Cardiac Function in Permanent High-Altitude Inhabitants of the Zanskar

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INTRODUCTION

- The Zanskar valley in Ladakh, India, is one of the most remote, permanently inhabited high altitude regions of the world (altitude 3500-3800m)
- Life at altitude leads to changes in cardiac function to adapt to the chronic hypoxia. However, data on cardiac adaptation to altitude in Indo-Tibetan populations of the Zanskar is lacking

OBJECTIVES

To evaluate cardiac function in inhabitants of the high-altitude Zanskar region in the Indian Himalayas

METHODS

- N=220 permanent high-altitude inhabitants of the Zanskar valley who presented to the ATMA-LIP Zanskar Health Camp in Padum, Ladakh (altitude 3675m) in July 2022
- Limited transthoracic echocardiography performed by physicians with advanced training in point-of-care ultrasound
- Anthropometric data, vital signs and 12-lead ECGs were collected
- Medical histories were obtained by a physician fluent in the local language
- Data presented as mean ± standard error of mean (SEM)
- Correlations calculated using Pearson linear regression models and plotted with 95% confidence interval bands

RESULTS

Variable	Mean ± SEM	Variable	Mean ± SEM
N	220	**SpO_2 (%)**	86.2 ± 5.8
Age (y)	52.1 ± 3.5	**HR (bpm)**	77.9 ± 5.3
Sex	154 (F), 66 (M)	**Waist circ. (cm)**	78.1 ± 5.3
Height (m)	1.52 ± 0.10	**SBP mean (mmHg)**	127.7 ± 8.6
Weight (kg)	54.45 ± 3.68	**DBP mean (mmHg)**	83.6 ± 5.7
BMI (kg/m^2)	23.41 ± 1.58	**Hb (g/dL)**	13.42 ± 0.91

Table 1: Baseline demographics Descriptive statistics of our study sample. Data were collected from n=220 individuals. SBP and DBP were measured 3 times in a seated position and the average was recorded. HR and SpO_2 were measured at rest by pulse oximetry. Blood samples were collected and analyzed post-hoc.

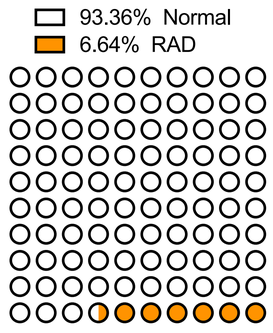

Figure 1: ECG characteristics Mean electrical axis was 48.25 ± 3.32. 6.64% of patients had right axis deviation on ECG. None had left axis deviation.

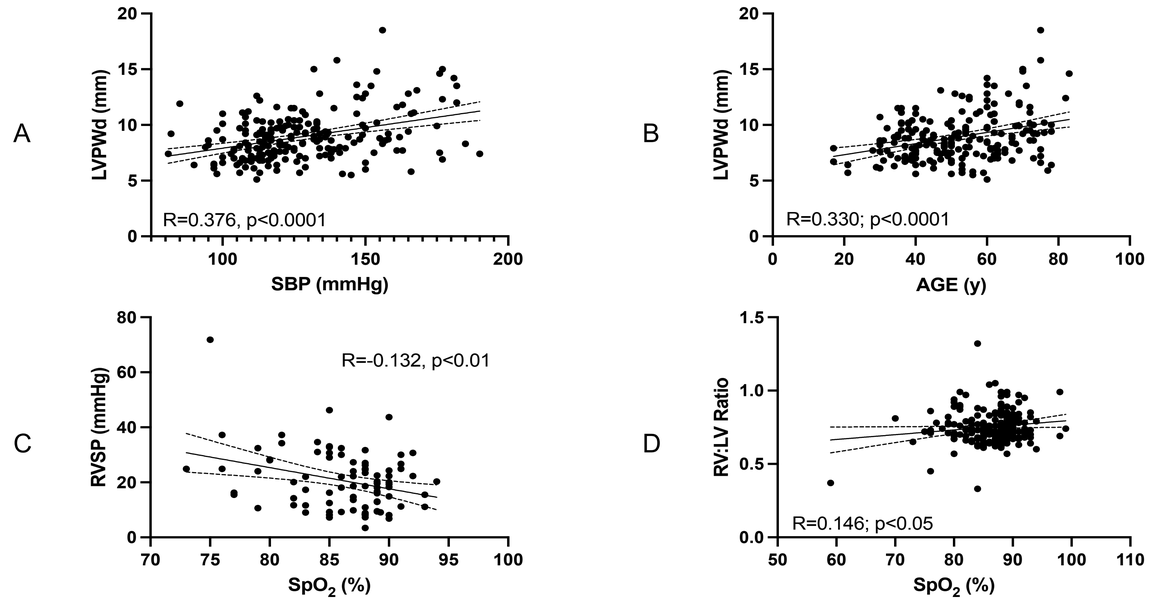

Figure 2: Correlations Left heart function correlated with factors such as age, weight and blood pressure. With advancing age, weight and blood pressure there was a corresponding increase in LV wall thickness (Fig 3A, 3B; data for IVS not shown). In contrast, right heart function correlated better with SpO_2 with no correlation with anthropometric measures or blood pressure. Higher RVSP was correlated with lower SpO_2 (Fig 3C). There was also a trend for TAPSE to negatively correlate with SpO_2 (R= -0.137; p=0.07; data not shown). Interestingly, there was a correlation between increased RV:LV ratios and higher SpO_2 (Fig 3D).

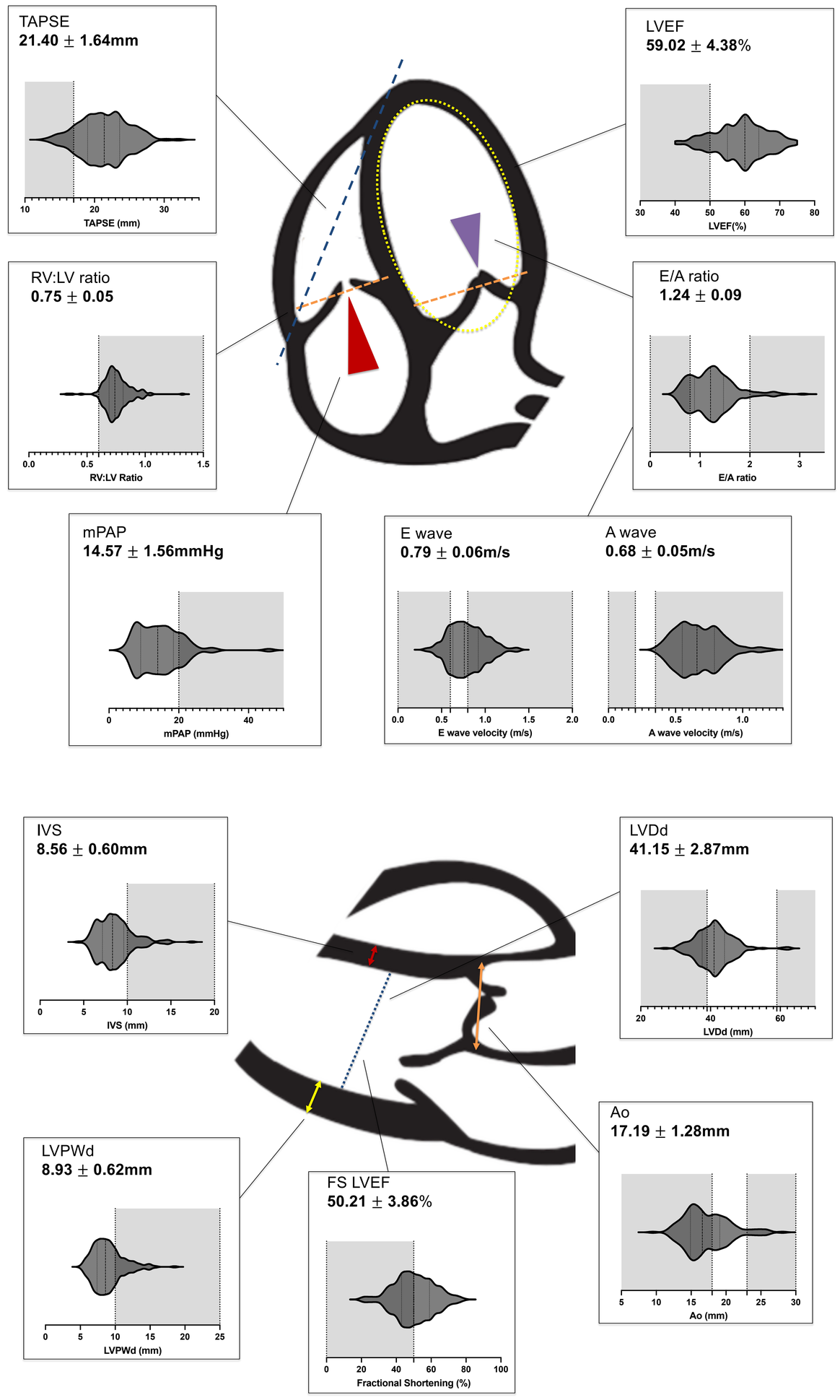

Figure 3: Cardiac function Values for various echocardiographic parameters are presented. Associated figures show spread of sample data for each variable. Shaded grey areas indicate abnormal range per reference values.

Reference: TAPSE=tricuspid annular plane systolic excursion; LVEF=left ventricular ejection fraction (Simpson's bi-plane method); FS-LVEF=fractional shortening LVEF; IVS=interventricular septal width, mPAP=mean pulmonary arterial pressure, calculated via RVSP in n=87; Ao=aortic annulus width; LVDd=left ventricular diastolic diameter; LVPWd=left ventricular posterior wall diameter; E/A ratio=ratio of mitral E-wave velocity divided by A-wave velocity.

CONCLUSION

- Chronic hypoxia at high altitude leads to increased RV strain demonstrated by increased RV:LV ratios, pulmonary arterial pressures, decreased TAPSE, and right axis deviation.
- LV systolic function is grossly preserved in this population.
- However, increased RV strain may impair LV diastolic filling, as demonstrated by reduced LV diastolic diameter and changes in E- and A-wave velocity.
- Chronic RV strain as demonstrated by increased RV:LV ratios may allow people at high altitude to maintain adequate oxygen saturations.
- **These data show, for the first time, how cardiac function in Indo-Tibetan inhabitants of the Zanskar adapts in response to life at high altitude.**