/min -> 150 cpm

**Figure 4**

Activity Level				
	Sedentary (SD)	Light (LPA)	Moderate (MPA)	Vigorous (VPA)
cpm	0-100	101-2019	2020-5998	5999+
MIMS/min	0-.667	.67-13.46	13.46-39.98	39.99+
MIMS/hr (~x60)	0-40	41-807	808-2399	2400+

Table 1: Physical Activity Levels obtained from NHANES 2003-04 cpm date by Troiano & colleagues[1]. Conversion made to MIMS/min using figure 4 in an article published by researchers at Northeastern University (John et al., 2019)[2]. The conversion unit is 1 MIMS/min = 150 cpm.

Activity Level for the Hour		
Sleep (SL)	Non-Wear (NW)	Unknown (UN)
Paxswmh >= 30	Paxnwmh >= 30	Paxumh >= 30

Table 2: Breakdown of SL vs. NW vs. UN using NHANES hourly variables

Seqn 73557
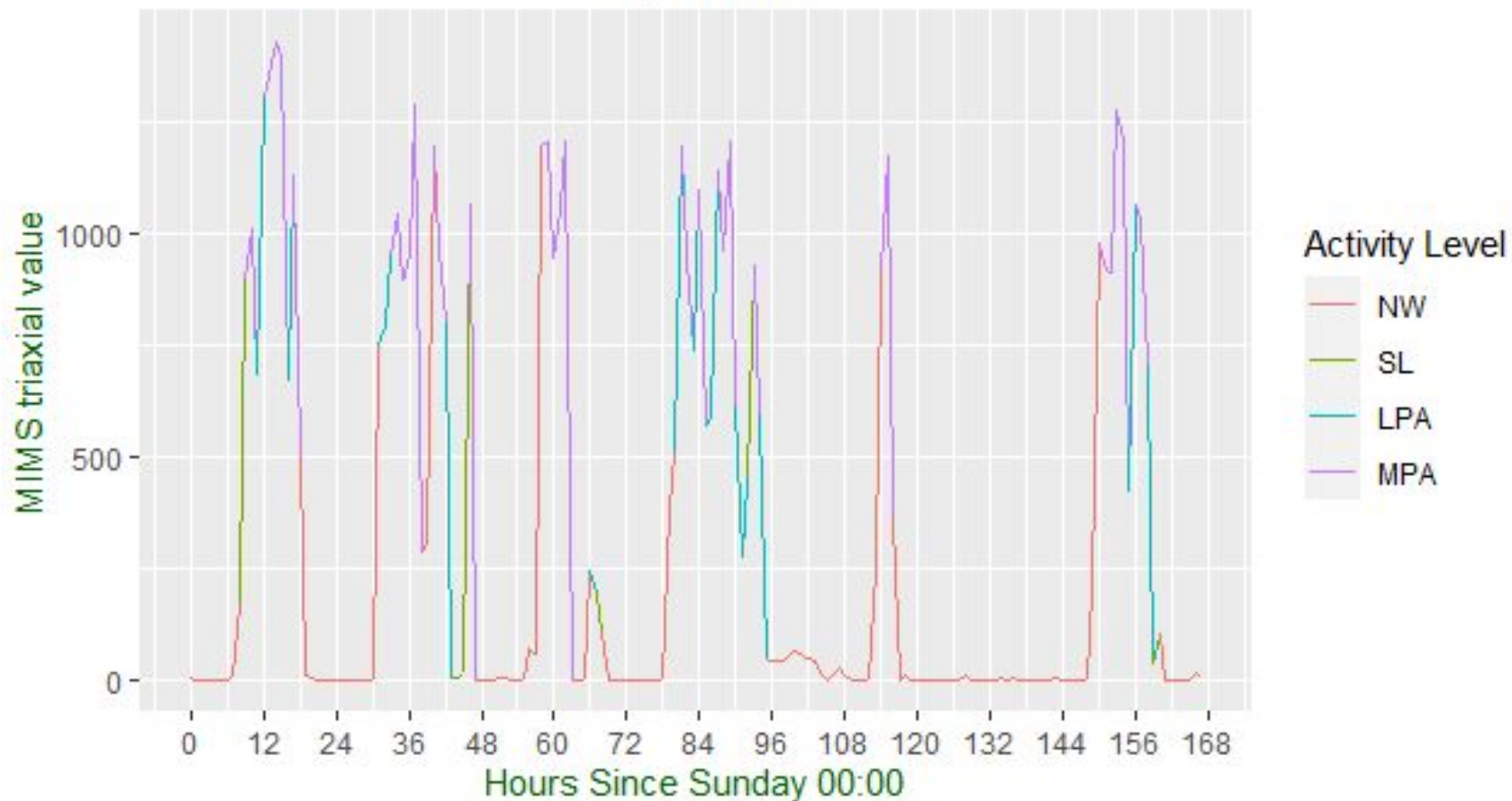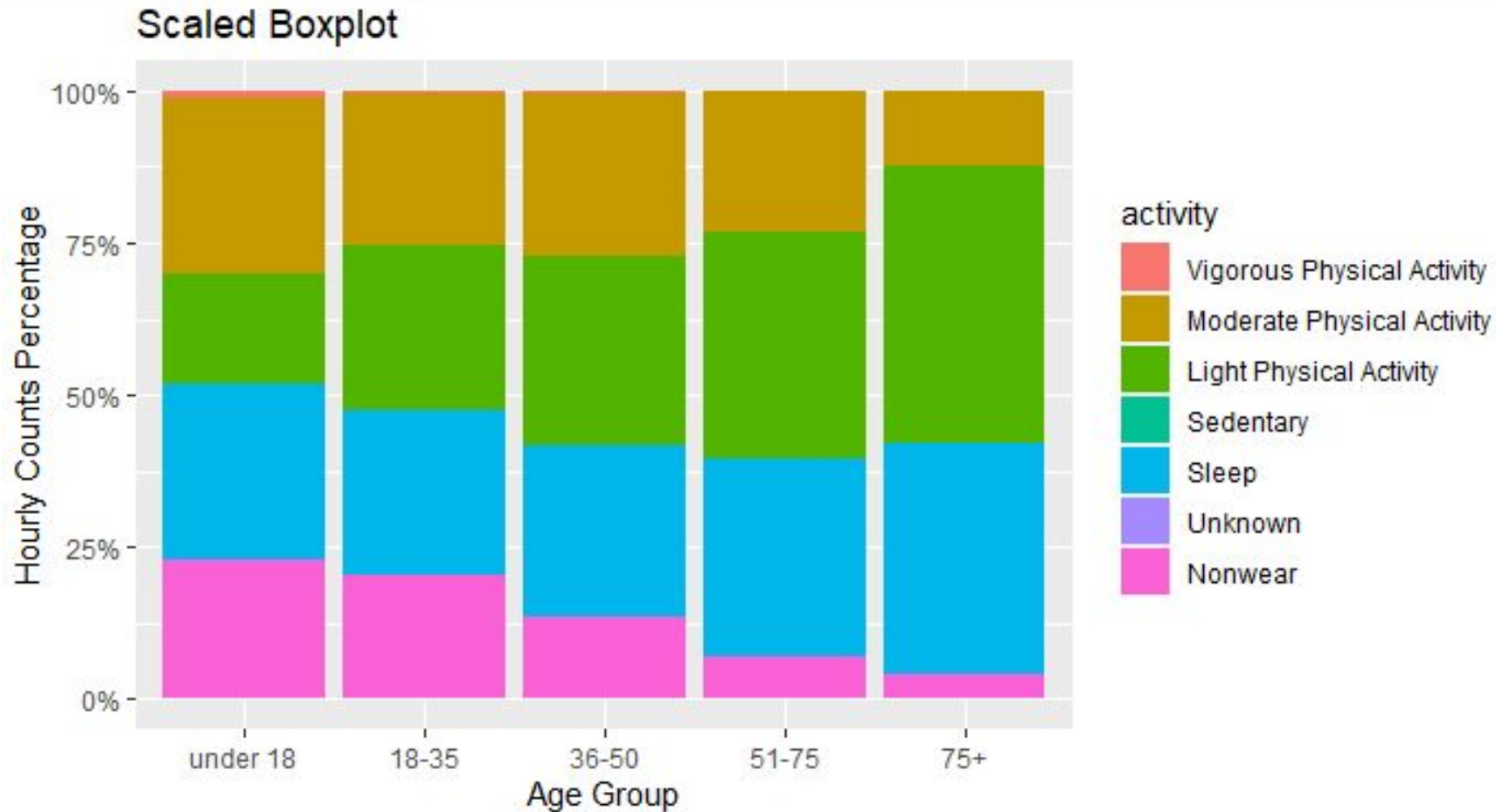
Scaled Boxplot

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Outcomes to Analyze:

1) Waist Circumference cm (BMXWAIST)
   - Examination Data > Body Measures
   - Range: 40.2 - 177.9

2) Body Mass Index (kg/m^2) (BMXBMI)
   - Examination Data > Body Measures
   - Range: 12.1 to 82.9

3) Total Cholesterol (mg/dL) (LBXTC)
   - Laboratory Data > Cholesterol - Total
   - Range: 69 - 813

BMI	Weight Status
Below 18.5	Underweight
18.5 – 24.9	Healthy Weight
25.0 – 29.9	Overweight
30.0 and Above	Obesity

seqn	nonwear	unknown	sleep	sedentary	light	moderate	vigorous	total_hr	agegroup	wtmec2yr Full sample 2 year MEC exam weight	BMXWAIST
73557	110	0	7	0	15	36	0	168	51-75	13481.042	100.0
73559	0	0	69	0	71	28	0	168	51-75	57193.285	109.2
73561	0	0	66	0	96	6	0	168	51-75	65541.871	NA
73564	0	0	65	0	65	38	0	168	51-75	61758.655	110.8
73567	33	0	53	0	45	37	0	168	51-75	34795.429	93.7
73568	6	0	60	0	25	77	0	168	18-35	91523.516	73.7
73571	0	0	62	1	103	2	0	168	75+	46190.114	122.1
73573	118	0	25	0	3	20	2	168	under 18	6460.788	72.5
73579	1	1	62	0	42	62	0	168	under 18	70708.034	62.6
73580	19	0	57	0	53	39	0	168	36-50	27196.638	107.4
73581	26	0	46	0	80	16	0	168	36-50	16764.261	99.3
73585	1	0	61	0	78	26	2	168	18-35	18590.965	90.3
73586	0	0	66	0	21	81	0	168	under 18	13569.677	53.7
73589	0	0	54	1	54	59	0	168	18-35	61374.100	94.6
73592	1	0	70	0	74	23	0	168	18-35	68450.780	107.7
73594	1	0	53	0	80	33	1	168	18-35	45736.924	88.6
73595	6	0	40	0	30	92	0	168	51-75	25027.723	114.8

Other Categorical Predictors

RIAGENDR - Gender

Variable Name: RIAGENDR

SAS Label: Gender

English Text: Gender of the participant.

Target: Both males and females 0 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1	Male	5003	5003	
2	Female	5172	10175	
.	Missing	0	10175	

Reclassified Income Levels

INDHHIN2 - Annual household income

Variable Name:	INDHHIN2
SAS Label:	Annual household income
English Text:	Total household income (reported as a range value in dollars)
Target:	Both males and females 0 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1	$ 0 to $ 4,999	273	273	
2	$ 5,000 to $ 9,999	407	680	
3	$10,000 to $14,999	639	1319	
4	$15,000 to $19,999	658	1977	
5	$20,000 to $24,999	880	2857	
6	$25,000 to $34,999	1185	4042	
7	$35,000 to $44,999	913	4955	
8	$45,000 to $54,999	764	5719	
9	$55,000 to $64,999	521	6240	
10	$65,000 to $74,999	378	6618	
12	$20,000 and Over	323	6941	
13	Under $20,000	133	7074	
14	$75,000 to $99,999	860	7934	
15	$100,000 and Over	1781	9715	
77	Refused	252	9967	
99	Don't know	75	10042	
.	Missing	133	10175	

low (codes 1–7)

medium (codes 8–12)

high (code 15)

missing (codes 77, 99, .)

DMDEDUC2 - Education level - Adults 20+

Variable Name: DMDEDUC2

SAS Label: Education level - Adults 20+

English Text: What is the highest grade or level of school {you have/SP has} completed or the highest degree {you have/s/he has} received?

English Instructions: HAND CARD DMQ1 READ HAND CARD CATEGORIES IF NECESSARY ENTER HIGHEST LEVEL OF SCHOOL

Target: Both males and females 20 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1	Less than 9th grade	455	455	
2	9-11th grade (Includes 12th grade with no diploma)	791	1246	
3	High school graduate/GED or equivalent	1303	2549	
4	Some college or AA degree	1770	4319	
5	College graduate or above	1443	5762	
7	Refused	2	5764	
9	Don't Know	5	5769	
.	Missing	4406	10175	

```
# 20+ Linear model using age group as categorical var
basic_model <- lm(BMXWAIST ~ unknown + sleep + sedentary + light + moderate +
    vigorous + agegroup + riagendr + dmdeduc2 + house_income + BMXHT,
  data = Seqn_Activity, weights = wtmec2yr)
```

Predictor Variables Used in Most Models:

❖ **Activity levels:** represent # of hourly counts for each person in each category out of 168 hr/week
  ➢ Non-wear, unknown, sleep, sedentary, light, moderate, vigorous
❖ Age group
  ➢ "20-35","36-50","51-75","75+"
❖ Age (yrs)
❖ Gender
❖ Education Level (for 20+)
❖ Annual Household Income
❖ Height (cm)

Waist Results Summary

Significant Codes:

$$*** \quad p < 0.001$$

$$** \quad 0.001 \leq p < 0.01$$

$$* \quad 0.01 \leq p < 0.05$$

$$. \quad 0.05 \leq p < 0.1$$

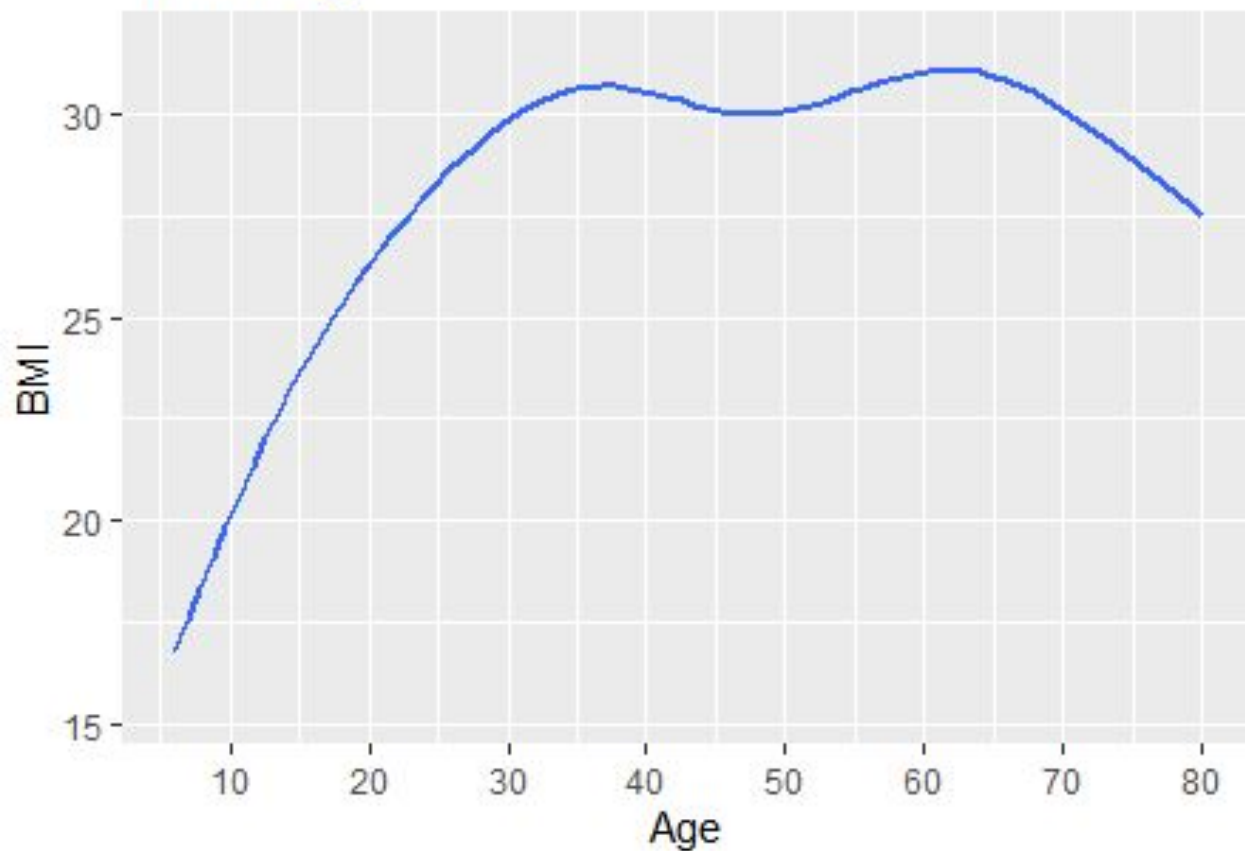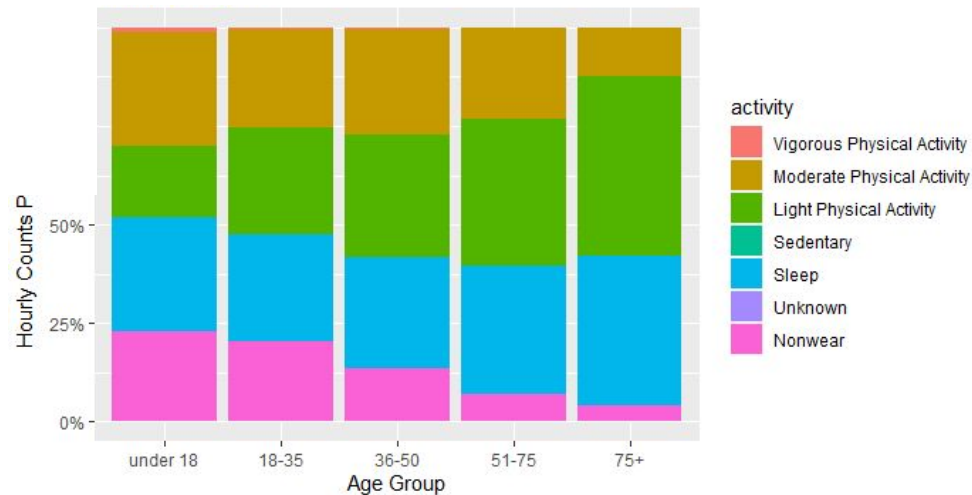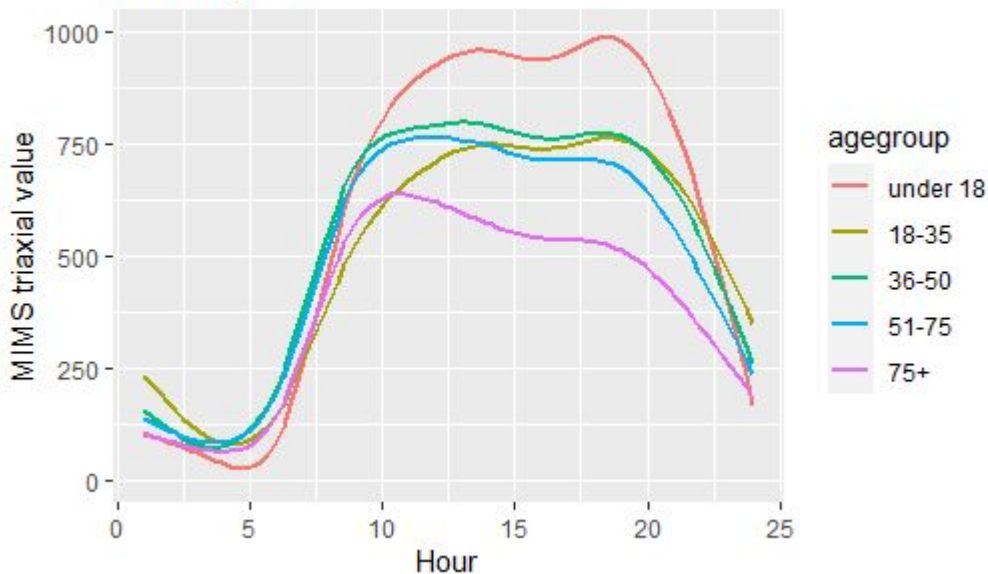| Variables	Under 20	20+	20-35	36-50	51-75	75+
Intercept	3.23	34.6***	52.48**	16.85	45.81***	62.75**
Activity: Non-Wear	REF	REF	REF	REF	REF	REF
Activity: Unknown	-2.07	1.40	-3.60	-1.25	5.13*	-3.23
Activity: Sleep	0.06*	0.05**	-0.05	0.09*	0.10***	0.02
Activity: Sedentary	-0.21	1.62 .	1.72	0.82	1.45	2.20
Activity: Light	-0.11***	0.05***	0.01	0.05	0.09***	0.05
Activity: Moderate	-0.02	-0.07***	-0.02	-0.03	-0.12***	-0.11*
Activity: Vigorous	-0.48**	-1.37***	-1.30*	-1.79***	-0.99 .	-0.29
Age (Yrs)	0.87***	-	-	-	-	-
Male	REF	REF	REF	REF	REF	REF
Female	-0.14	1.34	3.20	1.37	0.13	-2.40
< 9th Grade	-	REF	REF	REF	REF	REF
9 - 11th Grade (or 12 w/o diploma)	-	0.39	4.08	-1.97	-1.72	3.86
High School / GED	-	0.44	2.74	-2.13	-1.06	2.99
Some college / AA	-	0.78	3.39	-2.58	0.58	3.59
College Grad / Above	-	-4.47*	0.62	-9.07*	-5.86*	-0.36
Don't know Educ	-	-11.56	-	-	-14.08	-
Low Income	4.11 .	0.06	-5.57	6.15	-0.67	-1.43
Medium Income	2.82	0.08	-5.72	4.72	1.14	-5.00
High Income	-1.06	-3.45	-10.16 .	1.61	-2.52	-2.06
Missing Income	REF	REF	REF	REF	REF	REF
Height	0.41***	0.36***	0.29**	0.47***	0.33***	0.23 .
Agegroup: Under 18	-	-	-	-	-	-
Agegroup: 18-35	-	REF	-	-	-	-
Agegroup: 36-50	-	5.39***	-	-	-	-
Agegroup: 51-75	-	7.61***	-	-	-	-
Agegroup: 75+	-	2.28 .	-	-	-	-
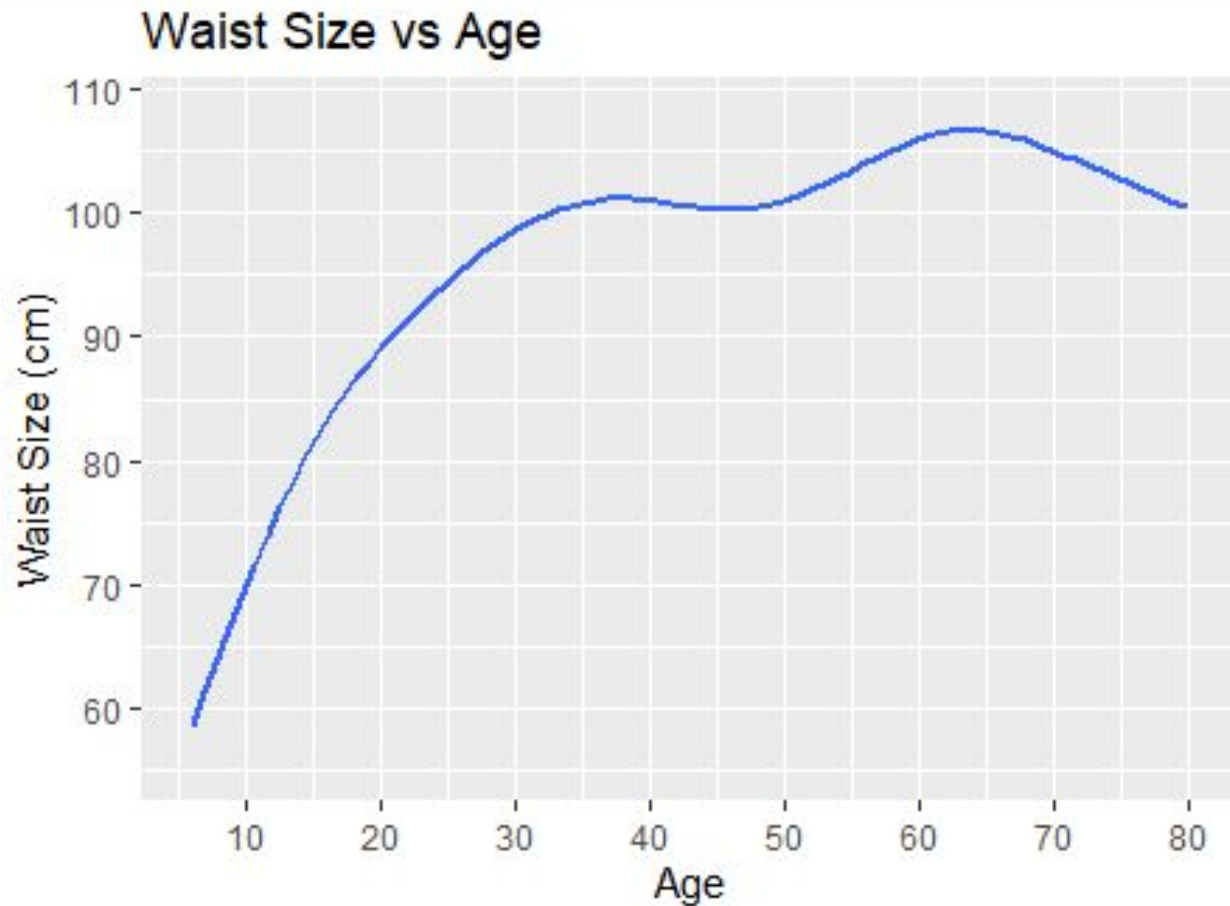
Waist Size vs Age

BMI Results Summary

Significant Codes:

*** $p < 0.001$

** $0.001 \leq p < 0.01$

* $0.01 \leq p < 0.05$

. $0.05 \leq p < 0.1$

| Variables	Under 20	20+	20-35	36-50	51-75	75+
Intercept	0.85	23.28***	37.90***	20.47**	28.72***	26.47***
Activity: Non-Wear	REF	REF	REF	REF	REF	REF
Activity: Unknown	-1.73	0.48	-1.31	-0.81	1.91	0.06
Activity: Sleep	0.03*	0.01 .	-0.02 .	0.04 .	0.04**	-0.02
Activity: Sedentary	-0.08	0.40	0.34	0.35	0	1.12
Activity: Light	-0.06***	0.02**	0.01	0.03 .	0.03**	0.01
Activity: Moderate	-0.01	-0.03***	-0.01	-0.01	-0.05***	-0.05**
Activity: Vigorous	-0.19*	-0.56***	-0.55*	-0.68***	-0.40	-0.17
Age (Yrs)	0.54***	-	-	-	-	-
Male	REF	REF	REF	REF	REF	REF
Female	-0.04	0.97*	0.73	0.98	1.14 .	0.71
< 9th Grade	-	REF	REF	REF	REF	REF
9 - 11th Grade (or 12 w/o diploma)	-	0.73	3.46	-0.56	-0.11	0.76
High School / GED	-	0.82	2.66	-0.47	0.50	0.25
Some college / AA	-	1.13	3.13	-0.03	0.98	0.68
College Grad / Above	-	-0.83	1.82	-2.55	-1.14	-0.44
Don't know Educ	-	-7.20	NA	NA	-7.70	NA
Low Income	1.21	0.37	-2.79	3.22 .	0.79	0.02
Medium Income	0.44	0.12	-2.98	2.27	1.16	-1.19
High Income	-1.14	-1.40	-4.94*	0.89	-0.35	-0.19
Missing Income	REF	REF	REF	REF	REF	REF
Height	0.10***	0	-0.04	0.03	-0.01	0.02
Agegroup: Under 18	-	-	-	-	-	-
Agegroup: 18-35	-	REF	-	-	-	-
Agegroup: 36-50	-	1.71***	-	-	-	-
Agegroup: 51-75	-	1.02**	-	-	-	-
Agegroup: 75+	-	-2.89***	-	-	-	-

BMI vs Age

MIMS by Hour

Cholesterol Results Summary

Significant Codes:

$*** \; p < 0.001$

$** \; 0.001 \le p < 0.01$

$* \; 0.01 \le p < 0.05$

$. \; 0.05 \le p < 0.1$

Variables	Under 20	20+	20-35	36-50	51-75	75+
Intercept	163.24***	216.61***	220.28***	267.67***	232.45***	166.99*
Activity: Non-Wear	REF	REF	REF	REF	REF	REF
Activity: Unknown	12.45 .	-1.15	5.80	-17.47	-0.18	7.90
Activity: Sleep	0.08	-0.02	-0.04	0.23	-0.07	-0.02
Activity: Sedentary	0.07	-0.82	-2.04	4.20	-5.57	2.96
Activity: Light	-0.02	-0.01	0.07	-0.04	-0.12 .	0.09
Activity: Moderate	-0.05	0.08*	0.09	-0.11	0.05	0.63***
Activity: Vigorous	0.22	-1.07	-0.51	-2.61 .	0.66	1.29
Age (Yrs)	0.64	-	-	-	-	-
Male	REF	REF	REF	REF	REF	REF
Female	5.58*	3.84	-4.28	-10.16 .	14.52***	24.40**
< 9th Grade	-	REF	REF	REF	REF	REF
9 - 11th Grade (or 12 w/o diploma)	-	4.43	13.48	-24.71 .	10.74	5.41
High School / GED	-	1.89	3.39	-24.26 .	6.70	7.91
Some college / AA	-	8.76 .	7.47	-13.35	14.82*	13.85
College Grad / Above	-	9.33 .	12.17	-18.61	15.78*	16.87 .
Don't know Educ	-	20.79	-	-	32.37	-
Low Income	-0.82	0.33	12.67	10.67	-17.22*	2.63
Medium Income	2.23	-1.31	16.56	13.18	-24.47**	-1.03
High Income	1.77	0.69	13.88	17.73	-21.38*	1.29
Missing Income	REF	REF	REF	REF	REF	REF
Height	-0.12	-0.28*	-0.39 .	-0.36	-0.17	-0.19
Agegroup: Under 18	-	-	-	-	-	-
Agegroup: 18-35	-	REF	-	-	-	-
Agegroup: 36-50	-	20.06***	-	-	-	-
Agegroup: 51-75	-	14.78***	-	-	-	-
Agegroup: 75+	-	3.78	-	-	-	-

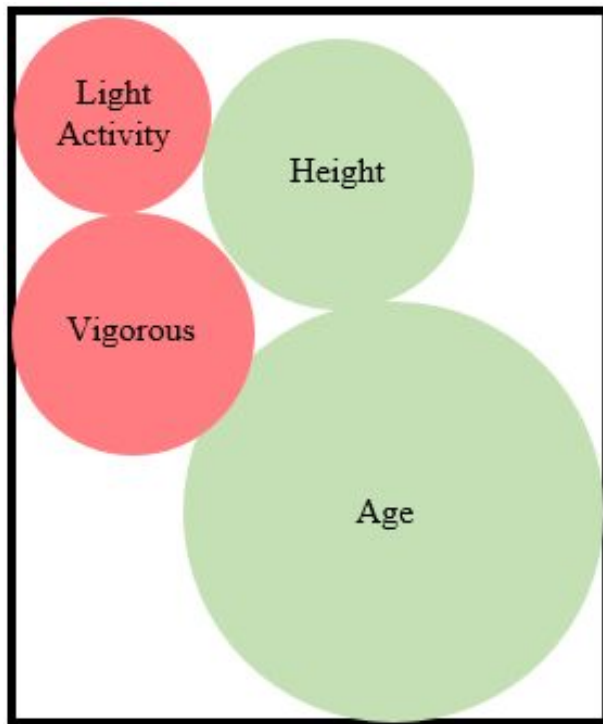Total Cholesterol vs Age
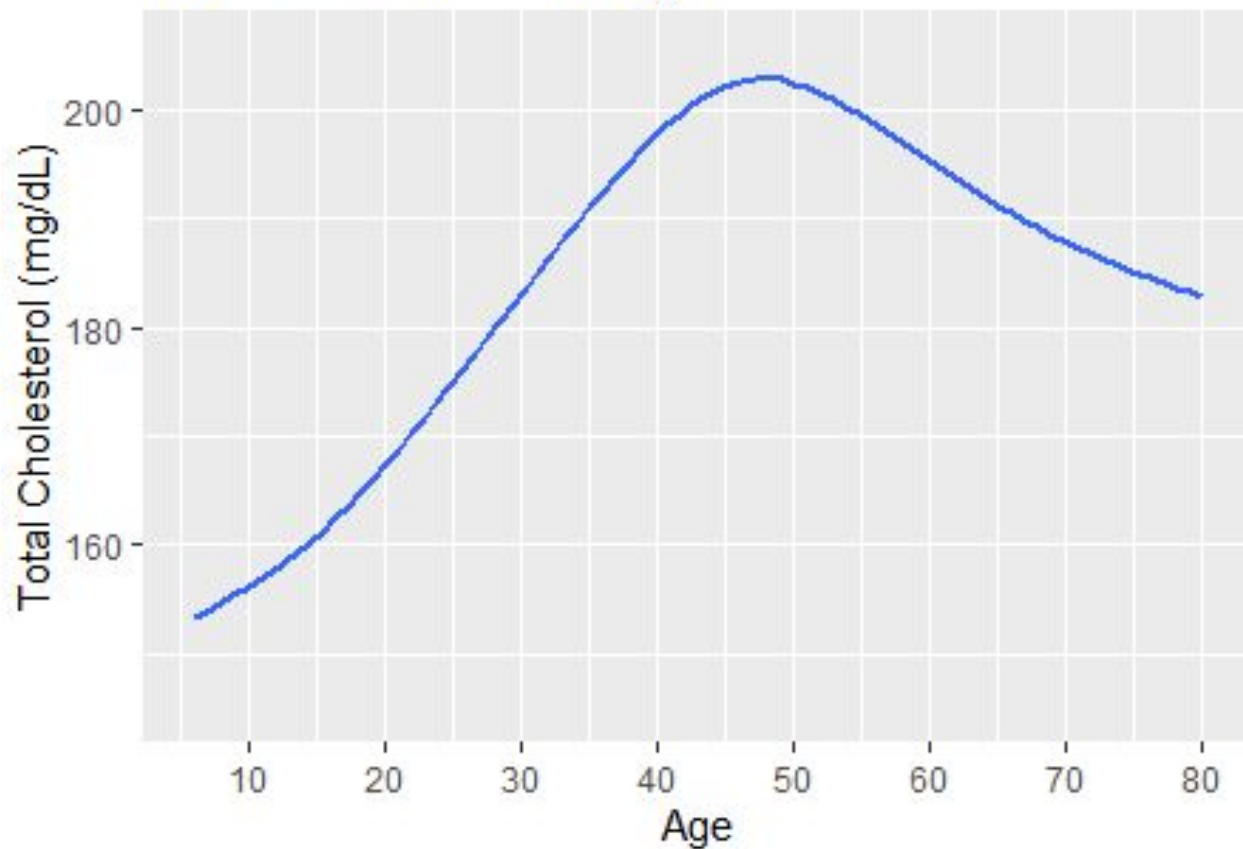
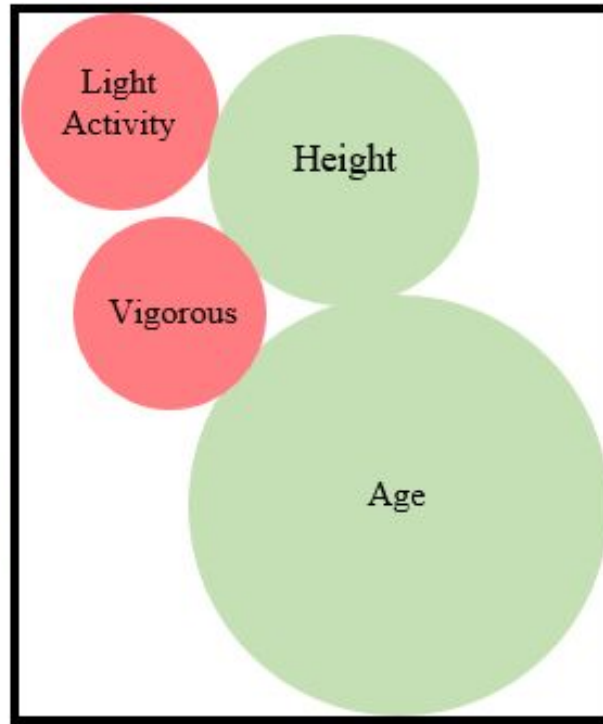Total Cholesterol vs Height
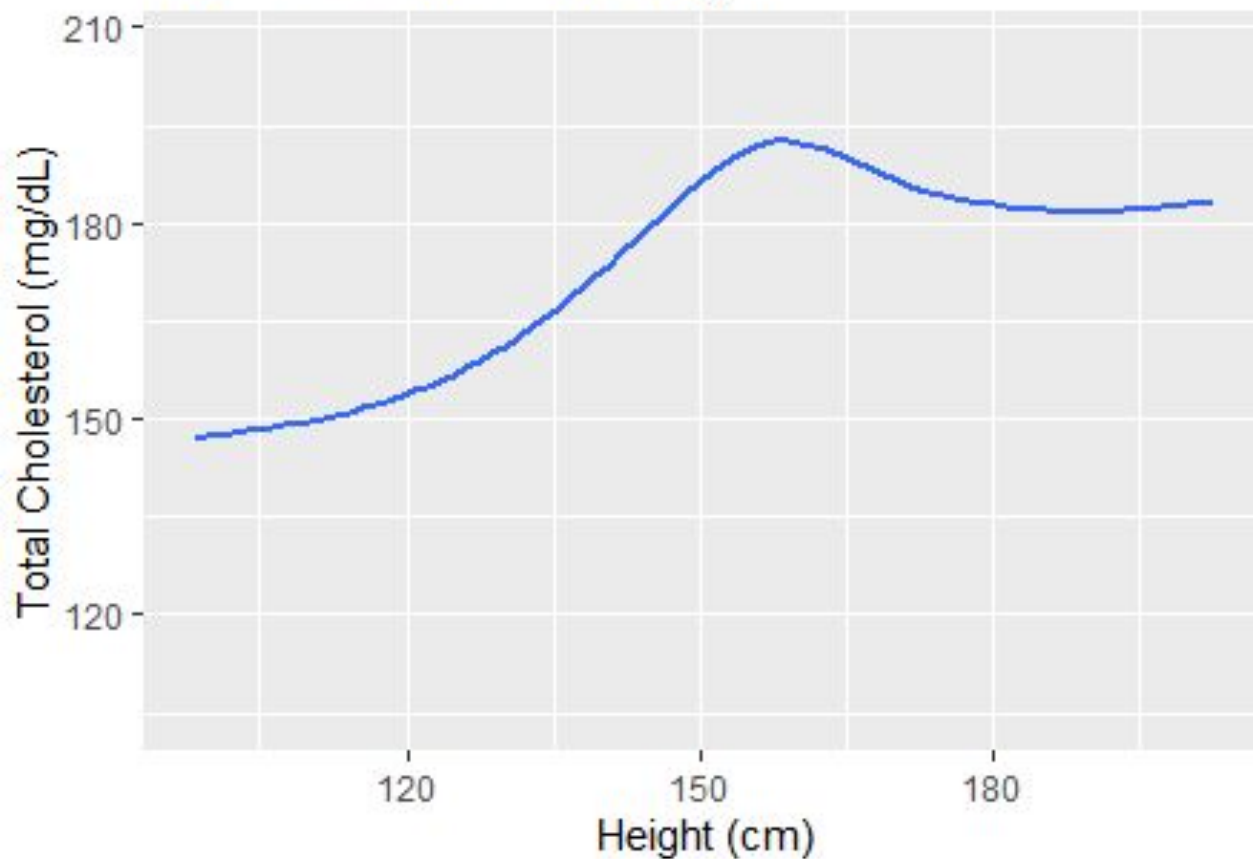
PRESENTATION OUTLINE

1. Introduction

    a. Background + Project Goals

    b. NHANES Dataset

    c. Summary of Contributions

2. Preliminary Visualizations

3. Activity Level Analysis
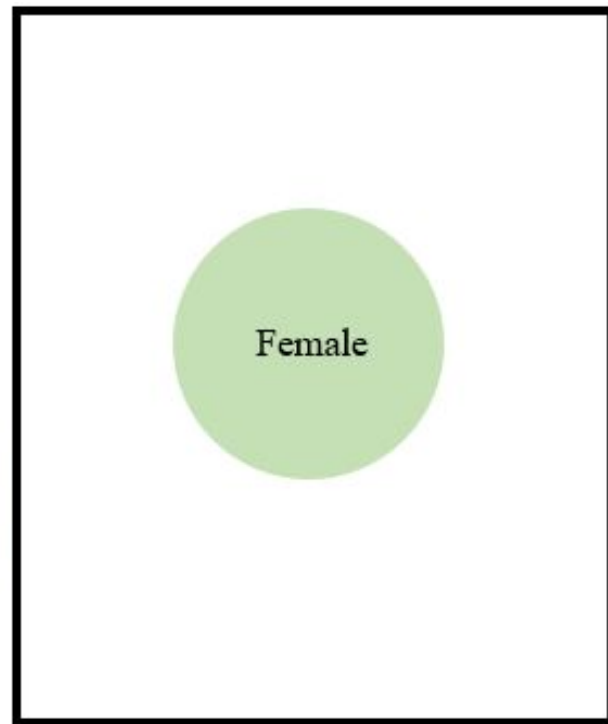
4. Linear Model Analysis

5. **Summary of Conclusions**

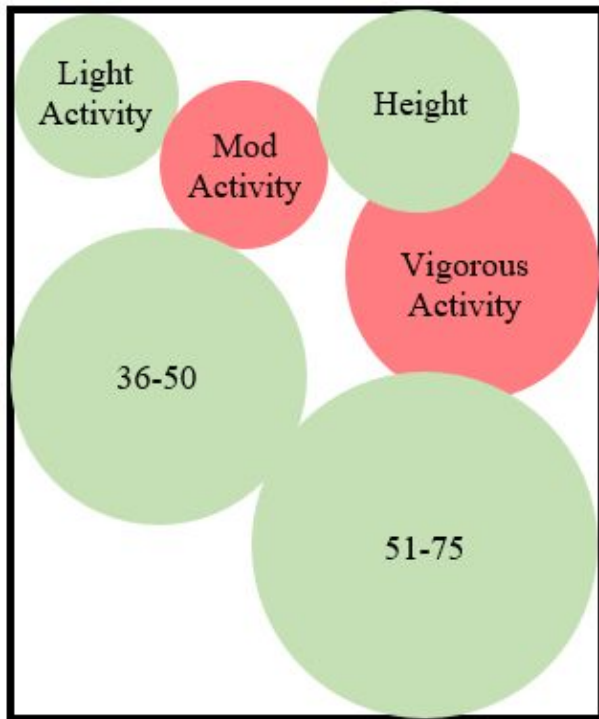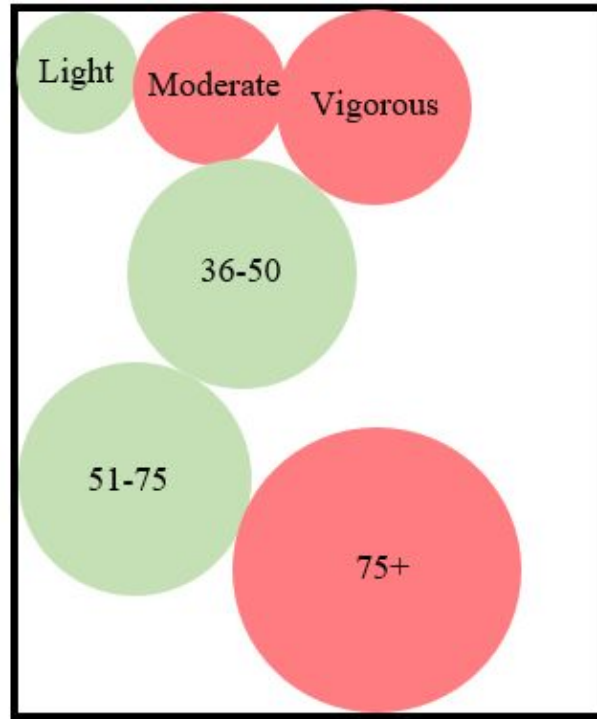# Most Significant Variables - Under 20

Waist Circumference

BMI
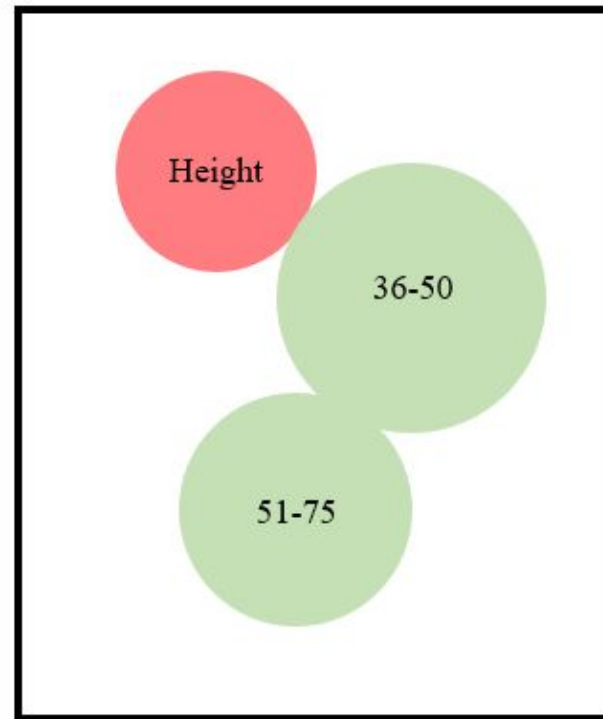
Cholesterol

Most Significant Variables - 20+

Waist Circumference **BMI** **Cholesterol**

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