Cardiology in the Young

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Psychiatric co-morbidity in children and adolescents with CHDs: a systematic review

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Review

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Abstract

The population of long-term survivors with CHDs is increasing due to better diagnostics and treatment. This has revealed many co-morbidities including different neurocognitive difficulties. However, the prevalence of psychiatric disorders among children and adolescents and the specific types of disorders they may experience are unclear. We systematically reviewed the existing literature, where psychiatric diagnoses or psychiatric symptoms were investigated in children and adolescents (age: 2–18 aged) with CHDs and compared them with a heart-healthy control group or normative data. The searches were done in the three databases PubMed, psychINFO, and Embase. We included 20 articles reporting on 8035 unique patients with CHDs. Fourteen articles repoted on psychological symptoms, four reported on psychiatric diagnoses, and two reported on both symptoms and diagnoses. We found that children and adolescents with a CHD had a higher prevalence of attention deficit hyperactivity disorder (ranging between 1.4 and 9 times higher) and autism (ranging between 1.8 and 5 times higher) than controls, but inconsistent results regarding depression and anxiety.

Introduction

Approximately 1% of newborns are born with a CHD.[1] The survival rate has improved due to better treatment and diagnostics, revealing an increased lifetime risk of neurological, endocrinological, and pulmonary co-morbidities.[2–4] In recent years, complex and simple CHD research has further revealed neurocognitive, social, and psychiatric difficulties.[5–9] Psychiatric disorders have a negative impact throughout life with a larger risk for lower educational attainments, unemployment, and divorce,[10–12] and early recognition and treatment may have the potential to change these negative impacts. However, studies investigating psychiatric co-morbidities in children and adolescents with CHD are sparse and show conflicting results. One study from 2014 found that children with a CHD had an increased risk of both attention deficit hyperactivity disorder and autism diagnoses.[13] Another study reported parental-reported symptoms related to attention deficit hyperactivity disorder, depression, and anxiety and found no difference between children and adolescents with CHD and a heart-healthy control group.[14] Two previous systematic reviews have investigated the evidence for psychiatric symptoms in patients with CHD.[15,16] The first review reported that young children aged 1–6 years old, who underwent early cardiac surgery, had a higher likelihood of experiencing challenges across larger symptom clusters (internal and external behaviour problems).[15] The second review observed an increased risk of psychological maladjustment, including internal and external symptoms combined, among children and adolescents (aged 2 to under 17 years old) with various CHDs,[16] but to the best of our knowledge, there is no systematic review investigating the most common child psychiatric psychopathology, that is, autism, attention deficit hyperactivity disorder, and emotional disorders, both on a diagnostic and symptomatic level in children and adolescents with CHD. The conflicting results on specific psychiatric diagnoses and symptoms (autism, attention deficit hyperactivity disorder, and emotional disorders) emphasise the need for a systematic review with this as the focus.

The aim of this study is to review the current literature on psychiatric co-morbidities, both symptoms and diagnoses, in children and adolescents with CHD.

Materials and methods

The systematic review was conducted according to the 24-step guide by Muka et Al, European Journal of Epidemiology.[17] The search strategies were defined in collaboration with a medical librarian from the Danish Royal Library. Searches were performed in three electronic databases (PubMed, Embase, and PsychINFO) using subject headings (MeSH, EMTREE, and PsycINFO

thesaurus) and free text searches related to CHDs (CHD), psychiatric disorders and symptoms, and children and adolescents. The search from PubMed is available in Supplementary Material (S1). The searches in the other databases were made in a similar way. Two searches were performed the first on November 26, 2021, and a second follow-up search on February 6, 2023. All articles from the searches were screened based on the following in- and exclusion criteria: Studies needed to involve (1) children and adolescents aged 2–18 years who were born with a structural CHD; (2) outcomes related to diagnoses and symptoms of attention deficit hyperactivity disorder, depression, anxiety, or autism; (3) a heart-healthy control group or a normative sample. Studies that only examined patients with a known syndrome (e.g. Trisomy21, 22q11), heart/lung transplant recipients, or were not written in English were excluded. Additionally, the reference lists of all selected articles were manually searched to identify additional studies (CB). The screening process of titles and abstracts was performed independently in pairs by three of the authors (CB: 100% of articles, SLJ: 50% of articles, JH: 50% of articles), followed by a second screening on full-text articles (CB: 100% articles, SLJ: 50% of articles, KB: 50% of articles).

Any conflicts that arose during the screening process were resolved by consensus. The researchers were not blinded to journal titles, authors, or authors' affiliations during the screening procedure. Data extraction was performed using a specific extraction template (based on PICO) and an online tool (Covidence) by two researchers (CB, SLJ). The outcome of the studies had to be a number (%) of participants (CHD and controls) with a psychiatric diagnosis or a mean (SD) of psychiatric symptoms of participants (CHD and controls). The severity of CHD was grouped as simple, moderate, complex, and a mixed group using the 2018 AHH/ACA guideline published in the Journal of the American College of Cardiology.[18]

To assess the risk of bias, we utilised the Newcastle-Ottawa scale, which uses a star-based rating system to evaluate articles. The domains of Selection, Comparability, and Outcome are each assigned stars, with a maximum of 8 stars attainable. A study receiving 1–3 stars is deemed unsatisfactory, 4 stars are deemed satisfactory, 5–6 stars are considered good, and 7–8 stars are considered very good.

Due to substantial differences in outcome measures, comparative data, and study design the studies were deemed too heterogeneous for a meaningful meta-analysis of effect. Consequently, a narrative synthesis of the results was conducted instead.

Results

We included 19 articles[13,14,19–34] from the first search and 1 extra from the second search[35] (Fig 1). Two articles were based on the same study.[14,35] Together, the included articles encompassed a total of 8035 unique patients with CHD. Fourteen articles reported on symptoms, four reported on psychiatric diagnoses, and two reported on both symptoms and diagnosis (Supplementary Material S2). In the articles (n = 13) that investigated proxy-reported symptoms, all but one article had parents as proxies.[14,19–21,24,26–31,35] The last articles had both teachers and parents as proxies.[32] The majority of the articles used control groups from another study[13,19,21,22,25,35] or healthy matched controls (sex, age) recruited from a local community sample.[24,30–34] Four articles compared with normative data,[20,26–28] one article included controls with one inpatient or emergency department record,[36] one article used a National Health Insurance Research Database,[23] one article used a sibling control,[29] and one article did not specify how the control group was recruited.[14]

Three articles reported on simple CHD (repaired ventricular septal defect), 3 on complex, and the remaining 14 reported on a mix of simple, moderate, and complex CHD.

Of the 20 included articles, six had psychiatric diagnoses as the outcome[13,19,21–23,36] and 15 had psychiatric symptoms measured by different questionnaires as the outcome.[14,19,21,24–35] Of the six articles that had a psychiatric diagnosis as the outcome, five looked at attention deficit hyperactivity disorder[13,19,21,23,36] three looked at autism[13,22,23,] and three looked at emotional disorders.[19,21,36] Of the 15 articles that had psychiatric symptoms as the outcome, 13 looked at attention deficit hyperactivity disorder[14,19,21,24–32,35] and 12 looked at emotional disorders.[14,19–21,24,25,29–31,33–35]

A total of 10 articles were conducted in the United States of America or Canada, 7 articles were conducted in Europe, and the remaining 3 articles in Asia.

No studies scored below 4 stars on the adapted NOS for risk of bias assessment; therefore, all studies are deemed satisfactory or above. The average score was 6 corresponding to a good study (Supplementary Material S2).

Psychiatric co-morbidities

Attention Deficit Hyperactivity Disorder

All of the included five attention deficit hyperactivity disorder articles found that the children and adolescents with CHD had a higher prevalence of attention deficit hyperactivity disorder than a matched (sex and age) control group (Table 1). The CHD group was mixed in three articles and complex in two. In three of the five articles, the attention deficit hyperactivity disorder diagnosis was made by a trained physician. One article used diagnoses based on registries, and one used parent information about a formerly established attention deficit hyperactivity disorder diagnosis.

Autism

All three articles concerning a diagnosis of autism documented a higher prevalence in children and adolescents with CHD compared to controls (Table 1). All studies included mixed groups of CHD. Two studies used diagnoses based on registries and one study used autism diagnosis collected from a questionnaire answered by a knowledgeable adult to the child.

Emotional disorders

Two articles investigated both depression and anxiety separately. They found no difference in depression rates or anxiety rates between children and adolescents with CHD (complex types) and controls (Table 1). Both depression and anxiety were diagnosed from an evaluation made by a trained physician. One article investigated depression and anxiety together as one metric and found that children and adolescents with CHD (mixed types) had a higher prevalence of emotional disorders (depression/anxiety) compared to controls (Table 1). This article found the diagnosis of depression/anxiety through hospital registers and/or prescription of medication.

Psychiatric symptoms

Attention deficit hyperactivity disorder

Self-reported. More attention deficit hyperactivity disorder symptoms were reported in three out of six articles. Two articles

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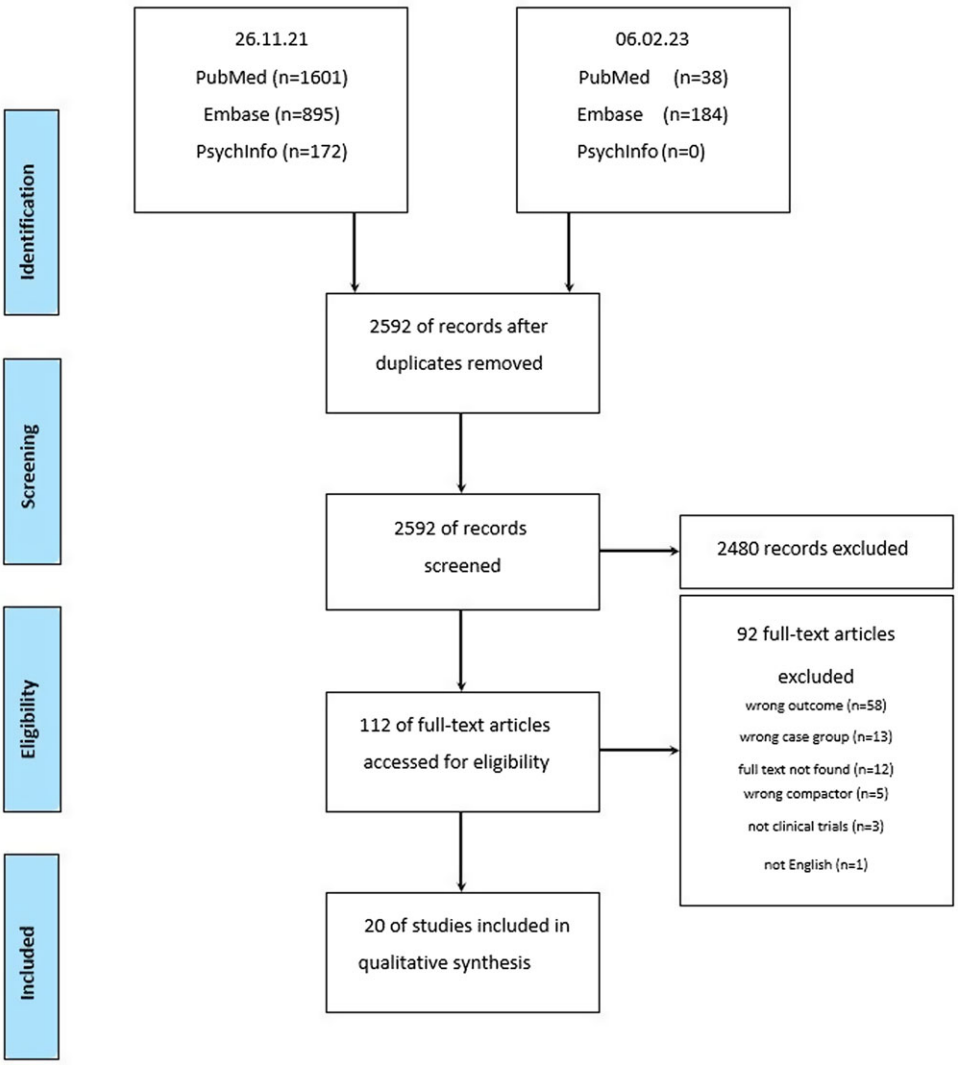

Figure 1. PRISMA flow diagram.

found no difference, and one article described no difference in boys but found that girls with CHD had more self-reported attention deficit hyperactivity disorder symptoms (Table 2).

Proxy-reported. Twelve articles investigated proxy-reported attention deficit hyperactivity disorder symptoms. Four of these articles also investigated self-reported attention deficit hyperactivity disorder symptoms. Eight of the twelve articles found that the proxies reported the CHD children to have more attention deficit hyperactivity disorder symptoms than the proxies of the heart-healthy peers. Four articles found no difference in attention deficit hyperactivity disorder symptoms between the CHD groups and the controls (all of the studies investigated simple CHD) (Table 2).

Depression

Self-reported. Six of the included articles investigated symptoms of depression through self-evaluation.

Three of the six articles found more symptoms of depression in the CHD compared to the controls. One article found no difference, and two articles found fewer symptoms of depression in the CHD group (Table 2).

Proxy-reported. Only one out of four articles found more symptoms of depression amongst CHD patients compared to controls (Table 2). Two of the articles that found no difference between the two groups are based on the same study.[14,35]

Anxiety

Self-reported. Three of the five articles found that the CHD group self-reported more anxiety symptoms than the control group (3/3 of the studies on complex CHD). One article found that girls with CHD had fewer anxiety symptoms than girls without CHD, but found no difference in anxiety symptoms between boys with CHD and boys without CHD (mixed CHD). The article reporting on simple CHD found no difference between the two groups in self-reported anxiety symptoms (Table 2).

Proxy-reported. Five articles investigated proxy-reported symptoms of anxiety. All articles found that there was no difference in proxy-reported anxiety symptoms between CHD and controls, but the one study that used both The State-Trait Anxiety Inventory and Child Behavior Checklist found that the CHD group have more anxiety/depression symptoms than the control group in the CBCL questionnaire (Table 2). Two of the articles that found no difference between the two groups are based on the same study.[14,35]

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Table 1. Diagnosed psychiatric disorder

Article	NOS score	CHD N	Control N	Severity of CHD	CHD with psychiatric disorder	Controls with psychiatry disorder	p-value OR (95% CI)	Group with more psychiatry disorder
ADHD								
DeMaso (2014 USA)	*****	139	61	Complex	22 (16%)	2 (3%)	0.01	CHD
Gonzalez (2021 USA)	*******	1164	117621	Mixed	59 (5%)	2399 (2%)	<0.05	CHD
Holland (2017 USA)	******	68	87	Complex	12 (18%)	2 (2%)	0.02	CHD
Razzaghi (2015 USA)	******	374	158243	Mixed	44 (10%)	9942 (7%)	OR 1.6 (1.1–2.4)	CHD
Tsao (2017 Taiwan)	******	3552	14,208	Mixed	135 (1000 person-years) (5%)	154 (1000 person-years) (1%)	<0.001	CHD
Autism								
Razzaghi (2015 USA)	******	374	158243	Mixed	6 (1.6%)	883 (0.5%)	OR 4.6 (1.9–11-0)	CHD
Tsao (2017 Taiwan)	******	3552	14,208	Mixed	30 (1000 person-years) (1%)	24 (1000 person-years) (0.2%)	<0.001	CHD
Sigmon (2019 USA)	******	8760 w autism	26,280 w/o autism	Mixed	401/8760 (4.6%) CHD w autism	662/26280 (2.5%) CHD w/o autism	<0.001	CHD
Emotional disorders								
DeMaso (2014 USA)	*****	139	61	Complex	Depression: 5 (4%)	Depression: 0	0.33	No difference
					Anxiety: 7 (5%)	Anxiety: 4 (7%)	0.74	No difference
Holland (2017 USA)	******	91	87	Complex	Depression: 0	Depression: 0		No difference
					Anxiety: 2 (3%)	Anxiety: 4 (5%)	0.97	No difference
Gonzalez (2021 USA)	*******	1164	117621	Mixed	212 (18%) (depression/anxiety)	6088 (5%) (depression/anxiety)	<0.05	CHD

Table 2. Symptoms of related psychiatric disorder

Study	NOS score	Survey	CHD N	Control N	Severity of CHD	CHD mean (SD) median (range)	Controls mean(SD) median (range)	p-value/OR (95% CI)	Group with more symptoms
ADHD symptoms – self-evaluation									
DeMaso (2017 USA)	*******	CADS	156	111	Complex	48 (41–56)	44 (39–51)	0.02	CHD
DeMaso (2014 USA)	*****	CADS	139	61	Complex	48 (10.5)	44.8 (8.9)	0.03	CHD
Fredriksen (2009 Norway)	****	YRS	307	368	Mixed				CHD girls
			Boys: 183	Boys: 159		Boys: 3.6 (2.9)	Boys: 3.1 (2.5)	Boys: NS	
			Girls: 124	Girls: 209		Girls: 2.9 (2.8)	Girls: 3.9 (2.8)	Girls: <0.001	
Holland (2017 USA)	*******	CADS	68	87	Complex	48 (42–61)	44 39–51)	0.007	CHD
Schaefer (2013 Switzerland)	*******	SDQ	59	Norms	Mixed	3.9 (2.0)	3.8 (2.2)	0.43	No difference
Lang (2022 Germany)	*****	DYSIPS-III	18–22	23–24	Simple	0.40 (0.36)	0.16 (0.22)	NS	No difference
ADHD symptoms – proxy-evaluation									
DeMaso (2017 USA)	*******	CADS	156	111	Complex	58 (48–70)	44 (42–48)	<0.001	CHD
DeMaso (2014 USA)	*****	CADS	139	61	Complex	53.6 (13.0)	46.3 (6.0)	<0.001	CHD
Holland (2017 USA)	*******	CADS	68	87	Complex	55 (47-63)	44 (42-48)	<0.001	CHD
Schaefer (2013 Switzerland)	*******	SDQ	59	Norms	Mixed	3.6 (2.3)	3.2 (2.6)	0.26	No difference
Werninger (2020 Switzerland)	*******	Conners-3 short form	98	Norms	Mixed	53.94 (3.8)	50 (10)	<0.001	CHD
Hansen (2012 USA)	****	SNAP-IV	51	41	Mixed	0.83 (?)	0.25 (?)	<0.001	CHD
McCusker (2013 UK)	*******	CBCL	31	18	Mixed	56.9 (7.3)	51.0 (5.1)	0.002	CHD
Miatton (2007 Belgium)	********	CBCL	43	43	Mixed	61.5 (10.2)	54.1 (5.1)	<0.001	CHD
Guan (2014 China)	*******	CBCL	64	56	Simple				No difference
			Boys: 41	Boys: 30		Boys: 3.31 (1.56)	Boys: 2.78 (1.32)	Boys: 0.12	
			Girls: 23	Girls: 26		Girls: 2.12 (0.89)	Girls: 2.43 (1.45)	Girls: 0.22	
Yamada (2013 Canada)	*****	SNAP-IV	56	60	Mixed	0.93 (0–3)	0.3 (0–1.4)	<0.001	CHD
Eichler (2019 Germany)	*******	DYSIPS-II	39	39	Simple	0.57 (0.45)	0.67 (0.50)	0.53	No difference
Lang (2022 Germany)	*****	DYSIPS-III	23	24	Simple	0.38 (0.39)	0.42 (0.40)	NS	No difference
Depression symptoms – self-evaluation									
DeMaso (2017 USA)	*******	CKI	156	111	Complex	42 (39–47)	40 (37–44)	0.001	CHD
DeMaso (2014 USA)	*****	CKI	139	61	Complex	43.5 (8.2)	41 (5.8)	0.01	CHD

(*Continued*)

Table 2. (*Continued*)

Study	NOS score	Survey	CHD N	Control N	Severity of CHD	CHD mean (SD) median (range)	Controls mean(SD) median (range)	p-value/OR (95% CI)	Group with more symptoms
Holland (2017 USA)	******	CKI	68	87	Complex	41 (38–50)	40 (37–44)	0.11	No difference
Luyckx (2016 Belgium)	******	CES-D	278	278	Mixed	10.10 (8.38)	15.64 (10.7)	<0.05	Controls
So MPhil (2019 Belgium)	******	CES-D	96	80	Mixed	18.63 (5.46)	14.03 (4.96)	<0.001	CHD
Lang (2022 Germany)	*****	DYSIPS-III	18–20	23–24	Simple	0.31 (0.33)	0.34 (0.36)	0.015	Controls
Depression symptoms – proxy-evaluation									
Eichler (2019 Germany)	******	DYSIPS-II	39	39	Simple	0.14 (0.18)	0.17 (0.19)	1	No difference
McCusker (2013 UK)	******	CBCL	31	18	Mixed	54.1 (5.8)	53.4 (5.8)	0.706	No difference
Guan (2014 China)	******	CBCL	64	56	Simple				CHD
			Boys: 45	Boys: 31		Boys: 4.45 (2.1)	Boys: 2.18 (1.07)	Boys: <0.05	
			Girls: 19	Girls: 25		Girls: 5.64 (2.3)	Girls: 2.57 (1.47)	Girls: <0.05	
Lang (2022 Germany)	*****	DYSIPS-III	20	24	Simple	0.15 (0.21)	0.10 (0.12)	NS	No difference
Anxiety symptoms – self-evaluation									
DeMaso (2017 USA)	******	RCMAS	156	111	Complex	45 (38-54)	38 (33-46)	<0.001	CHD
DeMaso (2014 USA)	*****	RCMAS	139	61	Complex	43.1 (11.8)	39.1 (10.2)	0.02	CHD
Fredriksen (2009 Norway)	****	YRS	307	368	Mixed				
			Boys: 183	Boys: 159		Boys: 3.6 (4.1)	Boys: 3.5 (3.7)	Boys: NS	Boys: No difference
			Girls: 124	Girls: 209		Girls: 3.3 (3.7)	Girls: 4.7 (4.6)	Girls: <0.001	Girls: Controls
Holland (2017 USA)	******	RCMAS	68	87	Complex	46 (32–52)	38 (34–48)	0.03	CHD
Lang (2022 Germany)	*****	DYSIPS-III	19–21	21–22	Simple	0.34 (0.42)	0.38 (0.33)	NS	No difference
Anxiety symptoms – proxy-evaluation									
Eichler (2019 Germany)	******	DYSIPS-II	39	39	Simple	0.28 (0.28)	0.26 (0.30)	0.21	No difference
Miatton (2007 Belgium)	******	CBCL	43	43	Mixed	54.7 (6.4)	52.9 (4.4)	0.163	No difference
McCusker (2013 UK)	******	CBCL	31	18	Mixed	54.0 (5.4)	52.5 (3.5)	0.204	No difference
Gupta (2001 Canada)	*****	STAI/CBCL	39	Norms	Mixed	36.84 (10.9)/57.05 (7.25)	35.2 (10.7)/54.1 (5.9)	NS/<0.001	No difference/CHD
Lang (2022 Germany)	*****	DYSIPS-III	20	23	Simple	0.18 (0.27)	0.09 (0.14)	NS	No difference

CADS: Conners' ADHD Rating Scale, YRS: Youth Report Scale, SDQ: Strengths and Difficulties Questionnaire, DYPSIPS-III: ICD-10/DSM-IV forms CADS: Conners' ADHD Rating Scale, SDQ: Strengths and Difficulties Questionnaire, SNAP-IV: Swanson, Nolan and Pelham Questionnaire, DYPSIPS-II/III: ICD-10/DSM-IV forms CKI: ADS: Children's Depression Inventory, CES-D: Center for Epidemiological Studies Depression Scale, DYPSIPS-III: ICD-10/DSM-IV forms CBCL: Child Behavior Checklist, DYPSIPS-II/III: ICD-10/DSM-IV forms RCMAS: The Revised Children's Manifest Anxiety Scale, YRS: Youth Report Scale, DYPSIPS-III: ICD-10/DSM-IV forms CBCL: Child Behavior Checklist, STAI: The State-Trait Anxiety Inventory, DYPSIPS-II/III: ICD-10/DSM-IV forms.

Discussion

In this systematic review, we found a consensus in the included articles for a higher prevalence of diagnosed attention deficit hyperactivity disorder (ranging between 1.4 and 9 times higher than controls) and autism (ranging between 1.8 and 5 times higher than controls) in children and adolescents with CHD, but inconsistent results regarding depression and anxiety. All the articles that investigated symptoms of attention deficit hyperactivity disorder in children and adolescents with complex CHD found that the children and adolescents with CHD (both by self-report and proxy-report) had more attention deficit hyperactivity disorder symptoms than controls. The evidence is less strong in children and adolescents with mixed CHD. We found no difference in attention deficit hyperactivity disorder symptoms between children and adolescents with simple CHD and controls. We found no consensus in the articles in this review investigating symptoms of depression (both self- and proxy-reports). Two of the three articles that found no difference between proxy-reported depression symptoms are based on the same study.[14,35] This should be taken into account when interpreting the results of course, but we still did not find any consensus on depression symptoms. Children and adolescents with complex CHD self-reported more anxiety symptoms than controls. Mixed and simple CHD groups had the same amount of anxiety symptoms (both self- and proxy-reported) as controls.

There could be different explanations as to why we found that some children and adolescents with CHD had a higher prevalence of attention deficit hyperactivity disorder (mixed/complex CHD) and autism (mixed) and not depression and anxiety compared to peers. One explanation could be that neurodevelopmental diseases, such as attention deficit hyperactivity disorder and autism, are characterised by symptoms and impaired functioning that often appears in early childhood, and are often diagnosed at an early age. Depression and anxiety disorders, on the other hand, are emotional disorders that often have a debut later in life.[37] Since we only included ages up to 18 years, depression and anxiety may not have fully surfaced yet. A prevalence study from 2019 found that attention deficit hyperactivity disorder and autism were more prevalent in adolescents in general, but depression and anxiety grew in prevalence in adulthood.[38]

Another explanation could be that these two diagnoses, attention deficit hyperactivity disorder and autism, arise from atypical brain development.[39] Brain development is influenced by a variety of factors both before and after birth, which can impact the risk of neurodevelopmental disorders such as autism and attention deficit hyperactivity disorder.[40,41] Genetics, immunological dysregulation, metabolic disturbances, disturbances in the blood-gut axis, and early brain injury (both developmental and structural lesions) are suggested aetiological pathways for neurodevelopmental disorders. Some of the same mechanisms are found to be affected in patients with CHD.[42–47] As many of the above-mentioned factors are potentially more disturbed in complex CHD both prenatal with desaturated blood in the developing brain[48,49] and postnatal with early, difficult, and long-lasting surgeries, it is not surprising that it is in this patient group that we found an increased risk for attention deficit hyperactivity disorder. The advancements in the treatment and clinical care of complex CHD have led to a decrease in post-operative brain injuries, injuries which are possible contributors to neurodevelopmental co-morbidities.[50] It will be interesting to see if this has an effect on the increased prevalence of attention deficit hyperactivity disorder found in this patient group. It is also in this patient group with complex CHD, that most of the psychiatry research has been done so far. Psychiatric co-morbidities in children with simple CHD are not investigated to the same extent. As studies in adults with simple CHD have found a greater risk for neurodevelopmental challenges, social challenges, and a greater risk for psychiatric co-morbidities, in general,[5,7,8,51] further and larger studies in this group of children and adolescents are important.

Children and adolescents with complex CHD self-reported more symptoms of anxiety.

Anxiety is not always notable for the outside world; this could explain why it is only in the self-reported data that we find this difference. We have found the same pattern looking at adults with simple CHD where symptoms like inattention are difficult for a proxy to recognise.[6,52] This has also been found in a study investigating other chronic diseases in childhood.[53]

As far as we know, this systematic review is the first that looked at diagnosed psychiatric disorders and more specific psychiatric symptoms in children and adolescents born with a CHD. We included 20 articles (19 studies) from Europe, Asia, and North America. All studies compared the study group with a healthy control group or with normative data. All studies were scored satisfactory or above in a risk of bias assessment. A limitation of our study is the lack of a meta-analysis of the studies included. The included studies in this research vary significantly in their outcome measures, study design, and comparative data. This heterogeneity made it difficult to conduct a meaningful meta-analysis of the effects; therefore, a meta-analysis was not deemed feasible. The studies focused on different types of CHD patients, ranging from simple to complex, with some including both types of CHD in a mixed group. CHD is a highly heterogeneous congenital malformation. The studies also used different reference groups to compare the CHD group, including community-based control groups, children with one emergency/inpatient record, control groups from prior studies, siblings, insurance database controls, and normative data. The age range of participants across the studies was also wide, spanning from 2 to 18 years old. The outcome of interest was obtained through different methods across the studies, including psychiatric diagnoses through psychiatric evaluations, registry data, a combination of registered diagnoses and prescription medicine, and parents' reports of psychiatric diagnoses. Studies that used psychiatric symptoms as the outcome used different survey measures.

Conclusion

In this systematic review, we found that children and adolescents with a CHD had a higher prevalence of attention deficit hyperactivity disorder and autism than controls, but inconsistent results regarding depression and anxiety. Focus on and subsequent interventions on psychiatric symptoms may have the potential to decrease the known risks of long-term social problems found in this patient group. A large and important aspect of further research in this area would be to make more comparable research. This could be done by not mixing very different CHD groups, but by looking at simple, moderate, or complex CHD separately and by making reasonable age intervals, for example preschool-age, early school-age, late school-age, and later adolescents.

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