Research Square

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Prevalence of Previously Undetected Moderate-to-Severe Valvular Heart Disease in Elderly Adults in Saudi Arabia

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Abstract

Background

Population aging is increasing the burden of non-communicable diseases, including non-rheumatic valvular heart disease (VHD), yet the epidemiology of VHD remains poorly characterized in many middle-income countries. In the Kingdom of Saudi Arabia (KSA), where the older adult population is rapidly expanding, data on previously undiagnosed VHD are lacking. This study estimated the prevalence of previously undiagnosed moderate-to-severe VHD among older adults to inform future public health planning and healthcare delivery.

Methods

In this cross-sectional study, consecutive adults aged ≥ 60 years without known VHD underwent transthoracic echocardiography at a tertiary care center in Riyadh, KSA. Moderate-to-severe disease affecting the aortic, mitral, and/or tricuspid valves was assessed using guideline-recommended criteria. Prevalence estimates with exact 95% confidence intervals (CI) were calculated. An exploratory multivariable logistic regression was used to evaluate associations with demographic and cardiometabolic factors.

Results

A total of 512 participants (mean age 70.0 ± 7.2 years) underwent echocardiographic screening. The prevalence of any previously undiagnosed moderate-to-severe VHD was 9.6% (95% CI 7.2–12.5), while moderate-to-severe aortic stenosis was identified in 2.2% (95% CI 1.1–3.8). Exploratory multivariable analysis (N = 510) suggested increasing age was associated with higher odds of moderate-to-severe VHD.

Conclusion

A substantial proportion of older adults had previously undiagnosed moderate-to-severe VHD, suggesting an important hidden burden of disease in KSA. These findings address a critical gap in epidemiological evidence and support future population-based studies to define the national burden of VHD. They also provide evidence to inform health system planning, early detection strategies, and resource allocation as the population continues to age.

BACKGROUND

Valvular heart disease (VHD) is increasingly recognized as a contributor to cardiovascular morbidity and mortality in aging populations (1). It is associated with impaired functional capacity, heart failure, arrhythmia, recurrent hospitalization, and premature death. With demographic aging, improved detection, and expanding access to surgical and transcatheter interventions, the burden of VHD and the healthcare resources required for optimal management are expected to increase substantially (2). Recent

guidelines emphasize early intervention in symptomatic and asymptomatic individuals with severe VHD to prevent disease progression and improve survival, symptom burden, and quality of life (3).

Degenerative VHD encompasses several conditions affecting the cardiac valves, including aortic stenosis (AS), aortic regurgitation, mitral stenosis, mitral regurgitation, and tricuspid regurgitation, each of which can lead to progressive cardiac dysfunction if left untreated (3). AS, the most common form of degenerative VHD in older adults, is characterized by progressive narrowing of the aortic valve leading to left ventricular outflow obstruction and reduced cardiac output (4). Once symptoms develop, untreated severe AS is associated with a poor prognosis and high mortality, with survival often limited to a few years without valve intervention (5–7).

Transthoracic echocardiography (TTE) remains the cornerstone of VHD detection and diagnosis (3, 8). Recommendations from the American College of Cardiology/American Heart Association (ACC/AHA) and European Society of Cardiology/European Association for Cardio-Thoracic Surgery (ESC/EACTS) emphasize the importance of systematic use of TTE in individuals with suspected disease, and the need for early detection to prevent advanced complications.

Understanding the epidemiology of VHD is essential for planning healthcare services, estimating future treatment needs, and informing strategies for early detection (9). While population-based studies from Europe and North America have demonstrated that clinically significant VHD becomes increasingly prevalent with advancing age (2, 10), epidemiological evidence from the Middle East and North Africa (MENA) region remains limited (1, 9, 11). In the Kingdom of Saudi Arabia (KSA), rapid demographic aging, increasing life expectancy, and a growing burden of cardiometabolic disease are likely to increase the prevalence of degenerative VHD (12), yet no studies have quantified the burden of previously undiagnosed clinically significant disease in older adults.

To address this evidence gap, we conducted the first systematic echocardiographic screening study of adults aged ≥ 60 years (13) without known VHD or previous valve intervention in KSA. The aim of this study was to estimate the prevalence of previously undiagnosed moderate-to-severe VHD and describe its distribution among older adults, providing evidence to support future epidemiological research, healthcare planning, and strategies for early detection.

METHODS

2.1 Study design and setting

We conducted a clinic-based, single-center, cross-sectional echocardiographic screening study within the Valve for Life program at King Saud Medical City (KSMC), a tertiary care center in Riyadh, KSA. This initiative forms part of a national Ministry of Health program aimed at reducing cardiovascular mortality by 2027. Recruitment was conducted in non-cardiac clinics over a 14-month period, concluding in December 2025. Medical history and demographic data were collected using a structured questionnaire. Individuals who met the inclusion criteria underwent TTE.

2.2 Sample size estimation

The sample size was determined to estimate the prevalence of moderate-to-severe VHD. Based on preliminary data and published studies in older adults (2, 10, 14–16), the expected prevalence of any moderate-to-severe VHD was estimated at 11%, and that of moderate-to-severe AS at 3%. Sample size was calculated using the single-proportion formula ($n = Z^2p(1 - p)/d^2$), where Z = 1.96 for a two-sided 95% confidence interval, p represents the expected prevalence, and d the desired precision. For an expected prevalence of 11% for any moderate-to-severe VHD with a precision of ± 2.5%, the required sample size was 600 participants. Assuming a prevalence of 3% for moderate-to-severe AS with a precision of ± 1.5%, the required sample size was 500 analyzable participants.

2.3 Participants

Consecutive adults aged ≥ 60 years who were able to provide informed consent in accordance with local ethical requirements were eligible for inclusion. Individuals were excluded if they reported a history of percutaneous cardiac intervention, prior cardiac surgery (including valve repair or replacement), or a previous diagnosis of VHD (including documented rheumatic or degenerative disease), as assessed through a standardized study questionnaire. Participant recruitment, screening, eligibility assessment, and inclusion are summarised in Fig. 1.

2.4 Echocardiography and lesion grading

Standard TTE was performed by certified cardiac sonographers, and tests were interpreted by cardiologists with expertise in echocardiography. Valve disease was assessed and graded for AS, aortic regurgitation, mitral stenosis, mitral regurgitation, and tricuspid regurgitation. Lesion severity was determined using standardized transthoracic echocardiographic criteria aligned with current guidelines, including the ACC/AHA and ESC/EACTS guidelines for management of VHD, and was categorized as none/trace, mild, moderate, or severe (8, 17). The quantitative echocardiographic thresholds for grading native valvular lesions remain unchanged in the 2025 ESC/EACTS guidelines (3). Moderate-to-severe disease was defined as moderate or severe valve dysfunction, as per guideline-recommended echocardiographic thresholds, based on lesion-specific quantitative parameters. Detailed echocardiographic criteria and thresholds used for grading lesion severity are provided in *Supplementary Table 1*.

2.5 Follow-up and clinical management

Participants identified with severe VHD were referred for specialist cardiology evaluation according to routine clinical practice. Follow-up data were collected to assess clinical management, including referral to a heart valve team, further diagnostic testing, treatment planning, and intervention where applicable. Follow-up outcomes were recorded descriptively.

2.6 Outcomes

The primary outcome was the presence of moderate-to-severe VHD, defined as moderate or severe involvement of any assessed valve lesion (AS, aortic regurgitation, mitral stenosis, mitral regurgitation, or tricuspid regurgitation).

Secondary outcomes included the distribution of individual valve lesions by severity and factors associated with moderate-to-severe VHD, based on demographic and clinical characteristics (e.g., age, sex, and key comorbidities) of screened individuals.

2.7 Covariates

Baseline characteristics extracted from program records included age, sex, ethnicity, educational levels, diabetes mellitus, hypertension, hypercholesterolemia, chronic kidney disease, smoking status (never/current/former), and cardiovascular history variables available at screening.

2.8 Statistical analysis

Analyses were conducted in Stata/IC 18.0 (18). Continuous variables are summarized as mean (standard deviation) or median (interquartile range), and categorical variables as counts (n) and percentages (%). Prevalence estimates are reported with 95% confidence intervals. Subgroup comparisons used χ^2 tests or Fisher's exact tests as appropriate. Statistical significance was set at $p < 0.05$. An exploratory multivariable logistic regression model examined associations between the primary outcome and prespecified predictors (age, sex, education levels, diabetes, and hypertension), with results reported as odds ratios (OR), 95% confidence intervals (CI), and statistical significance set at $p < 0.05$. Analyses used available case data. Denominators are reported for each analysis and vary depending on whether missing values are present. Missing data were recorded and excluded from the analyses.

2.9 Ethical approval

Ethical approval was obtained from the institutional review board (KACST, KSA; IRB No. H-01-R-053; IORG No. IORG0010374). The study was conducted in accordance with the Declaration of Helsinki. All data were analyzed in de-identified form.

RESULTS

3.1 Patient population

Of the 3,400 adults aged ≥ 60 years invited to participate, 625 responded. Following the eligibility assessment, 113 individuals were excluded for not meeting the inclusion criteria. A total of 512 participants underwent echocardiographic screening and were included in the final analysis (Fig. 1).

The mean age of the participants was 70.0±7.2 years (median 68 [IQR 9]). Sex distribution was balanced (258 men [50.4%], 254 women [49.6%]). Cardiometabolic comorbidities were common, including

diabetes mellitus (270/511 [52.8%]) and hypertension (312/511 [61.1%]). Smoking prevalence was low (9/512 ([1.8%]). Patient demographics are presented in Table 1.

Table 1. Baseline characteristics (N=512; denominators vary due to missing data).

Characteristic	Overall (N=512)
Age, years, mean ± SD	70.0 ± 7.2
Sex, n/N (%)	
o Men	258/512 (50.4)
o Women	254/512 (49.6)
Ethnicity, n/N (%)	
o Arab	512/512 (100)
Education level n/N (%)	
o Illiterate	202/506 (39.9)
o Primary/secondary school	287/506 (56.7)
o Diploma/bachelor	17/506 (3.4)
o Master/PhD	0/506 (0.0)
Diabetes mellitus, n/N (%)	270/511 (52.8)
Hypertension, n/N (%)	312/511 (61.1)
Hypercholesterolemia, n/N (%)	131/509 (25.7)
Chronic kidney disease, n/N (%)	117/508 (23.0)
History of acute coronary syndrome, n/N (%)	57/509 (11.2)
History of heart failure, n/N (%)	44/509 (8.6)
Smoking status, n (%)	
o Never smoker	496/512 (96.9)
o Current smoker	9/512 (1.8)
o Former smoker	7/512 (1.4)

3.2 Valvular heart disease prevalence and severity

Lesion severity data were available for 511 of 512 participants. The prevalence of the primary endpoint, any moderate-to-severe VHD, was 49 of 511 (9.6%; exact 95% CI 7.2–12.5). Moderate-to-severe AS was identified in 11 of 511 participants (2.2%; exact 95% CI 1.1–3.8). A bicuspid aortic valve was identified in 1 of 511 participants (0.2%).

A consolidated summary of VHD findings is presented in Table 2. Panel A reports participant-level prevalence outcomes derived from lesion severity grades. Panel B summarizes the number of individuals with moderate-to-severe VHD according to the number of affected valves (1, 2, or ≥3 lesions), noting that some participants had more than one valve affected. Panel C presents lesion-specific severity distributions across the five valve lesions assessed. Panel D reports the exploratory multivariable model evaluating associations between the primary endpoint and age, sex, diabetes mellitus, and hypertension; an exploratory subgroup analysis is provided in *Supplementary Table 2*.

Table 2. Valvular heart disease prevalence, severity, distribution, and predictors

Panel / Measure	n/N (%) or OR	Exact 95% CI	p-value
Panel A. Participant-level prevalence outcomes (lesion-derived)			
Any moderate-to-severe VHD (primary)	49/511 (9.59)	7.18-12.48	
Moderate-to-severe AS	11/511 (2.15)	1.08-3.82	
Panel B. Number of any moderate-to-severe VHD lesions per patient (N=49)			
1 lesion	35/49 (71.43)		
2 lesions	11/49 (22.45)		
3+ lesions	3/49 (6.12)		
Panel C. Lesion-specific severity distribution (N=511)			
Aortic stenosis			
None	496 (97.06)		
Mild	4 (0.78)		
Moderate	8 (1.57)		
Severe	3 (0.59)		
Aortic regurgitation			
None	475 (92.95)		
Mild	18 (3.52)		
Moderate	17 (3.33)		
Severe	1 (0.20)		
Mitral stenosis			
None	506 (99.02)		
Mild	1 (0.20)		
Moderate	4 (0.78)		
Severe	0 (0.00)		
Mitral regurgitation			
None	471 (92.17)		
Mild	22 (4.31)		
Moderate	14 (2.74)		
Severe	4 (0.78)		

Tricuspid regurgitation			
None	490 (95.89)		
Mild	5 (0.98)		
Moderate	11 (2.15)		
Severe	5 (0.98)		
Panel D. Exploratory multivariable logistic regression for primary endpoint (N=510)			
Age (per 1-year increase)	1.047	1.009-1.087	0.016
Sex (women vs men)	1.180	0.650-2.143	0.587
Diabetes mellitus (yes vs no)	0.765	0.401-1.460	0.417
Hypertension (yes vs no)	1.662	0.819-3.374	0.160

Abbreviations: *VHD, valvular heart disease; CI, confidence interval; OR, odds ratio.*

Exploratory analyses also examined the prevalence of moderate-to-severe VHD across education groups. Prevalence was similar across categories (illiterate: 21/202, 10.4%; primary/secondary school: 25/287, 8.7%; diploma/bachelor's degree: 2/17, 11.8%). In an adjusted model including age, sex, diabetes mellitus, and hypertension, education level was not associated with the primary endpoint (illiterate vs primary/secondary: OR 0.97, 95% CI 0.50–1.87; diploma/bachelor's vs primary/secondary: OR 1.80, 95% CI 0.38–8.56). Follow-up data were available for 11 individuals diagnosed with severe VHD, all of whom were referred for specialist cardiology evaluation. Specific follow-up outcomes are reported in *Supplementary Table 3*.

DISCUSSION

This systematic echocardiographic screening identified previously unrecognized moderate-to-severe VHD in nearly one in ten older adults (9.6%, 95% CI 7.2–12.5), highlighting a substantial burden of clinically significant but undiagnosed disease. To our knowledge, this is the first study to estimate the prevalence of previously undetected clinically significant VHD among older adults in the KSA. These findings address an important evidence gap and provide the first estimate of the hidden burden of VHD in an aging Saudi population, laying the foundation for future nationally representative studies.

The observed prevalence aligns with existing community-based screening cohorts in Europe, including the OxVALVE Population Cohort Study (PCS), which identified previously undiagnosed moderate-to-severe lesions in approximately 6% of older adults (2). The prevalence of moderate/severe VHD in those aged ≥ 75 years in OxVALVE-PCS increased to 11.9% (2). Similarly, population-based echocardiographic data from the United States reported an overall prevalence of at least moderate VHD of about 2.5%, rising to > 13% in adults aged ≥ 75 years (10). Likewise, the prevalence of moderate-to-severe aortic stenosis (2.2%) observed in our cohort aligns with international estimates (15, 16).

Population-based data on degenerative VHD in older adults in KSA have been lacking. School-based surveys from the late 1980s and early 1990s reported prevalences of rheumatic valve disease, while more recent tertiary-center studies describe cohorts with established rheumatic valve disease or isolated aortic stenosis (19–22). However, degenerative VHD has become the predominant form of valve disease in aging populations worldwide; our findings suggest that VHD burden is likely comparable to that reported in other high-income countries undergoing demographic transition.

Increasing age was independently associated with moderate-to-severe VHD in our cohort, supporting extensive evidence that aging is the principal determinant of degenerative valve disease (1, 2, 9, 10, 15, 16, 23, 24). KSA is undergoing rapid demographic change, with the proportion of adults aged ≥ 60 years expected to increase substantially over the coming decades (25). Together with the high prevalence of cardiometabolic risk factors (25), this demographic transition is likely to drive a considerable increase in the burden of VHD and the demand for diagnostic services, longitudinal surveillance, and valve interventions. Recent national data indicate that more than half of older adults have multiple chronic conditions, particularly hypertension and type 2 diabetes, alongside high levels of obesity, smoking, and suboptimal lifestyle behaviors (25). Estimates suggest a fivefold increase in AS is expected in Saudi Arabia by 2050 (26). However, data from the Saudi Health Council indicate that, based on modeling estimates, up to 90% of individuals with suspected severe AS do not reach specialist evaluation due to a lack of knowledge about the disease prevalence, its burden, and the importance of early prevention (27), resulting in underdiagnosis and missed treatment opportunities. Early detection is increasingly important given the expanding availability of transcatheter valve therapies and evolving guideline recommendations supporting intervention before irreversible cardiac dysfunction develops in appropriately selected individuals (3).

These findings have important implications for healthcare planning in KSA. As the burden of VHD increases with population aging, improved awareness, timely access to echocardiography, and structured referral pathways will be essential to facilitate earlier diagnosis and appropriate management. Furthermore, robust epidemiological data are needed to inform healthcare resource allocation, workforce planning, service capacity, and consideration of targeted screening strategies in high-risk populations (26). Such evidence will support national healthcare transformation goals under Saudi Vision 2030 (28) and provide a framework for future policies to improve the detection and management of VHD in Saudi Arabia. Larger multicentre studies are now warranted to establish the national prevalence of VHD and quantify the unmet need for valve intervention.

4.1 Limitations

This study has several limitations. The single-center design and recruitment from a tertiary care setting may limit generalizability, as individuals presenting for screening are likely to have a higher burden of comorbidities. In addition, participation was subject to potential selection bias. Of 3,400 adults aged ≥ 60 years invited to participate, only 625 responded (18.4%), and 512 met the inclusion criteria and underwent echocardiographic screening. Individuals who chose to participate may have differed

systematically from non-responders in health awareness, symptom burden, healthcare-seeking behavior, or cardiovascular risk, potentially influencing prevalence estimates. Although the sex distribution was balanced, the educational profile suggests lower attainment compared with national estimates, with around 40% of participants reporting less than elementary education and only 3.4% holding a bachelor's degree or higher, compared with 23.8% and 19.3%, respectively, in a recent nationwide survey of older adults in KSA (25). In addition, smoking was reported considerably lower than national estimates, with 1.8% of the cohort smoking compared to the reported 11.1% in a nationwide survey of older adults in KSA (25). The study population consisted exclusively of individuals of Arab ethnicity. Given the large expatriate population in KSA (29), these findings may not generalize to the entire population, particularly because differences in socioeconomic status, healthcare access, and cardiovascular risk profiles may influence disease detection.

The achieved sample size (n = 512) was lower than the planned target of 600 participants for estimating the prevalence of moderate-to-severe VHD; however, it remained sufficient for evaluating moderate-to-severe AS under the prespecified assumptions. Although multivariable analyses were performed, residual confounding cannot be excluded. Key variables, including diabetes mellitus and hypertension, were captured as binary measures without accounting for severity or control, and other relevant factors, such as frailty, physical activity, and access to healthcare, were not assessed. Education-stratified analyses were exploratory and limited by small sample sizes within higher education categories, which reduced statistical power and resulted in wide CIs. Finally, although missing data were minimal, complete-case analysis may have introduced minor bias.

CONCLUSION

In conclusion, this first single-center echocardiographic screening study identified a notable proportion of previously undiagnosed moderate-to-severe VHD among older adults, suggesting that clinically relevant disease may be under-recognized. As KSA undergoes rapid demographic aging (12), there is a clear need for larger, multi-center, and nationally representative studies to establish robust epidemiological data. Such efforts will be essential to define the true prevalence of VHD, inform resource planning, and guide the development of targeted detection and referral pathways within the healthcare system.

Abbreviations

ACC/AHA
American College of Cardiology/American Heart Association
AS
Aortic stenosis
CI
Confidence interval
ESC/EACTS

European Society of Cardiology/European Association for Cardio-Thoracic Surgery
IQR
Interquartile range
IRB
Institutional Review Board
KACST
King Abdulaziz City for Science and Technology
KSA
Kingdom of Saudi Arabia
KSMC
King Saud Medical City
MENA
Middle East and North Africa
OR
Odds ratio
SD
Standard deviation
TTE
Transthoracic echocardiography
VHD
Valvular heart disease

Declarations

Ethics approval and consent to participate

The study was approved by the Institutional Review Board of King Abdulaziz City for Science and Technology (KACST), Kingdom of Saudi Arabia (IRB No. H-01-R-053; IORG No. IORG0010374). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

Adham Salem is an employee of Edwards Lifesciences. Rachele Busca was an employee of Edwards Lifesciences at the time the article was produced. Daria Ropac is a consultant for Edwards Lifesciences and is affiliated with Last Mile, which contributed to scientific and editorial support, including manuscript development. Data analysis, interpretation, and manuscript development were funded by Edwards Lifesciences. The authors retained responsibility for data interpretation and the decision to submit the manuscript for publication.

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Authors' contributions

HR conceived the study and led the investigation. AAR, HAAO, and MA contributed to data validation and critical review of the manuscript. AA, KA, AE, AhS, FA, and HA contributed to participant recruitment, data collection, and data curation. AS supervised the study and contributed to data validation. RB and DR performed the formal statistical analyses and drafted the manuscript. All authors contributed to the interpretation of the data, critically revised the manuscript for intellectual content, read and approved the final manuscript, and agreed to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Figures

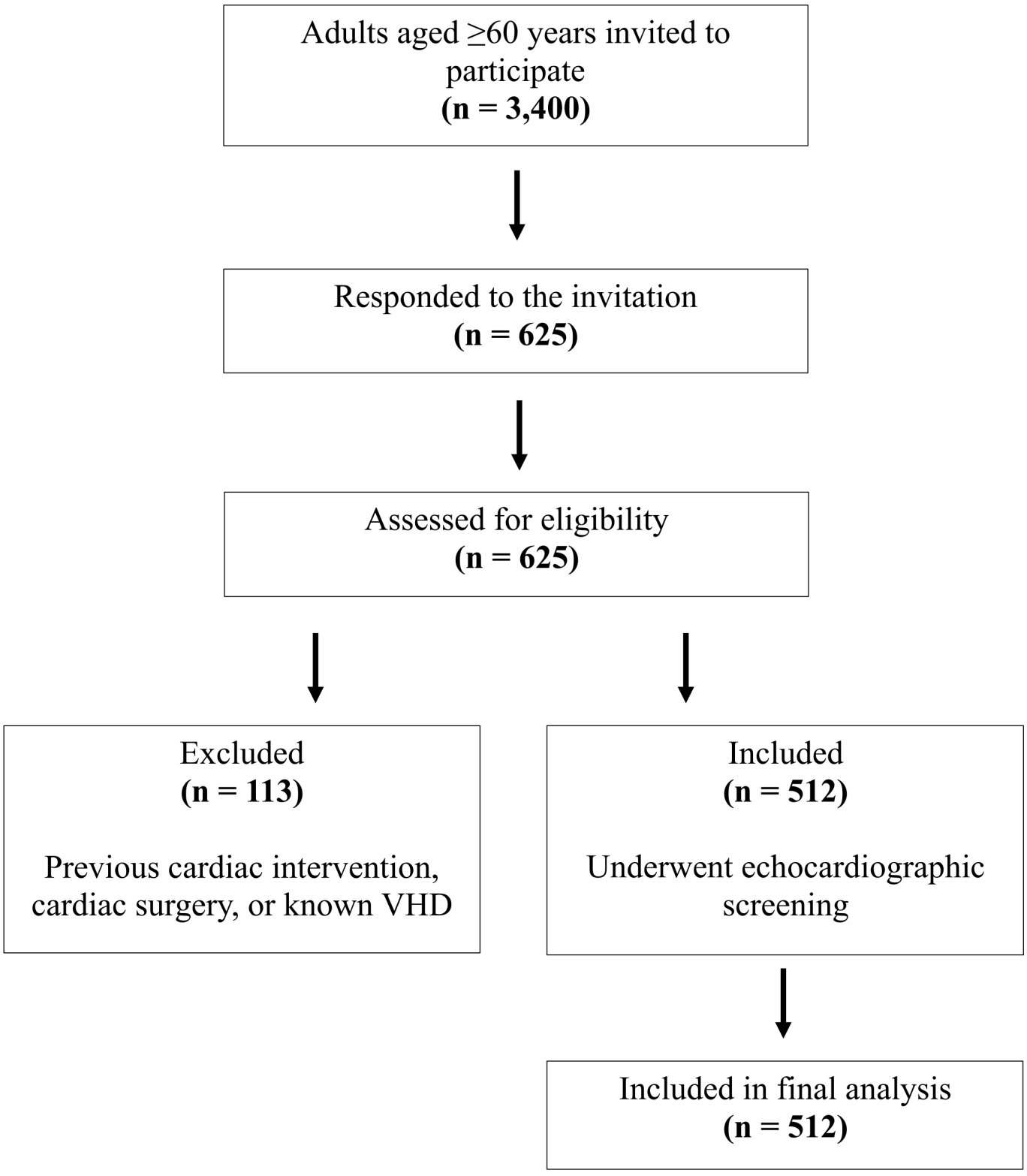


Figure 1

Participant flow diagram. ***Abbreviations:****VHD, valvular heart disease.*

Supplementary Files

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- SupplementarymaterialPrevalenceofVHD.docx