Systematic Review and Meta-Analysis of the Effect of Age and Body Size on Left Ventricular Volume
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Introduction: Studies pertaining to the averages of physiological parameters of the general population and their change with respect to a single variable have been conducted widely, but information about how multiple variables affect the physiological parameters is still limited. This study includes multi-variable predictive models of left ventricle end diastolic and systolic volumes (LVEDV and LVESV) with respect to age, height, weight, body surface area (BSA) and body mass index (BMI). The results of this study, with further validation, can help clinicians make better diagnosis and be useful for researchers by providing reference values for tuning computational models and boundary conditions.

Materials and Methods: The data used for building the models was compiled from previous published literature. Using the PRISMA guidelines, relevant research articles from the PubMed database were filtered and 65 and 63 datapoints from 17 and 16 research papers were compiled for LVEDV and LVESV respectively. The data is in the form of average and standard deviation of age, height, weight, BSA, BMI (predictors) and LVEDV or LVESV (outcome). Due to the small number of datapoints, 10-fold cross-validation repeated 3 times was used to train linear and non-linear predictive models such as ordinary linear regression, elastic net algorithm, support vector machines (SVM), etc. The models were firstly used for feature selection and outlier analysis and were then compared by fitting the compiled predictors versus outcome data. The best model with respect to physical interpretability and root mean square error (RMSE) was chosen as the final multi-variable model.

Results and Discussion: Due to correlation between the predictors, not all of them are used for predicting the outcome. For LVEDV, the predictors used are height, BSA, and BMI. The Elastic Net model was chosen for this outcome and has an RMSE of 14.36 ml. For LVESV, a reduced quadratic model was used which includes height, weight, age, and BSA as the predictors. This model contains the quadratic terms of height, weight, and BSA and the interaction terms involving age. The RMSE of this model is 7.40 ml. For both the outcomes, the SVM model gives a better fit of the data results in terms of RMSE. However, the SVM model is not used because of its tendency of overfitting the data and its low interpretability; the respective models have an RMSE greater than the SVM model but can be easily interpreted and generally do not overfit the data.

Translational Impact: This study is an effort to construct the qualitative model of the ventricular volumes that clinicians form intuitively based on their experience. The measured data for a patient being divergent from the value obtained from these models could be used as an indicator to investigate further into the health of the patient. Further work includes using statistical methods such as simulation studies to develop better ways of evaluating and comparing different models.

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