Summary
To assess changes in the quality of life in adult patients undergoing percutaneous device closure of atrial septal defect (ASD).

We used a standard Medical Outcome Study Short Form 36 (SF-36) that includes psychological and physiological aspects to assess and analyze the quality of life of 73 adult patients who underwent percutaneous device closure of ASD.

Of the 73 patients who were investigated in this study, 67 completed questionnaires successfully. The following findings were revealed after analyzing the preoperative results and postoperative results. In some dimensions (“physical functioning,” “vitality,” “general health”), the postoperative perception was better than the preoperative status. Some differences were found in the quality of life feedback between the case group and the control group. Among the different subgroups, older patients scored lower than younger patients on most dimensions, and men seemed to perform better on “role-physical” factors than women. Unmarried people performed worse on “role-physical” and “bodily pain” than married people. Among people with different academic degrees, those with higher degrees demonstrated better scores on multiple dimensions (“role-physical,” “mental health,” “social functioning,” and “general health”) than those with lower degrees.

After percutaneous device closure of ASD, most adult patients feel that the quality of life is improved compared with that during the preoperative status. With the change of patients’ own conditions, their quality of life seems to change differently. In order to better help patients integrate into life, psychological and physical support is still needed.

Key words: Percutaneous procedure

The traditional treatment for atrial septal defect (ASD) is direct repair under extracorporeal circulation through median sternal or right anterolateral intercostal incision. However, with the advanced, gradual development of the technique in recent years, percutaneous device closure of ASD was widely used in clinical practice because of its advantages of no incision and fast postoperative recovery. Due to the good clinical effect of ASD closure, the number of patients with long-term survival increased significantly. Most postoperative studies focused on the efficacy and complications of percutaneous device closure of ASD, and studies on the postoperative quality of life of patients are rare. In fact, due to the improvement in hemodynamics after ASD closure, patient symptoms are significantly reduced or disappear; thus, the procedure will exhibit an impact on the physiological and psychological state of patients. Quality of life reflects not only a patient’s satisfaction with their own physical condition but also the patient’s self-evaluation of psychological and social communication. The purpose of this study was to evaluate and analyze the quality of life of adult patients after percutaneous device closure of ASD.

Methods
In this survey, to better evaluate the quality of life of the respondents, we designed a questionnaire that was divided into two parts. The first part investigated the relevant clinical information of the respondents. The second part used the SF-36 (the Chinese version of a standard questionnaire for adults that is completed independently) to investigate quality of life-related aspects of patients. The SF-36 encompassed eight areas: (1) PF: Physical Functioning; (2) RP: Role Physical; (3) BP: Bodily Pain; (4) GH: General Health; (5) VT: Vitality; (6) SF: Social Functioning; (7) RE: Role Emotional; and (8) MH: Mental Health. In each area, respondents were required to answer the corresponding questions, and each answer corre-
sponded to a certain value.

The survey was conducted in the outpatient department of our cardiac center with informed and written consent. The survey was completed independently by patients. Volunteers could assist patients in completing the survey and providing appropriate translation help, but they could not intervene to complete the questionnaire. At the end of the survey, all questionnaires were returned to the research center for unified analysis by independent personnel.

According to each patient’s actual situation, we divided them into subgroups by age, sex, educational background, and marital status. Seventy healthy adults were randomly selected as the control group. Finally, we compared the SF-36 values of the preoperative status and postoperative status as well as the case group with the control group and each postoperative subgroup. Also, we compared the preoperative and postoperative echocardiographic data to assess changes in right cardiac function.

Statistics: SPSS 18.0 was used for statistical analysis. A chi-squared test was used to compare the distribution differences in the general demographic characteristics between the case and control groups. The independent samples t-test was used to compare the preoperative and postoperative echocardiographic data. Scores in each field were positively correlated with the patients’ satisfaction with life, and $P < 0.05$ indicated a statistically significant difference. In the statistical analysis of the preoperative and postoperative group results, the score data on all dimensions before and after the operation did not conform to a normal distribution after the normal test, and thus, the Wilcoxon test was used. In the comparison between the case and control groups, the normal test was conducted on the scores of each dimension in the two groups, and the data did not conform to a normal distribution; thus, the Mann-Whitney $U$ test was adopted. In the comparison of each subgroup in the postoperative group, the Mann-Whitney $U$ test (sex and marital status) and Kruskal-Wallis test (age, education background) were used to compare the postoperative scores of each dimension for patients in different subgroups.

### Results

**Research respondents:** Of the 73 patients surveyed, 67 successfully completed questionnaires and returned them for further evaluation. There were 39 males and 28 females. Among the participants, 27 were aged 18-30 years, 32 were aged 31-50 years, and 8 were aged older than 50 years. Additionally, 40 patients were married, and 27 were unmarried. Twenty patients presented with a bachelor’s degree or higher, 35 patients presented with a high school degree, and 12 patients presented with a junior high school degree or lower. The social and demographic data of the case group and the control group were recorded in Table I. The comparative results showed no statistically significant difference in general demographic characteristics, such as age, sex, marital status, and educational background between the two groups. We concluded that the population composition of the case and control groups was similar, thus, they could be used for comparison.

Most of the 67 patients in the study showed no significant symptoms before the closure, but some of them complained of small discomfort, which including 5 (7.4%) patients showed signs of fatigue, 3 (4.4%) showed breathlessness, and 4 (5.9%) showed palpitations. On the hemodynamic side, 3 (4.4%) patients presented with arrhythmias, and 26 (38.8%) presented with mild to moderate pulmonary hypertension. The criteria included the following: significant left-to-right shunt, pulmonary to systemic flow ratio $> 1.5$, accompanied by enlargement of the right atrium and right ventricle. Severe pulmonary hypertension and Eisenmenger syndrome were all ruled out from this study.

**Preoperative and postoperative status comparison:** The comparison of the preoperative and postoperative echocardiographic data was shown in Table II, which suggested an improvement in the function of the right heart. After comparing the scores of the preoperative and postoperative patients across all dimensions, the scores of most di-

### Table I. Socio-Demographic Characteristics of the Participants

| Item                        | Control group | Case group | $P$ |
|-----------------------------|---------------|------------|-----|
| Age (years)                 |               |            |     |
| 18-30                       | 30 (42.9)     | 27 (40.3)  | 0.917 |
| 31-50                       | 33 (47.1)     | 32 (47.8)  |     |
| > 50                        | 7 (10.0)      | 8 (11.9)   |     |
| Gender                      |               |            | 0.644 |
| Male                        | 38 (54.3)     | 39 (58.2)  |     |
| Female                      | 32 (45.7)     | 28 (41.8)  |     |
| Marital status              |               |            | 0.972 |
| Married                     | 42 (60.0)     | 40 (59.7)  |     |
| Unmarried                   | 28 (40.0)     | 27 (40.3)  |     |
| Education                   |               |            | 0.826 |
| Junior high school or lower | 10 (14.3)     | 12 (17.9)  |     |
| High school                 | 37 (52.9)     | 35 (52.2)  |     |
| Bachelor’s degree or higher | 23 (32.8)     | 20 (29.9)  |     |
| NYHA                        |               |            | 0.677 |
| NYHA functional class I/II  | 70 (100)      | 58 (86.6)  |     |
| NYHA functional class III/IV| 0 (0)         | 9 (13.4)   |     |
dimensions were noted to be improved compared with those in the preoperative status, especially in the three dimensions of “physical functioning” ($P < 0.01$), “vitality” ($P < 0.01$), and “general health” ($P = 0.014$) (Table III).

**Comparison between the case group and control groups:** Independent of sex, age, marital status, or education, the control group scored higher than the preoperative group on most dimensions, especially on the five dimensions of “Role-physical” ($P = 0.044$), “Physical functioning” ($P = 0.022$), “General health” ($P = 0.005$), “Vitality” ($P = 0.003$), and “Mental health” ($P = 0.011$). In the comparison between control group and postoperative group, the control group still scored higher in some dimensions, especially on the three dimensions of “vitality” ($P = 0.008$), “role-physical” ($P = 0.041$), and “role-emotional” ($P = 0.001$) (Table III).

**Case subgroup internal comparison:** In the comparison of different age groups after device closure of ASD, the scores of most dimensions showed a trend of decreasing with age, but the two dimensions of “bodily pain” ($P = 0.017$) and “role-emotional” ($P < 0.01$) showed an opposite trend.

In the comparison between the male and female groups, men scored significantly higher on the dimension of “role-physical” ($P = 0.012$) than women, but no significant sex difference was found in other dimensions.

In the comparison between the married and single groups, the scores of the married group on the two dimensions of “role-physical” ($P < 0.01$) and “bodily pain” ($P = 0.014$) were significantly higher than those of the unmarried group, while the scores of the married and unmarried groups were almost the same on other dimensions.

In the comparison of groups with different educational levels, the scores in the dimension of “role-physical” ($P < 0.01$) of the group with a college degree or higher were significantly improved compared with those of the other groups, while the scores in the three dimensions of “general health” ($P = 0.019$), “social functioning” ($P = 0.029$), and “mental health” ($P < 0.01$) tended to increase with the increase in educational level (Table IV).

**Discussion**

ASD is a common congenital heart disease. Due to the small pressure difference between the right and left atrium, most patients present with no obvious symptoms. Many patients are not diagnosed by routine medical examination until adulthood. The traditional treatment for ASD is surgical repair. With the development of interventional therapy and various devices, percutaneous device closure of ASD gradually became another standard treatment and has been widely used. The technique exhibits the advantages of no surgical incision, fast recovery, safety, and effectiveness. In our clinical practice, several adult patients with ASD achieved anatomic correction after percutaneous device closure, thus, improving hemo-

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**Table II.** Preoperative and Postoperative Echocardiographic Data of Right Heart in the Patients

| HRQoL Domain | Preoperative status | Postoperative status | $P$ value |
|--------------|---------------------|----------------------|-----------|
| End-systolic length of the right atrium (mm) | 56.8 ± 8.5 | 46.5 ± 4.9 | 0.034 |
| End-systolic width of the right atrium (mm) | 45.1 ± 7.2 | 42.3 ± 5.6 | 0.076 |
| End-diastolic length of the right ventricle (mm) | 68.4 ± 8.3 | 58.1 ± 6.5 | 0.022 |
| End-diastolic width of the right ventricle (mm) | 45.7 ± 5.6 | 42.5 ± 4.5 | 0.082 |
| Inner diameter of the middle portion of the pulmonary artery (mm) | 30.6 ± 4.1 | 26.4 ± 3.2 | 0.252 |
| RVFAC (%) | 48.5 ± 3.6 | 40.1 ± 2.2 | 0.013 |
| RV-Tei | 0.46 ± 0.05 | 0.32 ± 0.02 | 0.008 |
| 3D-RVEF (%) | 61.2 ± 4.3 | 51.4 ± 2.3 | 0.029 |
| TAPSE (mm) | 20.1 ± 2.6 | 19.4 ± 1.2 | 0.325 |

RVFAC indicates right ventricular fractional area change; RV-Tei: RV Tei index is defined as (A-B)/B, where A is time interval between the end and onset of tricuspid annular diastolic velocity and B is the duration of tricuspid annular systolic velocity (or RV ejection time); 3D-RVEF: right ventricular ejection fraction; and TAPSE: tricuspid annular plane excursion. $P < 0.05$ was considered statistically significant.

**Table III.** SF-36 Scores in Case Group and Control Groups

| HRQoL Domain | Preoperative status | Postoperative status | Control group | $P_1$ | $P_2$ | $P_3$ |
|--------------|---------------------|----------------------|---------------|-------|-------|-------|
| Physical functioning | 50.0 | 70.0 | 80.0 | 0.022 | 0.477 | 0.000 |
| Role-physical | 50.0 | 50.0 | 62.5 | 0.044 | 0.041 | 0.424 |
| Bodily pain | 65.0 | 62.5 | 62.5 | 0.081 | 0.731 | 0.327 |
| General health | 40.0 | 65.0 | 75.0 | 0.005 | 0.084 | 0.014 |
| Vitality | 45.0 | 60.0 | 75.0 | 0.003 | 0.008 | 0.000 |
| Social functioning | 62.5 | 65.0 | 67.5 | 0.323 | 0.745 | 0.082 |
| Role-emotional | 66.7 | 33.3 | 66.7 | 0.087 | 0.001 | 0.138 |
| Mental health | 64.0 | 68.0 | 72.0 | 0.011 | 0.612 | 0.425 |

$P_1$ indicates $P$ value of the preoperative group compared with the control group; $P_2$, $P$ value of the postoperative group compared with the control group; $P_3$, $P$ value of the preoperative status compared with the postoperative status; and HRQoL, health related quality of life. Date are expressed as median, score ranged from 0 to 100, higher scores indicating better health status. $P < 0.05$ was considered statistically significant.
With the increased cure rate of adult patients with ASD, increasing attention should be given to the prognosis of patients, and the quality of life of patients after percutaneous device closure of ASD is an important part of the prognosis. As a medical evaluation technique, quality of life can comprehensively evaluate the physiological, psychological, and social effects of diseases and treatments on patients. It can be measured by the health status of the general population, evaluation of the quality of life practices under the influence of disease and medical intervention. Generally, the measurement of quality of life includes four content areas: (1) physiological state, (2) psychological state, (3) social functional state, and (4) subjective judgment and satisfaction.

The SF-36 questionnaire selected in this study is a universal scale with good reliability, validity, and acceptability that is widely used in the measurement of the quality of life of the general population, evaluation of the clinical experiment effect, and health policy evaluation. It covers eight dimensions that mainly reflect the respondents’ perceived state of physical and mental health. Among them, physical functioning, role-physical, bodily pain, and general health belong to the physiological field, while vitality, social functioning, role-emotional, and mental health belong to the psychological field. Based on the long-term experience of the SF-36 in quality-of-life assessment, we used it to analyze the quality of life of adult patients with ASD who underwent percutaneous device closure.

Among the 67 adult patients who completed the questionnaire in this study, more male than female patients and more married patients than unmarried patients were present. Additionally, the education level of these 67 patients was mainly high school, a situation that may have led to some accidental factors. Of the 6 patients who failed to complete the survey, four could not because of insufficient time, and two were unwilling to cooperate with the survey. In our study, most of the patients came to see a doctor due to the discovery of ASD during accidental physical examination, while a small number of patients complained about related clinical symptoms of ASD. Of course, the psychological and social effects of illness on quality of life were also important reasons for patients to seek treatment. Since the symptoms of ASD were not typical, describing the time from symptom detection to treatment was difficult for those patients.

The results of preoperative and postoperative echocardiographic data were supported the improvement of the patients’ quality of life. By comparison, researchers found that the anatomical parameters of the right heart were improved, and the function of the right heart was improved accordingly. Many reports focused on right ventricular remodeling after percutaneous device closure of ASD. They got the same results in rapid normalization of RV volume overload and improvement of RV function. From some studies, we can know that right heart function is closely related to the state of the body. The improvement of right cardiac function is probably related to the improvement of quality of life, especially the improvement of "physical functioning." From the echocardiographic examination results, arrhythmia, hemolysis, endocarditis, or embolism did not occur during the hospital stay and the follow-up period. Therefore, the improvement of cardiac function in patients might lead to symptom relief or even disappearance. Through those previous studies, patients showed significant clinical and hemodynamic improvements after ASD closure and were maintained during the long-term follow-up period. It might also be one of the fundamental reasons leading to the improvement of patients’ quality of life.

After the analysis and comparison of the SF-36 scale scores of patients before and after percutaneous device closure of ASD, the scores of patients in the postoperative status were improved in most dimensions compared with those in the preoperative status. One reason may be that
after patients underwent percutaneous device closure of ASD, the long-standing psychological fear of disease disappeared, anatomical defects were corrected, and hemodynamic abnormalities were improved. Thus, patients’ self-sensory symptoms were reduced or even disappeared, and their somatosensory sensation was improved, thereby improving their quality of life. At the same time, due to the cure of the disease, the restriction on daily activities caused by the emotional problems of patients also improved, which also improves the quality of life of patients.

In comparison between the case group and the control group, our results indicated that a gap was found between the preoperative quality of life feedback of the patients and the normal subjects. In adult patients, the effects of ASD tended to be more than just a defect in physical function. The long-term effects of the disease on the patient’s social interaction, education, job hunting, and other aspects might contribute to this result. In the comparison between the postoperative group and the normal subjects’ quality of life, researchers found that the difference was smaller, but some differences were still present. Although the feedback of patients’ quality of life after treatment was not completely the same as that of normal people, we considered that if some interventions such as psychological counseling or physical exercise were added to patients’ recovery process, their quality of life might be more optimized.

Statistical analysis of the different subgroups revealed that the scores in most dimensions for patients of different ages after percutaneous occlusion of ASD showed a trend of decreasing with age, which may be due to a decline in various bodily functions with age, causing elderly patients to lack sufficient confidence in life. However, a few dimensions showed the opposite trend, among which “bodily pain” was the most obvious and may be related to the quality of life. The long-term effects of the disease on the patient’s social interaction, education, job hunting, and other aspects might contribute to this result. In the comparison between the postoperative group and the normal subjects’ quality of life, researchers found that the difference was smaller, but some differences were still present. Although the feedback of patients’ quality of life after treatment was not completely the same as that of normal people, we considered that if some interventions such as psychological counseling or physical exercise were added to patients’ recovery process, their quality of life might be more optimized.

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Murphy and his colleagues concluded that in comparing the prognosis of patients underwent ASD repair in age younger than 25 years with patients in age older than 25 years, those patients younger than 25 years experienced better results in terms of both survival and postoperative complications. Also, we conducted a comparative analysis of the quality of life of patients underwent percutaneous device closure of ASD in age younger than 25 years with patients in age older than 25 years. The corresponding results showed that the quality of life feedback of patients younger than 25 was more optimistic on most dimensions. (PF: < 25 years: 85 versus ≥ 25 years: 70; RP: 75 versus 50; VT: 75 versus 60; MH: 80 versus 68, respectively.) Combining our results with Murphy’s findings, we suggested that age might be an important factor in the management of ASD closure.

In the comparison of male and female patients, no significant difference was found in the scores between male and female patients except for the obvious advantage in the dimension of “role-physical.” The cause may be that men are calmer in the face of stress, demonstrate a better and more positive attitude than when they were hit by illness, and demonstrate better physical endurance. In comparing the married and unmarried groups, the married group scored significantly better on “role-physical” and “bodily pain,” likely because people could receive support from their partners after marriage and could better cope with the impact of illness. According to other dimensions, marital status did not seem to make a significant difference. Among the patients with different educational degrees, after percutaneous device closure of ASD, the scores increased with the increase in educational background in the two dimensions of “mental health” and “social functioning.” This finding may be related to the fact that, after patients receive higher education, their spiritual construction would be more perfect; thus, they can be more unperturbed by diseases. A higher degree may help patients better understand the disease and improve their awareness of self-care, which is also an important link in improving patients’ quality of life.

**Limitations:** This study possessed some limitations. First, this study was a cross-sectional study, which limits the causal relationship between research factors and results. A longitudinal study is needed to clarify the real causal relationship between the research factors and results. Second, the small sample size of patients in this study may lead to some deviations in the research results, reducing the ability to detect factors that influence the results. Third, all the respondents were Asian and thus, were not representative of other ethnicities or regions. Forth, in this study, the number of male patients was dominated, which was inconsistent with the findings of some other investigations and studies. The reason for this deviation might also be the limited sample size of this study. Our article may be one of the few researches on the quality of life of adult patients underwent percutaneous device closure of ASD, so we believe that a certain clinical significance exists in this paper even if there might be some limitations. In the future, we hope to complete a comparative study on quality of life among the different ASD closure treatments, which will deepen the significance of our research.

**Conclusion**

In the study of patients undergoing percutaneous device closure of ASD, ASD closure demonstrates a positive effect on the patients’ assessment of quality of life. However, factors such as age, sex, marriage, and education also seem to exhibit different degrees of influence on the patients’ quality of life. The influence of percutaneous device closure of ASD on the patients’ quality of life varies with the patients’ own conditions. Therefore, patients still need psychological and physiological support from their families and society in the process of returning to normal life.

**Acknowledgment**

We highly acknowledge the contribution by the participating doctors: Dao-zhong Chen, Liang-wan Chen, Feng Lin, Qi-min Wang, Han-fan Qiu, Xue-shan Huang, Dong-shan Liao, Xiao-fu Dai, Zeng-chun Wang.
Disclosure

Conflicts of interest: The authors declare that they have no competing interests.

References

1. Vida VL, Zanotto L, Zanotto L, et al. Minimally invasive surgery for atrial septal defects: a 20-year experience at a single centre. Interact Cardiovasc Thorac Surg 2019; 28: 961-7.
2. Hoashi T, Yazaki S, Kagiwaka K, et al. Management of ostium secundum atrial septal defect in the era of percutaneous transcatheter device closure: 7-year experience at a single institution. J Cardiol 2015; 65: 418-22.
3. Yang MC, Wu JR. Recent review of transcatheter closure of atrial septal defect. Kaohsiung J Med Sci 2018; 34: 363-9.
4. Suzuki K, Kato T, Koyama S, et al. Influence of Percutaneous Occlusion of atrial septal defect on left atrial function evaluated using 2D speckle tracking echocardiography. Int Heart J 2020; 61: 83-8.
5. Jalal Z, Hascoët S, Gronier C, et al. Long-term outcomes after percutaneous closure of ostium secundum atrial septal defect in the young: A Nationwide Cohort Study. JACC Cardiovasc Inter 2018; 11: 795-804.
6. Brida M, Diller GP, Kempny A, et al. ASD closure in adulthood is associated with normal survival in the mid to longer term. Heart 2019; 105: 1014-9.
7. Takaya Y, Akagi T, Kijima Y, Nakagawa K, Ito H. Functional tricuspid regurgitation after transcatheter closure of atrial septal defect in adult patients: Long-term follow-up. JACC Cardiovasc Interv 2017; 10: 2211-8.
8. Wang JK, Chiu SN, Lin MT, Chen CA, Lu CW, Wu MH. Mid-to-long-term follow-up results of transcatheter closure of atrial septal defect in patients older than 40 years. Heart Vessels 2017; 32: 467-73.
9. Matsumoto T, Tamiya E, Kanoh T, et al. Atrial septal defect of the ostium secundum type in a 101-year-old patient. Int Heart J 2019; 60: 489-91.
10. Lauermans JG, Post MC, ten Berg JM, Plokker HW, Suttorp MJ. Long-term outcome of percutaneous closure of secundum-type atrial septal defects in adults. EuroIntervention 2010; 6: 604-10.
11. Her AY, Lim KH, Shin ES. Transcatheter retrieval of embolized atrial septal defect occluder device by waist capture technique. Int Heart J 2018; 59: 226-9.
12. Alnasser S, Lee D, Austin PC, et al. Long term outcomes among adults post transcatheter atrial septal defect closure: systematic review and meta-analysis. Int J Cardiol 2018; 270: 126-32.
13. Gerth AM, Watkinson PJ, Young JD. Changes in health-related quality of life (HRQoL) after discharge from intensive care unit: a protocol for a systematic review. BMJ Open 2015; 5: e009508.
14. Exteberria I, Urdaleta E, Galldona N. Factors associated with health-related quality of life (HRQoL): differential patterns depending on age. Qual Life Res 2019; 28: 2221-31.
15. Jindal NL, Harniman E, Prior N, Perez-Fernandez E, Caballero T, Betschel S. Hereditary angioedema: health-related quality of life in Canadian patients as measured by the SF-36. Allergy Asthma Clin Immunol 2017; 13: 4.
16. White MK, McCausland KL, Sanchorawala V, Guthrie SD, Bayliss MS. Psychometric validation of the SF-36 Health Survey in light chain amyloidosis: results from community-based and clinic-based samples. Patient Relat Outcome Meas 2017; 8: 157-67.