Cardiology in the Young

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Physical and mental health in young adults with heart disease – a national survey of Norwegian university students

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Abstract

Background: Young adults with heart disease constitute a growing group with the risk of cognitive and physical impairment. The knowledge of their academic performance and mental and physical health is, however, scant. This study aimed to compare young adults with CHDs or arrhythmia with their peers. *Methods:* Information on physical health (Somatic Symptom Scale-8), mental health problems (Hopkins Symptoms Checklist-25), quality of life (Satisfaction With Life Scale), physical activity, and academic performance was collected online in a national cross-sectional survey in Norway among students in higher education (the SHoT2018 study). *Results:* Among 50,054 students, 172 (0.34%) reported CHD and 132 (0.26%) arrhythmias. Students reporting arrhythmias scored significantly higher than the control group on somatic symptoms (OR = 2.3 (95% CI: 1.62–3.27)), anxiety (OR = 1.60 (1.08–2.37)), depression (OR = 1.49 (1.05–2.11)), self-harm, and suicide attempt (OR = 2.72 (1.56–4.75)), and lower quality of life (OR 1.64 (1.16–2.32)) and more loneliness (OR = 1.99 (1.28–3.10)) compared to participants without heart disease. Participants with CHD reported an increased somatic symptom burden (OR = 1.58 (1.16–2.16)). Despite a tendency to a higher score, this group did not differ significantly from the control group on anxiety or depression, quality of life, or loneliness. However, the risk of self-harm thoughts and suicidality was significantly increased (OR for suicide attempt 2.22 (1.3–3.77)). There was no difference between the groups on academic performance. *Conclusions:* Although Norwegian students with heart disease reported more somatic symptoms, their academic progress was not reduced compared to students without heart disease. Students with CHD or arrhythmias showed an increased risk of self-harm thoughts and suicidality.

In adolescents and young adults, the most common heart conditions are CHDs and arrhythmias. CHDs are defined as malformations of the heart or the large blood vessels present at birth and are the most common birth malformations, affecting 5–13 per 1000 newborn infants worldwide.[1,2] The group of cardiac defects includes a variety of lesions, from minor anomalies without any need for treatment to complex deformities requiring extensive surgery and with reduced life expectancy. Medical and surgical treatments have improved substantially over the last decades, and more than 90% of children operated for CHD in Norway can be expected to reach adulthood.[3] Thus, adults with CHD constitute a heterogeneous and growing group.

Arrhythmias, either tachycardia, bradycardia, or heart block, are the major causes of morbidity and mortality among adults with CHD.[4] Arrhythmias are also the most frequent cause of cardiac symptoms in young adults without CHD. In individuals without other known cardiac diseases, diagnoses range from innocent palpitations caused by extrasystoles to genetic conditions with the risk of malignant arrhythmias.[5,6] Young adults with arrhythmias, thus, constitute a diverse group with regard to risks, treatment, and limitations.

Adults with CHD have been shown to have risk of worse physical health as assessed by reported somatic symptoms,[7] compared to peers without a heart condition. Likewise, arrhythmias are associated with symptoms like palpitations, fatigue/dizziness, and syncope.[6] The physical capacity in young adults with CHD varies depending on the severity of the original defect, and on whether a complete repair has been performed.[8] The level of physical activity appears to be high in this patient group in Norway, as shown by Larsson and colleagues in a recent international study of almost 4000 adults with CHD from 15 countries where 53% of the included Norwegian patients reported a high physical activity level within the WHO recommendations, compared to an average of 31%.[9] While a high level of physical activity may increase the risk of some arrhythmias like atrial fibrillation,[10] young adults with genetic

arrhythmogenic disorders may be subject to exercise restrictions and medications limiting their physical activity level.[11]

Measures of quality of life were generally high in the study by Larsson and colleagues,[9] with overall score of 80 (range 0–100) in the whole study population.[12] A review of 31 studies of quality of life in adults with CHD found reduced levels compared to healthy controls in the physical domain, but no difference in the psychosocial (i.e., measures of mental and emotional health, vitality, and social functioning) or environmental/occupational domain.[13] In a review of 12 studies assessing quality of life in children with CHD 1990–2008, Laval and colleagues found lower quality of life in some children with CHD, especially those with more complex lesions.[14] However, other studies have reported no difference, or even higher perceived quality of life in children and adolescents with CHD compared to the general population.[15–17] Methodological differences have made comparison of the studies difficult, and whether or not the quality of life among children and adolescents with CHD differs from their peers remains uncertain, according to a recent systematic review by Bertoletti and colleagues.[18] Reduced quality of life has been reported in adolescents with inherited arrhythmia syndromes,[19] but little is known about quality of life in general in young adults with arrhythmias.[20]

There has been a growing concern that adults with CHD may be at increased risk of mental health problems, especially depression.[21] However, the findings regarding mental health in this group are inconsistent. A meta-analysis by Karsdorp and colleagues concluded that older adolescents with CHD had more internalising problems than their peers, a pattern that was not present in younger years.[22] In contrast, another meta-analysis of emotional problems, including measures of emotional functioning, anxiety, depression, and general mental health, among adolescents and young adults with CHD by Jackson and colleagues did not find support for worse emotional functioning in this population, although significant heterogeneity among the studies was present.[23] The latter study did not have statistical power to assess possible age differences, which renders some uncertainty regarding the mental health of young adults with CHD.

The transition from adolescence to adulthood and specifically student life is characterised by major changes such as moving away from home and re-establishing social relationships and increased independence and responsibility. This developmental period is associated with a high rate of loneliness and mental health problem in the general population,[24] and may lead to increased vulnerability in young adults with CHD. A range of risk factors may be related to mental health problems among young adults with CHD, including the functional limitations and the patients' illness perceptions, as well as how they cope with the condition.[25] Further, symptom perception may give rise to co-occurrence. Palpitations may for instance be a symptom of mental health problems like anxiety, depression, and somatoform disorders,[26] and although mental health research among youth with genetic arrhythmias is limited, there also seem to be an increased risk of anxiety and depression in adolescents with inherited arrhythmia syndromes.[19]

We know little about other domains of mental health in young adults with heart disease beyond symptoms of anxiety and depression. In an English registry-based study of children and adults with various medical conditions, the risk of self-harm was reported lower among the patients with CHD compared with a control group of patients with simple conditions.[27] To the best of our knowledge, no studies have explored detailed measures of self-harm and suicidal ideation in young adults with CHD or arrhythmias.

Children with CHD have increased risk of impaired neurodevelopment.[28,29] Heart surgery during the first year of life increases the risk of need for special education services during childhood and adolescence, and reduced academic performance, compared to typically developing students.[30] Still, many adults with CHD pursue higher education,[31,32] but knowledge of their academic performance is scant. Whether there is an association between arrhythmias and reduced academic achievement has to our knowledge not been investigated.

With the hypotheses that young adults with heart disease have worse physical health, lower physical activity level, lower quality of life, more mental health problems, and reduced academic performance, the aim of the current study was to compare young adults with heart disease; CHD or arrhythmias, with their peers, across several well-validated measures of mental and physical health, as well as their academic performance as measured by reported study progression.

Materials and methods

The SHoT2018 study (*Students' Health and Wellbeing Study*) is a national cross-sectional student survey for higher education in Norway, initiated by the three largest student welfare associations (*Sammen* [Bergen and surrounding area], *Sit* [Trondheim and surrounding area], and *SiO* [Oslo and Akershus]). The information was collected electronically through a web-based platform. Details of the study have been published elsewhere,[33] but in short, *the SHoT2018* was conducted between 6 February and 5 April, 2018, and invited all full-time Norwegian students pursuing higher education, both in Norway and abroad. The students were explained that participation was completely voluntary, and that not filling out the survey would have no consequences. In all, 162,512 students were invited, of whom 50,054 students completed the online questionnaires, yielding a response rate of 30.8%.

Instruments

Heart disease

Physical conditions were assessed by a pre-defined list adapted to fit this age cohort, which also included "heart disease." If the respondent indicated heart disease, he/she was asked to further specify (1) valvular heart disease, (2) cardiomyopathy, (3) cardiac arrhythmias (including hereditary arrhythmias), (4) CHD, or (5) other (for which the students could answer in free text). Authors GG and EL coded all free-text responses and categorised them. All respondents indicating "CHD" were included in this category. The group responding "valvular heart disease" was small, and because valvular heart disease in this age group is mainly congenital, they were included in the "CHD" category. The respondents with cardiomyopathy were excluded due to small number (n = 7), as were respondents reporting hypertension (n = 11), perimyocarditis (n = 5), and atherosclerotic disease (n = 5), in total 26 individuals. The final study sample included three categories: 1) no heart disease (n = 49,724), 2) CHDs (n = 172), or 3) arrhythmias (n = 132).

Physical health by somatic symptoms

Physical health was assessed by the Somatic Symptom Scale-8 (SSS-8): an eight-item reliable and valid self-report measure of somatic symptom burden, originally derived from the well-validated PHQ-15. The SSS-8 consists of a general factor and four subscales, (gastrointestinal symptoms, pain, cardiopulmonary

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symptoms, and fatigue).[34] The Cronbach's alpha for the SSS-8 in the current study was 0.82.

Physical activity

Physical activity was assessed using three questions, assessing the average number of times exercising each week, and the average intensity and average hours each time[35]: (1) "*How frequently do you exercise?*" (Never, Less than once a week, Once a week, 2–3 times per week, Almost every day); (2) "*If you do such exercise as frequently as once or more times a week: How hard do you push yourself?* (I take it easy without breaking into a sweat or losing my breath, I push myself so hard that I lose my breath and break into a sweat, I push myself to near-exhaustion); and (3) '*How long does each session last?*' (Less than 15 minutes, 15–29 minutes, 30 minutes to 1 hour, More than 1 hour.") This three-item questionnaire has previously been used in the large population-based Nord-Trøndelag Health Study (the HUNT studies). Previous validation studies[35,36] have demonstrated strong correlations between the questionnaire responses, and direct measurement of VO_2max during maximal work on a treadmill, with ActiReg,[37,38] an instrument that measures physical activity and energy expenditure, and with the International Physical Activity Questionnaire (IPAQ).[39]

The WHO recommends that adults (≥18 years) should get at least 30 minutes (or preferable 60 minutes for increased health benefits) of moderate to vigorous physical activity 5 days or more per week.[40] Thus, we created a dichotomous variable based on the combined responses on the three exercise items: moderate to vigorous physical activity: 150 min/week: students answering both "Almost every day" on the frequency item, and "I push myself so hard that I lose my breath and break into a sweat" on the intensity item, and "30 minutes or more" or "More than 1 hour" on the duration item. Detailed information about physical exercise in the SHoT2018 study has been published elsewhere.[41]

Quality of life

Quality of life was assessed by the Satisfaction With Life Scale (SWLS).[42] The SWLS is a five-item scale designed to measure global cognitive judgements of one's life satisfaction (not a measure of either positive or negative affect). Participants indicate how much they agree or disagree with each of the five items using a seven-point scale that ranges from 7 (strongly agree) to 1 (strongly disagree). The Cronbach's alpha for the SWLS in the current study was 0.89.

Loneliness

Loneliness was assessed using an abbreviated version of the widely used UCLA Loneliness Scale, "The Three-Item Loneliness Scale (T-ILS)."[43] The T-ILS includes the following three items, each rates along a five-point Likert scale ("never," "seldom," "sometimes," "often," and "very often"): For each question below, please indicate how often you have felt that way during the last year: 1) "*How often do you feel that you lack companionship?*" 2) "*How often do you feel left out,*" and 3) "*How often do you feel isolated from others?*"

The T-ILS has displayed satisfactory reliability and both concurrent and discriminant validity. Detailed information on loneliness in the SHoT studies has been published elsewhere.[24] The Cronbach's alpha for the T-ILS in the current study was 0.88.

Mental health problems

Mental health problems were assessed using The Hopkins Symptoms Checklist (HSCL-25),[44] derived from the 90-item Symptom Checklist (SCL-90), which is a screening tool designed to detect symptoms of anxiety and depression. It is composed of a 10-item subscale for anxiety and a 15-item subscale for depression, with each item scored on a Likert scale from 1 ("*not at all*") to 4 ("*extremely*"). The period of reference is the two previous weeks. An average score on the HSCL-25 ≥ 2.0 is commonly used as a conservative cut-off for identifying a high level of depressive and anxiety symptoms.[45] Detailed trend and prevalence data on the HSCL-25 in the SHoT study have been published elsewhere.[46] The Cronbach's alpha for the HSCL-25 in the current study was 0.94.

Suicidal ideation, suicidal behaviour, and self-harm

Four items were used to assess thoughts and behaviours of self-harm and suicidality. History of suicidal ideation, suicide attempts, and self-harm was assessed with three items drawn from the Adult Psychiatric Morbidity Survey (APMS).[47] The three items were "*Have you ever seriously thought of taking your life, but not actually attempted to do so?*", "*Have you ever made an attempt to take your life, by taking an overdose of tablets or in some other way?*", and "*Have you ever deliberately harmed yourself in any way but not with the intention of killing yourself? (i.e., self-harm)*" (yes/no). The last question about self-harm thoughts were adapted from the Child and Adolescent Self-harm in Europe study (CASE),[48] "*Have you ever seriously thought about trying to deliberately harm yourself but not with the intention of killing yourself but not actually done so?*" (yes/no). More details regarding suicidality in the SHoT2018 study have been published elsewhere.[49] The Cronbach's alpha for the four items was 0.72.

Academic performance

Self-reported academic performance/failure was assessed with the following two dichotomous items, both answered with either "yes" or "no": 1) "*Do you follow normal study progress (30+ credits per semester) on the study program you are taking now?*" and 2) "*Have you failed an exam after you started studying at your college/university?*".

Participation in student activities

Students were also asked if they were involved in the following organised volunteer student activities: sports, cultural activities, student democracy, professional societies, and other interests' societies. Each of these variables were coded dichotomously ("yes" or "no").

Sociodemographic information

All participants indicated their gender and age. Participants were categorised by migration background if either the student or his/her parents were born outside Norway.

Statistical analyses

The control group was defined as students with no reported heart disease. In sensitivity analyses, students with CHD or arrhythmias were compared with students without any specified disease. We used IBM SPSS Statistics 26 for Windows (SPSS Inc., Chicago, IL) for all analyses. Analyses of variance and Pearson's chi-squared tests were used to examine differences in the outcome variables by heart disease. Logistic regression analyses were used to examine differences in dichotomous outcomes in the heart disease groups. Logistic regression was preferred, as it does not make many of the key assumptions of linear regression and general linear models that are based on ordinary least squares algorithms – particularly

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Table 1. Descriptive characteristics of 50,028 college or university students with CHDs, arrhythmias, and no heart disease

	No heart disease	CHDs	Arrhythmias	p-Value	χ^2(df)
% (n)	99.4% (49,724)	0.34% (172)	0.26% (132)		
Age, mean (SD)	23.2 (3.3)	23.7 (3.6)	24.1 (3.4)	.004	
Gender					
Females	69.1% (34,216)	65.9% (112)	76.2% (99)	.096	3.85 (2)
Marital status					
Single	50.0% (24,804)	53.8% (92)	45.8% (60)	.384	1.91 (2)
Ethnicity					
Migration background	8,0% (3985)	8.7% (15)	6.8% (9)	.830	0.37 (2)
Involved in organised volunteer activities					
Sports	12.8 % (6379)	9.9 % (17)	9,8 % (13)	.306	2.37 (2)
Cultural activities	14.2 % (7044)	12.8 % (22)	11.4 % (15)	.573	1.12 (2)
Student democracy	9.5 % (4717)	14.0 % (24)	7.6 % (10)	.103	4.55 (2)
Professional societies	16.5 % (8224)	15.1 % (26)	12.1 % (16)	.348	2.11 (2)
Other interest societies	18.2 % (9065)	20.3 % (35)	12.1 % (16)	.148	3.82 (2)
Physical activity					
Frequency (≥2×/week)	67.4% (33,353)	61.4% (105)	59.1% (78)	.033	6.84 (2)
Intensity (≥moderate)	82.4% (38,849)	80.8% (126)	75.2% (91)	.106	4.50 (2)
Duration (≥30 minute)	88.6% (41,816)	87.3% (137)	82.6% (100)	.103	4.55 (2)
MVPA: 150 minutes/week	19.6% (9729)	17.4% (40)	14.4% (19)	.256	2.73 (2)
MVPA: 300 minutes/week	11.4% (5662)	10.5% (18)	8.3% (11)	.507	1.36 (2)
Academic functioning					
Failed exam(s)	33.5% (16,672)	39.0% (67)	34.1% (45)	.320	2.28 (2)
Normal study progression	80.9% (40,230)	77.3% (133)	77.3% (102)	.281	2.54 (2)

p-Values are derived from Pearson's chi-squared tests for all categorical variables.
MVPA, moderate to vigorous physical activity.

regarding linearity, normality, homoscedasticity, and measurement level. However, the normality of the data was examined using skewness and kurtosis, and all continuous measures (HSCL-25, SWLS, SSS-8, and T-ILS) were well within the recommended ranges (+/−2).[50] There was generally little missing data, and hence missing values were handled using listwise deletion. As the SHoT2018 study had several objectives and was not designed to be a study of heart disease students specifically, no a priori power calculations were conducted to ensure that the sample size had sufficient statistical power to detect differences in outcomes.

Results

Sample characteristics

In all, 172 students (0.34%) were categorised as having CHD and 132 (0.26%) as having arrhythmias (Table 1). Among the students with CHD, 32 (18.6%) also reported arrhythmias. The control group was comprised of 49,724 students with no reported heart disease.

There were no significant group differences regarding sex and age, with the exception of participants with arrhythmias being slightly older than the control group (24.1 years versus 23.2 years, $p = 0.004$).

No group differences were observed regarding marital status, ethnicity, and involvement in organised volunteer activities.

Physical and mental health

The proportion of participants exercising twice or more weekly was slightly larger in the control group ($p = 0.033$), (see Table 1 for details). There were no significant group differences regarding how many met the minimum recommended criteria for exercise frequency, intensity, and duration (150/300 minutes per week of moderate to vigorous physical activity).

As displayed in Figure 1, participants with arrhythmias reported higher symptom burdens than the control group across most SSS-8 subscales, with the largest group differences being observed for cardiopulmonary symptoms. Participants with arrhythmias also scored significantly higher than the control group on the somatic and anxiety and depression subscales of HSCL-25. Further, they reported lower quality of life and more loneliness compared to participants with no heart disease.

In contrast, participants with CHD generally did not differ from the control group on any of the mental health, quality of life, and loneliness dimensions (except HSCL total), while they did report higher symptom burden compared to the control group on the cardiopulmonary and fatigue subscales on the SSS-8, and the somatic subscales on the HSCL-25

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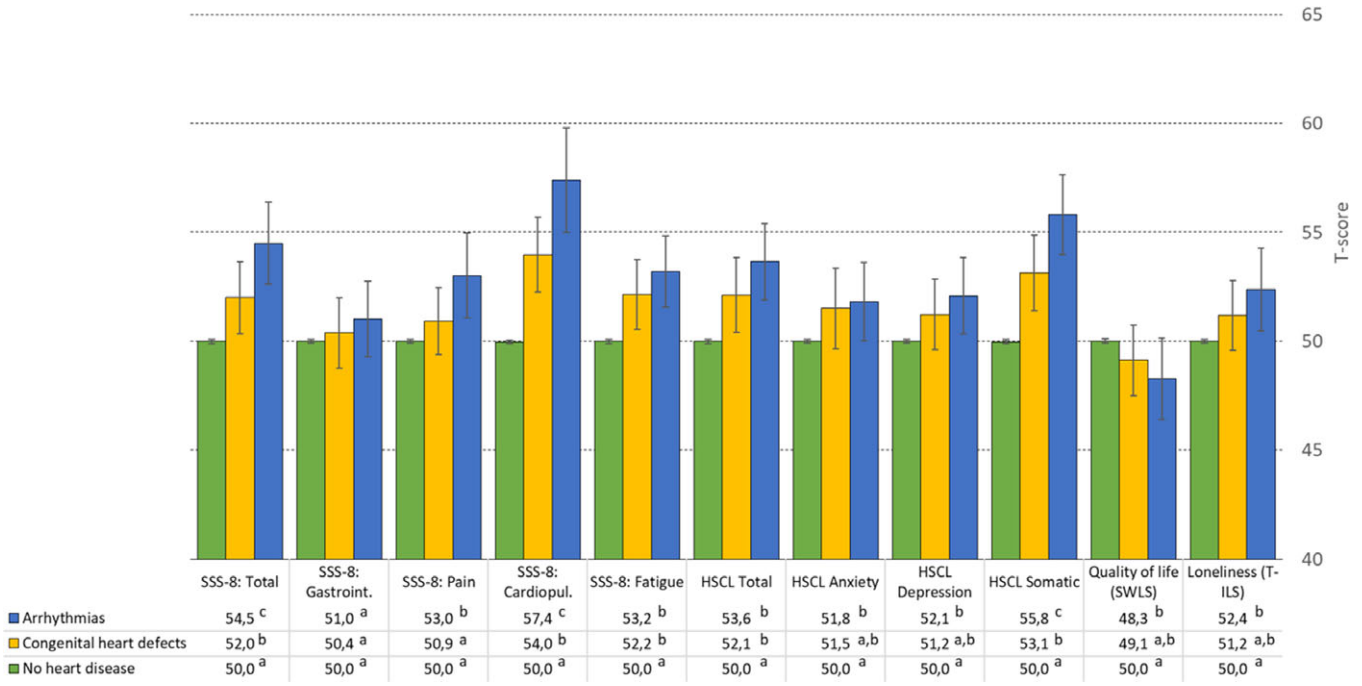
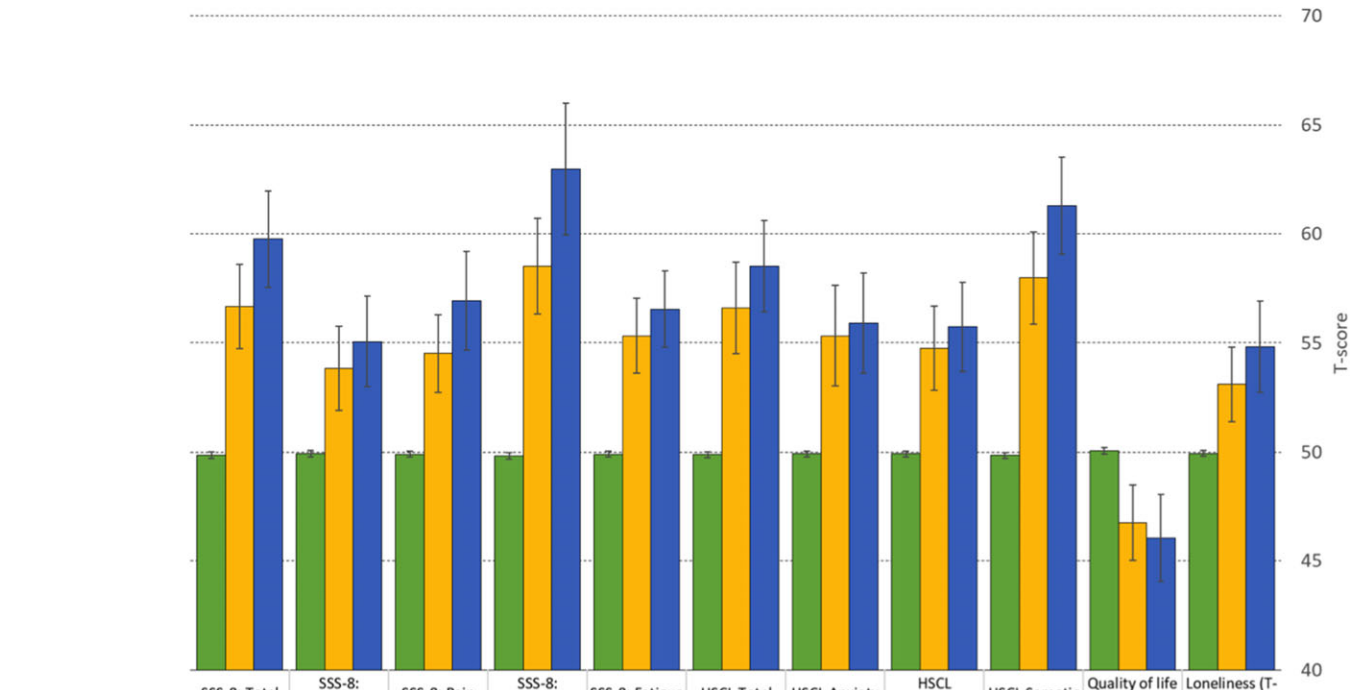


	SSS-8: Total	SSS-8: Gastroint.	SSS-8: Pain	SSS-8: Cardiopul.	SSS-8: Fatigue	HSCL Total	HSCL Anxiety	HSCL Depression	HSCL Somatic	Quality of life (SWLS)	Loneliness (T-ILS)
Arrhythmias	54,5 ^{c}	51,0 ^{a}	53,0 ^{b}	57,4 ^{c}	53,2 ^{b}	53,6 ^{b}	51,8 ^{b}	52,1 ^{b}	55,8 ^{c}	48,3 ^{b}	52,4 ^{b}
Congenital heart defects	52,0 ^{b}	50,4 ^{a}	50,9 ^{a}	54,0 ^{b}	52,2 ^{b}	52,1 ^{b}	51,5 ^{a,b}	51,2 ^{a,b}	53,1 ^{b}	49,1 ^{a,b}	51,2 ^{a,b}
No heart disease	50,0 ^{a}	50,0 ^{a}	50,0 ^{a}	50,0 ^{a}	50,0 ^{a}	50,0 ^{a}	50,0 ^{a}	50,0 ^{a}	50,0 ^{a}	50,0 ^{a}	50,0 ^{a}

Figure 1. Mental health characteristics in students with congenital heart defects, arrhythmias, and no heart disease in standardized t-scores. Mean scores and 95% confidence intervals. Significant group differences (***a***,***b***,***c***) are indicated for each row in the table using subscript letters, calculated at the 0.05 significance level based on the ANOVA post-hoc tests.



	SSS-8: Total	SSS-8: Gastroint.	SSS-8: Pain	SSS-8: Cardiopul.	SSS-8: Fatigue	HSCL Total	HSCL Anxiety	HSCL Depression	HSCL Somatic	Quality of life (SWLS)	Loneliness (T-ILS)
Arrhythmias	59,8	55,1	56,9	63,0	56,5	58,5	55,9	55,7	61,3	46,1	54,8
CHDs	56,7	53,8	54,5	58,5	55,3	56,6	55,3	54,7	58,0	46,8	53,1
No disease specified	49,9	49,9	49,9	49,8	49,9	49,9	49,9	49,9	49,9	50,1	49,9

Figure 2. Mental health characteristics in students with congenital heart defects, arrhythmias, and no specified disease in standardized t-scores. Mean scores and 95% confidence intervals.

(see Fig 1 for details). In analyses comparing students with CHD or arrhythmias with students without any specified disease, both groups with heart disease showed significantly higher levels of somatic symptoms, anxiety and depressive symptoms, and lower quality of life and more loneliness (Fig 2).

As detailed in Table 2, the odds of being classified as having "high or very high" somatic symptom burden on the SSS-8 was

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Table 2. Odds ratio of poor health in students with CHDs or arrhythmias compared to students with no heart disease, and arrhythmias compared to CHD

	CHD versus no heart disease	Arrhythmias versus no heart disease	Arrhythmias versus CHD (Ref)
Outcome variable	OR (95% CI)	OR (95% CI)	OR (95% CI)
Somatic symptoms (SSS-8 > 11)	1.58 (1.16–2.16)*	2.30 (1.62–3.27)***	1.45 (0.91–2.32)
Mental health problems (HSCL-25 avg. score > 2.0)			
Total score	1.34 (0.97–1.85)	1.68 (1.18–2.39)**	1.25 (0.78–2.01)
Anxiety	1.41 (0.99–2.01)	1.60 (1.08–2.37)**	1.14 (0.67–1.92)
Depression	1.31 (0.96–1.79)	1.49 (1.05–2.11)*	1.14 (0.71–1.82)
Somatic	1.48 (1.08–2.05)*	2.79 (1.98–3.93)***	1.88 (1.18–2.99)***
Self-harm (lifetime)	1.29 (0.91–1.84)	1.98 (1.37–2.85)***	1.53 (0.92–2.54)
Self-harm thoughts (lifetime)	1.45 (1.05–2.02)*	1.79 (1.25–2.57)**	1.23 (0.76–2.00)
Suicide attempt (lifetime)	2.22 (1.30–3.77)**	2.72 (1.56–4.75)***	1.23 (0.57–2.65)
Suicide thoughts (lifetime)	1.69 (1.22–2.34)**	1.76 (1.22–2.54)**	1.04 (0.64–1.69)
Poor quality of life (SWLS < 19)	1.16 (0.85–1.59)	1.64 (1.16–2.32)**	1.41 (0.89–2.25)
Loneliness ("often" or "very often" on 1 of 3 items)	1.31 (0.84–2.06)	1.99 (1.28–3.10)**	1.52 (0.81–2.84)

*p < 0.05; **p < 0.01; ***p < 0.001.

significantly higher among participants with arrhythmias (OR = 2.30, 95% CI: 1.62–3.27) compared to the control group, and to a lesser extent among participants with CHD (OR = 1.58, 95% CI: 1.16–2.16). Having arrhythmias also increased the odds of scoring above the recommended 2.0 cut-off on the HSCL-25 subscales, and although a similar pattern could also be observed for CHD, these associations were not statistically significant. The difference between the group reporting arrhythmias versus the group with CHD was not statistically significant except for the HSCL-25 somatic subscale (OR = 1.88, 95% CI: 1.18–2.99).

Suicidal ideation, suicidal behaviour, and self-harm

Participants with arrhythmias had higher odds of reporting self-harm behaviour and suicidality. The association was especially strong for lifetime suicide attempt (OR = 2.72, 95% CI: 1.56–4.75). The increased odds of self-harm thoughts and suicidality were also significant in the CHD group, but not for self-harm behaviour (see Table 2 for details).

Academic functioning

There were no significant differences between the three groups regarding having failed exams since starting at university. Similarly, there were no significant differences between the groups on study progression (see Table 1 for details).

Discussion

In this national survey of 50,054 students in higher education, 172 (0.34%) participants reported having CHD and 132 (0.26%) arrhythmias. Whereas the students with arrhythmias showed higher levels of anxiety and depressive symptoms and reported lower quality of life and more loneliness compared to participants with no heart disease, the students with CHD did not differ significantly from the control group on these parameters. However, both the group with arrhythmias and the group with CHD showed an increased risk of suicidality and self-harm. None of the two heart disease groups differed significantly from the control group on the measures of academic performance.

Similar to previous studies of physical activity in Norwegian adults with CHD, the participants classified with heart disease in this survey reported a high frequency of physical activity. Larsson et al found the highest proportion of participants reaching WHO's recommended physical activity level in the Norwegian group with 53% among 172 patients with CHD.[9] Reference data, however, were lacking in this study. In our survey, 61.4% of the students with CHD reported frequency of physical activity ≥2×/week, only slightly less than the control group (67.4%), with no difference regarding duration or intensity of the activity. In terms of meeting the recommended criteria for moderate to vigorous physical activity, there were also no significant group differences.

In the present study, the students with CHD did not report lower quality of life compared to students without heart disease, despite increased somatic symptom burden scores. This is in accordance with a recent Swiss study,[51] and a review by Fteropoulli et al,[13] both reporting similar levels of quality of life in psychosocial domains but compromised physical measures in young adults with CHD compared to healthy controls.

According to the findings in the larger previous studies of adults with congenital defects,[7,23,52] the students with CHD did not score significantly higher on anxiety and depression in the present study. However, in contrast to the findings in the English registry study reporting decreased risk of self-harm among patients with CHD,[27] we found that the odds of self-harm thoughts, suicide thoughts, and suicide attempts were significantly increased in the group with CHD.

In the present study, we chose to study two different groups of Norwegian university students with self-reported heart disease. The public higher education is free in Norway, and good study financing support systems make the universities accessible for a large proportion of young Norwegians. In 2018, 35% of all

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adolescents in Norway between 19 and 24 years were in higher education.[53] Adults with CHD is a well-defined group, but heterogeneous, and their physical, cognitive, and psychological challenges are related to the complexity of their congenital defect and to the treatment they have been subjected to during childhood and adolescence.[22] Although the vast majority of children with CHD are shown to have cognitive function within the normal range, CHD is associated with reduced intellectual functioning, especially for children with severe CHD.[54,55] The university students in our study are a selected group not necessarily representative for the entire population of young adults with CHD, and the results must be interpreted accordingly. In the present study, the university students with CHD presents as an overall well-functioning group with high social and physical activity levels, and normal study progression. They report an increased burden of somatic symptoms in accordance with previous studies of adults with CHD,[7] suggesting that the group includes a similar spectre of complexity.

Although they do not score significantly higher on anxiety or depression scales, the students with CHD have an increased risk of self-harm and suicidality. An increased suicidality risk is well known among patients with various chronic diseases[56] but has not been uncovered in previous studies of adults with CHD and needs to be investigated further. Given the seriousness of these mental health problems, clinicians should be sensitive to these issues in clinical consultations through questions regarding mental health including suicide and self-harm, as well as attention to self-inflicted harm in physical examinations. The transition between child-centred to adult-centred care has been identified as a vulnerable time for adolescents with chronic conditions, with the risk of gaps in care. Perhaps more important, the highly specialised culture in the adult-oriented health care system may not be adequate for the complex needs of these adolescents and young adults, carrying childhood traumas, physical or intellectual limitations, in addition to the general challenges of meeting adulthood. Our study shows the need of a broader and more holistic approach in the care of this group, with a multidisciplinary model including availability of psychological screening and interventions. While the findings of increased rate of self-harm and suicidal ideation should be further addressed in future studies, screening for these serious mental health problems is called for, and interventions should be made available. The young adults with these conditions are in regular contact with health care providers and this is also an opportunity to assess mental health and assure appropriate interventions.

The students reporting arrhythmias are likewise a diverse group and may include a variety of conditions like palpitations caused by extrasystoles or sinus tachycardia, paroxysmal supraventricular tachycardia or atrial fibrillation, and more infrequent and severe conditions like long QT time syndrome or arrhythmogenic right ventricular cardiomyopathy. The association between cardiac arrhythmias and psychosocial factors has been described previously.[57] Palpitations are common symptoms in psychiatric disorders such as anxiety, depression, or psychosomatic disorders.[26] Several factors, for example, mental and physical stress, may induce both arrhythmias and physiologic sinus tachycardia. Awareness of a genetic risk of sudden death, or frequent symptoms from arrhythmias, can on the other hand cause physiological stress and anxiety. In cases of autonomic dysfunction, inappropriate sinus tachycardia can give severe somatic symptoms like frequent syncope or exercise intolerance.[58] In the present study, it is difficult to distinguish if the arrhythmias were predominantly the primary problem. However, the fact that arrhythmias were reported by only 0.26% of the respondents suggests a selection of the students with more severe symptoms. Further studies are needed to investigate the mental health problems associated with documented arrhythmias.

The strengths of this study include the large study population, and the use of several well-validated questionnaires. The modest response rate of 31% could be a limitation for the generalisation of the results; however, the questions regarding heart disease constitute a very small part of the total survey, and the proportion of students reporting CHD is roughly as expected in the population.[59] We therefore consider the risk of selection bias related to the heart conditions to be small. The information available regarding the heart disease is self-reported. Having been in follow-up during childhood and adolescence, young adults with CHD are well informed about their heart defect, and this classification is considered reliable. Questions regarding severity of the heart defect, previous surgery, or medication could have given additional information about subgroups of the young adults with CHD but was not included in this survey. Given the exploratory nature of this study with multiple analyses capitalisation on chance cannot be ruled out, and further studies are necessary to confirm the findings. Finally, it should be noted that the control group in this study encompassed students who may have had other illnesses and disorders than heart disease. In sensitivity analyses comparing students with CHD or arrhythmias with students without any specified disease, both groups with heart disease showed significantly higher levels of somatic symptoms, anxiety and depressive symptoms, and lower quality of life and more loneliness.

In conclusion, in the present study, we found that Norwegian college and university students with heart disease constitute an overall well-functioning group with social and physical activity level, as well as academic progress, similar to students without such disease. Nevertheless, the students reporting arrhythmias scored high on scales for mental health problems and poor quality of life, and respondents with CHD showed a non-significant tendency of higher score on mental health problems, with significantly increased lifetime risk of self-harm and suicidality. It is important for caretakers to be aware of the increased risk of self-harm in adolescents and young adults with chronic disease or ailments, even if it is considered minor. Further studies could bring more light on the risk of mental health problems associated with specific arrhythmias.

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Conflicts of interest. None.

Ethical standards. The SHoT2018 study was approved by the Regional Committee for Medical and Health Research Ethics in Western Norway (no. 2017/1176). Electronic informed consent was obtained after the participants had received a detailed introduction to the study.

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