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Physical functioning, mental health and quality of life in different congenital heart defects: Comparative analysis in 3538 patients from 15 countries

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Physical functioning, mental health and quality of life in different congenital heart defects: Comparative analysis in 3538 patients from 15 countries

Brief title: Outcomes in congenital heart defects

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Brief Summary

We compared physical functioning, mental health and quality of life (QoL) in 3538 patients with different subtypes of congenital heart diseases (CHD). Patients with coarctation of the aorta and those with isolated aortic valve disease reported the best physical functioning, mental health and QoL. Patients with cyanotic heart disease or Eisenmenger syndrome had worst outcomes. However, functional status rather than the heart defect shapes the outcomes.

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Abstract

Background: We compared physical functioning, mental health and quality of life (QoL) of patients with different subtypes of congenital heart diseases (CHD) in a large international sample, and investigated the role of functional class in explaining the variance in outcomes across heart defects.

Methods: In the cross-sectional APPROACH-IS study, we enrolled 4,028 adult CHD patients from 15 countries. Diagnostic groups with at least 50 patients were included in these analyses, yielding a sample of 3,538 patients (median age=32y; 52% women). Physical functioning, mental health and QoL were measured with the SF-12 health status survey, Hospital Anxiety and Depression Scale (HADS), linear analog scale (LAS) and Satisfaction with Life Scale, respectively. Functional class was assessed using the patient-reported New York Heart Association (NYHA) class. Multivariable general linear mixed models were applied to assess the relationship between the type of CHD and patient-reported outcomes, adjusted for patient characteristics, and with country as random effect.

Results: Patients with coarctation of the aorta and those with isolated aortic valve disease reported the best physical functioning, mental health and QoL. Patients with cyanotic heart disease or Eisenmenger syndrome had worst outcomes. The differences were statistically significant, above and beyond other patient characteristics. However, the explained variances were small (0.6-4.1%), and decreased further when functional status was added to the models (0.4-0.9%).

Conclusions: Some types of CHD predict worse patient-reported outcomes. However, it appears that it is the functional status associated with the heart defect rather than the heart defect itself that shapes the outcomes.

Keywords: heart defects, congenital; patient-reported outcomes; quality of life; health status; effect sizes; multilevel

Introduction

Over the past four decades, research on quality of life (QoL) in persons with congenital heart disease (CHD) has grown exponentially.¹ The mounting interest in QoL among affected patients coincided with increasing longevity.² Indeed, after the dramatic improvements in patient survival in the second half of the 20th century, clinicians and researchers were intrigued by the question of what the lives of patients with CHD looked like and whether the heart defect itself had a direct impact on QoL.¹

Together with increased interest in QoL, there has been rising awareness of the importance of patient-reported health status.³ It has been argued that patients' perspectives should be routinely incorporated within health metrics.³ Perceived health, from both physical and mental perspectives, ought to be evaluated to obtain a comprehensive view of the patients' status. Further, in different cardiac populations, patient-reported outcomes are found to be independent predictors of mortality.³

There are previous studies that have indicated that a higher complexity of CHD is associated with poorer physical functioning and QoL.^{4, 5} However, within complexity categories, there may be large variation in outcomes according to the type of CHD. For instance, in one study adults with transposition of the great arteries (TGA) had an average SF-36 physical functioning of 93 on a scale from 0 (worst) to 100 (best),⁶ whereas in another study patients with single-ventricle physiology had a much lower average physical functioning score of 81.6.⁷ This is meaningful because both of these subtypes are categorized as complex heart defects.⁸ Conversely, there are examples in which similar patient-reported outcomes have been observed among patients with defects of great vs. moderate complexity. To illustrate, cohorts of patients who have undergone atrial switch operations for TGA (categorized as a defect of great complexity) and patients with repaired tetralogy of Fallot (a defect of moderate complexity) both reported average scores on a QoL linear analog scale of

80 on a scale from 0 (worst QoL) to 100 (best QoL).^{9, 10} These apparent inconsistencies warrant direct comparison of the physical functioning and QoL of patients with specific heart defects. Such studies, however, have been scarce, primarily because large sample sizes are needed to have sufficient patients for each diagnostic group.

The aims of the present study were therefore (i) to compare the physical functioning, mental health and QoL in patients with different heart defects drawn from a large international sample; and (ii) to investigate to what extent the outcome variance is predicted by patients' functional class rather than the heart defect itself.

Methods

Study population and procedure

In 2013-2015, we conducted the 'Assessment of Patterns of Patient-Reported Outcomes in Adults with Congenital Heart disease – International Study' (APPROACH-IS). This was a cross-sectional study involving 15 countries from 5 continents: Argentina, Australia, Belgium, Canada, France, India, Italy, Japan, Malta, Norway, Sweden, Switzerland, Taiwan, the Netherlands, and the United States of America (USA).¹¹ Patients were eligible for study inclusion if they met the following criteria: (i) diagnosis of CHD; (ii) aged ≥ 18 years; (iii) diagnosis established before adolescence; (iv) continued follow-up at a CHD center or included in a national/regional registry; and (v) physical, cognitive, and language capabilities required to complete self-report questionnaires. Patients with prior heart transplantation or primary pulmonary hypertension were excluded.¹¹ Patients who met inclusion criteria were contacted by mail or were approached during an outpatient visit. Overall, 4,028 adults with CHD were enrolled in APPROACH-IS.¹² For the present study, only diagnostic groups having at least 50 patients were included in the analyses, yielding a sample of 3,538 patients (88% of the total recruited sample).

The study was conducted in keeping with the Declaration of Helsinki and was approved by the Institutional Review Board of the University Hospitals Leuven/KU Leuven Belgium (coordinating center) and by the local institutional review boards of the participating centers (when required). All participants provided written informed consent. Detailed information on the rationale, design, and methods of APPROACH-IS can be found in a dedicated methods paper.¹¹

Measures

Patient characteristics included demographic data, such as sex, age, marital status, educational level, employment status, and patient-reported New York Heart Association (NYHA) functional class, which were collected using a self-report questionnaire. Specific diagnoses as well as the complexity of the patients' heart defects (simple, moderate, or great complexity) were extracted from the medical records.

Self-reported physical functioning was measured using the Physical Component Summary (PCS) of the 12-item Short Form Health Survey (SF-12).¹³ The score ranges from 0 to 100, with higher scores representing better physical functioning. Mental health was assessed using the Mental Component Summary (MCS) of the SF-12¹³ which also ranges from 0 to 100, and the anxiety and depression subscales of the Hospital Anxiety and Depression Scale (HADS), which range from 0 to 21.¹⁴ Whereas higher SF-12 scores represent better physical and mental health status, higher scores on the HADS anxiety and depression subscales reflect greater symptoms. QoL was evaluated using a Linear Analog Scale (LAS)¹⁵ and the Satisfaction With Life Scale.¹⁶ The LAS ranges from 0 (worst imaginable QoL) to 100 (best imaginable QoL) and the Satisfaction With Life Scale ranges from 5 (extremely dissatisfied) to 35 (extremely satisfied). Supplementary Table S1 provides

an expanded definition of the variables measured as well as the interpretation of scores for the individual questionnaires.

Statistical analyses

Continuous data are presented as means and standard deviations if normally distributed and as medians and interquartiles ranges (IQR) if not normally distributed. Categorical variables are represented by percentages. Multivariable general linear mixed models (GLMM) were applied to assess the relationship between the type of CHD and physical functioning, mental health and QoL, adjusted for patient characteristics (age, sex, educational status, employment status, and marital status), and with country as a random effect. These patient characteristics have previously been related to patient-reported outcomes.¹⁷ The heart defect with the highest score on the respective outcomes was used as reference group. A (pseudo) R^2 statistic was derived from the model χ^2 .¹⁸ This is an approximate estimate for the percentage of explained variance. When reported for the effect of the type of heart defect, these approximations are analogous to the semi-partial R^2 .

Data were visualized using ridgeline plots, expressing the density of the distribution of scores for the different heart defects (see Supplementary Box S1 for more details). To investigate the clinical difference between the respective heart defects and the reference group (=highest score), we calculated the standardized effect size (Cohen's d) for each type of defect and reported it in terms of absolute standardized effect size. The following cut-off values were used: 0.2-0.5 indicative of a small effect; 0.5-0.8 a moderate effect; and >0.8 a large effect.¹⁹

The proportion of missing values in the outcomes was small (5-8%). Therefore, multiple imputation was not used to address missing values as this would unnecessarily complicate data analysis, and only patients for whom full data were available for all variables

of interest were included in the GLMM. Data analysis was performed using IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, NY, USA). Ridgeline plots were made using Rstudio, version 1.1.463. A p -level <0.05 was used as the cut-off for statistical significance, and statistical tests were two-sided.

Results

Sample characteristics

The current sample was comprised of 3,538 patients with a median age of 32 years and 52% were women. The majority of patients had a high school degree, worked part or full time, and were married or living with a partner. With regard to medical characteristics, 49% had CHD of moderate complexity and 55% reported they were in NYHA functional class I (i.e. asymptomatic). Demographic and medical characteristics of the sample are described in Supplementary Table S2, and were consistent with those of the larger sample included in APPROACH-IS.¹² The distribution of the NYHA functional class in the different subtypes of CHD is described in Supplementary Table S3.

Physical functioning

Patients with coarctation of the aorta received the highest mean score on the physical component summary (83.6 ± 17.2), while patients with cyanotic heart disease or Eisenmenger syndrome had the lowest mean score (53.5 ± 21.8). The ridgeline plot shown in Figure 1 visually demonstrates that scores of patients with cyanotic heart disease/Eisenmenger syndrome were lower than those of other types of heart defects. When adjusted for patient characteristics, general linear mixed models showed that physical functioning was significantly lower in 12 heart defects compared to coarctation of the aorta (Figure 1). The type of heart defect explained 3.9% of the variance of the physical component summary.

When NYHA functional class was added to the model, the semi-partial R^2 for the type of heart defect dropped to 0.8%, whereas the semi-partial R^2 for NYHA was 36.5%

As demonstrated in the bar chart in Figure 1, scores of patients with cyanotic heart disease/Eisenmenger syndrome differed with a large standardized effect size from the reference group, namely patients with coarctation of the aorta. For patients with congenitally corrected TGA, pulmonary atresia, Fontan circulation, and Ebstein anomaly, a moderate difference was found with the reference group. A small difference was observed for several other diagnoses, as shown in Figure 1.

Mental health

In patients with coarctation of the aorta, the highest mean score on the mental component summary (76.3 ± 16.7) and the lowest mean score for depression (2.5 ± 2.7) were observed (Figure 2). Patients with isolated aortic valve disease had the lowest level of anxiety (4.7 ± 3.8). People with cyanotic heart disease/Eisenmenger syndrome consistently had the worst scores on mental health (61.2 ± 20.2), depression symptoms (7.5 ± 4.6) and anxiety symptoms (5.2 ± 4.1). For the mental component summary, patients with TGA, Fontan circulation, cyanotic heart disease/Eisenmenger syndrome, or repaired ductus arteriosus/ASD/VSD had significantly lower scores compared to the reference group, adjusted for patient characteristics. Patients with TGA, Fontan circulation, or cyanotic heart disease/Eisenmenger syndrome scored significantly lower than the reference group for anxiety symptoms. Patients with TGA, pulmonary atresia, Fontan circulation, cyanotic heart disease/Eisenmenger syndrome, or atrioventricular septal defect/ostium primum ASD scored significantly lower than the reference group in depression symptoms (Figure 2). The explained variance for the mental component summary, anxiety and depression was 1%, 1% and 0.7%, respectively. When adjusted for NYHA class, the semi-partial R^2 for the type of

heart defect declined to 0.7%, 0.4% and 0.5%, respectively. The semi-partial R^2 for NYHA was 14.4% for the mental component summary, 7.2% for anxiety, and 9.9% for depression.

Effect sizes (Figure 2) showed that the difference between the mental component summary of patients with cyanotic heart disease/Eisenmenger syndrome and the reference group was large. The difference was moderate for anxiety in patients with Fontan circulation and cyanotic heart disease/Eisenmenger syndrome. A large difference was also found for depression in patients with cyanotic heart disease/Eisenmenger syndrome. For the other differences, the effects were small or negligible (Figure 2).

Quality of life

Patients with isolated aortic valve disease had the highest QoL score, both on the LAS (82.0 ± 13.8) and the Satisfaction with Life Scale (27.1 ± 6.0). Patients with cyanotic heart disease/Eisenmenger syndrome reported the lowest scores on QOL (67.1 ± 21.8 ; 22.4 ± 7.1) (Figure 3). Compared to the reference group, a significantly lower score on the LAS was observed in patients with congenitally corrected TGA, Fontan circulation, cyanotic heart disease/Eisenmenger syndrome, and conduits. On the Satisfaction with Life Scale, patients with complete TGA, Fontan circulation, and cyanotic heart disease/Eisenmenger syndrome scored significantly lower, when adjusted for patient characteristics. The semi-partial R^2 for the type of heart defect on the LAS was 1.1% and on the Satisfaction with Life Scale 1.4%. These explained variances dropped to 0.4% and 0.6%, respectively, when NYHA class was added to the generalized linear mixed model. On the other hand, semi-partial R^2 for NYHA was 10.7% for the LAS and 7.1% for the Satisfaction with Life Scale.

The effect size for the score on the LAS in patients with cyanotic heart disease/Eisenmenger syndrome was large, and moderate for people with congenitally corrected TGA. On the Satisfaction with Life Scale, a moderate effect was found in patients

with Fontan circulation and cyanotic heart disease/Eisenmenger syndrome. The other effects were small or negligible (Figure 3).

Discussion

This was the first study in which the wide spectrum of CHD subtypes were compared using a comprehensive set of patient-reported outcomes. Most previous studies investigating patient-reported outcomes collapsed across a heterogeneous group of heart defects or focused on one particular heart lesion.¹ Few studies compared outcomes between two subtypes of heart defects. In these studies, heart defects of different complexity levels were compared,²⁰⁻²² or different interventions for the same condition were compared.²³ The present study demonstrated that patients with isolated aortic valve disease or coarctation of the aorta had the best scores on patient-reported outcomes, whereas patients with cyanotic heart disease/Eisenmenger syndrome consistently score lowest.

It may be surprising that individuals with coarctation of the aorta report such positive patient-reported outcomes, since it is categorized as a heart defect of moderate complexity. However, it has been shown that exercise capacity long-term after treatment for coarctation of the aorta is preserved and comparable to healthy controls.²⁴ Within the adult population of CHD, patients with coarctation of the aorta seem to have the best exercise capacity,²⁵ which is likely to reflect in good physical functioning. Further, mental health among patients within this CHD subgroup has been found to be comparable with the scores of a healthy population,²⁶ and the proportion of patients with coarctation of the aorta who developed depression (1.5%) was the lowest when compared to other heart defects.²⁷ A potential explanation for this finding is that coarctation of the aorta is usually treated without cardiopulmonary bypass and thereby the risk for neurological and cognitive side-effects is lower. Overall, these findings suggest that patients with coarctation of the aorta and isolated

aortic valve disease could be equally considered as reference groups as those with ASD or VSD, which have sometimes been used as a “healthy” comparison group.

The fact that people with cyanotic heart defects and Eisenmenger syndrome received lowest scores on all patient-reported outcomes was anticipated. Research and clinical experiences indicate that these patients have significantly impaired exercise capacity.^{25, 28} The level of anxiety in these patients was high, and was in keeping with the findings of a large-scale study in patients with Eisenmenger in France.²⁹ The level of depression in cyanotic heart disease/Eisenmenger syndrome in APPROACH-IS was actually even higher than that in the French cohort.²⁹

Despite reaching statistical significance, the explained variance of the type of heart defect on the respective outcomes was small (0.7-3.9%). When adjusted for NYHA functional class, the explained variance was even smaller (0.4-0.8%), whereas the explained variance of the NYHA ranged from 7.1-36.5%. This shows that the functional impact of the heart defect rather than the heart defect itself affects patient-reported outcomes. This was most pronounced for physical health status. In line with these findings, it is understandable that the 2018 AHA/ACC guidelines for the management of adults with CHD proposed a new classification scheme, in which both anatomical complexity and current physiological stage of the patient are included, the so-called ACHD-AP score.⁸ The first validity evaluation showed that adding the physiological component to anatomical complexity is able to better predict 15-year mortality.³⁰ Other functional indices, such as the Congenital Heart Disease Functional Index, also seem more predictive than anatomical classifications.³¹ The relationship between functional indices and QoL was found to be larger compared to anatomical complexity and QoL.³²

Findings of this study can inform clinicians about patient-reported outcomes as perceived by patients with different subtypes of CHD. Subgroups of patients with specific

defects who may be prone to developing worse outcomes have been identified. The present study also carries implications for research. Results from this large international sample may serve as a benchmark for previous and future studies on patient-reported outcomes. For instance, this study demonstrates that the composition of the sample may impact the outcomes of the study. Indeed, an overrepresentation of patients with coarctation of the aorta or isolated aortic valve disease would now be expected to inflate scores and may lead to an overestimation of the status of patients with CHD. Further, investigators should not assume that patient-reported outcomes vary by defect complexity in a linear fashion, as in this study a moderately complex defect, namely coarctation of the aorta, was associated with better outcomes than various mild heart lesions.

Methodological considerations

The present study has several strengths. We included more than 3,500 patients from 15 countries; we had a high degree of complete data; and we used valid and reliable instruments to comprehensively assess the self-reported outcomes in this international sample. For the present study, we conducted multilevel analysis and adjusted for patient characteristics that have been shown to predict patient-reported outcomes.¹⁷ In addition to statistical significance, we also reported effect sizes, which allowed us to appraise the magnitude of the differences in a standardized way. The visualization technique of the ridgeline plots provides insights into the density of distribution of scores, which extends the typical reporting of central tendency and dispersion measures.

However, we have to bear in mind some limitations inherent to APPROACH-IS that may hamper generalizability. It was a cross-sectional study (not allowing conclusions in terms of causality), for most participating countries data from only one center were available, patients who were physically or mentally incapable of completing the questionnaires were not

represented, and there was no healthy control group.¹⁷ A control group could have allowed us to put our findings more into perspective. However, a meta-analysis comprising 234 studies indicated that patients with moderate or complex CHD generally have worse physical functioning, yet an equal mental health than healthy individuals.⁴ Patients with mild heart defects did not differ from healthy persons.⁴

For the present study, defects with very low prevalence, such as truncus arteriosus, tricuspid atresia or pulmonary atresia that were not treated with a Fontan operation, and infundibular right ventricular outflow obstruction, were not included in the analyses. These less prevalent heart defects accounted for 12% of the APPROACH-IS sample. Future studies in adults with CHD will also include patients with heart defects that were lethal in infancy until two decades ago, e.g. hypoplastic left heart syndrome, because more of these patients are now reaching adulthood. The categorization of CHD used in this study was mutually exclusive. The most severe defect was reported, not including combinations with other heart lesions (eg TGA with VSD). Further, the current study did not allow an investigation of the impact of different treatment strategies. For instance, it could be interesting to compare the outcomes of patients with different surgical approaches for the same lesion (eg, ventriculotomy vs trans-atrial/trans-pulmonary approach in tetralogy of Fallot). The type of operation, or the specifics on the material used, was not available in APPROACH-IS. Finally, we did not measure extracardiac drivers for outcomes. Some syndromes may have systemic and neurocognitive consequences, impacting on physical functioning, mental health and QoL.³³ Health behaviors, such as smoking, drug use and alcohol consumption, also may have a differential impact on outcomes in different heart defects.^{34, 35} These are avenues for future research.

Conclusions

This largescale international study showed that some types of CHD predict worse patient-reported outcomes. However, the outcomes were shaped by the functional status associated with the heart defect rather than the heart defect itself. Indeed, the explained variances of the subtype of heart defect were small, and decreased further when the functional status was added to the models. Hence, it is important that patients are not only classified based on their anatomical complexity, but also on their current physiological and functional status.

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Figure legends

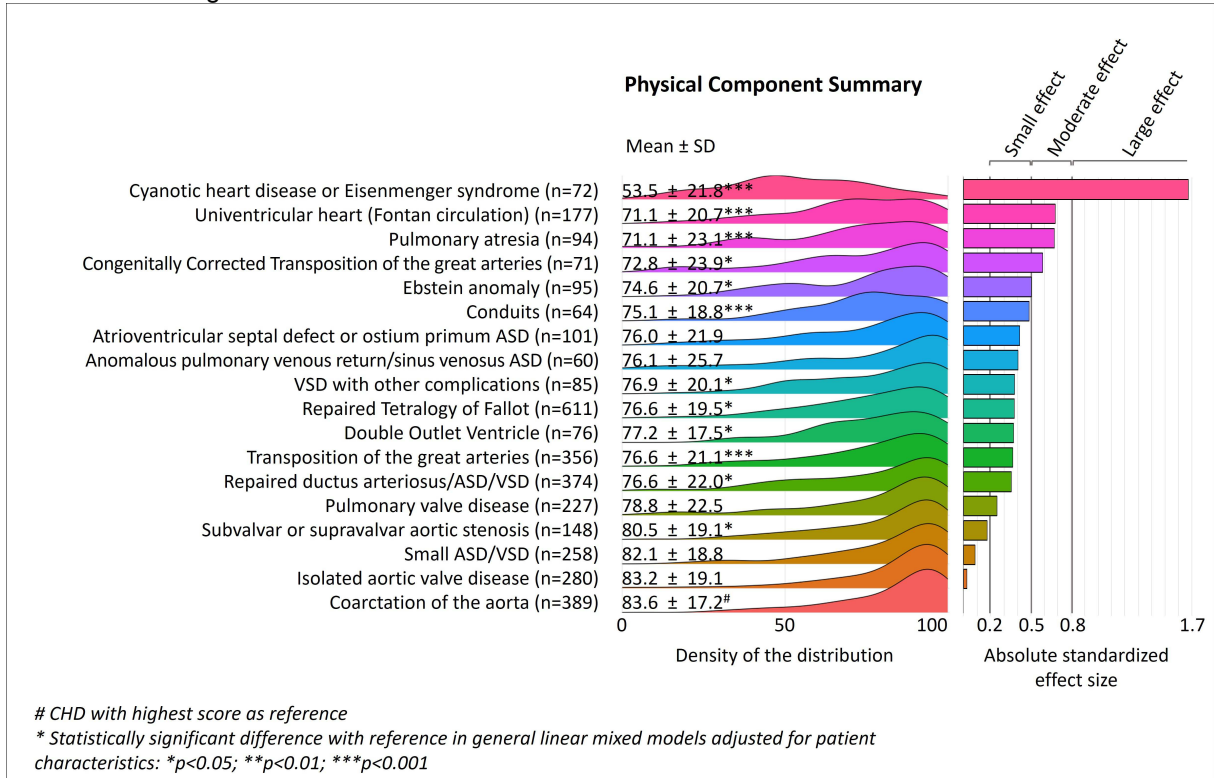
Figure 1: Physical functioning in patients with different heart defects and its comparison to the heart defect with the highest score

Figure 2: Mental health in patients with different heart defects and its comparison to the heart defect with the highest score

Figure 3: Quality of life in patients with different heart defects and its comparison to the heart defect with the highest score

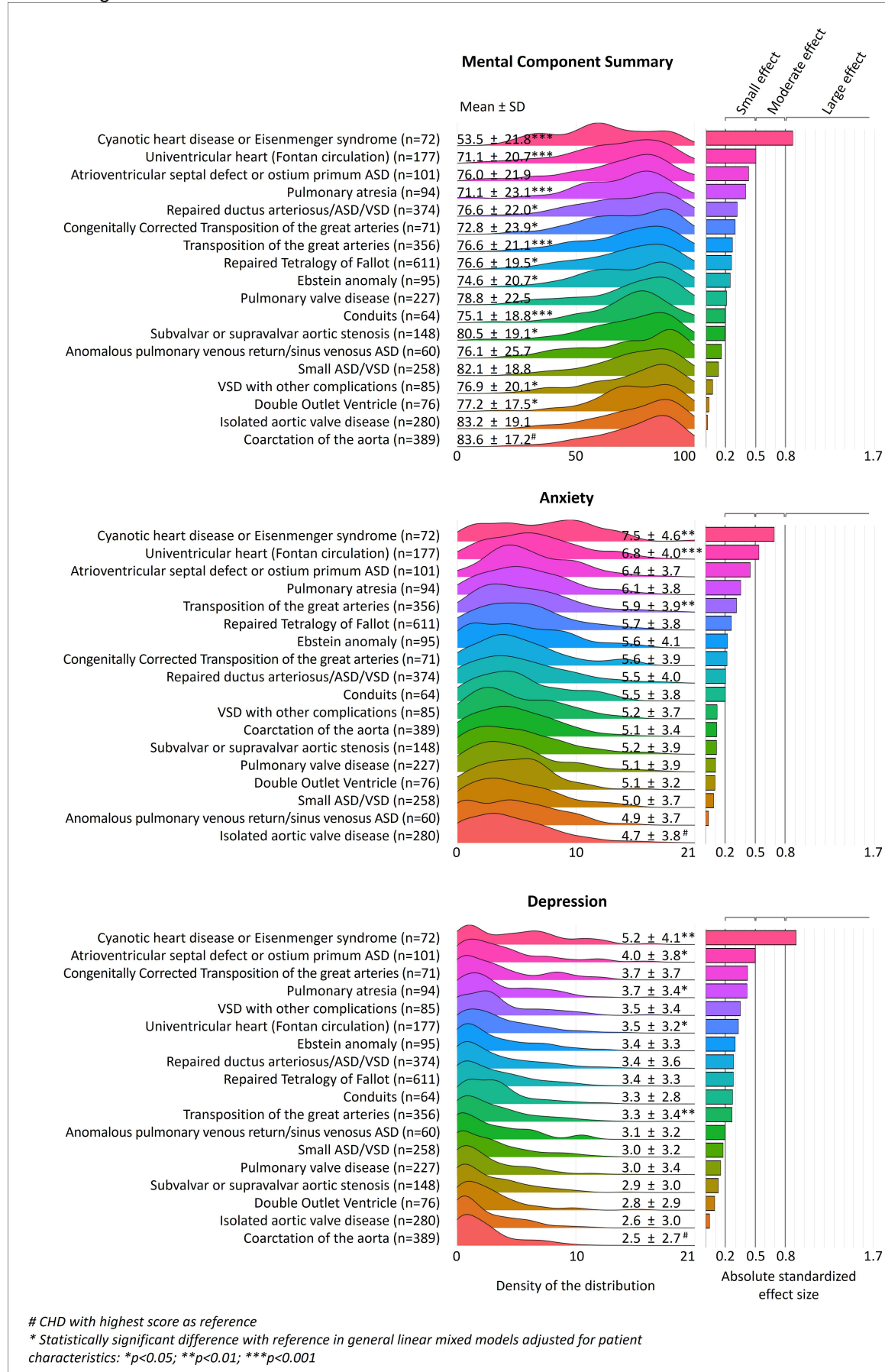
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Figure 1: Physical functioning in patients with different heart defects and its comparison to the heart defect with the highest score



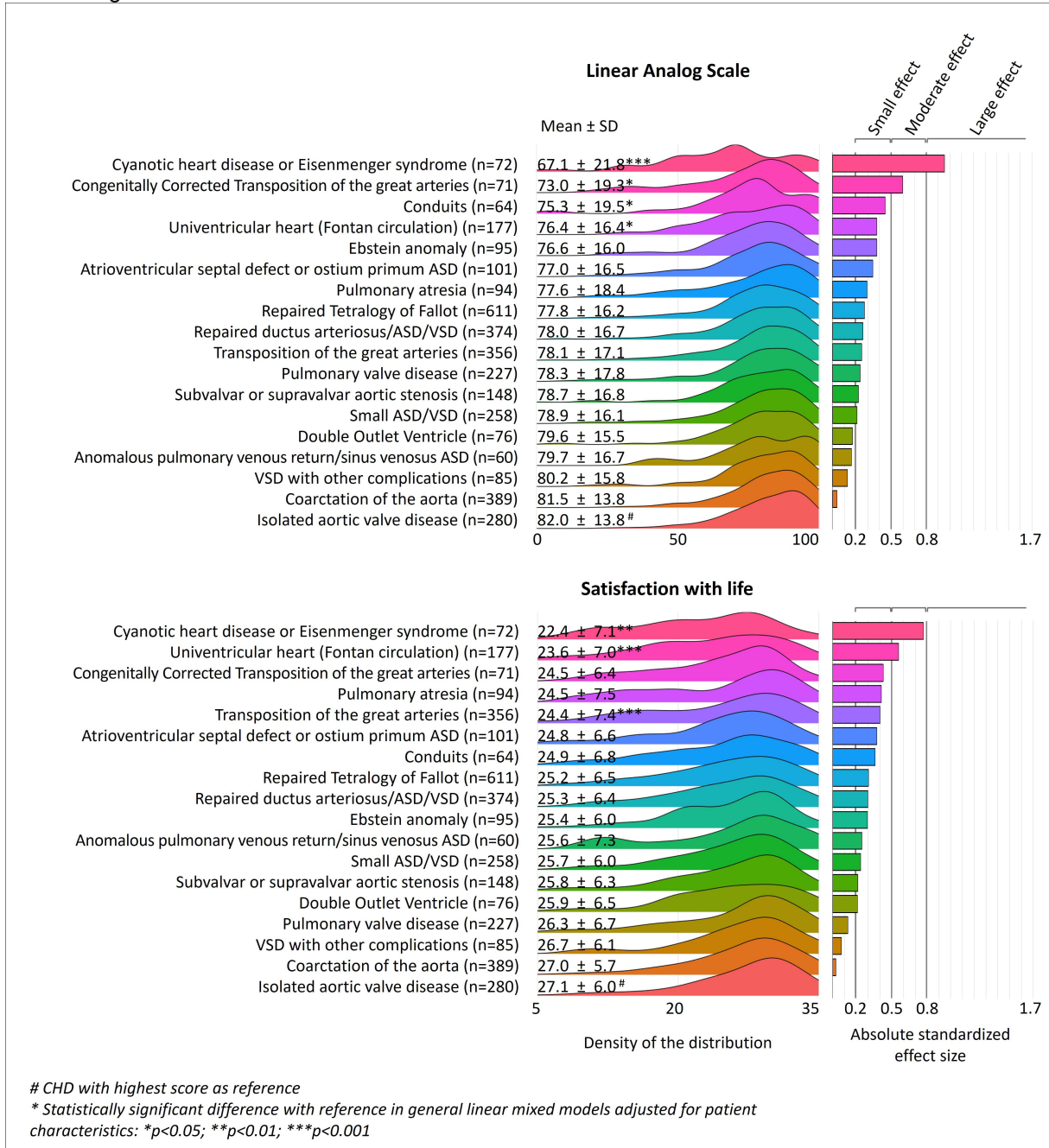
Legend: ASD=Atrial Septal Defect; VSD=Ventricular Septal Defect

Figure 2: Mental health in patients with different heart defects and its comparison to the heart defect with the highest score



Legend: ASD=Atrial Septal Defect; VSD=Ventricular Septal Defect

Figure 3: Quality of life in patients with different heart defects and its comparison to the heart defect with the highest score



Legend: ASD=Atrial Septal Defect; VSD=Ventricular Septal Defect