Factors Associated with Health-Related Quality of Life in Pediatric Patients after Minimally Invasive Right Axillary Approach for Ventricular Septal Defect Repair at the Cardiovascular Center - E Hospital

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ABSTRACT:

Ventricular septal defect (VSD) is one of the most common congenital heart diseases in children. Surgical correction offers a complete repair of the defect without long-term sequelae. Minimally invasive surgery is a novel technique that ys many advantages to patients. Evaluating postoperative quality of life (QoL) also reflects the outcomes of this approach.

Objective: To describe the health-related quality of life (HRQoL) and investigate associated factors in pediatric patients after VSD repair using a minimally invasive right axillary thoracotomy at the Cardiovascular Center - E Hospital.

Subjects and Methods: A cross-sectional descriptive study was conducted on 47 children aged 2-12 years who underwent VSD repair via minimally invasive right axillary approach from December 2022 to July 2024. HRQoL was assessed using the Vietnamese version of the Pediatric Quality of Life Inventory™ 4.0 Generic Core Scale (based on parent interviews and medical record reviews). Data were collected at least one month after surgery.

Results: The mean overall HRQoL score was 79.57 ÷ 7.13. Factors significantly associated with HRQoL included preoperative heart failure severity (Ross classification), parental education and employment status, and the child's school attendance ($p < 0.05$).

Conclusion: Minimally invasive VSD repair via the right axillary approach provides favorable HRQoL outcomes. However, children with specific clinical and social risk factors require closer monitoring and support to improve postoperative quality of life.

Keywords: *quality of life, congenital heart disease, minimally invasive surgery, associated factors, ventricular septal defect*

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I. INTRODUCTION

Health-related quality of life (HRQoL) is increasingly recognized as an essential criterion in pediatric healthcare. HRQoL encompasses physical, emotional, social, and school functioning, which are affected by a child's health status. In particular, for children undergoing surgery for congenital heart defects (CHDs), assessing HRQoL not only reflects surgical outcomes but also informs on their recovery, reintegration, and holistic development after treatment. Numerous HRQoL studies have been conducted, offering a broader perspective on disease burden and treatment efficacy [1]. These studies help determine how medical conditions, treatments, and living conditions impact individuals, thereby enabling healthcare professionals, families, and communities to implement timely interventions that minimize the adverse effects of disease and treatment on children's physical and mental development.

Ventricular septal defect (VSD) is the most common congenital heart defect, accounting for 25-30% of CHD cases. In Vietnam, according to data from Children's Hospital I and Il in Ho Chi Minh City, VSD represents approximately 40% of all congenital heart anomalies [2]. This condition affects not only physical health and growth but also diminishes the patient's quality of life. Surgery is considered a definitive treatment that can completely repair the defect without residual sequelae. The first successful VSD repair was performed in 1955 by Lillehei and colleagues at the University of Minnesota using cross-circulation. However, traditional median sternotomy techniques pose risks of bleeding, infection, and prominent scarring, all of which impact postoperative HRQoL. With advancements in medical technology, surgical approaches have become increasingly optimized, offering benefits such as reduced trauma, quicker recovery, and improved cosmetic outcomes. The Cardiovascular Center - E Hospital is one of the pioneering institutions in Vietnam to implement innovative surgical techniques, including minimally invasive and totally endoscopic VSD repair, achieving promising results. In many countries, successful cardiac surgery is now assessed not only by technical outcomes but also by postoperative HRQoL. However, few studies have evaluated the impact of these techniques on children's HRQoL. Therefore, we conducted this study titled: "Factors Associated with Health-Related Quality of Life in Pediatric Patients After Minimally Invasive Right Axillary Approach for Ventricular Septal Defect Repair at the Cardiovascular Center - E Hospital", with objective:

To identify factors associated with health-related quality of life in pediatric patients following right axillary thoracoscopic-assisted minimally invasive VSD repair at the Cardiovascular Center - E Hospital.

II. STUDY SUBJECTS AND METHODS

2.1. Study Subjects: Pediatric patients who underwent ventricular septal defect (VSD) repair via a minimally invasive right axillary thoracotomy at least one month prior to data collection.

• *Inclusion criteria:*

- Children aged 2 years and older who have undergone minimally invasive VSD closure via the right axillary thoracotomy approach.

- The child and their family have provided informed consent to participate in the study

- Complete and available medical records and documentation.

• *Exclusion criteria:*

- Children who underwent VSD closure via other minimally invasive approaches, including right submammary thoracotomy, median sternotomy, or fully thoracoscopic surgery.

- Children with VSD associated with other complex congenital heart defects such as atrioventricular septal defect, Tetralogy of Fallot, or abnormalities of the pulmonary artery.

- Children with coexisting conditions that may affect cognitive function, emotional or behavioral disorders, motor function impairments, or other chronic illnesses.

2.2. Study Site: Pediatric Cardiovascular Surgery Department, Cardiovascular Center - E Hospital.

2.3. Study Period: From December 2022 to July 2024.

2.4. Study Design and Methods:

- Study design: A descriptive cross-sectional study.

- Sample size and sampling method: A total sampling of all 47 pediatric patients who met the inclusion criteria during the study period.

2.5. Study Variables:

- HRQOL-related variables: Physical functioning, emotional functioning, social functioning, school functioning, and overall health-related quality of life.

- Associated factors: Sociodemographic factors: age, gender, place of residence, parental marital status, parental education level, and family economic condition. Clinical factors: time of disease diagnosis, time of surgery, length of hospital stay, preoperative heart failure status (based on the Ross classification), and size of the ventricular septal defect.

2.6. HRQOL Assessment Tool

Health-related quality of life was assessed using the Pediatric Quality of Life Inventory™ 4.0 Generic Core Scales (PedsQLT™ 4.0), developed by Varni et al. in 2001 [31. This tool evaluates the level of difficulty children aged 2 to 18 experience in four domains: physical, emotional, social, and school functioning. The PedsQL™ 4.0 has age-specific versions: 2-4 years, 5-7 years, 8-12 years, and 13-18 years, with both child self-report and parent proxy-report formats available. In this study, only the parent proxy-report version was used. The scale includes 23 items, each rated on a 5-point Likert scale (0-1-2-3-4), indicating the frequency with which the child experiences difficulties in daily activities. The scores were reverse-scored and linearly transformed to a 0-100 scale: 0 = 100 points; 1 = 75 points; 2 = 50 points; 3 = 25 points; 4 = 0 points. The mean score for each domain (physical, emotional, social, and school functioning) was calculated as the average of the individual item scores within that domain. The overall HRQOL score was calculated as the total score of all items divided by the total number of items on the scale.

2.7. Data Collection Method: Data on general characteristics were collected from the patients' medical records. One of the child's parents (either father or mother) was interviewed using the PedsQLT™ 4.0 parent proxy-reprort to assess the child's quality of life.

2.8. Data Analysis Method: Data were entered and analyzed using SPSS software version 20.0. The relationships between HRQOL and selected variables were examined using ANOVA (Analysis of Variance).

2.9. Ethical Considerations: The study was approved by the Scientific Ethics Committee and received permission from E Hospital. Informed consent was obtained from both the children and their parents prior to participation. All research data were kept confidential and used solely for scientific purposes.

III. RESULTS

Table 3.1. Distribution of pediatric patients by general characteristics of the study population (n = 47)

Characteristic		Frequency (n)	Percentage (%)
Age group	2 – 4 years	26	55,3
	5 – 7 years	16	34
	8 – 12 years	5	10,7
	Mean age ± SD	4,45 ± 1,93 years	
Gender	Male	22	46,8
	Female	25	53,2
Area of Residence	Rural	22	46,8
	Urban	16	34
	Mountainous region	9	19,2

Remarks: *The average age of the study participants was 4.5 ≤ 1.9 years, with a female-to-male ratio of 1.2:1. The majority of cases were detected in rural areas, accounting for 46.8% of the total.*

Table 3.2. Distribution of pediatric patients by clinical characteristics of the study population (n = 47)

Characteristic		Frequency (n)	Percentage (%)
Disease Classification	Perimembranous VSD	31	66
	Muscular VSD	16	34
Preoperative Heart Failure Severity	Grade I	27	57,5
	Grade II	16	34
	Grade III	4	8,5
Mean Preoperative Weight ± SD		12,38 ± 5,53	
Mean Age at time of diagnosis (mean ± SD)		6,47 ± 11,89 months	
Mean Age at time of surgery (mean ± SD)		3,49 ± 1,93 years	
Mean Duration of hospitalization (mean ± SD)		12,09 ± 2,84 days	
Postoperative Complications	No complications	43	91,5
	Surgical site infection	2	4,3
	Arrhythmia requiring medical intervention	1	2,1
	Minor cerebrovascular complications	1	2,1

Remarks: *The study showed that perimembranous ventricular septal defect accounted for 66%, representing the highest proportion. The average duration of hospitalization after surgery was 12.1 ≤ 2.8 days. Postoperative complications were relatively rare. Specifically, the rate of surgical site infection was 4.3%, arrhythmia requiring medication occurred in 2.1% of patients, and minor cerebrovascular events were observed in 2.1% of cases.*

Table 3.2. Association between children's health-related quality of life (HRQoL) and several sociodemographic factors

	Variable	N	HRQoL Score	p*
Gender	Male	22	77,41 ± 6,40	0,418
	Female	25	77,72 ± 7,85	
Age group	2-4 years	26	78,57 ± 7,22	0,512
	5-7 years	16	76,75 ± 6,44	
	8-12 years	5	75,00 ± 9,30	
Living area	Urban area	22	76,27 ± 6,78	0.055
	Rural area	16	80,94 ± 5,76	
	Mountainous area	9	74,78 ± 8,60	
Education status	Not enrolled in school	6	70,17 ± 7,86	0,008
	Not attending school	0		
	Delayed school attendance	1	87,00	
	On-track school attendance	40	78,43 ± 7,13	

p*: Statistical tests: Independent-Samples T- Test and ANOVA

Remarks: *There was no statistically significant association between children's HRQoL and age group, gender, or area of residence. However, children who were attending school on time for their age group had higher HRQoL scores than those not attending school or experiencing delays in school attendance ($p < 0.05$).*

Table 3.3: Association Between Children's Quality of Life and Certain Family-Related Factors

	Factors	n	HRQoL score	p*
Father's Educational Level	No formal education	2	77,50 ± 6,36	**0,018**
	Primary/Secondary school	14	73,93 ± 7,99	
	High school	18	77,00 ± 6,62	
	College/University/Postgraduate	13	82,31 ± 4,51	
Mother's Educational Level	No formal education	2	77,50 ± 6,36	**0,025**
	Primary/Secondary school	10	74,60 ± 8,64	
	High school	19	75,58 ± 7,02	
	College/University/Postgraduate	16	81,81 ± 4,40	
Father's Employment Status	Stable	28	80,68 ± 4,75	**0,001**
	Unstable	16	73,31 ± 8,20	
	Unemployed	3	71,33 ± 4,73	
Mother's Employment Status	Stable	26	80,58 ± 4,96	**0,003**
	Unstable	17	74,29 ± 7,38	
	Unemployed	4	72,00 ± 7,13	

p*: Statistical tests: ANOVA

Remarks: *Children whose parents had lower educational levels and unstable or unemployed work status had significantly lower quality of life scores compared to those whose parents had higher education and stable employment ($p < 0.05$).*

Table 3.4: Association Between Children's Quality of Life and Certain Clinical Factors

Factors		n	HRQoL Score	p*
Disease Classification	Perimembranous VSD	31	76,55 ± 6,73	0,150
	Muscular VSD	16	76,63 ± 8,09	
Preoperative Heart Failure Severity (follow Ros)	Grade I	27	79,52 ± 6,02	**0,0001**
	Grade II	16	74,63 ± 5,49	
	Grade III	4	64,50 ± 4,80	
Duration of Hospitalization	≤ 10 days	14	76,14 ± 9,08	0,077
	10 days	33	76,76 ± 6,29	

p*: Statistical tests: Independent-Samples T-Test and ANOVA

Remarks: *In this study, no significant association was found between children's quality of life and the type of congenital heart defect or the length of hospital stay. However, a higher degree of preoperative heart failure was significantly associated with a lower quality of life score in children ($p < 0.05$).*

III. DISCUSSION

Ventricular septal defect (VSD) is the most common congenital heart defect. Management of VSD includes monitoring and medical treatment when the defect is small and does not significantly affect cardiac chambers or pulmonary artery pressure. In selected cases, device closure may be applied for small perimembranous or muscular VSDs. However, open-heart surgery with cardiopulmonary bypass remains the standard treatment and is usually performed via median sternotomy. In recent years, with the advancement of medical technology, less invasive surgical approaches have been developed that offer significant advantages over traditional techniques. These include reduced surgical trauma, fewer complications, faster recovery, and better cosmetic outcomes-factors that directly influence postoperative health-related quality of life (HRQoL). These benefits are consistent with the findings of Yuan et al. (2022) and BMC Pediatrics (2021), which highlighted superior HRQoL outcomes for patients undergoing minimally invasive surgery compared to conventional approaches [9]. Numerous studies have confirmed the feasibility and benefits of minimally invasive VSD repair in pediatric patients. For instance, Selim Aydin and colleagues (2021) reported excellent outcomes in 24 patients with no postoperative mortality or major complications, along with high parental satisfaction regarding cosmetic results [6]. Similarly, Tran Thien Dat et al. demonstrated favorable outcomes in their study "Results of Minimally Invasive Open Heart Surgery for VSD Repair via Right Thoracotomy in Children at the Cardiovascular Center - E Hospital" [7]. In our study of 47 children who underwent minimally invasive VSD repair via the right axillary approach, all surgeries were successful, and the complication rate was low. The mean overall HRQoL score reported by parents was 79.57 ÷ 7.13, which is comparable to the HRQoL score of healthy children in a previous study by Nguyen Thi Thanh Mai et al. (2017) conducted in Thai Binh (80.94 ÷ 15.28) [4]. This suggests that the surgical approach is a feasible and promising

option for families. As Dodge-Khatami et al. (2023) affirmed, minimally invasive cardiac surgery is the future direction of the field, especially in pediatric patients.

Although minimally invasive cardiac surgery has become increasingly common in clinical practice, both domestic and international research on HRQoL in this pediatric population remains limited. In this study, we used the Vietnamese version of the PedsQL 4.0 Generic Core Scale, aiming to obtain reliable HRQoL data and identify associated factors to guide care and improve postoperative outcomes.

Our findings indicated no significant association between HRQoL and the child's age, gender, or place of residence. This may be due to the young age of participants (all under 10 years), a period in which psychosocial development is relatively stable. However, we observed that beyond technical factors, socioeconomic conditions significantly influenced outcomes. Specifically, parental education and employment were positively correlated with better HRQoL, aligning with previous studies suggesting that higher parental educational attainment and stable employment improve a child's ability to receive adequate care and support during recovery.

VSD is a relatively simple congenital defect that can be completely corrected without residual lesions. Early diagnosis and regular follow-up are crucial to preventing disease progression and avoiding postoperative complications that could impair long-term quality of life. Importantly, our findings showed that higher preoperative heart failure severity significantly reduced HRQoL after surgery ($p < 0.001$).

Limitations: This study was conducted over a relatively short duration and involved a limited sample size due to the novelty of the surgical technique. Additionally, the analysis of individual factors may be subject to confounding variables, potentially affecting the observed associations with HRQoL

IV. CONCLUSION

The quality of life in children after ventricular septal defect (VSD) repair using a minimally invasive right axillary thoracotomy approach has shown promising outcomes. This surgical method represents an effective treatment option for families to consider. Several factors were found to be associated with health-related quality of life in these pediatric patients, including academic performance, parental educational level and employment status, and the degree of preoperative heart failure. These findings suggest that more attention and closer follow-up should be given to children presenting with such risk factors. Another important consideration is postoperative screening: it is recommended that quality of life and cardiac function be reassessed at least one month after surgery, followed by regular evaluations depending on the severity of heart failure before and after surgery, as well as any postoperative complications.

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