



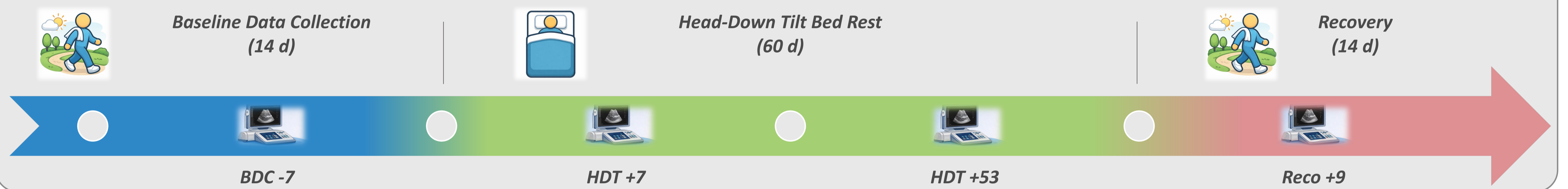
# CARDIAC REMODELING IN 60-DAY HYPOXIC BED REST WITH RESISTANCE VIBRATION EXERCISE AND ARTIFICIAL GRAVITY (BRAVE)

Nikolas Lehmann<sup>1</sup>, Saša Repanšek<sup>1,2</sup>, Marcus Vollmer<sup>1,3</sup>, Michael Boschmann<sup>4</sup>, Jens Fielitz<sup>1,5</sup>

**Background and Purpose:** Long-duration head-down tilt bed rest (HDT, 60 days), an analogue for long-duration spaceflights, induces cardiac unloading resulting in cardiac atrophy and dysfunction. It is uncertain whether muscle-activating countermeasures, either alone or in combination with artificial gravity applied via a short-arm centrifuge (AG), mitigate the changes to cardiac structure and function induced by HDT under normobaric hypoxia (FiO<sub>2</sub> = 0.14). Furthermore, recovery of cardiac performance during remobilization is barely understood.

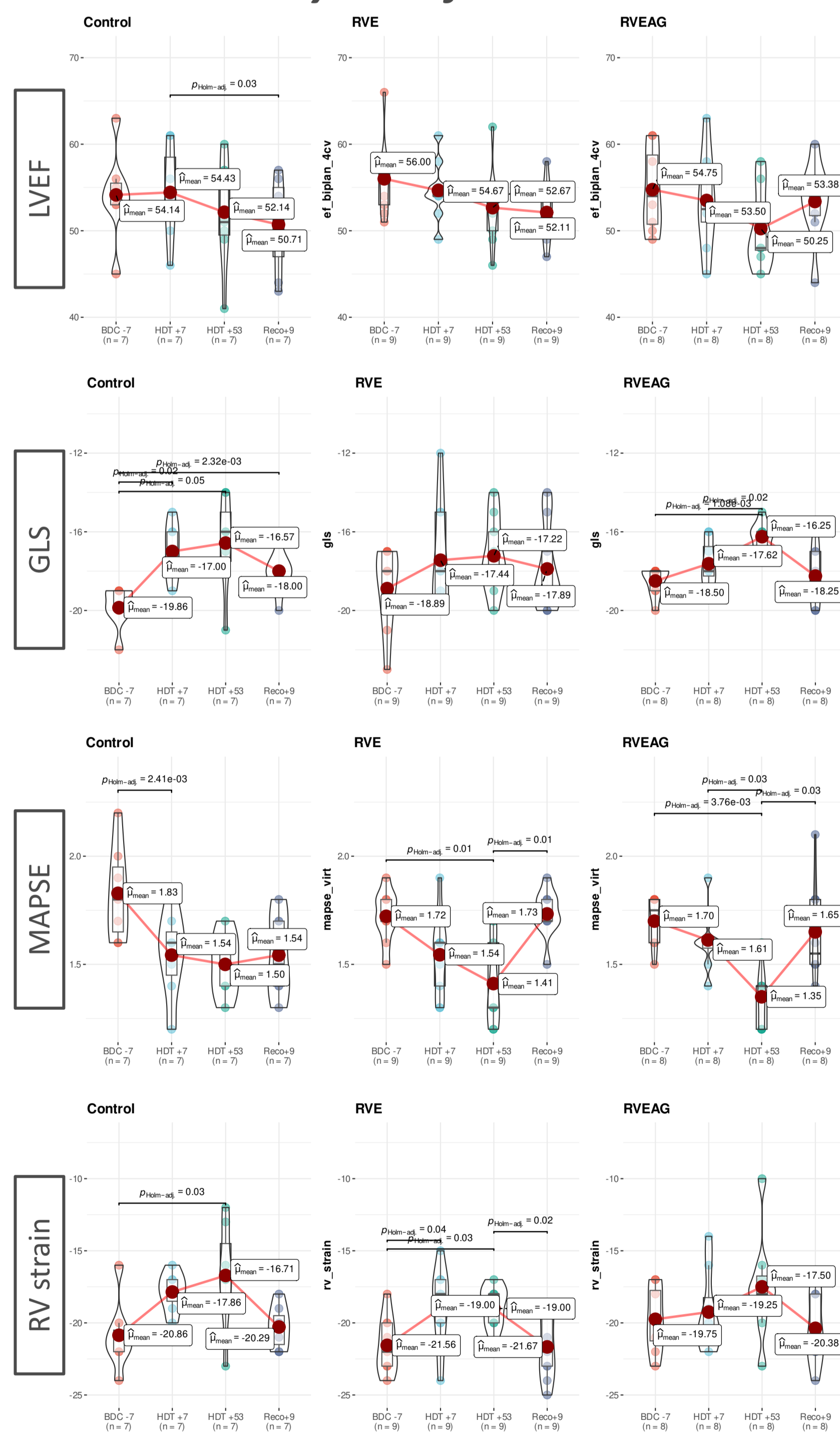
**Hypotheses:** HDT under hypoxia reduces systolic and diastolic cardiac function over time, which is reversible during remobilization. Muscle-activating countermeasures alone or in combination with AG mitigate cardiac deconditioning during hypoxic HDT and supports recovery during remobilization.

**Methods:** Twenty-four healthy men completed the study. Participants were assigned to control (no countermeasures; n=7), resistance vibration exercise (RVE; n=9), or RVE combined with AG (RVEAG; n=8). Normobaric hypoxia and countermeasures were only applied during the HDT phase. Standardized transthoracic echocardiography was performed at BDC -7, HDT +7, HDT +53, and Reco +9. A single investigator and examiner performed TTE and offline analyses, respectively, while being blinded to treatment.

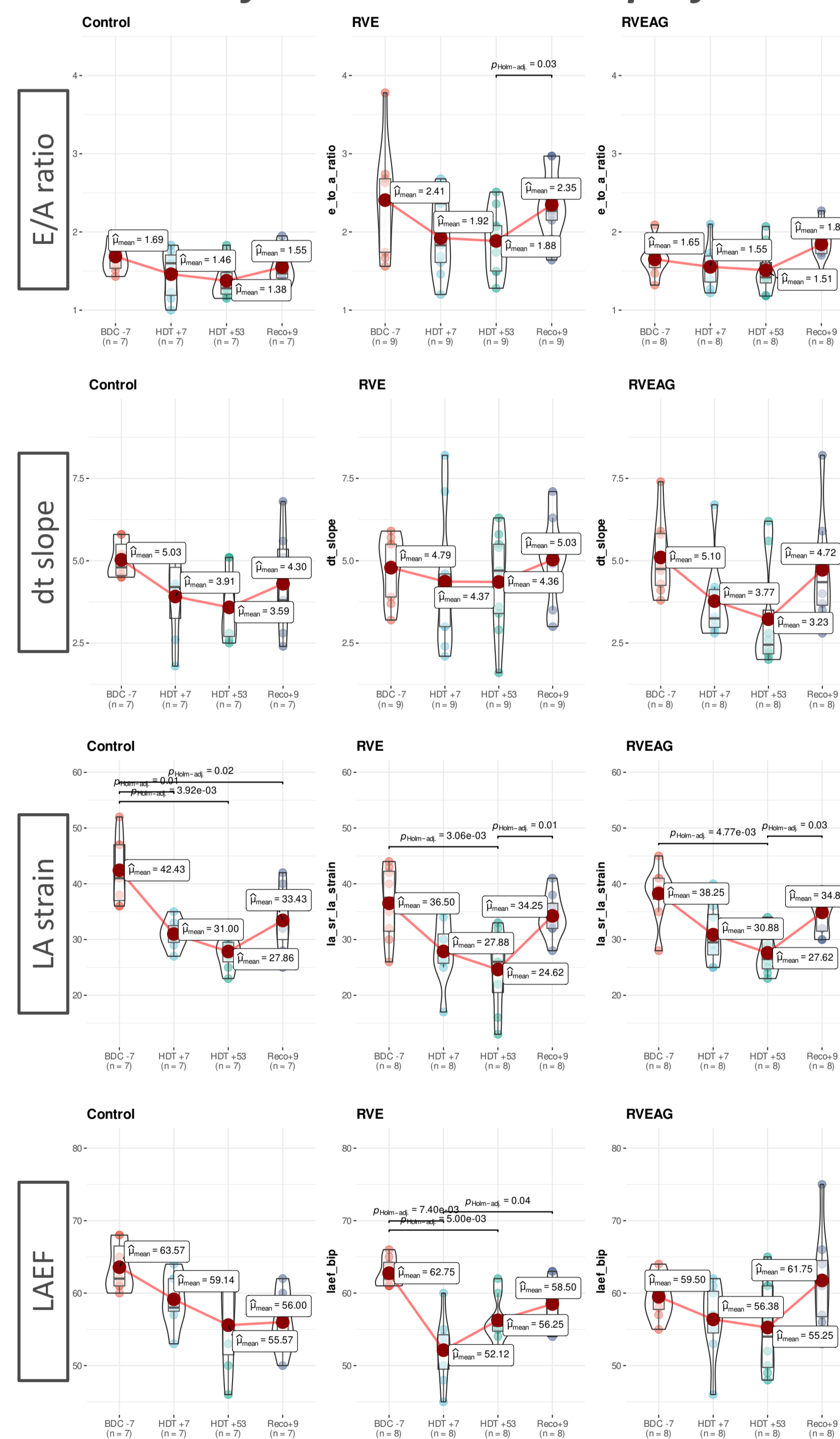


## RESULTS

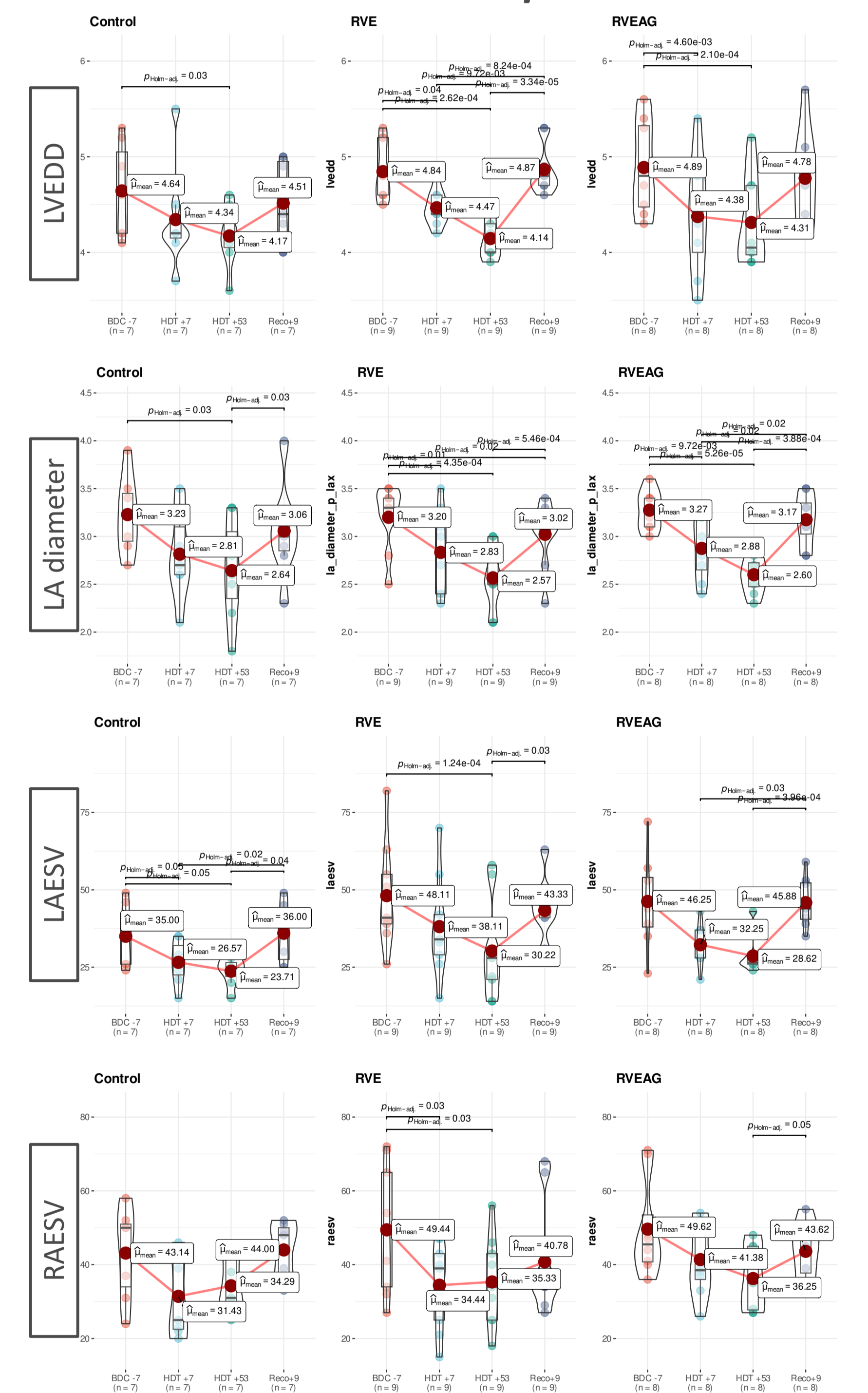
### Systolic function



### Diastolic function and atrial performance



### Structural adaptations



## SUMMARY AND CONCLUSION

- Hypoxic HDT causes significant cardiac remodeling and functional deconditioning.
- At Reco +9, cardiac structure and function showed early but often incomplete recovery as compared to BDC -7.
- RVE, with or without AG, did not counteract cardiac adaptations and did not affect early recovery.
- Protecting the cardiovascular system during hypoxic unloading likely requires countermeasures that directly target cardiac loading.

<sup>1</sup>DZHK (German Center for Cardiovascular Research), Partner Site Greifswald, 17475 Greifswald, Germany

<sup>2</sup>Department of Automatics, Biocybernetics and Robotics, Jožef Stefan Institute, Ljubljana, Slovenia.

<sup>3</sup>Institute of Bioinformatics, University Medicine Greifswald

<sup>4</sup>Clinical Research Unit (CRU) at the Experimental & Clinical Research Center (ECRC) – a joint collaboration of Charité-Universitätsmedizin Berlin, Max Delbrück Center (MDC) for Molecular Medicine in the Helmholtz Association, Berlin, Germany.

<sup>5</sup>University Medicine Greifswald, Department of Cardiology, Germany

### Declaration of interest

No conflicts of interest, financial or otherwise, are declared by the authors.

