Mechanisms of orthostatic tolerance improvement following artificial gravity exposure differ between men and women. JM Evans[1] MB Stenger[3], CR Ferguson[1], LC Ribiero[3], Q Zhang[1], FB Moore[2], J Serrador[4],' JD Smith[2], and CF Knapp[1]

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Introduction. We recently determined that a short exposure to artificial gravity (AG) improved the orthostatic tolerance limit (OTL) of cardiovascularly deconditioned subjects. We now seek to determine the mechanisms of that improvement in these hypovolemic men and women.

Methods. We determined the orthostatic tolerance limit (OTL) of 9 men and 8 women following a 90 min exposure to AG compared to 90 min of head down bed rest (HDBR). In both cases (21 days apart), subjects were made hypovolemic (low salt diet plus 20 mg intravenous furosemide). Orthostatic tolerance was determined from a combination of head up tilt and increasing lower body negative pressure until presyncope. Mean values and correlations with OTL were determined for heart rate, blood pressure, stroke volume, cardiac output and peripheral resistance (Finometer), cerebral artery blood velocity (DWL), partial pressure of carbon dioxide (Novametrics) and body segmental impedance (UFI THRIM) were measured during supine baseline, during OTL to presyncope and during supine recovery

Results. Orthostatic tolerance of these hypovolemic subjects was significantly greater on the day of AG exposure than on the HDBR day. Regression of OTL on these variables identified significant relationships on the HDBR day that were not evident on the AG day: resting TPR correlated positively while resting cerebral flow correlated negatively with OTL. On both days, women's resting stroke volume correlated positively with orthostatic tolerance. Higher group mean values of stroke volume and cerebral artery flow and lower values of blood pressure, peripheral vascular and cerebrovascular resistance both at control and during OTL testing were observed on the AG day. Even though regression of OTL on resting stroke volume was significant only in women, presyncopal stroke volume reached the same level on each day of study for both men and women while the OTL test lasted 30% longer in men and 22% longer in women. Cerebral artery flow appeared to follow stroke volume and absolute values of cerebral flow did not correlate with the development of presyncope. Women responded to AG exposure with elevated cerebral flow at resting control and throughout the OTL test, implying a loss of autoregulation in deconditioned (hypovolemic) women following AG exposure.

Conclusions. Before countermeasures to space flight cardiovascular deconditioning are established, gender differences in cardiovascular responses to orthostatic stress, in general, and to orthostatic stress following exposure to artificial gravity, in particular, need to be determined. Since, in both men and women, a single, acute bout of AG exposure improved orthostatic tolerance, the feasibility of short exposures to AG during longer spaceflights or prior to entry into a gravity (Earth or Mars) environment, should be explored. Given the known beneficial effects of AG on other organ systems, the present study indicates that the positive effects of AG on cardiac stroke volume make AG a likely candidate for maintaining cardiovascular conditioning. Supported by KY NASA EPSCoR Grant #NNX07AT58A, KY State Matching Grants, NASA JSC Human Research Program and NASA Ames Research Center.