Prevalence of structural heart diseases detected by handheld echocardiographic device in school-age children in Iran: The SHED LIGHT study

Supplementary materials
Supplementary methods- Study protocol and population selection
Supplementary methods- Echocardiographic examination
Supplementary methods- Electrocardiographic examinations
Supplementary table S1- Diagnostic criteria for screening of RHD using Vscan and standard transthoracic echocardiography
Supplementary table S2- The frequency of newly diagnosed CHD and cardiomyopathies
Supplementary table S3- The frequency of individuals with concomitant CHD
Supplementary table S4- ECG findings among all individuals
Supplementary table S5- ECG findings in patients with SHD upon Vscan examinations and corresponding diagnosis upon standard echocardiographic examinations
Supplementary table S6- The details of echocardiographic findings upon standard echocardiographic examinations and corresponding ECG diagnosis
Supplementary table S7- The comparison of individuals with or without total SHD
Supplementary table S8- The comparison of individuals with or without non-rheumatic VHD
Supplementary table S9- The comparison of individuals with or without RHD
Supplementary table S10- The comparison of individuals with borderline RHD, definite RHD, and without RHD
Supplementary Fig. S1 The areas of study located in the Tehran urban territory
Supplementary Fig. S2 Age distribution of the studied population
Supplementary Fig. S3 The proportion of students with (A) CHD, (B) non-rheumatic VHD, (C) RHD, and (D) SHD in age groups from 6 to 18 years old.

References
Supplementary methods

Study protocol and population selection

The present study was conducted in the Tehran urban area, Iran. At the commencement of the study, the population of Tehran, divided into 22 municipality districts, was more than 8.9 million. The total number of schools and/or educational centers in Tehran urban area was around 3900, and the total population of school-age children was approximately 1.2 million at study commencement. The study was performed between October 2017 and December 2018 in selected schools of Tehran. The sample size from each region was proportionate to the population of the district. Given the probability of absence in examinations and parental non-consent for examination, the sample size was aimed to reach approximately 15 000 students for the final cohort. Random school selection was done by considering an equal number of single-sex schools for boys and girls. The number of private schools was obtained based on the proportion of the students studying at private schools confirmed by the Tehran Department of Education. After the random selection of schools, the members of the schools’ management departments were informed regarding the details of the study, and they were requested to transfer the details of the study protocol to all the parents and students via group meetings in school and/or telephone interviews. All the parents provided consent at least 14 days before the examinations.
Supplementary methods

Echocardiographic examinations

Echocardiographic examinations were performed using a pocket-sized ultrasound device (Vscan, GE Healthcare, Milwaukee, WI, USA). The Vscan echo machine weighs 391 g and is 13.5 × 7.4 × 2.8 cm in size. The device provides 2D grayscale and color Doppler images obtained with a 1.7–3.8 MHz phased-array transducer. It does not possess zoom, spectral Doppler, or the ability to perform velocity or time measurements.

The interpretation of valvular heart disease (VHD) was qualitatively performed. Valvular regurgitation was categorized into mild, moderate, or severe based on color-flow mapping. For the assessment of the severity of aortic insufficiency and pulmonary insufficiency, eyeball assessment of the regurgitant jet width was drawn upon. Accordingly, regurgitant jets of less than 20%, between 20% and 50%, and greater than 50% of the annulus diameter were considered mild, moderate, and severe regurgitation, respectively. Mitral regurgitation and tricuspid regurgitation were estimated based on the presence of central or lateral jets and by the eyeball assessment of the jet area to the left atrium and the right atrium, respectively. The grading of severity was similar to that in the aortic and tricuspid valves. The prolapse of the valves and valvular stenosis were interpreted as absent or present for being pathologic even for a mild lesion. Valvular leaflet motion, identified as normal or any restrictions or malcoaptation, was assessed by color turbulency. The identification of rheumatic heart disease (RHD) was based on the criteria of the World Heart Federation (WHF) [1]. However, since we used pocket-sized echocardiography with on-site interpretation, the simplified version was used for the detection of
RHD (Table S1) [2]. The measurement of ventricular systolic function was performed visually (ie, normal function vs mild, moderate, and severe dysfunction). The eyeball evaluation of the left ventricular ejection fraction was classified into 4 groups of greater than 55%, between 55% and 45%, between 45% and 35%, and less than 35% as normal, mild, moderate, and severe dysfunction, respectively. The heart chambers were evaluated qualitatively as normal, dilated, or hypoplastic/small. Large vessel abnormalities were also qualitatively reported as normal, dilated, or stenotic based on 2D images and color study. Any other congenital heart disease (CHD) or anatomic variations were reported when detected.
Supplementary methods

Electrocardiographic examinations

The electrocardiogram (ECG) was recorded by 4 technicians with more than 5 years of experience. The technicians work in a tertiary hospital and take at least 50 ECGs per working day. At the time of the examination, all ECGs were checked by cardiologists. In the event significant noises rendered an ECG uninterpretable, another ECG was recorded. The interpretation of traces was performed according to current international standards by a pediatric cardiologist with a fellowship in electrophysiology [3-7].
### Supplementary table S1- Diagnostic criteria for screening of RHD using Vscan and standard transthoracic echocardiography

| Screening criteria for Vscan | Pathologic MV regurgitation | Pathologic AV regurgitation | Screening criteria for standard transthoracic echocardiography using WHF |
|------------------------------|-----------------------------|----------------------------|---------------------------------------------------------------------|
| Pathologic MV regurgitation  | □ MV regurgitation jet >2 cm presents in any views which was estimated based on the scale at the border of sector and/or the eyeball assessment of jet area to the left atrium area >20%  
□ Both conditions in the absence of concomitant prolapse and congenital anomalies | □ AV regurgitation presents in any views without prolapse and congenital anomalies | Pathologic MV regurgitation  
All of: 1) Regurgitation jet seen in 2 views; 2) with at least one view >2 cm; 3) with high velocity (>3 m/s); and 4) pan systolic jet in at least one envelope  
Pathologic AV regurgitation  
All of: 1) Regurgitation jet seen in 2 views; 2) with at least one view >1 cm; 3) with high velocity (>3 m/s) in early diastole; and 4) pan-diastolic jet in at least one envelope  
Morphological changes of MV  
Two or more of: 1) anterior MV leaflet thickening ≥3 mm; 2) chordal thickening; 3) restricted leaflet motion; 4) and excessive leaflet tip motion during systole  
Morphological changes of AV  
Two or more of: 1) irregular or focal thickening of AV; 2) coaptation defect; 3) restricted leaflet motion; and 4) prolapse  
Definite RHD  
□ Definite A: Pathological MV regurgitation plus morphological changes of the mitral valve (i.e. two or more)  
□ Definite B: Mitral stenosis .4 mmHg  
□ Definite C: Pathological AV regurgitation plus morphological changes of the aortic valve (i.e. two or more)  
□ Definite D: Borderline disease of both MV and AV  
Borderline RHD  
□ Borderline A: Morphological features of the MV (i.e. at least two) without pathological MV regurgitation or mitral stenosis  
□ Borderline B: Pathological MV regurgitation  
□ Borderline C: Pathological AV regurgitation |

AV denotes aortic valve, MV mitral valve, RHD rheumatic heart disease, and WHF world heart federation
### Supplementary table S2 - The frequency of newly diagnosed CHD and cardiomyopathies

| Findings, number (%) | Crude rate, per 1000 persons | 95% confidence interval |
|----------------------|-----------------------------|-------------------------|
| Atrial septal defect | 35 (0.23%)                  | 2.31                    | 1.6 – 3.2               |
| Patent foramen ovale | 33 (0.22%)                  | 2.18                    | 1.5 – 3                 |
| Bicuspid aortic valve| 18 (0.13%)                  | 1.19                    | 0.8 – 2                 |
| Patent ductus arteriosus | 16 (0.10%)            | 1.06                    | 0.6 – 1.7               |
| Ventricular septal defect | 9 (0.06%)             | 1.06                    | 0.6 – 1.7               |
| Cardiomyopathies      | 9 (0.06%)                  | 0.6                     | 0.2 – 1.1               |
| Sub-aortic web        | 4 (0.026%)                 | 0.26                    | 0.07 – 0.7              |
| Persistent LSVC       | 3 (0.019%)                 | 0.19                    | 0.04 – 0.6              |
| Coarctation of aorta  | 2 (0.013%)                 | 0.13                    | 0.01 – 0.5              |
| Isolated PA dilatation| 2 (0.013%)                 | 0.13                    | 0.01 – 0.5              |
| Isolated sinus valsalva dilatation | 2 (0.013%) | 0.13 | 0.01 – 0.5 |
| Isolated right aortic arch | 1 (0.007%)          | 0.07                    | 0.002 – 0.3             |
| Supravalvular mitral mass | 1 (0.007%)          | 0.07                    | 0.002 – 0.3             |
| Quadricuspid aortic valve | 1 (0.007%)          | 0.07                    | 0.002 – 0.3             |
| Isolated aorta dilatation | 1 (0.007%)          | 0.07                    | 0.002 – 0.3             |
| Situs inversus        | 1 (0.007%)                 | 0.07                    | 0.002 – 0.3             |

CHD denotes congenital heart disease, LSVC left superior vena cava, PA pulmonary artery, and STE standard transthoracic echocardiography
**Supplementary table S3**- The frequency of individuals with concomitant CHD

| Concomitant Condition                  | Number (%) | 95% confidence interval |
|----------------------------------------|------------|-------------------------|
| Concomitant PFO and PDA                | 2 (0.013%) | 0.01 – 0.5              |
| Concomitant PFO and ASD                | 2 (0.013%) | 0.01 – 0.5              |
| Concomitant CoA and BAV                | 2 (0.013%) | 0.01 – 0.5              |
| Concomitant PFO and VSD                | 1 (0.007%) | 0.002 – 0.3             |
| Concomitant ASD and VSD                | 1 (0.007%) | 0.002 – 0.3             |
| Concomitant VSD and BAV                | 1 (0.007%) | 0.002 – 0.3             |
| Concomitant right aortic arch and situs inversus | 1 (0.007%) | 0.002 – 0.3 |

ASD denotes atrial septal defect, BAV bicuspid aortic valve, CoA coarctation of aorta, PDA patent ductus arteriosus, PFO patent foramen ovale, and VSD ventricular septal defect
Supplementary table S4- ECG findings among all individuals

Major and minor electrocardiographic findings in studied population

| Major findings                          | Frequency (%) | Crude rate, per 1000 persons | 95% confidence interval |
|-----------------------------------------|---------------|------------------------------|-------------------------|
| PAC                                     | 50 (0.33%)    | 3.31                         | 2.46 – 4.36             |
| PVC                                     | 44 (0.29%)    | 2.91                         | 2.12 – 3.91             |
| QT interval >470 ms                     | 22 (0.15%)    | 1.46                         | 0.91 – 2.20             |
| Ventricular pre-excitation              | 13 (0.086%)   | 0.86                         | 0.45 – 1.47             |
| Complete RBBB                          | 10 (0.066%)   | 0.66                         | 0.31 – 1.21             |
| PR interval >200 ms                     | 9 (0.059%)    | 0.6                          | 0.27 – 1.13             |
| Non-conducted PAC                       | 8 (0.053%)    | 0.53                         | 0.22 – 1.04             |
| SND                                     | 6 (0.04%)     | 0.40                         | 0.14 – 0.86             |
| LPFB                                    | 4 (0.026%)    | 0.26                         | 0.07 – 0.67             |
| Paced rhythm**                         | 2 (0.013%)    | 0.13                         | 0.01 – 0.47             |
| Epsilon wave                            | 1 (0.007%)    | 0.07                         | 0.002 – 0.36            |

| Minor findings                          | Frequency (%) | Crude rate, per 1000 persons | 95% confidence interval |
|-----------------------------------------|---------------|------------------------------|-------------------------|
| Incomplete RBBB or RVCD                | 1071 (7.1%)   | 71                           | 66.95 – 75.21           |
| Sinus arrhythmia                       | 887 (5.9%)    | 58.8                         | 52.10 – 62.67           |
| Sinus tachycardia                      | 562 (3.7%)    | 37.25                        | 34.29 – 40.40           |
| Sinus bradycardia                      | 162 (1%)      | 10.74                        | 9.15 – 12.51            |
| Early repolarization                   | 52 (0.34%)    | 3.45                         | 2.57 – 4.51             |
| Sinus pause                             | 44 (0.29%)    | 2.91                         | 2.12 – 3.91             |
| Pseudo delta wave                      | 35 (0.22%)    | 2.32                         | 1.61 – 3.22             |
| ST segment changes                     | 29 (0.19%)    | 1.92                         | 1.28 – 2.76             |
| Atrial rhythm                          | 28 (0.18%)    | 1.86                         | 1.23 – 2.68             |
| Tall T wave                            | 19 (0.12%)    | 1.26                         | 0.75 – 1.96             |
| Minimal ventricular pre-excitation     | 17 (0.11%)    | 1.13                         | 0.65 – 1.80             |
| Q wave                                 | 3 (0.02%)     | 0.2                          | 0.04 – 0.58             |

* Suspicious for sinus node dysfunction requiring further evaluations

** Patients with paced rhythm had cardiac block and sinus node dysfunction causing bradyarrhythmia which were counted once as mentioned diagnoses in this table

Abbreviations: PAC = premature atrial contraction; PVC = premature ventricular contraction; ms = millisecond; RBBB = right bundle branch block; SND = sinus node dysfunction; LPFB = left posterior fascicular block; RVCD = right ventricular contraction delay
**Supplementary table S5-** ECG findings in patients with SHD upon Vscan examinations and corresponding diagnosis upon standard echocardiographic examinations

| ECG findings | Frequency of ECG findings in individuals with Vscan abnormalities* (n = 205) | CHD and CMP upon Vscan examinations found as normal on STE (n = 43) | CHD and CMP upon STE examinations† (n = 162) |
|--------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------|
| Normal       | 138 (67.3%)                                                                   | 31 (72.1%)                                                      | 107 (66.1%)                     |
| Abnormal     | 67 (32.7%)                                                                    | 12 (27.9%)                                                     | 55 (33.9%)                      |
| Sinus tachycardia | 28 (41.8%)                                                              | 4 (33.3%)                                                      | 24 (43.6%)                      |
| Incomplete RBBB | 16 (23.9%)                                                                 | 3 (25%)                                                       | 13 (23.6%)                      |
| Sinus arrhythmia | 6 (8.9%)                                                                   | 1 (8.3%)                                                      | 5 (9.1%)                        |
| RVCD         | 4 (6%)                                                                        | 1 (8.3%)                                                      | 3 (5.5%)                        |
| Complete RBBB | 3 (4.5%)                                                                     | 0                                                             | 3 (5.5%)                        |
| Atrial rhythm | 3 (4.5%)                                                                     | 1 (8.3%)                                                      | 2 (3.6%)                        |
| Early repolarization | 2 (3%)                                                                    | 1 (8.3%)                                                      | 1 (1.8%)                        |
| Sinus bradycardia | 1 (1.5%)                                                                  | 0                                                             | 1 (1.8%)                        |
| PVC          | 1 (1.5%)                                                                      | 0                                                             | 1 (1.8%)                        |
| Sinus pause  | 1 (1.5%)                                                                      | 1 (8.3%)                                                      | 0                               |
| Epsilon wave | 1 (1.5%)                                                                      | 0                                                             | 1 (1.8%)                        |
| Tall T wave  | 1 (1.5%)                                                                      | 0                                                             | 1 (1.8%)                        |

*Pathologies include CHDs (n = 172) listed in table 2, CMPs (n = 32), and pulmonary arterial hypertension (n = 1)
†Pathologies include CHDs (n = 152) listed in table 2, CMPs (n = 9), and pulmonary arterial hypertension (n = 1)
**Supplementary table S6-** The details of echocardiographic findings upon standard echocardiographic examinations and corresponding ECG diagnosis

| ECG findings        | CHD and CMP findings upon STE examination (n = 55)                                                                 |
|---------------------|-------------------------------------------------------------------------------------------------------------------|
| Sinus tachycardia   | 8 ASD, 7 PFO, 3 BAV, 1 Repaired TGA, 1 Repaired CoA, 1 CoA, 1 PDA, 1 PAH, 1 CMP                                         |
| Incomplete RBBB     | 5 ASD, 3 VSD, 2 ASD/PFO, 1 PFO, 1 VSD/BAV, 1 PDA                                                                   |
| Sinus arrhythmia    | 3 ASD, 1 BAV, 1 VSD                                                                                                 |
| RVCD                | 1 Right aortic arch, 1 ASD, 1 CMP                                                                                |
| Complete RBBB       | 1 TFTC, 1 PS, 1 VSD                                                                                                |
| Atrial rhythm       | 1 CMP, 1 PDA                                                                                                       |
| Early repolarization| 1 BAV                                                                                                               |
| Sinus bradycardia   | 1 ASD                                                                                                               |
| PVC                 | 1 ASD                                                                                                               |
| Epsilon wave        | 1 ARVC                                                                                                              |
| Tall T wave         | 1 CMP                                                                                                               |

ASD denotes atrial septal defect, BAV bicuspid aortic valve, CHD congenital heart disease, CMP cardiomyopathy, CoA coarctation of aorta, ECG electrocardiogram, PAH pulmonary arterial hypertension, PDA patent ductus arteriosus, PFO patent foramen ovale, PS pulmonary valve stenosis, PVC premature ventricular contraction, RBBB right bundle branch block, RVCD right ventricular conduction delay, SHD structural heart disease, STE standard transthoracic echocardiography, TFTC tetralogy of Fallot total correction, TGA transposition of great artery, VSD ventricular septal defect
Supplementary table S7- The comparison of individuals with or without total SHD

|                            | With SHD† (n = 162) | Without SHD (n = 14968) | P value |
|-----------------------------|---------------------|-------------------------|---------|
| Age, years                  | 11.9 ± 2.9          | 12.2 ± 3.1              | 0.162   |
| Gender                      |                     |                         | 0.386   |
| Boys                        | 90 (55.6%)          | 7804 (52.1%)            |         |
| Girls                       | 72 (44.4%)          | 7164 (47.9%)            |         |
| School type                 |                     |                         | 0.345   |
| Public                      | 145 (89.5%)         | 13022 (87%)             |         |
| Private                     | 17 (10.5%)          | 1946 (13%)              |         |
| Parental consanguinity      | 66 (40.7%)          | 3888 (26%)              | <0.001  |
| Father literacy†            |                     |                         | 0.079   |
| High school diploma or less | 129 (79.6%)         | 10233 (73.5%)           |         |
| University degrees          | 33 (20.4%)          | 3686 (26.5%)            |         |
| Mother literacy†            |                     |                         | 0.612   |
| High school diploma or less | 127 (78.4%)         | 10740 (76.7%)           |         |
| University degrees          | 35 (21.6%)          | 3262 (23.3%)            |         |
| Number of children in family|                     |                         | 0.870   |
| 1 child                     | 37 (22.8%)          | 3360 (22.4%)            |         |
| 2 children                  | 78 (49.9%)          | 7551 (50.4%)            |         |
| 3 children                  | 32 (19.8%)          | 2909 (19.4%)            |         |
| ≥4 children                 | 15 (9.3%)           | 1148 (7.7%)             |         |
| Height, cm                  | 150.4 ± 16.3        | 151.34 ± 17.1           | 0.508   |
| Weight, kg                  | 46.1 ± 16.6         | 48.4 ± 18.8             | 0.126   |
| Body mass index, kg/m²      | 19.8 ± 4.5          | 20.4 ± 4.9              | 0.135   |
| Waist circumference, cm     | 69.2 ± 10.5         | 70.2 ± 11.4             | 0.296   |
| Systolic blood pressure, mm Hg | 113.6 ± 12.4   | 113.9 ± 12.2            | 0.763   |
| Diastolic blood pressure, mm Hg | 72.1 ± 7.8       | 72.3 ± 7.6              | 0.705   |
| Arterial oxygen saturation, %| 97 ± 2.5            | 97.2 ± 1.5              | 0.095   |

SHD denotes structural heart disease

* Pathologies include CHDs (n = 152) listed in table 2, CMPs (n = 9), and pulmonary arterial hypertension (n = 1)

† These data were not available in about 7% of individuals

Data are presented as number (%) or mean ± SD
**Supplementary table S8-** The comparison of individuals with or without non-rheumatic VHD

|                                | With non-rheumatic VHD (n = 465) | Without non-rheumatic VHD (n = 14665) | P value |
|--------------------------------|----------------------------------|--------------------------------------|---------|
| Age, years                     | 13.2 ± 3.1                       | 12.2 ± 3                             | <0.001  |
| Gender                         |                                  |                                      | <0.001  |
| Boys                           | 187 (40.2%)                      | 7707 (52.6%)                        |         |
| Girls                          | 287 (59.8%)                      | 6958 (47.4%)                        |         |
| School type                    |                                  |                                      | 0.015   |
| Public                         | 422 (90.8%)                      | 12745 (86.9%)                       |         |
| Private                        | 43 (9.2%)                        | 1920 (13.1%)                        |         |
| Parental consanguinity         | 129 (27.7%)                      | 3825 (26.1%)                        | 0.423   |
| Father literacy*              |                                  |                                      | 0.035   |
| High school diploma or less    | 346 (77.9%)                      | 10016 (73.4%)                       |         |
| University degrees             | 98 (22.1%)                       | 3621 (26.6%)                        |         |
| Mother literacy*              |                                  |                                      | 0.045   |
| High school diploma or less    | 359 (80.7%)                      | 10508 (76.6%)                       |         |
| University degrees             | 86 (19.3%)                       | 3211 (23.4%)                        |         |
| Number of children in family   |                                  |                                      | 0.040   |
| 1 child                        | 93 (20%)                         | 3304 (22.5%)                        |         |
| 2 children                     | 220 (48.3%)                      | 7409 (50.5%)                        |         |
| 3 children                     | 105 (22.6%)                      | 2836 (19.3%)                        |         |
| ≥4 children                    | 47 (10.1%)                       | 1116 (7.6%)                         | <0.001  |
| Height, cm                     | 155.3 ± 17.1                     | 151.2 ± 17.1                        | <0.001  |
| Weight, kg                     | 47.7 ± 17                        | 48.4 ± 18.8                         | 0.415   |
| Body mass index, kg/m²         | 19.2 ± 4.3                       | 20.4 ± 4.9                          | <0.001  |
| Waist circumference, cm        | 67.7 ± 10                        | 70.3 ± 11.4                         | <0.001  |
| Systolic blood pressure, mm Hg | 111.7 ± 12                       | 114 ± 12.2                          | <0.001  |
| Diastolic blood pressure, mm Hg| 71.6 ± 7.8                       | 72.3 ± 7.6                          | 0.070   |
| Arterial oxygen saturation, %  | 97.4 ± 1.8                       | 97.2 ± 1.6                          | 0.003   |

VHD denotes valvular heart disease

*These data were not available in about 7% of individuals

Data are presented as number (%) or mean ± SD
Supplementary table S9- The comparison of individuals with or without RHD

|                         | With RHD (n = 143) | Without RHD (n = 14987) | P value   |
|-------------------------|--------------------|-------------------------|-----------|
| Age, years              | 13.1 ± 3.1         | 12.2 ± 3                | <0.001    |
| Gender                  |                    |                         | <0.001    |
| Boys                    | 53 (37.1%)         | 7841 (52.3%)            |           |
| Girls                   | 90 (62.9%)         | 7146 (47.7%)            |           |
| School type             |                    |                         | 0.059     |
| Public                  | 132 (92.3%)        | 13035 (87%)             |           |
| Private                 | 11 (7.7%)          | 1952 (13%)              |           |
| Parental consanguinity  | 36 (25.2%)         | 3918 (26.1%)            | 0.793     |
| Father literacy         |                    |                         |           |
| High school diploma or less | 118 (86.1%) | 10244 (73.5%) | 0.001     |
| University degrees      | 19 (13.9%)         | 3700 (26.5%)            |           |
| Mother literacy         |                    |                         | 0.065     |
| High school diploma or less | 115 (83.3%) | 10752 (76.7%) |           |
| University degrees      | 23 (16.7%)         | 3274 (23.3%)            |           |
| Number of children in family | 24 (16.8%) | 3373 (22.5%) | 0.363     |
| 1 child                 |                    |                         |           |
| 2 children              | 75 (52.4%)         | 7554 (50.4%)            |           |
| 3 children              | 30 (21%)           | 2911 (19.4%)            |           |
| ≥4 children             | 14 (9.8%)          | 1149 (7.7%)             |           |
| Height, cm              | 155 ± 16.8         | 151.3 ± 17.1            | 0.011     |
| Weight, kg              | 49.4 ± 18.2        | 48.4 ± 18.8             | 0.521     |
| Body mass index, kg/m²  | 19.9 ± 4.6         | 20.3 ± 4.9              | 0.219     |
| Waist circumference, cm | 69.1 ± 10.7        | 70.2 ± 11.4             | 0.270     |
| Systolic blood pressure, mm Hg | 113.3 ± 12.7 | 113.9 ± 12.2 | 0.535     |
| Diastolic blood pressure, mm Hg | 71.9 ± 7.8   | 72.3 ± 7.6              | 0.536     |
| Arterial oxygen saturation, % | 97.4 ± 1.8   | 97.2 ± 1.6              | 0.186     |

RHD denotes rheumatic heart disease

* These data were not available in about 7% of individuals

Data are presented as number (%) or mean ± SD
**Supplementary table S10-** The comparison of individuals with borderline RHD, definite RHD, and without RHD

|                          | Definite RHD (n = 30) | Borderline RHD (n = 113) | Without RHD (n = 14987) | P value |
|--------------------------|-----------------------|--------------------------|--------------------------|---------|
| **Age, years**           | 13.4 ± 3              | 13 ± 3.2                 | 12.2 ± 3                 | 0.005   |
| **Gender**               |                       |                          |                          |         |
| Boys                     | 12 (40%)              | 41 (36.3%)               | 7841 (52.3%)             |         |
| Girls                    | 18 (60%)              | 72 (63.7%)               | 7146 (47.7%)             |         |
| **School type**          |                       |                          |                          | 0.165   |
| Public                   | 28 (93.3%)            | 104 (92%)                | 13035 (87%)              |         |
| Private                  | 2 (6.7%)              | 9 (8%)                   | 1952 (13%)               |         |
| Parental consanguinity   | 7 (23.3%)             | 29 (25.7%)               | 3918 (26.1%)             | 0.935   |
| **Father literacy**      |                       |                          |                          | 0.003   |
| High school diploma or less | 24 (82.8%)          | 94 (87%)                 | 10244 (73.5%)            |         |
| University degrees       | 5 (17.2%)             | 14 (13%)                 | 3700 (26.5%)             |         |
| **Mother literacy**      |                       |                          |                          | 0.167   |
| High school diploma or less | 25 (86.2%)          | 90 (82.6%)               | 10752 (76.7%)            |         |
| University degrees       | 4 (13.8%)             | 19 (17.4%)               | 3274 (23.3%)             |         |
| **Number of children in family** |               |                          |                          | 0.135   |
| 1 child                  | 8 (26.7%)             | 16 (14.2%)               | 3373 (22.5%)             |         |
| 2 children               | 18 (60%)              | 57 (50.4%)               | 7554 (50.4%)             |         |
| 3 children               | 2 (6.7%)              | 28 (24.8%)               | 2911 (19.4%)             |         |
| ≥4 children              | 2 (6.7%)              | 12 (10.6%)               | 1149 (7.7%)              |         |
| **Height, cm**           | 155.6 ± 15.7          | 154.8 ± 17.1             | 151.3 ± 17.1             | 0.038   |
| **Weight, kg**           | 49.3 ± 18.5           | 49.5 ± 18.3              | 48.4 ± 18.8              | 0.813   |
| **Body mass index, kg/m²**| 19.6 ± 4.5            | 19.9 ± 4.6               | 20.3 ± 4.9               | 0.453   |
| **Waist circumference, cm** | 69.3 ± 10.7          | 69.1 ± 10.7              | 70.2 ± 11.4              | 0.542   |
| **Systolic blood pressure, mm Hg** | 116.4 ± 13.4        | 112.4 ± 12.4             | 113.9 ± 12.2             | 0.233   |
| **Diastolic blood pressure, mm Hg** | 72.7 ± 8             | 71.7 ± 7.7               | 72.3 ± 7.6               | 0.662   |
| **Arterial oxygen saturation, %** | 97.7 ± 1.4           | 97.3 ± 1.9               | 97.2 ± 1.6               | 0.234   |

RHD denotes rheumatic heart disease

* These data were not available in about 7% of individuals

Data are presented as number (%) or mean ± SD
Supplementary Fig S1. The areas of study located in the Tehran urban territory.
Supplementary Fig. S2 Age distribution of the studied population
Supplementary Fig. S3 The proportion of students with (A) CHD, (B) non-rheumatic VHD, (C) RHD, and (D) SHD in age groups from 6 to 18 years old.
The vertical lines indicate the 95% confidence intervals for the prevalence of echocardiographic finding, and the square in the middle of the vertical line indicates the point estimate of the prevalence of echocardiographic finding in the particular age group.
References

[1] Remenyi B, Wilson N, Steer A, Ferreira B, Kado J, Kumar K et al. World Heart Federation criteria for echocardiographic diagnosis of rheumatic heart disease— an evidence-based guideline. Nat Rev Cardiol 2012;9:297-309.

[2] Mirabel M, Bacquelin R, Tafflet M, Robillard C, Huon B, Corsenac P et al. Screening for rheumatic heart disease: evaluation of a focused cardiac ultrasound approach. Circ Cardiovasc Imaging 2015;8.

[3] Maron BJ, Friedman RA, Kligfield P, Levine BD, Viskin S, Chaitman BR et al. Assessment of the 12-lead electrocardiogram as a screening test for detection of cardiovascular disease in healthy general populations of young people (12-25 years of age): a scientific statement from the American Heart Association and the American College of Cardiology. J Am Coll Cardiol 2014;64:1479-514.

[4] Hancock EW, Deal BJ, Mirvis DM, Okin P, Kligfield P, Gettes LS et al. AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: part V: electrocardiogram changes associated with cardiac chamber hypertrophy: a scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society: endorsed by the International Society for Computerized Electrocardiology. Circulation 2009;119:e251-61.

[5] Rautaharju PM, Surawicz B, Gettes LS, Bailey JJ, Childers R, Deal BJ et al. AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: part IV: the ST segment, T and U waves, and the QT interval: a scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society: endorsed by the International Society for Computerized Electrocardiology. Circulation 2009;119:e241-50.

[6] Kligfield P, Gettes LS, Bailey JJ, Childers R, Deal BJ, Hancock EW et al. Recommendations for the standardization and interpretation of the electrocardiogram: part I: the electrocardiogram and its technology a scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society endorsed by the International Society for Computerized Electrocardiology. J Am Coll Cardiol 2007;49:1109-27.

[7] Ackerman MJ, Priori SG, Willems S, Berul C, Brugada R, Calkins H et al. HRS/EHRA expert consensus statement on the state of genetic testing for the channelopathies and cardiomyopathies this document was developed as a partnership between the Heart Rhythm Society (HRS) and the European Heart Rhythm Association (EHRA). Heart Rhythm 2011;8:1308-39.