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Sense of coherence is a predictor of perceived health in adolescents with congenital heart disease: A cross-lagged prospective study

Silke Apers^{a,1}, Koen Luyckx^{b,c,1}, Jessica Rassart^{b,1}, Eva Goossens^{a,c,1}, Werner Budts^{d,1}, Philip Moons^{a,d,e,1,*}

^aDepartment of Public Health, Centre for Health Services and Nursing Research, University of Leuven, Leuven, Belgium

^bFaculty of Psychology and Educational Sciences, School Psychology and Child and Adolescent Development, University of Leuven, Leuven, Belgium

^cResearch Foundation Flanders, Belgium

^dDivision of Congenital and Structural Cardiology, University Hospitals Leuven, Leuven, Belgium

^eThe Heart Centre, Copenhagen University Hospital, Copenhagen, Denmark

* Corresponding author at: University of Leuven, Centre for Health Services and Nursing Research, Kapucijnenvoer 35 box 7001, B-3000 Leuven, Belgium. Tel.: +32 16 336984; fax: + 32 16 336970. *E-mail address*: philip.moons@med.kuleuven.be (P. Moons).

¹ on behalf of the i-DETACH investigators.

Abstract

Background: The life expectancy of patients with congenital heart disease (CHD) has increased substantially. Health care should meet their needs through enhancing psychological functioning, quality of life, and perceived health. A possible determinant of these variables is sense of coherence (SOC). The interplay between SOC and outcome variables is not thoroughly scrutinized yet.

Objective: To examine the direction of relationships between SOC and domains of perceived health in adolescents with CHD.

Design: A longitudinal, observational study with two measurement points and a time lag of nine months.

Setting: The pediatric and congenital cardiology department of a university hospital in Belgium.

Participants: Adolescents with CHD ($n=429$ at time 1) were recruited from the hospital's database. At time 1, mean age was 15.8 years, 53.4% were boys, and most adolescents had a moderately complex heart defect (47.6%).

Methods: Participants filled out the 13-item SOC questionnaire and the PedsQL scale at both time points. Cross-lagged path analysis using structural equation modeling was conducted, controlling for age, sex, educational level, disease complexity, and prior heart surgery for CHD.

Results: SOC at time 1 positively predicted all domains of generic perceived health (physical, emotional, social, and school functioning) and three out of five domains of disease-specific perceived health (symptoms, physical appearance, and cognitive problems) at time 2. Conversely, better school functioning and less cognitive problems at time 1 positively predicted SOC at time 2.

Conclusions: Evidence was obtained for reciprocal pathways between SOC and the domains of perceived health, although the predominant direction of effects was found to be from SOC to perceived health. Hence, improving SOC has the potential to enhance future perceived health of adolescents with CHD.

Key words: Adolescence; Cross-lagged analysis; Heart defects, congenital; Longitudinal; Perceived health; Sense of coherence; Transition.

What is already known about the topic

- Adolescence is a crucial period in the formation of one's sense of coherence (SOC) as this period is characterized by many changes and challenges.
- The relation between SOC and health is hypothesized to be reciprocal, although longitudinal research on this topic is largely absent.
- Children and adults with congenital heart disease (CHD) perceive their health as similar to that of their healthy counterparts.

What this paper adds

- SOC is an important determinant of generic and disease-specific perceived health in adolescents with CHD.
- The different domains of perceived health are less consistent predictors of SOC over time.
- SOC could be an important individual characteristic to focus on in intervention and prevention efforts.

1. Introduction

Congenital heart disease (CHD) is the most common birth defect with a worldwide prevalence of 9.1 per 1000 live births (van der Linde et al., 2011). Patients' life expectancy increased substantially over the past decades, which has led to a survival rate of almost 90% into adulthood (Moons et al., 2010). Due to these improved survival rates, increasingly more attention is being paid to psychological functioning, quality of life, and health perceptions in these patients (Karsdorp et al., 2007; Manlhiot et al., 2009; Spurkland et al., 1993; Teixeira et al., 2011). In general, studies in this area focus on limitations and impediments, leaving aspects that positively impact psychological functioning and quality of life unaddressed (Moons et al., 2006a). However, there are numerous aspects that contribute to a good quality of life (Moons et al., 2005). Furthermore, little research in CHD has been conducted on determinants of quality of life and perceived health using longitudinal designs. Such longitudinal studies, which determine how variables exactly influence one another over time, are urgently needed. If specific temporal sequences can be identified, they could potentially guide prevention and intervention efforts aimed at improving patients' quality of life and perceived health.

A potentially important determinant of both perceived health and quality of life (Eriksson and Lindström 2006, 2007) is sense of coherence (SOC) (Antonovsky, 1987). Antonovsky abandoned the prevailing pathogenic model that focused on the origins of disease and ill-being, and introduced a salutogenic model focusing on the origins of health and well-being. Whereas the pathogenic model applies a dichotomous classification of persons into either healthy or ill, the salutogenic model represents a continuum ranging from total health (the optimal end of the continuum or 'health-ease') to total ill health (the opposite end of the continuum or 'dis-ease'). Antonovsky forwarded SOC as a protective factor explaining how individuals could move toward the health pole of this continuum. SOC represents "a global

orientation that expresses the extent to which one has a pervasive, enduring though dynamic feeling of confidence that (a) the stimuli deriving from one's internal and external environments in the course of living are structured, predictable, and explicable; (b) the resources are available to one to meet the demands posed by these stimuli; and (c) these demands are challenges worthy of investment and engagement" (Antonovsky, 1987, p. 19). These three components are known as comprehensibility, manageability, and meaningfulness, respectively. Overall, SOC represents a salutogenic factor, actively promoting and facilitating health (Antonovsky, 1996).

Antonovsky (1987) stated that SOC mainly develops during childhood and adolescence. Adolescence is deemed a crucial period in the formation of one's SOC because adolescents face many identity choices, biopsychosocial changes, and challenges in their development (Luyckx et al., 2011a; Williams et al., 2002). It has been argued that growing up with a chronic disease represents a substantial additional challenge, which may affect the development of SOC (Moons and Norekvål, 2006). This means that the foundations for adult health in individuals with chronic disorders are already laid in the young ages. However, the relationship between SOC and health could be reciprocal (Antonovsky, 1987; Eriksson and Lindström, 2006; Kivimäki et al., 2000; Veenstra et al., 2005). In other words, SOC potentially influences health, but health can also have an impact on SOC (Antonovsky, 1987).

A review of the literature confirmed the relation between SOC and health. A higher SOC was related to various indicators of psychological and physical health across the lifespan (Eriksson and Lindström, 2006). Additionally, evidence suggested that children and adults with CHD perceive their health as similar to that of their healthy counterparts (Larsen et al., 2010; Moons et al., 2006b). Unfortunately, research on this topic is characterized by some limitations. First, most studies have a cross-sectional design which makes it impossible to draw conclusions on temporal sequences and the direction of effects. Second, studies focusing

on chronic illness are scarce. Third, perceived health is often measured in a unidimensional way which results in less detailed information (Eriksson and Lindström 2006). Fourth, previous research in both adolescent and adult samples has demonstrated that quality of life and perceived health are two distinct constructs (Smith et al., 1999; Zullig et al., 2005). Nonetheless, the term (health related) quality of life is often referred to when, in reality, perceived health is being measured (Moons, 2004).

Therefore, longitudinal research investigating the direction of effects between SOC and health for patients with a chronic illness is needed. Consequently, the present study aimed at examining the direction of effects between SOC and both generic and disease-specific domains of perceived health in adolescents with CHD. We hypothesized that SOC would influence the different domains of perceived health over time, but assumed that some domains of perceived health would also influence SOC over time.

2. Methods

2.1. Design

We conducted a longitudinal, observational study in which we measured all variables of interest at two time points with a nine month interval. This study is part of the larger Information technology Devices and Education program for Transitioning Adolescents with Congenital Heart disease (i-DEATCH project). Regarding this project, previous, mainly cross-sectional, studies on identity formation, perceived parenting, and quality of life have been published (Luyckx et al., 2011a,b, 2012). The current phase of the i-DEATCH project does not entail any intervention.

2.2. Study population

Adolescents with CHD were recruited from the database of pediatric and congenital cardiology of the University Hospitals Leuven (Belgium). Patients were eligible for inclusion if they met the following criteria: confirmed CHD, defined as structural abnormalities of the

heart and/or great intrathoracic vessels that are actually or potentially of functional significance (Mitchell et al., 1971); aged 14-18 years at the start of the study; last cardiac consult less than five years ago at our tertiary care center; being able to read and write Dutch; and valid contact details available. Exclusion criteria were: cognitive and/or physical limitations inhibiting filling out questionnaires; prior heart transplantation; and absence of consent to participate by patients or parents. The database included 33,895 patients in September 2009 of which 498 met the inclusion criteria.

2.3. Procedure

All eligible patients ($n=498$) were sent an information letter, a set of questionnaires, and a prestamped and addressed return envelope by surface mail. An informed consent form was included and needed to be signed by the patients and/or their parents. Completing the set of questionnaires took 60 min on average. Patients were asked to complete the set of questionnaires themselves and to return them within three weeks. To increase the response rate, participants received a movie ticket as an incentive. Additionally, a modified Dillman (1983) procedure was used to minimize non-response. First, documents were sent by surface mail. Second, non-responders received a first personalized reminder after three weeks and a second reminder (formal letter) after five weeks. Third, persistent non-responders were contacted by telephone after seven weeks and were asked whether they received the questionnaire, whether the mailing address was correct, whether they wanted to receive a new questionnaire and whether they still wanted to participate.

2.4. Measures

Demographic and clinical data were extracted from the completed questionnaires (sex and educational level, i.e., general secondary/university/university college, technical secondary, and vocational secondary/special education) and patients' medical records (age, complexity of heart defect, primary diagnosis, and heart surgery for CHD prior to the start of

the i-DETACH study). The complexity of patients' cardiac lesions was divided into simple, moderate, and complex based on Task Force 1 of the 32nd Bethesda conference (Warnes et al., 2001). The primary cardiac defect was categorized, using a modified version of the hierarchy of cardiac defects developed by the CONgenital CORvitia project (Moons et al., 2009; van der Velde et al., 2005).

SOC and the domains of perceived health were assessed at both time points and were adolescent-reported. Patients' SOC was measured using the 13-item Orientation to Life Questionnaire comprising meaningfulness (four items), comprehensibility (five items), and manageability (four items) (Antonovsky, 1987). A sample item reads: "Do you have the feeling that you don't really care about what goes on around you?". Responses are given on a seven-point semantic differential scale ranging from 1 (very seldom or never) to 7 (very often). According to the standard coding procedure, five items were reverse-coded, in order to have high scores reflecting high levels of SOC. The SOC scale has proven to be reliable and valid (Eriksson & Lindström, 2005). In the present study, Cronbach's alpha coefficients for internal consistency were 0.83 and 0.84 for times 1 and 2, respectively.

The domains of patients' perceived health were assessed using a self-report version for adolescents aged 13-18 years of the Pediatric Quality of Life Inventory™ 4.0. This instrument was originally developed to measure health-related quality of life. However, researchers often use the term quality of life when they are actually discussing health status or functional ability (Moons, 2004). Therefore, the Pediatric Quality of Life Inventory (PedsQL) more likely expresses generic and disease-specific domains of health as perceived by the patient. The generic model comprises four subscales: physical (eight items), emotional (five items), social (five items), and school functioning (five items). Five subscales of the cardiac module were used for this study: symptoms (seven items), perceived physical appearance (three items), treatment anxiety (four items), cognitive problems (five items), and communication (three

items) (Uzark et al., 2003; Varni et al., 1999). A five point scale ranging from 0 (never) to 4 (almost always) evaluated the degree to which patients experienced problems during the past month. After reverse-scoring and linearly transforming the items to a 0 to 100 scale, a higher score reflects better perceived health. The PedsQL scale has proven to be reliable and valid (Varni et al., 2001). In the present sample, Cronbach's alphas ranged from 0.79 to 0.80 for the domains of generic perceived health, and from 0.75 to 0.77 for the domains of disease-specific perceived health for times 1 and 2.

2.5. Data analysis

Non-parametric test statistics were used to compare median scores between variables measured at an ordinal level (i.e., SOC and perceived health). Conversely, mean and standard deviations (*SD*) of these variables were calculated to describe the study sample for reasons of clarity and comparability. Mann-Whitney *U* tests were used to assess whether scores on SOC and the domains of perceived health differed significantly between boys and girls and between patients who underwent prior heart surgery and patients who did not (two independent groups). Kruskal-Wallis tests were used to investigate whether scores on SOC and the domains of perceived health differed for groups of patients with a different disease complexity or educational level (three independent groups).

Spearman's rho (ρ) correlation coefficients were computed among study variables. A *p*-value of 0.05 was used as cut-off for statistical significance. Data were analyzed with SPSS version 15.0 (SPSS Inc., Chicago, IL).

For this longitudinal study, cross-lagged path analysis using structural equation modeling was conducted. Despite the fact that cross-lagged results should not be interpreted as definite proof of causation, they can be an indication of the predominant direction of effects over time. Fig. 1 exemplifies a cross-lagged model in which variables X and Y are measured at two time points, resulting in three types of relations: within-time or synchronous

relations (1 and 2) referring to the association between X1 and Y1, or X2 and Y2; autoregressive or stability relations (3 and 4) referring to the prediction of X2 by X1, or Y2 by Y1; and cross-lagged relations (5 and 6) referring to the prediction of Y2 by X1 controlling for Y1, or X2 by Y1 controlling for X1 (Anderson and Kida, 1982). The generated cross-lagged estimates can be interpreted as X1 predicting relative changes (i.e., relative increases or decreases) in Y2 (Kline, 2006).

To assess model fit, four fit indices were used: the model chi-square (which should be as small as possible); the root mean square error of approximation (RMSEA, <0.08); the Comparative Fit Index (CFI, >0.90); and the standardized root mean square residual (SRMR, <0.10) (Kline, 2006). To correct for non-normality in the data, the Satorra-Bentler scaled chi-square statistic (SBS χ^2) was used (Kline, 2006).

Previous studies in adolescents with CHD have demonstrated that SOC and perceived health were associated with age, sex, educational level, and disease complexity (Luyckx et al., 2012; Nio, 2010). In addition, it has been hypothesized that the existential experience of undergoing surgery might contribute to SOC by building up meaningfulness (Moons and Norekvål, 2006). Therefore, these variables were controlled for in these analyses, if they appeared to be significantly associated in the univariate analyses (see above). Cross-lagged analyses were done using Mplus 4.0.

2.6. Ethical approval

The proposed study protocol was approved by the Institutional Review Board of the University Hospitals Leuven. Ethical standards, as described in the 2002 Declaration of Helsinki, were observed.

3. Results

3.1. Sample characteristics

Of the 498 eligible patients, a total of 429 participated at time 1 (86% response rate). For the purpose of the i-DETACH study project, participants and non-responders at time 1 ($n=464$) were invited to partake at time 2 of whom 398 participated (85.8%). In total, 382 adolescents with CHD participated at time 1 and 2.

The occurrence of occasional drop-out is inevitable when conducting longitudinal research (Jelčić et al., 2010). Therefore, participants with and without complete data were compared using Little's Missing Completely At Random (MCAR) test (Little, 1988). This resulted in a non-significant test statistic ($df=580$, $\chi^2=34.89$, $p=1.00$) suggesting that missing values could be reliably estimated. Accordingly, the Full Information Maximum Likelihood (FIML) procedure provided in Mplus 4.0 (Muthén and Muthén, 2002) was used to deal with missing data. FIML has proven to be less biased, more efficient, and more reliable as compared to other methods such as listwise deletion (Armsden and Greenberg, 1987; Enders and Bandalos, 2001). Hence, all primary analyses were performed on the full sample of 429 participants.

At time 1, the sample consisted of 229 boys and 200 girls with a mean age of 15.8 years ($SD=1.2$). Almost half of the patients went to general secondary school, university, or university college (47.0%). Ventricular septal defect (18.1%), aortic valve abnormality (16.0%), atrial septal defect type II (13.1%), coarctation of the aorta (10.0%), and pulmonary valve abnormality (8.9%) were the five most frequent heart defects. Most adolescents had a moderate level of disease complexity (47.6%). In total, 46.6% underwent heart surgery. Demographic and clinical data are detailed elsewhere (Luyckx et al., 2012).

3.2. Preliminary analyses

Mean scores and standard deviations of the study variables at time 1 are presented in Table 1. Mann-Whitney U tests showed that girls scored significantly lower than boys on two domains of generic perceived health at time 1: physical and emotional functioning ($p<0.001$).

Additionally, girls were found to score lower on four domains of disease-specific perceived health at time 1: symptoms ($p=0.002$), physical appearance ($p<0.001$), treatment anxiety ($p<0.001$), and communication ($p=0.001$). Conversely, boys scored significantly higher on SOC at time 1 as compared to girls ($p=0.04$). Furthermore, patients who underwent prior heart surgery for CHD had significantly lower scores on social functioning ($p=0.03$) and physical appearance ($p=0.01$) at time 1 compared to patients without prior heart surgery (Table 1).

Kruskal-Wallis tests revealed significant differences in perceived health between adolescents with a different disease complexity at time 1: physical functioning ($p=0.02$), social functioning ($p=0.02$), and symptoms ($p=0.03$). In addition, significant differences were found between patients with a different educational level regarding SOC ($p=0.003$) and perceived health at time 1: social functioning ($p=0.03$), school functioning ($p<0.001$), cognitive problems ($p<0.001$), and communication ($p=0.003$) (Table 1).

Furthermore, age was significantly correlated with school functioning at time 1 ($\rho=-0.10$; $p\leq 0.05$). Consequently, age, sex, educational level, disease complexity, and prior heart surgery for CHD were controlled for in the cross-lagged analyses by estimating paths from these variables to each of the constructs in the model.

SOC at time 1 was positively correlated to both generic and disease-specific perceived health at time 1 (ρ s ranging between 0.55 and 0.28; $p\leq 0.01$); and SOC at time 2 was also positively correlated to both generic and disease-specific perceived health at time 2 (ρ s ranging between 0.61 and 0.35; $p\leq 0.01$).

3.3. Cross-lagged analyses on the direction of effects

All significant stability coefficients and cross-lagged paths are presented in Figs. 2 and 3. The control variables (i.e., age, sex, educational level, disease complexity, and prior heart surgery for CHD) are not displayed in the figures because they were substantially related to the study variables as detailed before.

The first cross-lagged model linking SOC and generic perceived health (Fig. 2) had an excellent fit to the data ($df=12$, $\chi^2=12.87$, $p=0.38$; RMSEA=0.01; CFI=1.00; SRMR=0.02). Stability coefficients were moderate in strength, ranging from 0.40 (emotional functioning) to 0.60 (physical and social functioning) ($p<0.001$). Regarding the cross-lagged paths, high levels of SOC at time 1 positively predicted physical, emotional, social, and school functioning at time 2. High levels of school functioning at time 1, in turn, positively predicted SOC at time 2 (Fig. 2).

The second cross-lagged model linking SOC and disease-specific perceived health (Fig. 3) had a good fit to the data ($df=20$, $\chi^2=39.88$, $p=0.01$; RMSEA=0.05; CFI=0.99; SRMR=0.02). Stability coefficients were moderate in strength, ranging from 0.57 (cognitive problems) to 0.67 (symptoms). Regarding the cross-lagged paths, high levels of SOC at time 1 positively predicted less symptoms, better perceived physical appearance, and less cognitive problems at time 2. Better cognition (i.e., higher scores on the cognitive problems scale) at time 1, in turn, positively predicted SOC at time 2 (Fig. 3).

4. Discussion

The present longitudinal study was the first to investigate how SOC and different domains of generic and disease-specific perceived health influenced one another in a large sample of adolescents with CHD. This study is important by demonstrating that SOC can be a factor for determining future perceived health of individuals with CHD.

First, consistent with previous research, girls scored significantly lower on SOC than boys (Moksnes et al., 2012; Nio, 2010). Apparently, females with CHD tend to use less favorable coping mechanisms than men (van Rijen et al., 2004) which could negatively affect SOC. Additionally, adolescent girls experience higher levels of interpersonal stress and are also more sensitive to stress than boys (Bouma et al., 2008; Rudolph, 2002). Consequently, they tend to show more negative emotional responses, such as anxiety and depression, in

comparison to boys (Moksnes et al., 2012; Rudolph, 2002). This explanation is reflected in the significantly lower scores of girls on several domains of perceived health, for example emotional functioning. In addition, as could be expected (Latal et al., 2009), patients who underwent heart surgery scored lower on one domain of generic (i.e., social functioning) and on one domain of disease-specific perceived health (i.e., physical appearance). Relatedly, patients differed in perceived health depending on their disease complexity level and in perceived health and SOC depending on their educational level. This underscores the need for healthcare professionals to be extra vigilant towards these vulnerable groups of patients.

Second, in line with our primary hypothesis, SOC and the domains of perceived health were positively interrelated at both time points. Furthermore, the predominant direction of effects was from SOC to the domains of perceived health. Thus, high levels of SOC at time 1 were associated with relative increases over time for all the domains of generic perceived health and for three out of five domains of disease-specific perceived health, controlled for age, sex, educational level, disease complexity, and prior heart surgery for CHD. However, some of these longitudinal relations also proved to be reciprocal, as higher levels of certain domains of perceived health at time 1 were associated with relative increases in SOC over time.

Hence, SOC was found to be a rather consistent predictor of different domains of perceived health over time. These results confirm the status of SOC as an important determinant of generic and disease-specific perceived health. Previous studies also found SOC to be an over-time predictor of quality of life in adolescents with CHD (Luyckx et al., 2012; Neuner et al., 2011). Collectively, these findings demonstrate that having a strong SOC could help adolescents with CHD to cope with their illness. Hence, improving SOC through intervention and prevention efforts has the potential to improve quality of life and perceived health for adolescents with CHD. Crucial in the development of a strong SOC is the

availability and the use of resources (e.g., social support) that facilitate effective tension management to overcome stressors, thereby shaping positive life experiences (Antonovsky, 1987). Therefore, in order to improve SOC, nurses must have an eye for potential resources to support the patient, besides identifying potential problems (Lindström and Eriksson, 2009). Previous research has demonstrated that a lifestyle intervention and interventions led by health professionals based on talk-therapy, case management, and patient empowerment have the potential to improve SOC (Delbar and Benor, 2001; Forsberg et al., 2010; Langeland et al., 2006). Hence, nurses can play a crucial role in enhancing adolescents' comprehensibility, manageability, and meaningfulness by empowering adolescent patients, by involving them in decision making and through education and support (Moons and Norekvål, 2006). In this way, nurses serve as a resource for the development of a strong SOC.

The domains of perceived health, in turn, were found to be less consistent predictors of SOC over time. However, both a better school functioning and less cognitive problems predicted relative increases in SOC. In adolescence, school plays a central role in everyday life and cognitive development is an important part of this period (Harter, 1999). Therefore, experiences in these areas might indeed have a substantial influence on adolescents' SOC.

Certain limitations need to be taken into account when interpreting the study results. First, despite the fact that SOC was positively related to lower treatment anxiety and communication at both time points, SOC did not predict relative changes in these variables over time. Future research should examine which other individual or contextual factors could potentially influence these domains of disease-specific functioning. Second, data collection at two points in time carries the risk of participant drop-out resulting in a potential selection bias (Miller and Hollist, 2007). Efforts were made to reduce attrition, through providing rewards and personalized reminders. This resulted in, at both times, only 14% of eligible patients who did not participate. Nevertheless, this attrition represents a potential threat to the

generalizability of the results. Third, the single-center setting and the specific nature of the study population also reduce the generalizability of the findings to other settings and to other populations. On the other hand, the proportion of patients with a simple, moderate, or complex heart defect in this study corresponds to the reported prevalence in empirical literature (Hoffman et al., 2004; Moons et al., 2010). Furthermore, patients were recruited from the database of one university hospital, but received follow-up in different hospitals across the country. The composition of our sample can therefore be considered to be representative for the total population of adolescents with CHD. Hence, future research should examine the direction of effects between SOC and domains of perceived health in different settings with different populations to replicate our findings. In addition, it would be interesting to follow cohorts of early to late adolescents well into adulthood and investigate how SOC develops over time and whether SOC and perceived health develop in tandem and mutually reinforce one another over longer periods of time. Further, a longitudinal control group should be included to compare SOC scores between adolescents with and without CHD. Finally, in addition to mapping the development of SOC and its relation with quality of life and the domains of perceived health, future research using qualitative designs should explore potential mechanisms detailing how these variables exactly influence one another over time.

Despite these limitations and suggestions for future research, the present study has several strengths. Longitudinal evidence on the relation between SOC and health is scarce. Only two studies investigated the direction of effects between SOC and health in municipal employees (Kivimäki et al., 2000) and in patients with a chronic illness such as congestive heart failure (Veenstra et al., 2005). The present study is the first to focus on the relation between SOC and perceived health in adolescents with CHD. Next, the high response rate at both time points resulted in a large sample size. Finally, the measurement of both generic and

disease-specific domains of perceived health resulted in detailed information regarding the relation with SOC. In sum, we encourage future researchers to examine SOC in individuals with a chronic disease to explore how salutogenic functioning unfolds across the life span in these individuals who face substantial health-related stressors and challenges.

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Table 1

Scores of the study variables at time 1 labeled by sex, prior heart surgery for congenital heart disease (CHD), disease complexity, and educational level and results of non-parametric test statistics.

Variables at time 1 (mean ± SD)	Sex			Prior heart surgery for CHD			Disease complexity				Educational level			
	Boys	Girls	<i>p</i> -value*,§	Yes	No	<i>p</i> -value*,§	Simple	Moderate	Complex	<i>p</i> -value*,* *	General secondary/ University/ University college	Technical secondary	Vocational secondary/ Special education	<i>p</i> -value*,* *
Sense of coherence	4.80 (±0.91)	4.64 (±0.93)	0.04	4.72 (±0.88)	4.73 (±0.96)	0.92	4.72 (±0.96)	4.75 (±0.92)	4.61 (±0.81)	0.54	4.90 (±0.86)	4.57 (±0.95)	4.59 (±0.96)	0.003
Generic perceived health														
Physical functioning	88.99 (±13.22)	84.67 (±14.07)	<0.001	86.22 (±13.78)	87.63 (±13.77)	0.18	87.76 (±13.40)	87.63 (±13.25)	81.66 (±16.07)	0.02	88.81 (±11.82)	86.85 (±11.96)	83.37 (±19.07)	0.15
Emotional functioning	79.59 (±16.51)	71.61 (±19.30)	<0.001	75.53 (±17.33)	76.16 (±19.11)	0.48	75.90 (±19.61)	76.21 (±17.28)	74.41 (±17.74)	0.74	75.85 (±18.06)	75.94 (±18.39)	74.36 (±19.16)	0.85
Social functioning	86.29 (±14.86)	85.92 (±14.59)	0.74	84.28 (±15.87)	87.72 (±13.45)	0.03	87.50 (±13.77)	86.37 (±14.47)	80.39 (±17.55)	0.02	87.85 (±14.16)	86.14 (±13.53)	82.52 (±16.62)	0.03
School functioning	77.33 (±15.89)	77.80 (±16.80)	0.70	76.29 (±15.94)	78.65 (±16.57)	0.07	79.20 (±16.45)	77.03 (±15.84)	73.97 (±17.24)	0.09	81.75 (±13.90)	75.09 (±15.42)	72.92 (±19.42)	<0.001
Disease-specific perceived health														
Symptoms	81.95 (±14.17)	77.16 (±16.38)	0.002	80.40 (±14.31)	79.14 (±16.29)	0.67	79.43 (±16.26)	81.29 (±14.14)	74.36 (±16.32)	0.03	81.23 (±14.37)	79.78 (±15.76)	77.65 (±15.72)	0.21
Physical appearance	83.92 (±19.26)	73.72 (±22.72)	<0.001	75.76 (±23.69)	82.23 (±18.95)	0.01	81.63 (±20.09)	77.68 (±22.46)	77.17 (±21.94)	0.19	79.17 (±20.50)	79.01 (±21.56)	78.51 (±24.25)	0.85
Treatment anxiety	86.90 (±19.47)	79.14 (±22.47)	<0.001	82.69 (±21.91)	83.87 (±20.67)	0.56	83.26 (±21.66)	83.63 (±21.59)	82.25 (±18.53)	0.48	84.96 (±18.72)	83.30 (±22.60)	79.12 (±24.26)	0.24
Cognitive problems	73.16 (±19.78)	70.54 (±21.35)	0.24	71.10 (±19.88)	72.65 (±21.13)	0.36	72.20 (±21.33)	72.05 (±19.74)	70.54 (±21.32)	0.88	76.79 (±17.66)	69.91 (±20.42)	64.76 (±24.01)	<0.001
Communication	80.23 (±21.33)	73.22 (±23.29)	0.001	76.43 (±22.52)	77.46 (±22.54)	0.54	78.11 (±22.19)	76.79 (±23.11)	73.86 (±21.28)	0.32	80.04 (±20.45)	77.59 (±21.94)	69.35 (±24.65)	0.003

* Statistically significant at $p \leq 0.05$; § *Mann-Whitney U tests*; ** *Kruskal-Wallis tests*.

Fig. 1. Cross-lagged model estimating three types of relations.

Fig. 2. Cross-lagged path model linking sense of coherence and generic perceived health.

Cross-lagged path model linking SOC and generic perceived health (i.e., physical, emotional, social, and school problems) over time. Within-time correlations and paths of the control variables (age, sex, educational level, disease complexity, and prior heart surgery for CHD) are not presented for reasons of clarity. All path coefficients are standardized. Only significant stability and cross-lagged paths are demonstrated. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Fig. 3. Cross-lagged path model linking sense of coherence and disease-specific perceived health.

Cross-lagged path model linking SOC and disease-specific perceived health (i.e., symptoms, physical appearance, treatment anxiety, cognitive problems, and communication problems) over time. Within-time correlations and paths of the control variables (age, sex, educational level, disease complexity, and prior heart surgery for CHD) are not presented for reasons of clarity. All path coefficients are standardized. Only significant stability and cross-lagged paths are demonstrated. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.