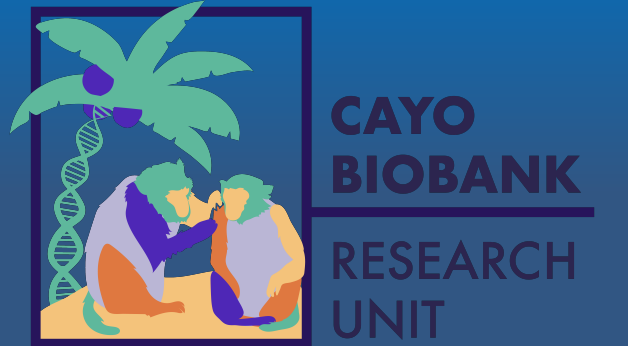# Relationships between Blood Cell Types and Demographic/Morphological Factors in Rhesus Macaques

By Lora Assi

Platt Labs
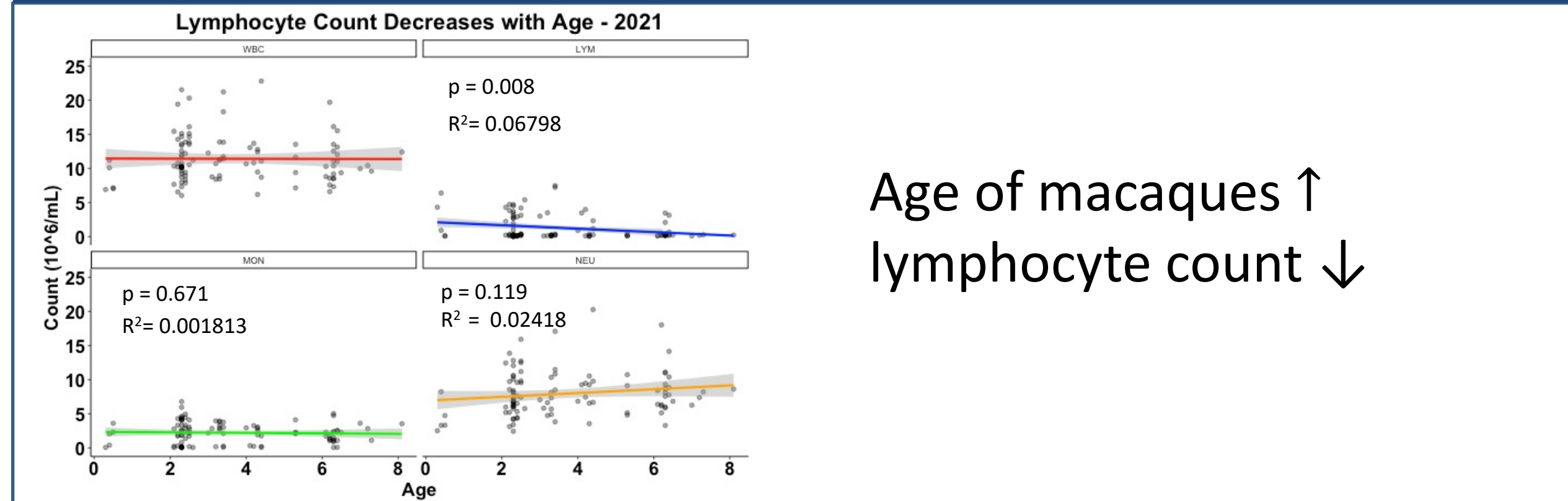University of Pennsylvania, Philadelphia, PA, USA

Background

- **Free-ranging rhesus macaques** (*Macaca mullatta*): excellent model to investigate relations between demographic and morphological factors **(age, sex, body mass, group membership, pregnancy status, others)** and **cell types**
- Macaques are highly sociable. Sociability, or lack thereof, can greatly affect one's health and likelihood of survival. Immune function can be highly sensitive to changes in one's social environment.
- Looking at components of complete blood counts (CBC) in rhesus macaques to explore the effects of these factors on **measures of immune activation in the blood:**
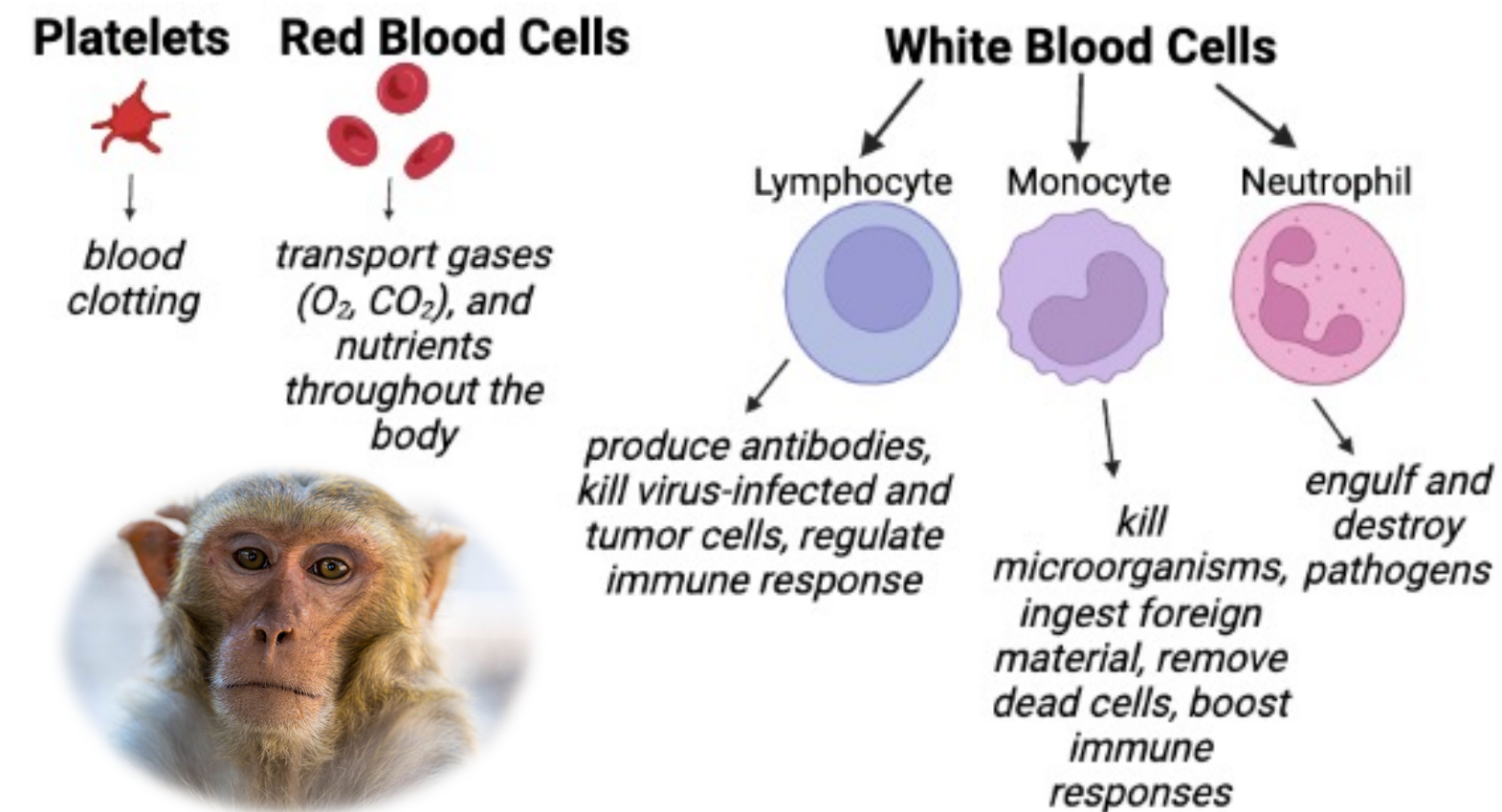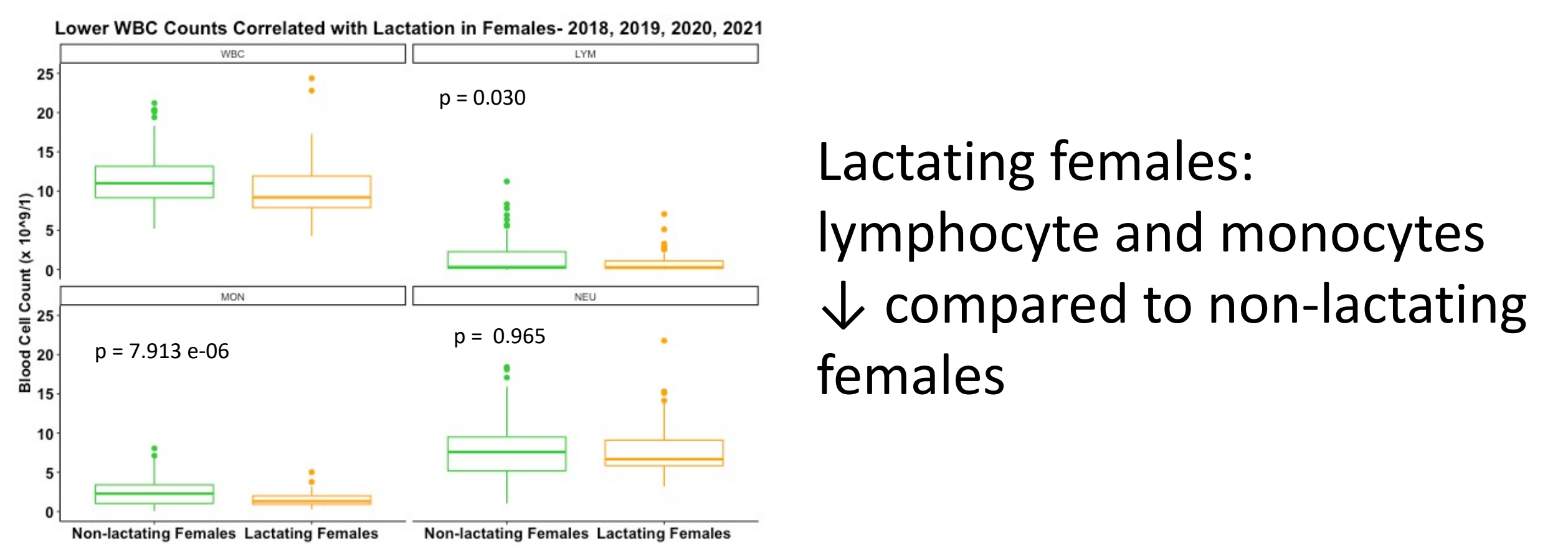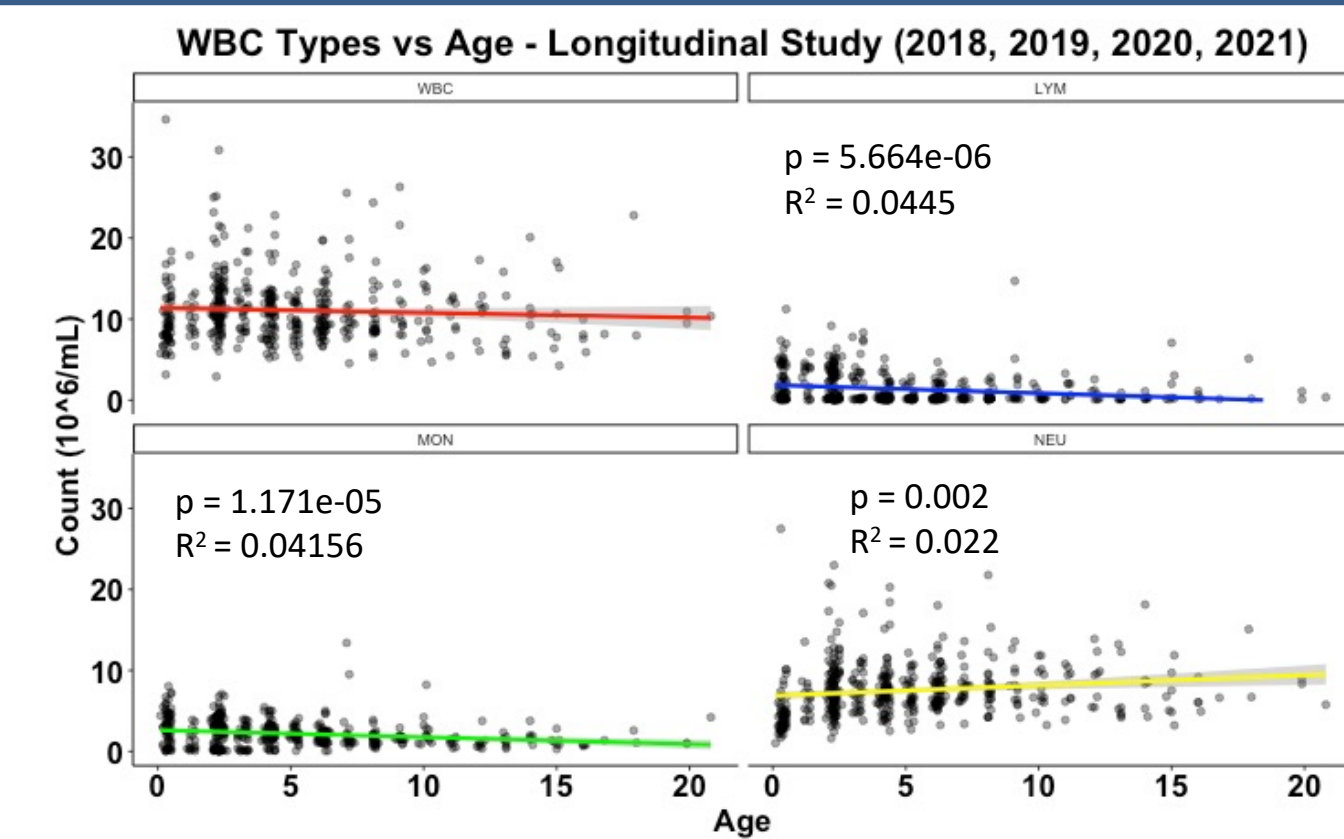

Methods

- Blood samples collected by the Caribbean Primate Research Center (CPRC) at the Cayo Santiago field station, Puerto Rico, from free-ranging rhesus macaques over the span of **2018, 2019, 2020, and 2021.**
- Complete blood counts obtained from blood samples using VetScan® HM5 analyzer (Abaxis, Inc.)
- Complete blood counts and demographic/morphological data from **456 animals** analyzed using R

Results

Lymphocyte Count Decreases with Age - 2021

p = 0.008
R² = 0.06798

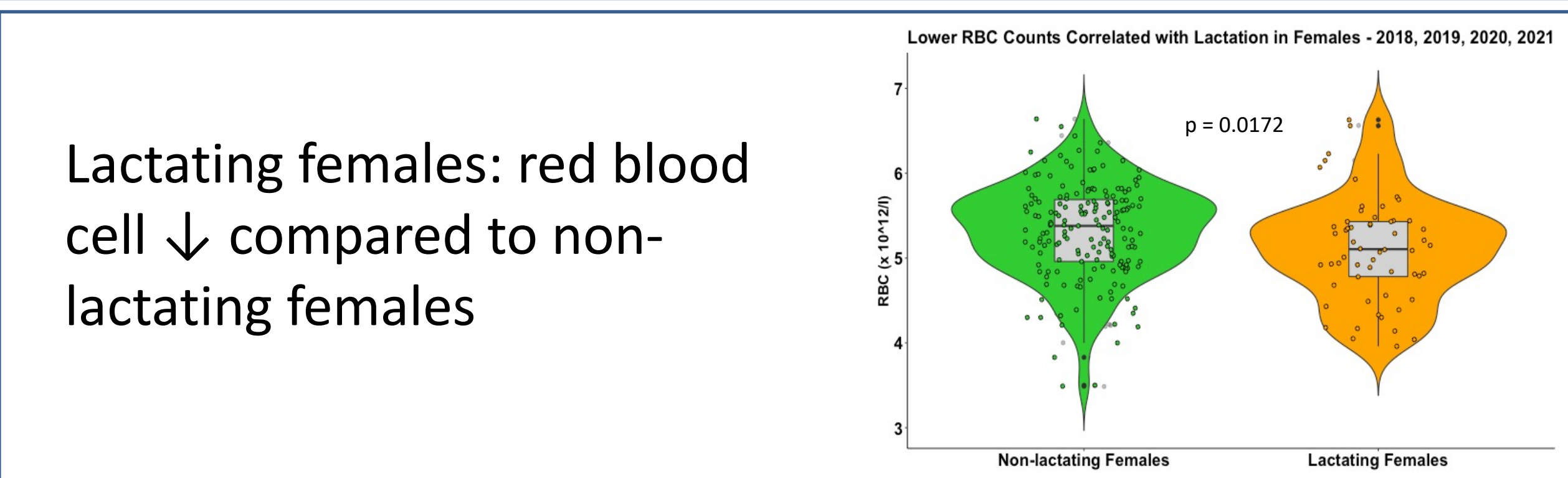p = 0.671
R² = 0.001813

p = 0.119
R² = 0.02418

Age of macaques ↑
lymphocyte count ↓

- Lymphocytes ↓ as age ↑
- Monocytes remain almost constant/slowly ↓ as age ↑
- Neutrophils ↑ as age ↑
- 2018-2021 WBC patterns with age match those of 2021 alone

WBC Types vs Age - Longitudinal Study (2018, 2019, 2020, 2021)

p = 5.664e-06
R² = 0.0445

p = 1.171e-05
R² = 0.04156

p = 0.002
R² = 0.022

Lower WBC Counts Correlated with Lactation in Females- 2018, 2019, 2020, 2021

p = 0.030

p = 7.913 e-06

p = 0.965

Lactating females: lymphocyte and monocytes ↓ compared to non-lactating females

Lower RBC Counts Correlated with Lactation in Females - 2018, 2019, 2020, 2021

p = 0.0172

Lactating females: red blood cell ↓ compared to non-lactating females

Discussion

- **Similar response to aging in lymphocyte count between macaques and humans**
  - Human studies: birth - age 20 lymphocyte counts sharply ↓ , then stay constant until ~ age 50, then ↓ rapidly
  - ↓ lymphocytes may be correlated with the macaques' social structure, since, as macaques age ↑, number of social connections ↑
  - In previous study, individuals that were more socially connected (↑ grooming partners) had ↓ WBCs
- **Lactating rhesus macaques slight ↓ in total WBC count may be due to ↑ time spent in social circles.**
  - Human literature - women exhibit ↑ WBC levels during pregnancy, but WBC levels return to normal levels postpartum.
- **↓ RBC in lactating macaques may be due to iron depletion and blood loss during childbirth**
  - 2015 study on anemia prevalence and associated factors among lactating mothers in Ethiopia: mothers may be susceptible to anemia during lactation.

Future Directions

- Analyzing measures of immune activation via blood counts → relations between macaque characteristics and blood cell types inferred → more accurate predictions of blood cell ranges in the future → medical implications
- Future analyses can incorporate behavioral data (grooming behaviors or aggression scores) into R analyses
- Incorporate organ weights (specifically, spleen and liver, as they are involved in the immune response) into the R analyses

- Investigate mixed effects of age and weight on WBC types, specifically lymphocytes
- Compare levels of WBCs, RBCs, and platelets of macaques within same social network