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Quality of life and emotional vulnerability in a national cohort of adolescents living with Fontan circulation

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Abstract

Introduction: To investigate quality of life and mental health after Fontan completion, we aimed to characterise outcomes in a representative group of adolescent patients. The study was part of the pre-transition clinical work-up in adolescents with Fontan-type palliation of univentricular CHD. The programme covers the entire paediatric Fontan patient population in Norway. *Methods:* Our cross-sectional study included 42 adolescents with Fontan circulation aged 15–18. We recruited a control group of 29 healthy peers. Quality of life was measured by the Pediatric Quality of Life Inventory Questionnaire, while mental health was assessed with the Strength and Difficulties Questionnaire. *Results:* Fontan patients scored lower than healthy controls on the Pediatric Quality of Life Inventory total ($p = 0.004$), the physical ($p < 0.001$) and social ($p = 0.001$) functioning subscale, and the Strength and Difficulties Questionnaire subscale of emotional symptoms ($p = 0.035$). Compared to two of the healthy teens (7%), seven patients (16%) in the Fontan group scored as having impaired mental health ($p = 0.224$). The female/male ratio for individuals with impaired health was 7:2 ($p = 0.003$). *Conclusions:* Compared to healthy controls, adolescents after Fontan-type palliation in Norway have good health-related quality of life and mental health, despite having slightly lower score than healthy individuals, mainly in physical domains and school functioning. Compared to healthy controls and healthy teenagers, these adolescents have somewhat more emotional problems, and compared to male patients, female patients more often have impaired mental health.

Fontan-type palliation of univentricular heart disease has saved many lives since its introduction in the 1970s. In Norway, survival to the age of 16 increased gradually from 33% in the 1971–1989 period to 82% in the 2000–2011 period. In Norway, with its population of 5.4 million, approximately 350 patients live with Fontan circulation.[1] However, there are several well-known long-term challenges associated with palliation that might impact quality of life and mental health, such as impaired exercise tolerance, Fontan-associated liver disease, lymphatic complications, and thromboembolic events.[2] Previous studies have examined quality of life and mental health in various age groups of Fontan patients.[3–5] In a recent meta-analysis of 50 studies covering 2793 Fontan children and adults, Marshall et al found that Fontan patients had reduced quality of life across multiple domains. The relationships between numerous clinical variables and health-related quality of life in many of the reviewed studies were highly variable, and no consistent correlation was detected. Remarkably, older patient age was correlated with better psychosocial and social functioning, which supports the concept of gradual social adaptation to health-related limitations. However, Marshall et al did not provide specific information about the adolescent patient population. In a recent single-centre study, adolescents with Fontan circulation showed a high incidence of mental health problems and psychosocial dysfunction, such as anxiety, hyperactivity disorders, and attention deficits.[6] According to Pike et al, who compared adolescents and adults with Fontan circulation with age-matched healthy controls, 28% of the Fontan group had mild depressive symptoms, while 32% had moderate symptoms.[5]

Research regarding quality of life among Fontan patients has produced mixed results, with some studies reporting lower levels of quality of life than that of healthy controls[7] and other findings showing no differences.[5] However, most studies have reported that quality of life is relatively high in this population despite medical outcomes and functional complications associated with Fontan circulation.[8] It is of central importance to recognise the variability of quality of life within this population.[5]

We know that adolescents with CHD, who are transiting from paediatric to adult care, are particularly vulnerable in terms of quality of life and mental health.[9] However, specific population-based data on quality of life issues and mental health in adolescents with Fontan

circulation are limited, constituting a knowledge gap. Quality of life and mental health in this population have not previously been studied in Norway. We wanted to conduct this population-based study to compare our data with those from existing research.

The aim of our study was to investigate quality of life and mental health in a nationwide cohort of adolescents living with Fontan circulation and its association with other general and cardiac factors. We hypothesised the following: (1) health-related quality of life and mental health in Fontan adolescents are reduced compared to those of healthy controls in terms of physical, psychosocial and mental health, and (2) health-related quality of life and mental health are related to the number of post-operative days of admission after the Fontan operation, total duration of re-admission since the Fontan operation and ventricular morphology.

Materials and methods

This study is a single-centre national study with a cross-sectional design and prospective enrolment (ClinicalTrials.gov identifier: NCT02378857).

Study population

The study was conducted at Oslo University Hospital, the only centre currently performing paediatric and congenital cardiac surgery in Norway. From March 2015 to December 2018, 45 Fontan patients aged 15–18 were invited to participate during their routine hospital admission for a multidisciplinary work-up before transition to adult care. Our pre-transition diagnostic programme includes heart catheterisation, cardiac and abdominal MRI, exercise testing and pulmonary function tests. During admission, several structured conversations are provided for patient education. The adolescents enrolled in our study received the questionnaires upon arrival and returned them to the researcher as soon as they were completed and before they participated in any patient education activities. The clinical data retrieved from the patients' records consisted of biometrical data, date of the Fontan operation, number of post-operative days of admission after the Fontan operation, total duration of re-admission since the Fontan operation and ventricular morphology. Research suggests a correlation between disease severity as expressed by these clinical variables and quality of life and mental health in patients with CHD.[10]

The exclusion criterion was the inability to read or speak Norwegian without a translator.

Twenty-nine healthy controls, aged 16–24, were recruited by local project announcements, from hospital employee families and networks and their peers over the same time period as the Fontan patients. The healthy participants had to be without any heart condition or severe lung disease. A certain portion of the control group had to be 18 years of age or older to be legally able to give consent for contrast MRI imaging. The quality-of-life project was part of a multidisciplinary cross-sectional study with a comprehensive and time-consuming programme of study tests (including ultrasound of the heart/liver, cycling echo and blood tests). Recruitment of healthy controls generally requires a leave of absence from higher education, which is under strict regulation and sanctioning in Norway. Therefore, we did not achieve our goal of equal group size patient and healthy control groups within the time frame of study completion.

The Pediatric Quality of Life Inventory

The Pediatric Quality of Life Inventory Questionnaire is a generic tool designed to measure the health-related quality of life of children and adolescents. It was developed by Varni in the United States in 1998,[11] and the authorised Norwegian translation of the version for patients aged 13–18 years was used in this project for both the Fontan patients and healthy controls.[12] The Pediatric Quality of Life Inventory Questionnaire is brief and typically takes <5 minutes to complete. The reliability and validity of the Pediatric Quality of Life Inventory generic core scales have been demonstrated in healthy and patient populations.[13,14]

The questionnaire comprises 23 questions that contribute to four subscales: physical (8 items), emotional (5 items), social (5 items), and school functioning (5 items). A score can be calculated for each subscale. In addition to the four subscales, a total summary health score can be computed as the sum of all the items divided by the number of items answered. A psychosocial summary score can be calculated based on the subscales of emotional, social, and school functioning (15 questions), and finally, there is a scale that provides a physical health summary, which is the same as the physical function subscale.

0 = "never a problem",
1 = "almost never a problem",
2 = "sometimes a problem",
3 ="often a problem", and
4 = "almost always a problem".

Items were reverse-scored and linearly transformed to a 0–100 scale, where 0 = 100, 1 = 75, 2 = 50, 3 = 25, and 4 = 0. The highest possible score was 100. A total of 100 points indicates optimal quality of life.[15] Scores below 70 indicate reduced quality of life.[16]

Strengths and Difficulties Questionnaire

The Strengths and Difficulties Questionnaire assesses mental health, friendships and prosocial behaviour in children and adolescents aged 11–16 years[17] and was developed by Goodman in 1997.[18] The Strengths and Difficulties Questionnaire has been translated into 70 languages. Its reliability and validity have been well documented.[18–20] We used the Norwegian version of the Strengths and Difficulties Questionnaire, which has been used since 2001, for both the Fontan patients and healthy controls.[21] The Strengths and Difficulties Questionnaire consists of 25 questions and includes the following topics: emotional symptoms, conduct problems, hyperactivity, peer problems, and prosocial behaviour. The first four topics are summarised into the total difficulties score ranging from 0 to 40. Each item within a topic uses a three-point scale and can be answered with "not true", "somewhat true" or "certainly true". Items are scored 0–2 for negatively worded items and inversely score 2–0 for positively worded answers. For all items, a higher score indicates a more negative answer. A score of 16–18 is defined as "borderline", and a score of $\geq$ 19 defines symptom "caseness" according to Goodman. This means that a total score from 19 or higher predicts the likelihood that a patient meets the criteria for a psychiatric diagnosis if they had been assessed with a diagnostic interview. A total score of 16–18 indicates that a patient's mental status is considered borderline between normality and psychopathology.[21] The cut-offs for the various domains in the Strengths and Difficulties Questionnaire are as follows: values between 0 and 4 on the emotional subscale, 0–3 on the behaviour subscale, 0–6 on the

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hyperactivity subscale, 0–3 on the peer problems subscale, and 10–6 on the prosocial subscale.[22]

The research project was conducted in conformity with the Helsinki Declaration, and it was approved by the Regional Committee for Medical and Health Research Ethics in Southeast Norway. All patients and individuals in the healthy control group and their caregivers, if necessary, gave their informed consent.

Statistical analysis

Descriptive statistics for demographics and basic characteristics are reported as the mean and standard deviation (mean ± SD) or as the median and interquartile range (IQR) for continuous variables and frequencies/percentages for categorical variables. Associations between two binary variables were assessed by using the chi-squared test. Missing data were treated with the expectation maximisation method.[23]

Patient characteristics, Pediatric Quality of Life Inventory, and Strengths and Difficulties Questionnaire summary scores were compared between the Fontan patient group and the healthy control group using a two independent samples t-test or the Mann–Whitney U test. Clinically important factors, characteristics, and their association with the Pediatric Quality of Life Inventory and Strengths and Difficulties Questionnaire scores were examined by linear regression analysis. The level of significance was set at 0.05 for summary scores. Two-sided p-values were not corrected for the subdomains of the Pediatric Quality of Life Inventory and the Strengths and Difficulties Questionnaire. All analyses were performed with IBM SPSS Statistics Version 25 (IBM Corporation, Armonk, New York, USA).

Results

Subjects

Seventy-one individuals were included in the study; 45 Fontan patients and 29 healthy controls received the questionnaires. The response rate for patients was 93.3% (42/45) and that for healthy controls was 100%. Five responses in the Fontan group and five responses in the control group were treated with the expectation maximisation method to address missing data.

The demographic characteristics of the Fontan patients and the healthy controls are shown in Table 1. There was a slight dominance of males in our Fontan group. The mean age was 16.6 ± 0.6 for the Fontan group. The control group comprised 13 males and 14 females. The mean age of the control group was 18.96 ± 1.78.

Eighteen patients had a dominant right ventricle, 22 had a dominant left ventricle, and two patients had a morphologically or functionally common ventricle. The length of initial post-operative hospital stay after the Fontan operation ranged from 4 to 90 days (median 13, IQR 14). One patient underwent surgery in the United States, and three of our patients underwent surgery at the university hospital in Bergen, Norway, shortly before programme closure. Since 2003, all surgical and interventional CHDs in Norway have been performed at Oslo University Hospital, Rikshospitalet. No post-operative admission data were available for these four patients.

Quality of life

Compared to the healthy controls, the mean total score of the Pediatric Quality of Life Inventory Questionnaire was significantly lower for the Fontan patients (74 ± 16 versus 85 ± 13, p = 0.004) (Table 2).

Table 1. General characteristics

	Fontan group n = 42	Healthy group n = 29	p-Value	Total n = 71
Female	17 (40%)	14 (48%)	0.515	
Age (years)	16.6 (0.9)	18.9 (1.8)	<0.001	71
Body mass index (kg/m2)	20.9 (4.6)	20.8 (4.7)	0.736	71
Age at TCPC (years)	2.0 (1.25)			42
Time since TCPC (years)	14.4 (2.3)			42
Number of post-operative days after TCPC	13.7 (14.0)			42
Number of re-admission days after TCPC	0.0 (0.0)			42
Ventricular morphology:				42
Left ventricle	22 (52%)			
Right ventricle	18 (42%)			
Common	2 (4%)			

TCPC = total cavopulmonary connection.
Absolute data are presented as N (%), and continuous data are presented as the median (interquartile range).

Compared to the healthy controls, the Fontan patients had significantly lower Pediatric Quality of Life Inventory scores on the physical subscale and social functioning subscale.

There was no difference between the groups on the subscores dealing with school and emotional functioning or on the psychosocial summary score.

Mental health

A difference between the Fontan patients and the healthy controls was found in the topic of emotions. No group differences were found in the domains of conduct, hyperactivity, peer problems, prosocial behaviour, or total difficulties score.

Six Fontan patients (14%) and two healthy control individuals (7%) had high Strengths and Difficulties Questionnaire scores equivalent to borderline function. One of the 42 patients (2%) in the Fontan group met the criteria for “caseness”. For the Fontan group, impaired mental health (borderline score or worse) was not significantly different from that of the healthy control group (p = 0.224), but compared to male patients, the mental health of female patients was impaired significantly more often (6/17 vs. 1/25, Chi square p = 0.008). The sex ratio for all borderline or worse cases within both groups together was female:male 7:2 (chi square p = 0.003). Table 2 presents the PedsQL and SDQ scores.

To analyse the associations of test variables with general characteristics within the patient group, we analysed the following factors by univariate and multivariate linear regression analyses: time elapsed since Fontan operation, dominant ventricular morphology, and sex. For another three variables, we performed only univariate linear regression analysis: age at Fontan operation, number of post-operative admission days after Fontan operation,

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Table 2. PedsQL and SDQ scores in Fontan patients and healthy controls

	Fontan		Healthy controls		
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	
	n = 42		n = 29		p-Value
PedsQL adolescents self-report:					
Total summary score	74.4 ± 16.0	79.7 (25.6)	85.1 ± 13.5	90.0 (13.3)	0.004
Psychosocial sum score	75.6 ± 15.5	77.5 (23.7)	83.3 ± 15.0	88.3 (16.6)	0.094
Physical functioning	72.1 ± 20.7	75.2 (29.7)	88.3 ± 12.3	93.7 (12.5)	<0.001
Emotional functioning	74.5 ± 19.3	75.0 (31.0)	77.3 ± 18.4	80.0 (33.0)	0.542
Social functioning	80.4 ± 17.3	81.7 (27.5)	93.1 ± 9.9	100 (15.0)	0.001
School functioning	71.9 ± 16.1	75.0 (25.0)	79.6 ± 22.3	90.0 (23.0)	0.094
SDQ adolescents self-report:					
Total difficulties score	9.7 ± 5.2	9.5 (9)	8.7 ± 4.6	9 (6)	0.415
N (%) caseness, 19–40	1 (2%)		0		0.224
N (%) borderline, 16–18	6 (14%)		2 (7%)		
Emotional problems	3.3 ± 2.8	3.0 (5)	2.0 ± 1.9	2 (3)	0.035
Conduct problems	1.1 ± 1.3	1 (2)	1.2 ± 0.9	1 (2)	0.608
Hyperactivity problems	3.4 ± 1.7	3 (3)	3.5 ± 1.9	4 (3)	0.724
Peer problems	1.8 ± 1.4	2 (3)	1.8 ± 1.7	2 (3)	0.963
Prosocial behaviour	8.8 ± 1.3	9 (2)	8.3 ± 2.0	9 (2)	0.235

Absolute data are presented as N (%), and continuous data are presented as the mean ± SD or the median (interquartile range), as appropriate. PedsQL = Higher scores are indicative of better health-related quality of life. SDQ = Higher scores indicate more problematic attributes.

and cumulative days of hospital admission after Fontan operation (Tables 3 and 4).

Female sex was predictive of a lower score for all subscales of the Pediatric Quality of Life Inventory Questionnaire in the univariate analysis. For the multivariate analysis, sex was still significantly associated with the total score, the psychosocial summary score, and the physical and social subscores.

For the Strengths and Difficulties Questionnaire, female sex was equally predictive of negative scores in the emotional domain and total difficulty score. No sex differences were found in the hyperactivity, peers, conduct problems, or prosocial domains.

Apart from increasing age being predictive of a lower physical Pediatric Quality of Life Inventory score, none of the remaining factors, such as age and body mass index, was of predictive value for any subscale or domain results in the univariate analysis.

Discussion

Our population-based data showed that adolescents living with a Fontan-type palliation of univentricular CHD had Pediatric Quality of Life Inventory Questionnaire scores above the cut-off in all domains. Compared to the healthy controls, the Fontan adolescents scored somewhat lower on multiple domains. Furthermore, compared to the healthy controls, our data demonstrated more emotional vulnerability in the Fontan group.

Total summary score

Our Pediatric Quality of Life Inventory Questionnaire results showed that compared to the healthy controls, the adolescents with Fontan circulation had lower total scores. At the same time, the score was above the cut-off value, which means that they are still defined within a normal ranking of health-related quality of life. Previous studies of adolescents and adults with CHD have shown conflicting results in terms of total scores.[7,24,25] Reiner et al included 514 patients (age 12.9 ± 3.1) and 734 healthy controls (age 13.4 ± 2.1) in their study and demonstrated that patients with CHD scored at least as high as their healthy peers. There were no differences between the severity classes or diagnostic subgroups in the total health-related quality of life score or in the six subdomains.[26] Patients with simple or complex CHD appeared to have developed strategies in perceiving high quality of life. This suggests that these patients can cope with the burden of illness.[26] Likewise, d´Udekem et al showed that Fontan patients (N = 36, age 17 ± 4 years after Fontan) had normal or satisfactory quality of life.[27] This outcome might be influenced by the fact that Fontan patients have never experienced normal health as healthy people know it. In contrast, Knowels et al demonstrated lower summary scores in 477 children with CHD (age 12.1 ± 1.0) and 464 healthy controls (age 12.0 ± 1.1).[28] One explanation for the fact that the Fontan adolescents in our study scored above the cut-off in the total summary score domain might be the structure and accessibility of the health care system. Norway has a public tax-financed healthcare system offering the same health care access and the same quality of treatment to each individual, independent of socio-economic background.[29] Furthermore, in our small country, the care providers for paediatric and adult CHD consist of a network of healthcare professionals, including child psychiatrists/psychologists, in close collaboration, which prevents healthcare gaps and loss of follow-up. Finally, the Norwegian school system provides preventive health care professionals within the school building, and we have a strict public integrative school model with educational participation independent of somatic or psychosocial disabilities.

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Table 3. Regression analysis results and associated variables for health-related quality of life

	Total summary score								Psychosocial summary score								Physical functioning							
PedsQL	Univariate				Multivariate adj R2 = 0.188				Univariate				Multivariate adj R2 = 0.128				Univariate				Multivariate adj R2 = 0.197			
	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value
Fontan age	−0.8	−3.3–1.5	0.013	0.478					−0.5	−2.9–1.8	0.005	0.658					−1.5	−4.7–1.6	0.023	0.340				
Time since TCPC	1.6	−0.7–4.0	0.047	0.167	0.8	−1.5–3.1		0.469	1.0	−1.2–3.4	0.022	0.350	0.4	−1.9–2.7		0.71		−0.3–5.7	0.075	0.079	1.6	−1.4–4.5		0.286
Number of post-operative days after TCPC	−0.1	−0.4–0.1	0.024	0.356					−0.05	0.3–0.2	0.003	0.725					−0.3	−0.6–0.1	0.069	0.111				
Number of re-admission days after TCPC	−0.2	−0.7–0.3	0.015	0.458					−0.03	−0.5–0.0	0.000	0.912					−0.5	−1.2–0.1	0.063	0.129				
Ventricular morphology	0.6	−7.9–9.2	0.001	0.883	0.8	−8.6–7.0		0.837	0.9	−9.3–7.3	0.001	0.813	−2.1	−9.9–5.8		0.597	3.6	−7.4–14.7	0.011	0.508	1.6	−8.5–11.6		0.752
Gender	−15.6	−24.6–5.6	0.237	**0.001**	−14.9	−24.4–5.4		**0.003**	−13.3	−22.3–4.3	0.184	**0.005**	−13.1	−22.6–3.6		**0.008**	−19.9	−31.6–8.2	0.228	**0.001**	−18.2	−30.4–5.9		**0.005**
Multivariate							0.188	**0.012**							0.128	**0.042**							0.197	**0.01**

	Social functioning								Emotional functioning								School functioning							
PedsQL	Univariate				Multivariate adj R2 = 0.128				Univariate				Multivariate adj R2 = 0.067				Univariate				Multivariate adj R2 = 0.071			
	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value
Fontan age	−0.6	−3.3–2.0	0.006	0.632					−0.1	−3.1–2.8	0.000	0.912					−0.7	−3.2–1.7	0.010	0.528				
Time since TCPC	1.1	−1.5–3.7	0.018	0.396	0.3	−2.2–2.9		0.796	1.5	−1.4–4.4	0.027	0.303	0.7	−2.2–3.7		0.617	0.6	1.7–3.1	0.007	0.586	0.2	−2.2–2.6		0.868
Number of post-operative days after TCPC	−0.2	−0.5–0.1	0.044	0.206					0.06	−0.3–0.4	0.003	0.749					0.0	0.2–0.2	0.000	0.997				
Number of re-admission days after TCPC	−0.4	−1.0–0.1	0.051	0.174					0.3	−0.3–0.9	0.027	0.328					0.0	−0.5–0.5	0.000	0.986				
Ventricular morphology	−0.7	−10.0–8.5	0.001	0.868	−1.9	−10.6–6.8		0.662	1.0	−9.3–11.4	0.001	0.837	−0.2	−10.3–9.9		0.967	−3.2	−11.8–5.3	0.014	0.451	−4.1	−12.5–4.3		0.333
Gender	−15.0	−25.0–5.0	0.187	**0.004**	−14.9	−25.5–4.3		**0.007**	−14.0	−25.6–2.3	0.129	**0.019**	−13.3	−25.6–1.0		**0.035**	−11.1	−20.8–1.3	0.117	**0.026**	−11.3	−21.5–1.0		**0.032**
Multivariate							0.128	**0.042**							0.067	0.133							0.071	0.124

Table 4. Regression analysis results and associated variables for mental health

	Hyperactivity problems								Emotional problems								Peer problems							
SDQ	Univariate				Multivariate adj R2 = −0.055				Univariate				Multivariate adj R2 = 0.233				Univariate				Multivariate adj R2 = −0.026			
	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value
Fontan age	−0.1	−0.3–0.1	0.017	0.418					0.1	−0.2–0.5	0.013	0.477					0.02	−0.2–0.2	0.001	0.863				
Time since TCPC	0.1	−0.1–0.3	0.018	0.399	0.1	−0.2–0.4		0.406	−0.2	−0.6–0.1	0.044	0.182	−0.1	−0.5–0.3		0.537	−0.02	−0.2–0.2	0.001	0.829	0.0	−0.2–0.3		0.712
Number of post-operative days in hospital after TCPC	−0.1	0.04–0.01	0.028	0.319					0.02	−0.02–0.08	0.034	0.265					0.0	−0.02–0.03	0.003	0.728				
Number of readmitted days after TCPC	−0.1	−0.06–0.04	0.005	0.687					0.03	0.06–0.1	0.018	0.426					0.03	0.0–0.1	0.064	0.126				
Ventricular morphology	0.1	0.7–1.1	0.004	0.703	0.1	−0.8–1.1		0.804	−0.9	−1.6–1.4	0.000	0.903	0.2	−1.2–1.5		0.808	−0.4	−1.1–0.3	0.026	0.310	−0.4	−1.2–0.4		0.343
Gender	0.1	−1.0–1.1	0.000	0.899	0.2	−1.0–1.4		0.728	2.9	1.4–4.5	0.281	<**0.001**	2.9	1.3–4.5		0.001	0.8	−0.1–1.7	0.074	0.081	0.8	−0.1–1.8		0.091
Multivariate							−0.055	0.832							0.233	**0.004**							0.026	0.269

	Conduct problems								Total difficulties score								Prosocial behaviour							
SDQ	Univariate				Multivariate adj R2 = −0.007				Univariate				Multivariate adj R2 = 0.044				Univariate				Multivariate adj R2 = 0.096			
	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value	β	95% CI	R2	p-value
Fontan age	0.06	−0.1–0.2	0.014	0.454					0.1	−0.6–0.9	0.003	0.744					−0.5	−0.2–0.1	0.006	0.623				
Time since TCPC	−0.06	−0.2–0.1	0.012	0.491	−0.1	−0.3–0.1		0.279	−0.2	−1.0–0.5	0.010	0.520	−0.1	−0.9–0.7		0.882	−0.1	−0.3–0.02	0.074	0.082	−0.2	−0.4–0.0		0.101
Number of post-operative days in hospital after TCPC	−0.01	−0.03–0.0	0.040	0.226					0.0	−0.08–0.1	0.000	0.899					0.03	0.004–0.05	0.136	**0.023**				
Number of readmitted days after TCPC	−0.2	−0.06–0.02	0.024	0.349					0.04	−0.1–0.2	0.008	0.586					0.03	−0.01–0.07	0.046	0.195				
Ventricular morphology	0.2	−0.3–0.8	0.019	0.389	0.3	−0.3–0.9		0.339	−0.04	−2.8–2.7	0.000	0.972	0.2	−2.6–3.0		0.881	0.3	−0.3–1.1	0.030	0.272	0.5	−0.2–1–2		0.13
Gender	−0.3	−1.0–0.3	0.021	0.359	−0.4	−1.2–0.3		0.278	3.5	0.3–6.7	0.113	**0.029**	3.5	0.1–6.9		**0.042**	0.6	−0.1–1.5	0.062	0.110	0.5	−0.3–1.4		0.194
Multivariate							−0.007	0.448							0.044	0.198							0.096	0.079

These factors combined might explain the good health-related quality of life of our young Fontan population compared to that found in studies from other parts of the world.

Quality of life in the general Norwegian population has been shown to be good, consistent with our study results.[30] This was recently demonstrated in a March, 2020, study by Statistics Norway that aimed to determine the quality of life of the Norwegian population. The results demonstrated that 26% of the population was highly satisfied, while 22% was quite dissatisfied with life. Participants were aged > 18 years, and 40,000 were invited to participate. The response rate was 44%.[30]

Psychosocial functioning

The results from the Pediatric Quality of Life Inventory Questionnaire showed no difference in the psychosocial summary scores of the Fontan patients and the healthy controls.

The results in our study showed a difference between the Fontan group and the healthy controls in the domain of social functioning. This was the domain of the Pediatric Quality of Life Inventory Questionnaire on which both the Fontan adolescents and the healthy controls scored the highest. However, emotional and school functioning were not significantly different between the groups. Uzark et al (N = 408, age 18.5 ± 3.4) described a lower social function in younger adults with Fontan circulation. In addition, Uzark et al showed impaired psychosocial quality of life in approximately one in three patients with Fontan, particularly related to social function. The same study also showed that psychosocial quality of life was significantly related to physical function in Fontan patients and was often not related to clinical indicators such as severity of the disease.[7] This is in contrast to the findings of Pike et al, where no difference was found between the groups in the social function domain.[5] Studies by Van Den Bosch et al and Teixeira et al used proxy data and found that parents can become overprotective, which can limit the child´s social life, making it difficult for children and adolescents to adapt to social life and live independently.[31,32] Fontan patients' limited physical competence relative to that of other CHD patients might contribute to this heightened vulnerability by increasing the risk of social isolation.[6] In the process of becoming independent adults, adolescence poses many challenges, especially for chronically ill patients. Special support is therefore recommended to help this group meet their medical and psychosocial needs.[33,34] Several factors may explain our findings regarding the psychosocial summary score. The main group of Norwegian Fontan adolescents achieved scores consistent with a good quality of life.

In the current study, the scores on the school functioning domain were the lowest among the Pediatric Quality of Life Inventory Questionnaire domains, with the scores being in the boundary area of the cut-off. The low scores, although within normality in our study, might be explained by a few patients' negative experiences with Fontan circulation consequences, in addition to more severe complications related to hospital interventions, readmissions, and controls. This might entail less time at school and spending less leisure time with friends, resulting in a negative influence on school functioning.

Physical functioning

The physical function scores of the Pediatric Quality of Life Inventory Questionnaire significantly differed between the Fontan group and the healthy control group. However, the scores were not below the cut-off, indicating that the Fontan adolescents still had a good quality of life. Other studies have shown that exercise capacity deteriorates after Fontan palliation in childhood, resulting in a negative impact on quality of life.[35,36] As previously mentioned, Uzark et al also compared physical functioning of Fontan patients with that of healthy controls. Fontan patients demonstrated lower scores, which means lower physical functioning with increased patient age and thereby increased time since the Fontan operation was performed.[7] Further results from the study of Uzark et al showed that male individuals with Fontan circulation scored significantly higher than females in the domain of physical functioning. As in healthy populations, this may reflect different sex expectations. Approximately 50% of young adults with Fontan had impaired quality of life related to physical functioning.[7]

Idorn et al included 158 children with Fontan (age 13.9, IQR 10.2–19.3) and 172 healthy controls in a study performed in Denmark. The results showed a significant difference between groups in physical functioning using the Pediatric Quality of Life Inventory Questionnaire.[8] McCrindle et al presented data from a multicentre, cross-sectional study of 537 children with Fontan (age 6–18 years, 60% male) evaluating quality of life by parent proxy reports. They showed that the physical functioning scores were significantly lower than normative values.[37] Marshall et al identified lower scores across all health-related quality of life domains, with the largest differences in physical functioning,[3] as confirmed in our study.

Mental health

The results from the Strengths and Difficulties Questionnaire in our study showed a significant difference between groups only in the domain of emotional problems and not in the domains of hyperactivity, conduct, peer problems, prosocial behaviour, or total difficulties. Both the Fontan patients and healthy controls had normal scores. Compared to the male patients, the female patients had impaired mental health more often, in accordance with general findings,[38] as confirmed in our study. A Norwegian study using the Strengths and Difficulties Questionnaire included 30,000 adolescents from the general population aged 10–19 years and found that 9% of the population had symptoms or difficulties that created distress in everyday life and reduced their well-being.[22] As our study results showed, females in Van Roy's study reported the most emotional problems and males reported the most behaviour and peer problems. Norwegian adolescents had a high prevalence of hyperactive behaviour compared with adolescents from other countries. Research on CHD, especially those with single ventricles, shows a high prevalence of psychosocial problems and anxiety.[6] Pike et al compared 54 adolescents with Fontan circulation and 66 healthy controls and found that the patients with Fontan circulation had symptoms of depression.[5] Demaso et al compared the mental health and psychosocial status of 156 adolescents with Fontan with those of 111 healthy peers.[6] The Fontan patients had a significantly higher rate of lifetime psychiatric diagnosis (65% versus 22%). Concerning the most common[39] psychiatric dysfunction, especially anxiety and attention deficit hyperactivity disorder, it is commonly recommended to screen patients in childhood to determine whether they are at risk and should be referred for treatment.[6,10] Zentner et al found higher rates of anxiety and behavioural disorders in Fontan patients and recommended awareness and early intervention and support to prevent or minimise negative consequences.[40]

Rassart et al showed that adolescents with CHD start developing their own personal identity, future orientation and concerns

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during adolescence, making them more aware of what it means to live with a chronic illness.[41]

Several university and local hospitals in Norway, including OUH Rikshospitalet, have worked purposefully with the transition to adult care. The results of this work may explain our relatively high scores.

Diseth et al, who included 38 kidney transplanted (mean 12.2) children and 42 healthy controls (mean 11.8), found that the healthy control group had better mental health.[42] Diseth et al published their paper in 2011; the results from this paper might be partially explained by the date of the study and might not be representative today.

According to Bratt et al, nearly 50% of parents expressed concern regarding the transition the adult care.[39] This showed that there is good reason to start the transition early, preferably at 12–13 years of age. Du Plessis et al studied the parents of youths with Fontan circulation who completed the Strengths and Difficulties Questionnaire at the beginning of the transition to the adult ward and found 17 young people between the ages of 15–18 and 15 of their parents to report poor knowledge of their own Fontan circulation, and 41% had poor knowledge of the purpose of their medication and their treatment. Most patients reported feeling uncomfortable talking about problems, especially problems with emotional well-being. All parents reported high levels of anxiety surrounding the transition to an adult ward.[43]

Concerning our hypotheses, we found the health-related quality of life of the patients to be reduced compared to that of the healthy controls for all domains from the Pediatric Quality of Life Inventory Questionnaire. Significant deviations from healthy controls were demonstrated in the total summary score and physical and social functioning scores. On the Strengths and Difficulties Questionnaire, only the emotional problems domain showed a difference between groups.

Concerning hypothesis 2, no significance difference was found based on age at Fontan operation, number of post-operative admission days after Fontan operation or cumulative days of hospital admission after Fontan operation.

Our data are in line with those of previous non-population-based studies in young patients with CHD for both the Pediatric Quality of Life Inventory Questionnaire and the Strengths and Difficulties Questionnaire in the Fontan population, despite medical and functional complications. However, our results also show that the Fontan group scored somewhat lower in all domains of the Pediatric Quality of Life Inventory Questionnaire and in multiple domains of the Strengths and Difficulties Questionnaire.

To prevent the occurrence of mental health issues or impaired quality of life during the vulnerable phase of transition from paediatric to adult care, preparations should begin from the age of 12, and the transition itself should be planned in a structured and individualised manner. This process should include both medical and psychoeducation.[40,44,45] It is important to identify adolescents at risk for mental health problems and impaired health-related quality of life.[46] Routine psychosocial assessment is essential to form interventions to strengthen health-related quality of life and to improve mental health.

Limitations

The results of this study must be interpreted in the context of several limitations. The limitations include a small patient population, which may have influenced our statistical results. The results are not widely generalisable, as the data reflect the practice of a single centre, and the study is not randomised with a slightly different population in the study and the healthy control group.

Because of ethical restrictions in performing MRI for other parts of the project, the control group had to be slightly older than the patient group, which might introduce an age-related bias. However, as increasing age was associated with lower quality of life scores, any group differences were unlikely to be overestimated because of age bias.

A significant number of our control group members were recruited by health care workers, which might have introduced a bias towards a group that was physically and mentally healthier than the general adolescent population. The timing of the distribution of the questionnaires may affect the answers. Completing the questionnaires at home in a safe environment can result in higher scores. However, the downside of completing the questionnaires in the laboratory is that the response rate would probably be lower. The distribution of the forms on arrival at the hospital may have reminded the patients of their disease, possibly yielding lower scores. Some of the Fontan adolescents were also worried that they would be hospitalised for five days and undergo several medical examinations. This may also have influenced the responses of the Fontan adolescents.

Conclusion

Compared to healthy controls, adolescents after Fontan-type palliation in Norway have good health-related quality of life and mental health, despite slightly lower scores than those of healthy individuals, mainly in the physical and school functioning domains. Compared to healthy controls and healthy teenagers, these adolescents have somewhat more emotional problems, and compared to male patients, female patients exhibited impaired mental health more often. Compared with the populations investigated by previous studies from other parts of the world, adolescents with Fontan circulation in Norway have remarkably good quality of life and few mental health challenges.

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Conflicts of interest. None.

Ethical standards. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national guidelines on human experimentation (*Lov om medisinsk og helsefaglig forskning*) and with the Helsinki Declaration of 1975, as revised in 2008, and have been approved by the institutional committees (Regional Committee for Medical and Health Research Ethics in South East Norway).

References

1. Erikssen G, Aboulhosn J, Lin J, et al. Survival in patients with univentricular hearts: the impact of right versus left ventricular morphology. Open Heart 2018; 5: e000902.
2. Mori M, Aguirre AJ, Elder RW, et al. Beyond a broken heart: circulatory dysfunction in the failing Fontan. Pediatric Cardiol 2014; 35: 569–579.
3. Marshall KH, D'Udekem Y, Sholler GF, et al. Health-related quality of life in children, adolescents, and adults with a Fontan circulation: a meta-analysis. J Am Heart Assoc 2020; 9: e014172.

https://doi.org/10.1017/S1047951121003188 Published online by Cambridge University Press

4. Rychik J, Atz AM, Celermajer DS, et al. Evaluation and management of the child and adult with fontan circulation: a scientific statement from the American Heart Association. Circulation 2019; 140: e234–e284.
5. Pike NA, Evangelista LS, Doering LV, Eastwood JA, Lewis AB, Child JS. Quality of life, health status, and depression: comparison between adolescents and adults after the Fontan procedure with healthy counterparts. J Cardiovasc Nurs 2012; 27: 539–546.
6. DeMaso DR, Calderon J, Taylor GA, et al. Psychiatric disorders in adolescents with single ventricle congenital heart disease. Pediatrics 2017; 139: e20162241.
7. Uzark K, Zak V, Shrader P, et al. Assessment of quality of life in young patients with single ventricle after the Fontan operation. J Pediatr 2016; 170: 166–172.
8. Idorn L, Jensen AS, Juul K, et al. Quality of life and cognitive function in Fontan patients, a population-based study. Int J Cardiol 2013; 168: 3230–3235.
9. Bratt EL, Luyckx K, Goossens E, Budts W, Moons P. Patient-reported health in young people with congenital heart disease transitioning to adulthood. J Adolesc Health 2015; 57: 658–665.
10. Drakouli M, Petsios K, Giannakopoulou M, Patiraki E, Voutoufianaki I, Matziou V. Determinants of quality of life in children and adolescents with CHD: a systematic review. Cardiol Young 2015; 25: 1027–1036.
11. Varni JW, Seid M, Rode CA. The PedsQL™: measurement model for the pediatric quality of life inventory. Med Care 1999; 37: 126–139.
12. Reinfjell T, Diseth TH, Veenstra M, Vikan A. Measuring health-related quality of life in young adolescents: reliability and validity in the Norwegian version of the Pediatric Quality of Life Inventory™ 4.0 (PedsQL) generic core scales. Health Qual Life Outcomes 2006; 4: 61.
13. Varni JW, Burwinkle TM, Seid M. The PedsQL™ as a pediatric patient-reported outcome: reliability and validity of the PedsQL™ Measurement Model in 25,000 children. Expert Rev Pharmacoecon Outcomes Res 2005; 5: 705–719.
14. Varni JW, Seid M, Kurtin PS. PedsQL 4.0: reliability and validity of the Pediatric Quality of Life Inventory version 4.0 generic core scales in healthy and patient populations. Med Care 2001; 39: 800–812.
15. Reinfjell T, Jozefiak T. Måleegenskaper ved den norske versjonen av The Pediatric Quality of Life Inventory TM, 4.0 (PedsQL). PsykTestBarn 2012; 2: nr 2:1.
16. Reinfjell T, Diseth TH, Veenstra M, Vikan A. Measuring health-related quality of life in young adolescents: reliability and validity in the Norwegian version of the Pediatric Quality of Life Inventory 4.0 (PedsQL) generic core scales. Health Qual Life Outcomes 2006; 4: 61.
17. Goodman R, Meltzer H, Bailey V. The strengths and difficulties questionnaire: a pilot study on the validity of the self-report version. Eur Child Adolesc Psychiatry 1998; 7: 125–130.
18. Goodman R. The extended version of the strengths and difficulties questionnaire as a guide to child psychiatric caseness and consequent burden. J Child Psychol Psychiatry 1999; 40: 791–799.
19. Obel C, Heiervang E, Rodriguez A, et al. The strengths and difficulties questionnaire in the Nordic countries. Eur Child Adolesc Psychiatry 2004; 13: ii32–ii39.
20. Van Roy B, Veenstra M, Clench-Aas J. Construct validity of the five-factor Strengths and Difficulties Questionnaire (SDQ) in pre-, early, and late adolescence. J Child Psychol Psychiatry 2008; 49: 1304–1312.
21. Heyerdahl S. SDQ-strength and difficulties questionnaire: En orientering om et nytt spørreskjema for kartlegging av mental helse hos barn og unge, brukt i UNGHUBRO, OPPHED og TROFINN. Norsk Epidemiologi 2003; 13: 127–135.
22. Roy B, Grøholt B, Heyerdahl S, Clench-Aas J. Self-reported strengths and difficulties in a large Norwegian population 10–19 years. Eur Child Adolesc Psychiatry 2006; 4: 189–198.
23. Enders CK. Using the expectation maximization algorithm to estimate coefficient alpha for scales with item-level missing data. Psychol Methods 2003; 8: 322.
24. Spijkerboer AW, Utens EM, Bogers AJ, Helbing WA, Verhulst FC. A historical comparison of long-term behavioral and emotional outcomes in children and adolescents after invasive treatment for congenital heart disease. J Pediatr Surg 2008; 43: 534–539.
25. Ringle ML, Wernovsky G. Functional, quality of life, and neurodevelopmental outcomes after congenital cardiac surgery. Semin Perinatol Elsevier, 2016: 556–570.
26. Reiner B, Oberhoffer R, Ewert P, Müller J. Quality of life in young people with congenital heart disease is better than expected. Arch Dis Child 2019; 104: 124–128.
27. d'Udekem Y, Cheung MM, Setyapranata S, et al. How good is a good Fontan? Quality of life and exercise capacity of Fontans without arrhythmias. Ann Thorac Surg 2009; 88: 1961–1969.
28. Knowles RL, Day T, Wade A, Bull C, Wren C, Dezateux C. Patient-reported quality of life outcomes for children with serious congenital heart defects. Arch Dis Childhood 2014; 99: 413–419.
29. McCrindle BW, Williams RV, Mitchell PD, et al. Relationship of patient and medical characteristics to health status in children and adolescents after the Fontan procedure. Circulation 2006; 113: 1123–1129.
30. Støren KS, Rønning E, Gram KH. Livskvalitet i Norge 2020. *Statistisk sentralbyrå*, 2020.
31. Van Den Bosch AE, Roos-Hesselink JW, Van Domburg R, Bogers AJJC, Simoons ML, Meijboom FJ. Long-term outcome and quality of life in adult patients after the Fontan operation. Am J Cardiol 2004; 93: 1141–1145.
32. Teixeira FM, Coelho RM, Proença C, et al. Quality of life experienced by adolescents and young adults with congenital heart disease. Pediatr Cardiol 2011; 32: 1132–1138.
33. van der Mheen M, Meentken MG, van Beynum IM, et al. CHIP-family intervention to improve the psychosocial well-being of young children with congenital heart disease and their families: results of a randomised controlled trial. Cardiol Young 2019; 29: 1172–1182.
34. Mora MA, Saarijärvi M, Sparud-Lundin C, Moons P, Bratt E-L. Empowering young persons with congenital heart disease: using intervention mapping to develop a transition program-The STEPSTONES Project. J Pediatr Nurs 2020; 50: e8–e17.
35. Hedlund ER, Lundell B, Soderstrom L, Sjoberg G. Can endurance training improve physical capacity and quality of life in young Fontan patients? Cardiol Young 2018; 28: 438–446.
36. Goldberg DJ, Avitabile CM, McBride MG, Paridon SM. Exercise capacity in the Fontan circulation. Cardiol Young 2013; 23: 824–830.
38. Lundh LG, Wangby-Lundh M, Bjarehed J. Self-reported emotional and behavioral problems in Swedish 14 to 15-year-old adolescents: a study with the self-report version of the strengths and difficulties questionnaire. Scand J Psychol 2008; 49: 523–532.
39. Bratt E-L, Burström Å, Hanseus K, Rydberg A, Berghammer M, and consortium ObotSC. Do not forget the parents—Parents' concerns during transition to adult care for adolescents with congenital heart disease. Child Care Health Dev 2018; 44: 278–284.
40. Zentner D, Celermajer DS, Gentles T, et al. Management of people with a Fontan circulation: a Cardiac Society of Australia and New Zealand position statement. Heart Lung Circ 2020; 29: 5–39.
41. Rassart J, Apers S, Kovacs AH, et al. Illness perceptions in adult congenital heart disease: a multi-center international study. Int J Cardiol 2017; 244: 130–138.
42. Diseth TH, Tangeraas T, Reinfjell T, Bjerre A. Kidney transplantation in childhood: mental health and quality of life of children and caregivers. Pediatr Nephrol 2011; 26: 1881–1892.
43. Du Plessis K, Culnane E, Peters R, d'Udekem Y. Adolescent and parent perspectives prior to involvement in a Fontan transition program. Int J Adolesc Med Health 2019; 31: 1–3.
44. Burström Å, Acuña Mora M, Öjmyr-Joelsson M, et al. Ready for transfer to adult care? A triadic evaluation of transition readiness in adolescents with congenital heart disease and their parents. J Fam Nurs 2019; 25: 447–468.
45. Burström Å, Bratt E-L, Frenckner B, et al. Adolescents with congenital heart disease: their opinions about the preparation for transfer to adult care. Eur J Pediatr 2017; 176: 881–889.
46. Dulfer K, Bossers SS, Utens EM, et al. Does functional health status predict health-related quality of life in children after Fontan operation? Cardiol Young 2016; 26: 459–468.

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