Lower Physical Activity and Fitness Levels are Associated with Smaller Brain Volumes in Older Individuals with HIV

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Poster #: 00392

Background

- The average age of persons living with HIV (PLWH) is now greater than 50 years of age.
- Older PLWH are more sedentary than similarly aged HIV-seronegative (HIV-) individuals
- Previous studies in HIV- populations have shown an association between sedentary lifestyle and smaller brain volumes.
- The effect of physical activity on brain health in PLWH is not well understood.

Aims

- To examine the cross sectional relationship between levels of physical activity and brain volumes in PLWH.
- To examine the cross sectional relationship between VO_2 max (ml/kg/min) and brain volumes in PLWH.
- To examine the cross sectional relationship between neuropsychological testing and VO_2 max and % time spent sedentary in PLWH.

Demographics

Table 1	PLWH (n=64)
Age (years), Mean(SD)	56.5 (5.6)
Sex (% Male)	80%
Race (% African American)	67%
Years of education, Mean(SD)	13.3 (2.3)
Recent CD4 T-cell count, median (IQR)	648.5 (478.5, 880.8)
Recent CD8 T-cell count, median (IQR)	774.0 (504.5, 1056.0)
Nadir CD4 T-cell count, median (IQR)	180.0 (25.0, 356.0)
Duration of infection (months), median (IQR)	249.0 (143.3, 320.5)

Methods

- Participants (cross-sectional):
  - 64 PLWH who are ≥ 40 years of age and who have undetectable plasma viral load <50 copies/mL) (Table 1)
- Activity Monitoring:
  - Wrist actigraphy was worn for one week to measure daily physical activity
  - From the actigraphy output, the average number of minutes spent sedentary or in light, moderate or vigorous activity was calculated
- VO_2 Max Testing:
  - Graded exercise testing was performed on a cycle ergometer
  - VO_2 max scores were classified into very poor, poor, fair, good and excellent groups, based on data from American College of Sports Medicine Guidelines for Exercise Testing and Prescription, 5th Edition, 1995.
- Neuroimaging:
  - An MRI was performed using a 3T Siemens Prisma scanner
  - The FreeSurfer software suite (v5.3) (Martinos Center, Harvard University, Boston, MA) was used to determine volumes of the thalamus, caudate, putamen, hippocampus, amygdala, cerebellum, cortical white matter, and total and subcortical gray matter areas of the brain typically affected by HIV.
- Neuropsychological Testing:
  - Participants completed a 15-test battery that examined multiple domains, including executive function, learning, memory, psychomotor speed and language.
  - Raw scores for each test were converted into demographically-corrected Z-scores, averaged to create domain Z-scores.
  - Domain Z-scores were used to create a global Z-score
- Statistical Analyses:
  - Partial correlations assessed relationships between significant time spent in sedentary activity and brain volumes
  - Partial correlations assessed relationships between physical fitness (VO_2 max) and brain volumes
  - ANCOVAs examined the differences between very poor, poor and fair groups of VO_2 and brain volumes.

Results

- By design, participants were sedentary and spent 89% of the day in sedentary (green) or light activity (blue) and only 11% of the day was spent in moderate physical activity (gold) (Fig 1).
- VO_2 scores were grouped into levels (Fig 1)
  - Very Poor (green) – 71%
  - Poor (blue)– 16%
  - Fair (gold) – 11%
  - Good (dark green) – 2%
- Physical fitness (VO_2 max, ml/kg/min) was positively correlated with brain volumes including (Fig 2):
  - Total Gray Matter Volume (*p*= .027)
  - Temporal Lobe Volume (*p*= .028)
  - Occipital Lobe Volume (*p*= .03)
- Group differences were seen in total gray matter volumes, with PLWH with a fair VO2 max exhibiting larger total gray matter volume compared to the very poor VO2 max group (Fig 2) (*p*= .048)
- Time spent in sedentary was inversely correlated with brain volumes including (Fig 3):
  - Caudate Volume (*p*= .003)
  - Putamen Volume (*p*= .013)
  - Amygdala Volume (*p*= .018)
  - Cortical White Matter Volume (*p*= .036)
  - Subcortical Gray Matter Volume (*p*= .003)
- In contrast, we did not find observe significant relationships between VO_2 max or actigraphy measures of percent sedentary time and neuropsychological performance (Fig 4)
  - Total Z score / VO_2 (*p*=.93)
  - Total Z score / % sedentary (*p*=.69)

Figure 1 – Charts of Categories % Time Spent & VO_2 Groups

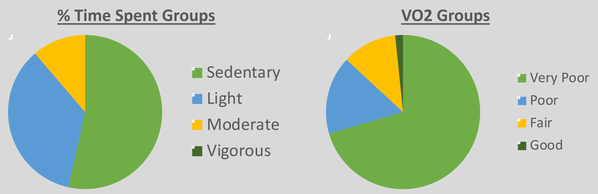


Figure 2 – Plots of Brain Volume by VO_2 Max (ml/kg/min)

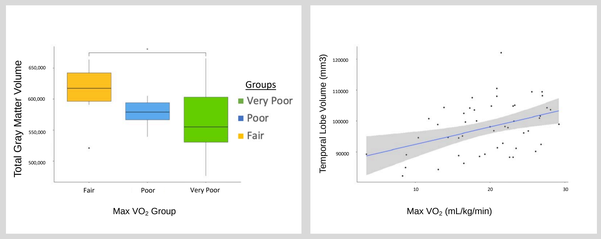


Figure 3 – Plots of Brain Volume by % of time spend sedentary

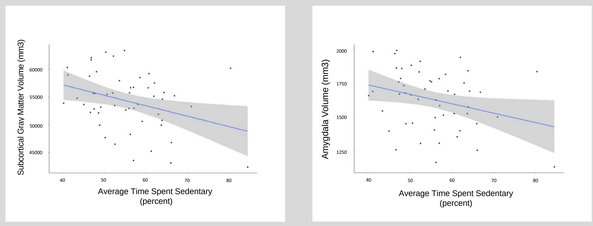
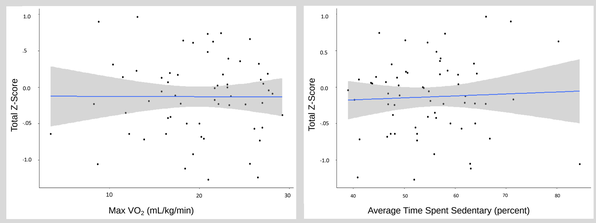


Figure 4 – Plots of Cognition by % of time spent sedentary and VO_2 Max (ml/kg/min)



Conclusions

- Better physical fitness measures were associated with larger brain volumes.
- Lower physical activity within sedentary PLWH is associated with smaller brain volumes (subcortical and cortical)
- These changes were not captured on standard neuropsychological tests, suggesting that neuroimaging may be important in the evaluation of sedentary PLWH

Future Directions

- Future studies should the examine the effects of exercise training and increasing physical activity on volumes in sedentary PLWH

The study was supported by grants from the National Institute of Nursing Research (NINR) R01-NR015738