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Mediation role of health behaviours in the relation between mental resilience and cardiovascular risk in young adults with a diagnosed congenital heart defect

Renata Mroczkowska[1], Elżbieta Szlenk-Czyczerska[1,2*], Katarzyna Szwamel[1] and Roland Fiszer[3]

Abstract

Introduction With age, patients with a congenital heart defect are under higher risk of cardiovascular diseases and more complex selfcare requirements.

Aim of the study The analysis of the mediation role of health-oriented behaviours in the relation between mental resilience and the cardiovascular risk in young adults with congenital heart defects.

Materials and methods This is an observational study with a cross-sectional design. The research was based on the examination of 201 patients with congenital heart defects using the medical record analysis, the method of estimating and the diagnostic survey method. The other examination tools included the Cardiovascular Disease Risk Factors Scale, the Resilience Assessment Scale (SPP-25) and the Health Behaviour Inventory (HBI).

Results The examination confirmed that 50% of patients were susceptible to a cardiovascular disease due to the prevalence of three risk factors. The general indicator of the intensity of health-related behaviours amounted to 83.16 ± 12.94. The lowest intensity of all health behaviours was observed for eating habits (3.14 ± 0.83). The highest score of mental resilience was reported in terms of openness to new experience and sense of humour (15.31 ± 3.05), whereas the lowest was related to optimism and mobilization capability in difficult situations (12.97 ± 3.46). The higher the perseverance and determination (β = -0.16; $p < 0.001$), openness and sense of humour (β = -0.09; $p < 0.01$), tolerance to failure and perceiving life as a challenge (β = -0.09; $p < 0.01$), optimism and the mobilization capability in difficult situations (β = -0.08; $p < 0.01$) and overall mental resilience scale measurement (β = -0.11; $p < 0.001$), the lower the cardiovascular risk. In short, higher psychological resilience was associated with higher intensity of health-related behaviours. Greater intensity of health behaviours and higher indices of eating habits, prophylactic behaviours and health practices fostered lower risk of CVDs.

Conclusions Health-related behaviours play a mediation role between mental resilience and the cardiovascular risk in the group of young adults with congenital heart defects. Psychological resilience as a preventive and promotional factor of mental health appears to be of a very essential value while developing health promoting programmes

*Correspondence:
Elżbieta Szlenk-Czyczerska
elzbieta.szlenkczyczerska@uni.opole.pl

Full list of author information is available at the end of the article

aimed at decreasing the cardiovascular risk in patients with a congenital heart defect. The evaluation of mental resilience may provide better understanding of the patient and ensure proper health care.

Keywords Congenital heart defects, Cardiovascular risk, Mental resilience, Health behaviours

Introduction

Congenital heart defects (CHDs) are structural abnormalities of the heart and blood vessels that arise during prenatal development. The symptoms of CHDs vary depending on the type and severity of the defect but commonly include cyanosis, shortness of breath, growth and developmental delays, fatigue, and heart murmurs. Additionally, some milder defects may be asymptomatic and are often detected incidentally during medical examinations. CHDs can be diagnosed at various stages of life. Most are identified prenatally through advanced imaging techniques. Severe heart defects often manifest within the first hours or days of life, while milder forms that do not cause symptoms during infancy may only be diagnosed later in childhood or even adulthood [1]. Nowadays, due to the advancements in medical and surgical procedures, even children born with complex CHDs or other non-cardiac anomalies may live to adulthood [2]. It is estimated that 90% of patients with a benign form, 75% with a moderate form and 40% with an advanced form of a heart disease will live to be 60 with an upward trend in the future [3].

With age, however, such patients are more susceptible to a higher risk of cardiovascular diseases (CVD) as well as more complex requirements related to selfcare. The transition from adolescence to adulthood is a time of significant biological and psychological changes, and in this age group, it is often accompanied by an elevated level of stress [4–6]. As numerous studies show, traumatic experience connected with invasive procedures, prolonged treatment, existential questions or genetic predispositions result in more frequent diagnosis of mental disorders in CHD patients when compared to healthy individuals [4, 7].

As it was mentioned above, with time, the likelihood of long-term complications of a specific heart defect increases as well as the risk of civilization diseases typical in general public, including the ischemic heart disease. Therefore, it is worth noticing that except for genetic and behavioural CVD risk factors, such as high blood pressure, wrong diet and insufficient physical activity, the reports on circulatory system issues include psychosocial aspects [8–11].

According to Fredrickson, psychological resilience is shaped as a result of experiencing serious difficulties or dangers by an individual and constitutes their constant reserve [12]. But, Ogińska-Bulik and Juczyński claim that psychological resilience is built up of cognitive, emotional and behavioural components, being nothing more than a self-regulation mechanism of an individual. Consequently, a person characterised by a high degree of resilience is emotionally stable, perceives oneself as fully controlling the process of making decisions, whereas life disturbances are seen as a chance and mobilization to undertake remedial actions in difficult moments [13, 14]. Existing studies have showed that mental resilience correlates with higher levels of mental and physical health condition [15–18], what, in case of the CVD risk in CHD patients, gains additional significance. Moreover, it has been proved that it may benefit the relation with CVDs since it has an essential impact on much slower progression of the diseases. What is also important, individuals with higher mental resilience may reveal a lower risk of a CVD due to a better stress and difficulties management what directly affects cardiac and blood vessels condition. Thus, mental resilience may play an essential role in cardiac risk modulation [15] as it was proved that it is related to health behaviours protecting against CVDs [19].

It is also commonly known that behaviours connected with lifestyle have a positive impact on stress, health condition and general well-being [20]. Rippe et al.l [21], basing upon current guidelines and recommendations, developed a definition of an 'ideal' health condition of the cardiovascular system determining a set of seven behaviours and healthcare agents. They include tobacco smoking abstinence, maintaining proper body mass index, maintaining proper level of physical activity, applying healthy diet, having optimal level of total cholesterol, keeping the right level of blood pressure and controlling fasting glucouse levels. Undoubtedly, the behaviours mentioned above are considered to be crucial in CVDs prophylaxis [21–24]. And what is more, healthy lifestyle contributes to higher quality of life. Thus, health-related behaviours may directly correspond with reducing CVD risk factors in patients with CHDs as well as improve their overall quality of life [25]. In the view of the above, changing lifestyle is indispensable to maintain good health condition and quality of life both in general population and in young adults with congenital heart defects [26].

A limited number of patients with CHDs maintain an optimal cardiovascular condition, highlighting the need for a more targeted healthcare model [27]. Cilli et al. [28] emphasize the critical role of monitoring psychoemotional issues, which can increase the risk of recurrent cardiovascular events and re-hospitalizations. Awareness of these issues and their consideration in the

physician-patient relationship support improvements in quality of life.

Psychological resilience may play a pivotal role in the health of CHD patients by fostering the development of sustainable health-promoting behaviours and adherence to medical recommendations. The examination of health behaviours as a mediator between psychological resilience and CVD risk could facilitate the design of supportive systems provided by interdisciplinary therapeutic teams. However, there is a lack of studies addressing the long-term effects of interventions promoting psychological resilience and healthy behaviours in this patient group [29].

The aim of this study was to analyse health-promoting behaviours as a mediator between psychological resilience and cardiovascular risk in young adults with CHDs. The research question posed was: Does psychological resilience influence health behaviours and, consequently, the cardiovascular risk factors in this population?

Materials and methods

Study design and setting

The research was of a cross-sectional and observational character and constitutes a part of a larger project focused on identifying the mediation role of health-related behaviours in the relation between the health locus of control or psychological resilience and the CVD risk factors in young adults with CHDs. The research was carried out from 2016 to 2017. This study followed guidelines for STROBE (strengthening the reporting of observational studies in epidemiology).

Participants

The research was conducted in the medical institution within the Silesian Voivodeship. Initially, the total number of 235 patients with congenital heart defects were qualified for the study. They were hospitalized in the Department of Congenital Defects and Paediatric Cardiology of the Silesian Centre for Heart Diseases in Zabrze or under care of the cardiological out-patient hospital clinic while the research was in progress.

Assuming that only 8% of all the patients with congenital heart defects are in the care of a specialised clinic for adults with a congenital heart defect, the size of the sample was considered adequate [30].

The inclusion criteria contained: age 18–30 (regardless of gender), a diagnosed congenital heart defect, the ability to fill in the questionnaire on their own. The exclusion criteria included: lack of consent to participate in the study, age below 18 or over 30, coexistent cognitive impairment or other mental disorders which prevented the respondents from active participation in the study. Based on the exclusion criteria, 34 patients were excluded, leaving a study sample of 201 patients.

The participation in the study was voluntary and anonymous. Before the examination each patient was informed about its aim and methods as well as the possibility of withdrawal at any stage.

Data sources/measurement

The research was conducted through the analysis of medical documentation, the method of estimating and the diagnostic survey method.

The analysis of medical documentation

The analysis of medical documentation included the overview of the patients' medical records (type of congenital heart defect, time of its diagnosis and the treatment applied).

Measurement

The estimation method was based on measuring blood pressure (BP) and selected anthropometric parameters (height, body mass, waist and hips circumference). The values which indicated elevated BP included ≥ 140 mmHg for systolic pressure and ≥ 90 mmHg for diastolic pressure. Anthropometric measurement was performed with the use of standardized medical scales with the height measure. The accuracy of the measurement was accepted at the level of 0,1 kg. The waist and hips circumference was assessed with the use of a non-stretch tailor tape as recommended by the World Health Organization (WHO) [31].

The measurements above were used to evaluate general obesity and the fattening of the abdominal cavity. While estimating the weight-height ratio in the population of females aged 18–30, the following indicators were applied: the body mass index (BMI) and the waist to hip ratio (WHR). The norm of BMI amounts to 19–25 kg/m2 [31].

Questionnaires

To assess the degree of health behaviour in CHD patients, Juczyński's Health Behaviour Inventory Questionnaire (HBI) was used. It is a self-description tool which consists of 24 statements describing health behaviours in four categories: proper eating habits, prophylactic behaviours, proper health practices and attitudes. Respondents evaluate each statement on a 5-degree scale (1-almost never, 2-rarely, 3-from time to time, 4-often, 5-almost always). Then the scores are summed up to calculate the overall intensity of health-related behaviours which ranges from 24 to 120 points. The higher the score, the greater the intensity of the behaviours. Moreover, it verifies the intensity in all four categories separately. The reliability of this test for the four subscales ranges from 0.6 to 0.65, for the whole 0.85 (α-Cronbach's), while the

test-retest constancy index over 7 months for the Polish version is 0.88 [32].

To assess psychological resilience the Resilience Assessment Scale (SPP-25) was applied. It consists of 25 statements evaluating the resilience and its five components: perseverance and determination, openness and sense of humour, personal competence, tolerance to failure and optimistic attitude to life and mobilization capability in difficult situations. Respondents address to each statement based on the scale in which 0-means definitely 'no', 1-rather 'no', 2-neither 'no', nor 'yes'/'hard to say', 3-rather 'yes', 4-definitely 'yes'. The score is calculated for the whole scale and separate parameters as well. The greater the number of points, the higher the resilience. The overall score of SPP-25 may be read in stein-scale in which 1–4 steins display low, 5–6 average and 7–10 high resilience. The internal consistency, established on the basis of Cronbach's alpha, is 0.89 for the whole scale, while the standard error of measurement for the total score is 3.81. The standard error of measurement for the total score is 3.81. The reliability of the identified five subscales is similar, ranging from 0.67 to 0.75 [13].

The research also took advantage of the authors' own questionnaire which consists of 30 multiple choice questions. The second part of the tool collected data on the family history of premature coronary artery disease (CAD), life environment and lifestyle preferred by the respondent, as well as some sociodemographic data (details available in supplementary materials - The Author's Interview Questionnaire).

Modelled on CANHEART (a health index developed for the population of Canada) [33], the index to evaluate the risk factors of cardiovascular diseases in CHD patients was also created. The following factors, approved by WHO, were taken into account for their prevalence:

- **Being male**.
- **Genetic background such as**:
- Myocardial or cerebral infarction in a father before the age of 55.
- Myocardial or cerebral infarction in a mother before the age of 65.
- Hypertension in a father and/or in mother.
- **Little physical activity determined by**:
- Not performing any physical activity or devoting a few minutes for motor activity and/or not devoting time on physical activity or spending time on physical activity maximum once a week.
- **Irrational nutrition determined by**:
- Little amount of fruit and vegetables consumption (rarely, not daily) or no fruit or vegetable consumption at all.
- Consumption of 2–3 portions of fast food a week (e.g. crisps, salty snacks, sweets) and/or.
- Consumption of alcohol 2–3 times a week.
- **Nicotine addiction - regular cigarette smoking;**
- **Hypercholesterolemia - elevated blood cholesterol level;**
- **Hypertension determined by**:
- Systolic pressure ≥ 140mmHg and/or.
- Diastolic pressure ≥ 90mmHg;
- **Overweight or obesity determined by**:
- BMI ≥ 25 kg/m2 and/or.
- WHR ≥ 1,0 in men and ≥ 0,8 in women.

It was assumed that each of the cardiovascular risk factors was of equal value and was assigned one point if at least one of the risk factor components was present. There was no detailed evaluation of the specific risk factors in the scales of genetic background or nutritional habits. The total score was calculated as a summary of the points assigned to each factor. The higher the sum, the higher the risk of a CVD prevalence.

Statistical methods

The compatibility of the distribution of variables with the normal distribution was analysed with the Shapiro-Wilk test. The application of the Shapiro-Wilk test for a sample of 201 participants was justified based on its high statistical power, suitable range of sample sizes, and its widespread endorsement in statistical literature as a preferred method for testing the normality of distributions [34]. The values of the analysed measurable parameters were presented with the use of basic descriptive statistical values, while the unmeasurable ones with the cardinality and percentage distribution. The comparison of two independent groups in terms of quantitative variables was performed with the non-parametric U Mann-Whitney test, but the comparison of three or more independent groups with the non-parametric Kruskal-Wallis test. The correlations were examined with the Spearman rank order correlation method or the Pearson linear correlation depending on the normality of the distribution of the variables.

Due to the abnormal distribution of most of the variables in the process of the mediation model estimation, the Monte Carlo stimulation method was applied concerning Iman-Conover correction (1000 samples). To develop the mediation model, the mediation analysis in regression was used, with the classic approach by Baron and Kenny which is based on testing mediation correlations by checking other correlations in three steps:

1) the independent variable with the dependant variable (direct correlation, step c).
2) the independent variable with the mediator (step a) and the mediator with the dependant variable (step b).

3) the independent variable with the dependant variable (direct correlation) with both the independent variable and the mediator present in the model (step c') [35].

Full mediation is found when an independent variable stops predicting a dependant variable to a significant degree in the regression model with a mediator. Whereas, partial mediation occurs when an impact of an independent variable on a dependent one only diminishes [36]. In case of partial mediation the Sobel test was applied to complete the analysis which informs about the significance of the regression coefficients' product for step a and b after the introduction of a mediator.

The simulations and calculations were performed with the use of Statistica programme version 13.1 PL by StatSoft, Inc., while the analysis with the Sobel test was run with the use of a calculator available on the website http://quantpsy.org/sobel/sobel.htm. The level of statistical significance was accepted for all the analysis as $p < 0.05$.

Table 1 Characteristics of the study group

Variable	Categories	*n*	%
Types of heart defects	ASD II	57	28.35
	ToF	39	19.40
	TGA	29	14.42
	VSD	26	12.93
	CoA	23	11.45
	PS	16	7.97
	Other defects	11	5.48
Time to diagnosis of CHD	Neonatal period (0–28 days)	91	45.27
	Childhood period (29 days-12 years)	46	22.89
	Adolescent period (13–18 years)	26	12.94
	Adult period (< 18 years)	26	12.94
	No data in medical records	12	5.79
Method of correction of heart defect*	Transcutaneous interventional	68	36.57
	Cardio surgery	61	32.79
	Combination of transcutaneous and cardio surgery methods	57	30.64
Type of CVD risk factors	Male gender	96	47.76
	Genetic burden	87	43.28
	Low level of physical activity	51	25.37
	Irrational nutrition	154	76.62
	Nicotinism	24	11.94
	Hypercholesterolemia	11	5.47
	Hypertension	35	17.41
	Overweight and obesity	101	50.25
Number of CVD risk factors	0	4	1.99
	1	29	14.43
	2	58	28.86
	3	53	26.37
	4	36	17.91
	5	15	7.46
	6	6	2.99
	7	0	0.00
	8	0	0.00

Legend: n– group quantity; %– percentage; ASD II– Atrial septal defect of the second type; ToF– Tetralogy of Fallot; TGA– Heart defect; VSD– Ventricular septal defect; CoA– Coarctation of the aorta; PS– Pulmonary stenosis. *The figures in column n do not sum up to 201 due to missing data

Ethical approval

The research was carried out after receiving the consent of the Managing Board of the Silesian Centre for Heart Diseases and approval by the Bioethical Committee at the Silesian Medical University no KNW/0022/KB/159/15 in compliance with the requirements of the Declaration of Helsinki of 1975 (amended in 2013). The aim and the procedures were explained at the selection stage and only those participants who expressed their written consent were accepted.

Results

Characteristics of the study group

The research group consisted of 52.24% ($n = 105$) of women– the average age.

of 24.60 ± 3.46 and 47.79% ($n = 96$) of men– the average age of 23.10 ± 3.41. The analysis of the type of a CHD showed that 28.35% ($n = 57$) of the respondents were diagnosed with the atrial septal defect (ASD II), 19.40% ($n = 39$) with the tetralogy of Fallot (TOF) and the less numerous group (7.97%, $n = 16$) with the pulmonary stenosis (PS). Almost a half of the group (48.15%, $n = 91$) was diagnosed with a CHD in their neonatal period. 36.57% ($n = 68$) of the respondents were treated with the transcutaneous interventional medical procedure, while 32.79% ($n = 61$) of the respondents underwent cardio surgery. 30.64% ($n = 57$) of the examinees were subjected to the combination of the two methods mentioned above. Irrational eating habits were found in 76.62% ($n = 154$) of the respondents which constitutes the main factor of the CVD risk. More than a half of the respondents (50.25%; $n = 101$) were characterised with the CVD risk because of being overweight or obese and 47.76% ($n = 96$) due to being male. It was also revealed that 43.28% ($n = 87$) of the examined were genetically burdened (Table 1).

Descriptive statistics for the questionnaires and scales used in the research

The first stage of the analysis aimed at calculating descriptive statistics for the variables evaluated in the study. The analysis of the CVD risk factors revealed that the average weight of the risk amounted to 2.78 ± 1.32, while the number of the weight of the risk factors ranged from 0 to 6. It was observed that 50% of patients were subjected to a CVD due to the prevalence of three risk factors, and 25% of individuals due to four of them. The general index of the intensity of health behaviours was 83.16 ± 12.94. The greatest intensity of the behaviours was noted in terms of positive mental attitude

Table 2 Descriptive statistics for the questionnaires and scales used in the study ($n = 201$)

Variables	M ± SD	Median [Q25 - Q75]	Min. - Max.	Confidence interval		Standard error
				-95.00%	+95.00%	
CVD risk factor scale	2.78 ± 1.32	3 [2–4]	0–6	2.60	2.97	0.09
Health Behaviour Inventory (HBI)						
General index of the intensity of health behaviours	83.16 ± 12.94	86 [75–92]	45–110	81.36	84.96	0.91
Proper eating habits (PEH)	3.14 ± 0.83	3.17 [2.67–3.67]	1.17–5	3.03	3.26	0.06
Prophylactic behaviours (PB)	3.58 ± 0.75	3.67 [3.17–4.17]	1.83–5	3.48	3.68	0.05
Positive mental attitude (PMA)	3.61 ± 0.62	3.67 [3.17–4]	1.67–5	3.52	3.69	0.04
Health practices (HP)	3.53 ± 0.64	3.67 [3–4]	1.67–5	3.44	3.62	0.04
Resiliency Assessment Scale (SPP-25)						
General resilience	70.25 ± 14.43	72 [63–80]	29–98	68.24	72.26	1.02
Perseverance	13.98 ± 3.33	15 [12–16]	2–20	13.52	14.44	0.23
Openness	15.31 ± 3,05	16 [14–18]	7–20	14.89	15.74	0.21
Competence	13.74 ± 3.56	14 [12–16]	2–20	13.25	14.24	0.25
Tolerance	14.26 ± 3.07	15 [13–16]	5–20	13.84	14.69	0.22
Optimistic attitude	12.97 ± 3.46	13 [11–15]	4–20	12.49	13.45	0.24

Legend: M- mean; SD- standard deviation; Min- minimum; Max- maximum

Table 3 Correlation between respondents' scores on the resiliency assessment scale and their CVD risk factor scores

Variables	M ± SD	Pearson linear correlation			
		r(X, Y)	r^2	t	p
Resiliency assessment scale (SPP-25)	70.25 ± 14.43	-0.11	0.01	-1.62	$p = 0.107$
The CVD risk factor scale	2.78 ± 1.32				
Perseverance	13.98 ± 3.33	-0.17	0.03	-2.49	$p < 0.05$
The CVD risk factor scale	2.78 ± 1.32				
Openness	15.31 ± 3.05	-0.10	0.01	-1.43	$p = 0.155$
The CVD risk factor scale	2.78 ± 1.32				
Competence	13.74 ± 3.56	-0.05	0.00	-0.68	$p = 0.498$
The CVD risk factor scale	2.78 ± 1.32				
Tolerance	14.26 ± 3.07	-0.10	0.01	-1.38	$p = 0.168$
The CVD risk factor scale	2.78 ± 1.32				
Optimistic attitude	12.97 ± 3.46	-0.08	0.01	-1.10	$p = 0.272$
The CVD risk factor scale	2.78 ± 1.32				

Legend: M- mean; SD- standard deviation

subcategory– 3.61 ± 0.62 and the lowest with respect to eating habits– 3.14 ± 0.83. The general count of resilience amounted to 70.25 ± 14.43.

Of all five components of the resilience scale, the highest score was found in openness to new experience and sense of humour (15.31 ± 3.05), whereas the lowest score was reported in optimism and mobilization capability in difficult situations (12.97 ± 3.46) (Table 2).

Cardiovascular risk vs. the resilience assessment scale (SPP-25)

The next step of statistical analysis of the collected data included calculating Pearson's correlations - r. The analysis showed that out of all subscales of SPP-25 only perseverance and determination in action appeared to be statistically significant and related to the CVD risk factors scale (r = -0.17; $p < 0.05$). Greater perseverance and determination in action facilitated lower scores on the risk factors scale. However, it is worth noting that the correlation between these variables was weak. The other subscales of SPP-25 were not significantly determinant for the CVD risk factors scale (Table 3).

The evaluation of the relation between mental resilience (SPP-25), health-related behaviours (HBI) and the cardiovascular risk

The following model of mediations presupposed the prevalence of the relation between mental resilience in the respondents (scores on SPP-25) and the CVD risk factors scale with health-related behaviours (HBI scores) which functioned as a mediator (Fig. 1).

Proper eating habits (HBI)

The analysis showed that all the subscales of the resilience measurement (SPP-25) showed statistically significant and negative impact on the CVD risk. It was reported that the higher the level of perseverance and determination (β = -0.16; $p < 0.001$), openness and sense of humour

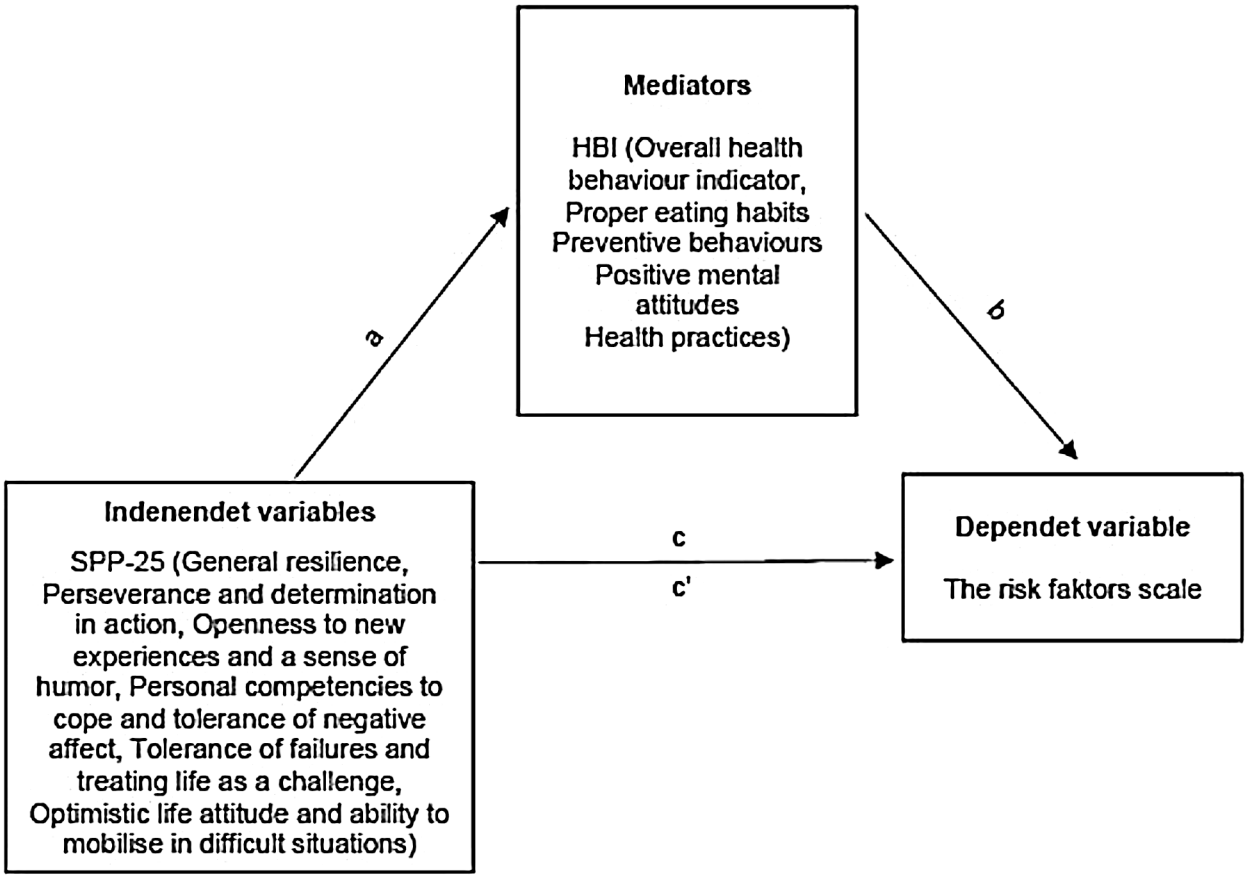

Fig. 1 The mediation diagram used in the examination of the mediation role of health behaviours (HBI) in the relation between the SPP-25 scale and the risk factors of the cardiovascular disease. Legend: a – direct relationship between the independent variable and the mediator (path a), b – direct relationship between the mediator and the dependent variable (path b), c – direct relationship between the independent variable and the dependent variable (path c), c' – relationship between the independent variable and the dependent variable including the mediator in the model (path c')

(β = -0.09; $p < 0.01$), tolerance to failure and perceiving life as a challenge (β = -0.09; $p < 0.01$), optimism and mobilization capability when faced with difficulties (β = -0.08; $p < 0.05$) and overall mental resilience measurement (β = -0.11; $p < 0.001$), the lower the CVD risk. Additionally, some statistically significant direct correlations were revealed between the mediator– eating habits, and perseverance and determination (β = 0.34; $p < 0.001$), openness and sense of humour (β = 0.33; $p < 0.01$), tolerance to failure (β = 0.33; $p < 0.01$), optimism and mobilization (β = 0.21; $p < 0.05$) and overall resilience (β = 0.32; $p < 0.001$). Greater resilience correlated with better eating habits (details available in supplementary materials - Table S1). However, taking into account the model with the mediator and each of the independent variables mentioned above, it turned out that the role of perseverance and determination decreased but remained statistically vital (β = -0.07; $p < 0.005$), while the role of the other resilience components as well as general resilience appeared to be statistically insignificant. The association between eating habits and the risk factors scale was statistically significant in case of each score of the SPP-25 scale. Thus, the mediation of eating habits in the relation between perseverance and determination and the risk factors scale proved to be partial, while in case of the other determinants of the resilience and the overall score it was full. The statistical significance of the partial mediation was confirmed with the Sobel test (Z = 6.47; $p < 0.001$). As personal competence and tolerance to negative emotions did not prove to be directly related to the CVD risk (β = -0.04; $p = 0.165$), the variable was excluded from further analysis (Fig. 2).

Prophylactic behaviours (HBI)

The analysis of the correlations between the resilience and prophylactic behaviours reported statistically significant and positive impact of its components: perseverance and determination (β = 0.32; $p < 0.001$), openness and sense of humour (β = 0.35; $p < 0.01$), tolerance to failure and perceiving life as a series of challenges (β = 0.31; $p < 0.01$) and optimism and mobilization capability when faced with difficulties (β = 0.24; $p < 0.05$) as

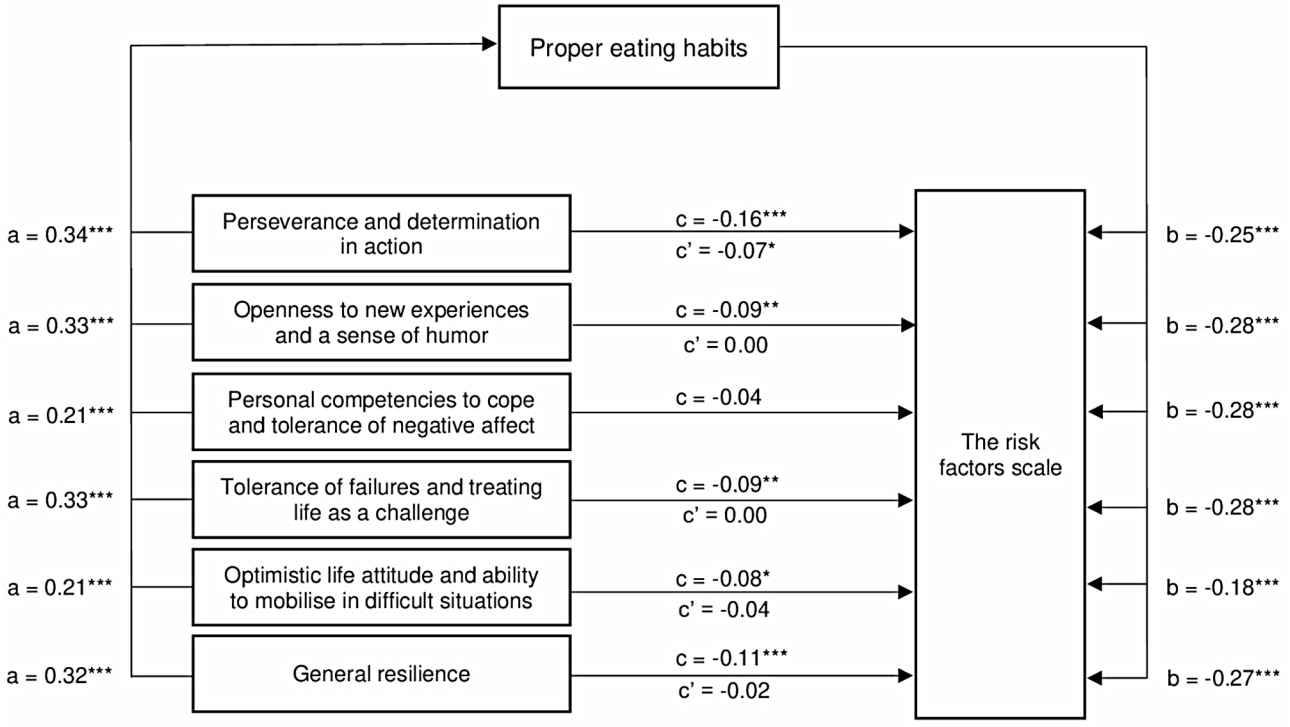

Fig. 2 The mediation model of the influence of the SPP-25 scale on the cardiovascular disease risk factors scale– the mediation role of eating habits (HBI). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

well as significant and positive influence of overall resilience measurement (β = 0.34; $p < 0.001$). Greater mental resilience facilitated higher evaluation of prophylactic behaviours (details available in supplementary materials - Table S2). However, the model including each of the independent variables mentioned above and prophylactic behaviours as a mediator revealed that the role of each independent variable in estimating the risk factors scale proved to be statistically insignificant with a statistically significant relation of the mediator with the dependant variable mentioned in the correlation with every factor determining mental resilience and overall resilience scale measurement (SPP-25). Thus, the mediation of prophylactic behaviours in the relation between the CVD risk factors scale and psychological resilience was full (Fig. 3).

Positive mental attitude (HBI)

The analysis noted a statistically significant and positive relationship between the mediator (namely positive mental attitude) and perseverance and determination in action (β = 0.23; $p < 0.001$), openness to new experience and sense of humour (β = 0.28; $p < 0.001$), tolerance to failure and perceiving life as a challenge (β = 0.37; $p < 0.001$), optimism and mobilization in difficult situations (β = 0.29; $p < 0.001$) and overall mental resilience measurement (β = 0.32; $p < 0.001$). The influence of perseverance and determination in action on the risk factors scale diminished after the introduction of the mediator in the model, however, it still remained statistically significant (β = -0.15; $p < 0.001$) (details available in supplementary materials - Table S3). But, the role of the other components determining resilience and overall resilience measurement scale became statistically insignificant after the introduction of the mediator to the model. It should, however, be added that the significance of positive attitudes for the risk factors scale was statistically significant in case of the relation regarding each of the independent variables mentioned above. The results indicate that the mediation of positive mental attitudes in the relation between perseverance and determination in action and the risk factors scale proved to be partial (however the Sobel test did not confirm statistical significance of the mediation Z = 0.87; $p = 0.386$), while in case of the other resilience components and the SPP-25, it was full (Fig. 4).

Health practices (HBI)

It was found that health practices were also statistically significant and positively linked to the components determining mental resilience: perseverance and determination in action (β = 0.07; $p < 0.05$), openness to new experience and sense of humour (β = 0.16; $p < 0.001$), tolerance to failure and perceiving life as a challenge (β = 0.16; $p < 0.01$), optimism and mobilization in difficult situations (β = 0.09; $p < 0.001$) and overall mental resilience measurement (β = 0.13; $p < 0.001$). Greater mental resilience in the respondents, in all the categories

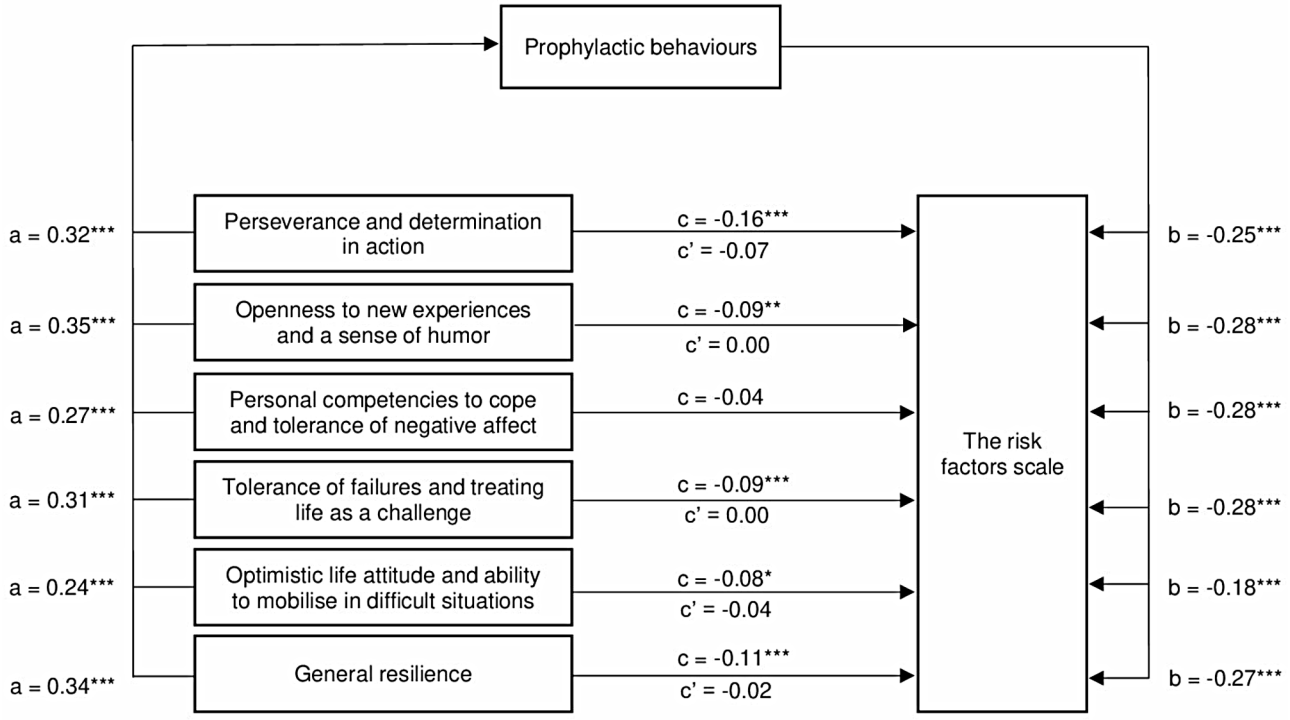

Fig. 3 The mediation model of the influence of the SPP-25 scale on the cardiovascular disease risk factors scale– the mediation role of prophylactic behaviours (HBI). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

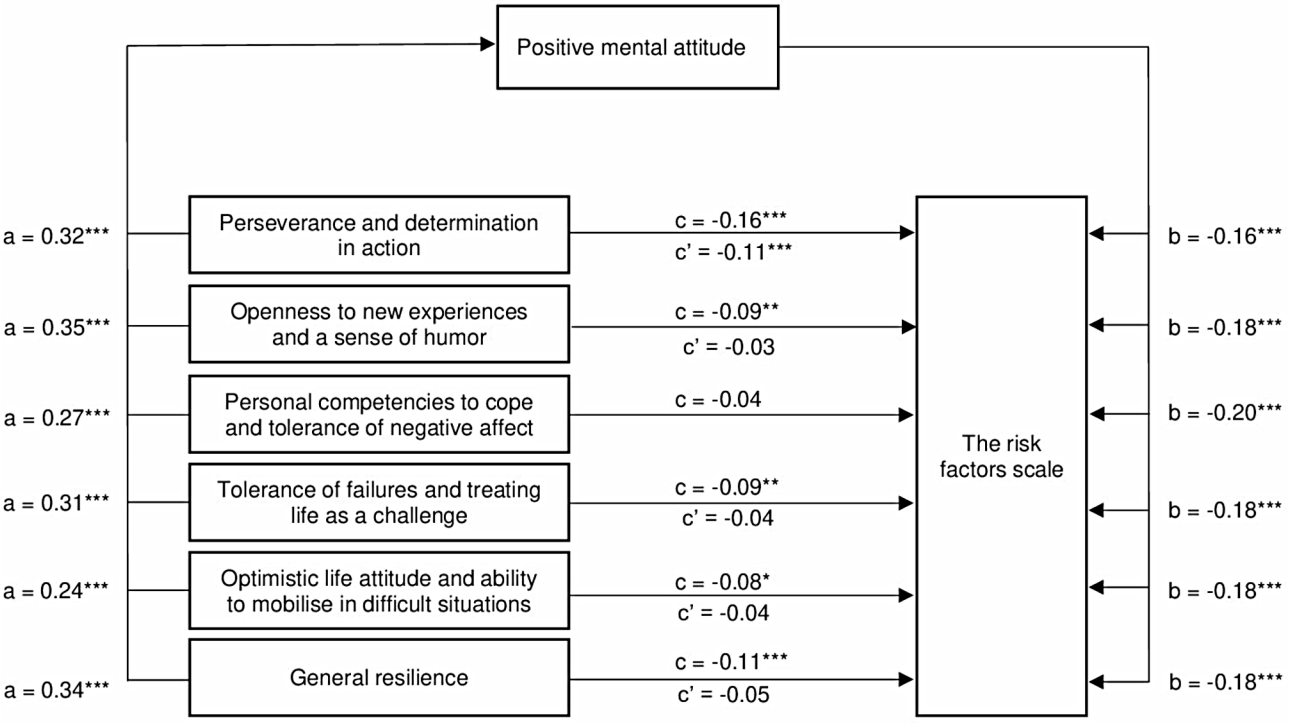

Fig. 4 The mediation model of the influence of the SPP-25 scale on the cardiovascular disease risk factors scale– the mediation role of positive mental attitude (HBI). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

mentioned above, was linked to higher evaluation of their health practices (details available in supplementary materials - Table S4). After the introduction of health practices as a mediator to the relation between the SPP-25 scale scores mentioned above and the risk factors scale it turned out that the role of openness to new experience and sense of humour lost its significance, while the role of the other independent variables decreased but still remained statistically significant. The impact of health practices on the risk factors scale was statistically significant and of the same value in case of the relation with each independent variable mentioned above (and negative in each relation). In the relation between openness to new experience and sense of humour and the risk factors scale, the mediation role of health practices proved to be full, while in case of the other components– partial. The results indicating partial mediation of health practices were confirmed with the Sobel test which proved its statistical importance in terms of perseverance and determination ($Z = 2.05$; $p < 0.05$), tolerance to failure ($Z = 3.93$; $p < 0.001$), optimism ($Z = 2.53$; $p < 0.05$) as well as for overall resilience scale measurement ($Z = 3.41$; $p < 0.001$) (Fig. 5).

General indicator of the intensity of health behaviours (HBI)

The analysis of the mediation revealed that direct relationship between the general indicator of the intensity of health behaviours and individual independent variables related to mental resilience proved to be statistically significant and positive. Greater level of perseverance and determination in action ($\beta = 0.33$; $p < 0.001$), openness to new experience and sense of humour ($\beta = 0.37$; $p < 0.001$), tolerance to failure and perceiving life as a challenge ($\beta = 0.38$; $p < 0.001$), optimism and mobilization in difficult situations ($\beta = 0.27$; $p < 0.001$) and of overall score mental resilience ($\beta = 0.37$; $p < 0.001$) was connected with higher general indicator of the intensity of health behaviours (details available in supplementary materials - Table S5). The role of the latter as the mediator in the relation between the independent variables mentioned above and the risk factors scale was also statistically significant, although the impact was negative. At the same time, after the introduction of the mediator, the role of each of the independent variables diminished, however only in case of perseverance and determination in action the impact on the risk factors scale remained statistically significant. Hence, the mediation of the general indicator of the intensity of health behaviours in the relation between perseverance and determination in action and the risk factors scale was partial (the Sobel test proved partial mediation to be statistically vital $Z = 5.86$; $p < 0.001$), and in case of the other resilience components it was full (Fig. 6).

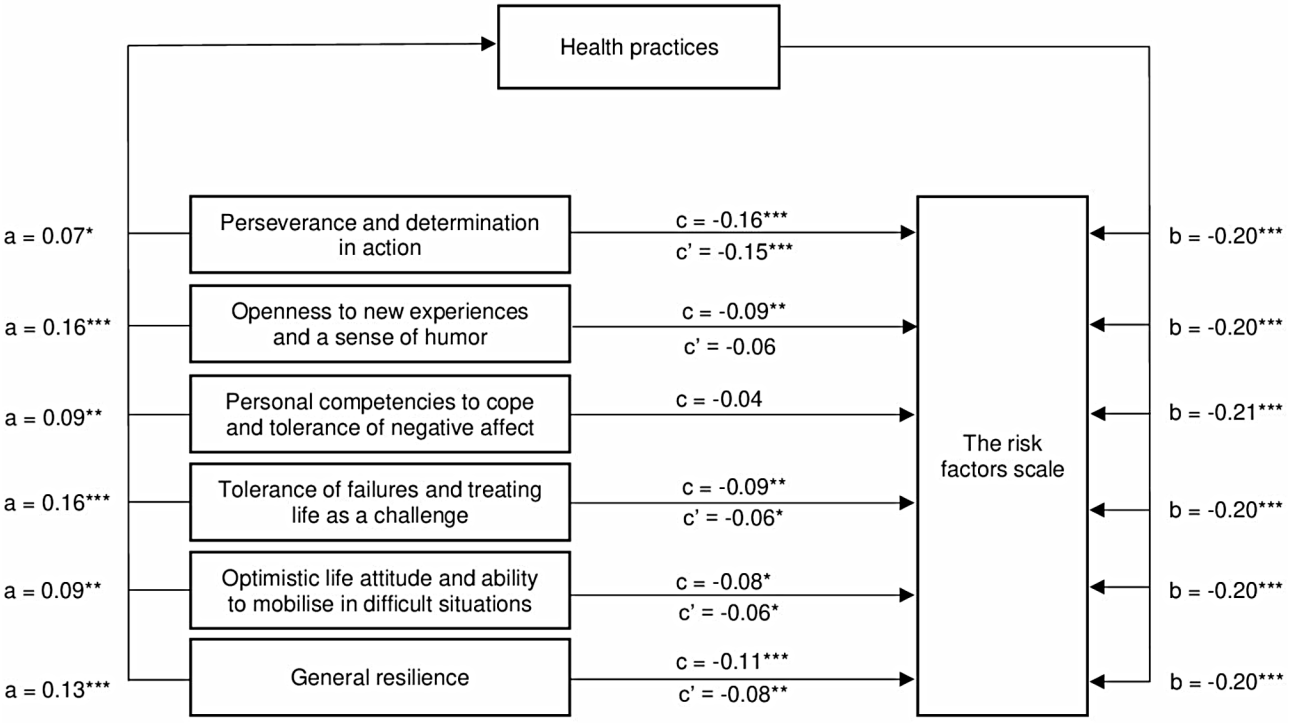

Fig. 5 The mediation model of the influence of the SPP-25 scale on the cardiovascular disease risk factors scale– the mediation role of health practices (HBI). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

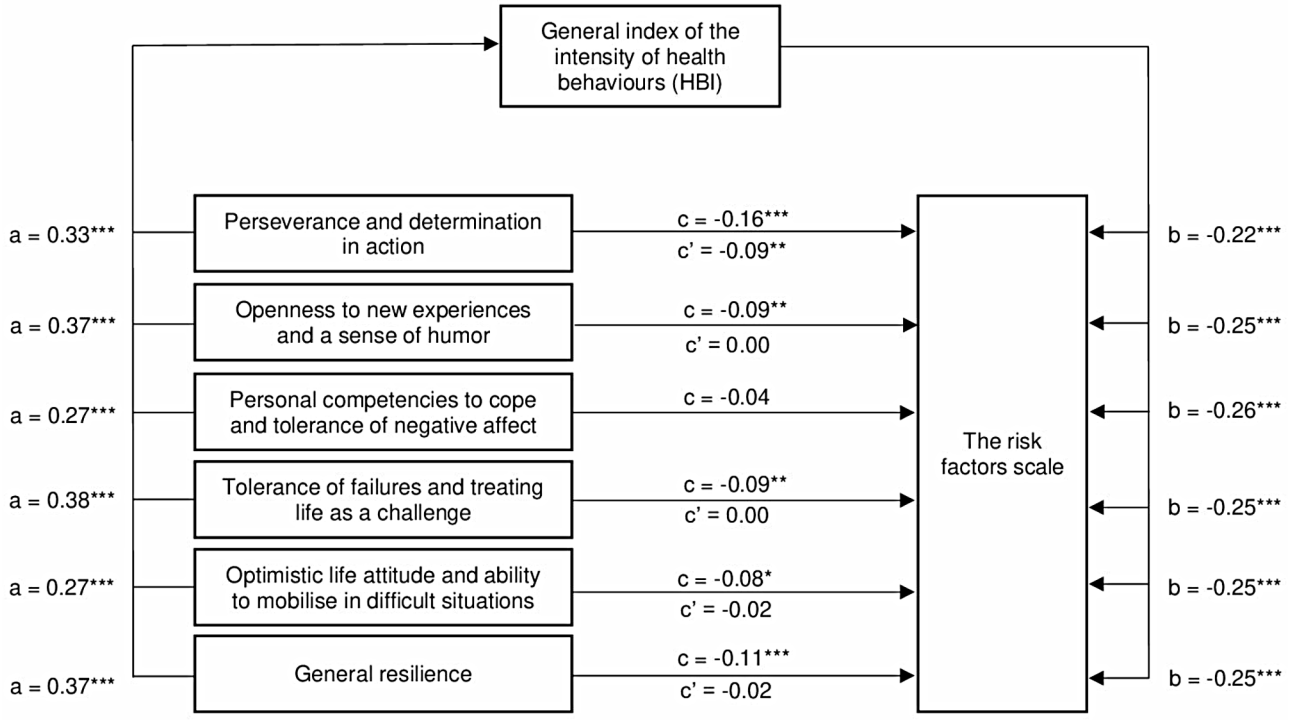

Fig. 6 The mediation model of the influence of the SPP-25 scale on the cardiovascular disease risk factors scale– the mediation role of general index of the intensity of health behaviours (HBI). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Discussion

The biopsychosocial model emphasizes the integration of biological, psychological, and social dimensions in understanding health and disease [37]. Within this framework, self-efficacy and psychological resilience are crucial psychological components that influence individual health outcomes and the ability to cope with challenges. Patients with higher self-efficacy are more likely to adhere to treatment plans, engage in regular physical activity, and maintain dietary restrictions, which lead to improved quality of life and reduced symptoms of depression [38, 39]. Concepts of self-efficacy and resilience often interact synergistically within the biopsychosocial framework. For instance, individuals with higher self-efficacy tend to display greater resilience as they are better equipped to set realistic goals, mobilize resources, and maintain a positive attitude [40].

Main results

The research studied the correlations between mental resilience and the cardiovascular risk in patients with CHDs incorporating the role of health-promoting behaviours as a mediator. Lower risk of CVDs was associated with higher values of the overall resilience and its components such as perseverance and determination, openness and sense of humour, tolerance to failure and perceiving life as a challenge as well as optimism and mobilization capability. What is more, greater resilience determined healthier eating habits, which, in turn, decreased the risk of CVDs. Greater intensity of health behaviours and higher indices of eating habits, prophylactic behaviours and health practices fostered lower risk of CVDs.

Cardiovascular risk and its correlation with mental resilience in patients with a CHD

It is well documented that with age, individuals with CHDs are at an increased risk of developing long-term complications associated with their specific cardiac defect, as well as lifestyle-related diseases that are prevalent in the general population, including CVD [4]. The self-reported study clearly showed that the largest group of patients with CHDs was susceptible to the CVD risk due to the prevalence of two risk factors. It was observed that 50% of respondents were subjected to a CVD due to the prevalence of three risk factors, and 25% of individuals due to four of them. It is worth highlighting that irrational nutrition constituted a risk factor of a CVD in a significant majority of the patients. What is more, over a half of the sample group was exposed to a CVD due to being overweight or obese and 25% of individuals were characterised with low physical activity. It suggests that there is a strong need to develop a more effective and targeted health care model for adults with a CHD [41]. In fact, circulatory system disorders affect physical and mental health. And as mental issues are linked with low physical condition, the need for better identification

strategies is increasingly noticed [6, 29]. The self-reported study aimed at evaluating mental resilience in patients with CHDs and the average score of the patients on the resilience scale (70.25 ± 14.43) is comparable to the values normalized for young population (below 40 years of age) which amounts to 70.24 ± 12.10, but lower than the index for the diabetics (72.75 ± 9.75) [13]. Undoubtedly, psychological resilience brings many benefits to both mental and physical condition. Resilient individuals more rarely experience emotional disturbances such as depression or anxiety [13].

Mental resilience is closely linked to better health outcomes, including a reduced risk of CVDs [15–18]. The physiological mechanisms underlying this relationship involve a range of processes that support heart and vascular health. First and foremost, mental resilience promotes effective regulation of the autonomic nervous system, helping to maintain a balance between the sympathetic and parasympathetic branches, thereby reducing the risk of hypertension and other circulatory disorders [42, 43]. Additionally, individuals with high mental resilience exhibit lower levels of inflammation, which plays a key role in preventing the development of atherosclerosis and other CVD. Another important mechanism is the improvement of endothelial function, which helps regulate blood pressure and maintain vascular elasticity. Reduced oxidative stress, resulting from the body's enhanced ability to cope with stress, protects blood vessels from damage that could lead to heart disease [44, 45].

The self-reported analysis revealed that the lowest result of all components of resilience was noted in terms of optimism and mobilization capability in difficult situations (12.97 ± 3.46). It was confirmed that greater perseverance and determination in action supported a lower risk of CVDs (r = -0.17; $p < 0.05$). Research underscores the need for greater focus on developing programs aimed at enhancing coping skills in challenging situations and fostering self-awareness among individuals with CHD. This is particularly crucial given the strong link between psychological resilience and positive emotions, which play a pivotal role in overcoming negative experiences. Positive emotions empower individuals with severe illnesses to manage difficulties more effectively, thereby fostering health-promoting mechanisms [13].

The role of health-related behaviours as a mediator in the relation between mental resilience and the CVD risk in CHD patients

Lifestyle including health-oriented behaviours plays a significant role in the process of shaping and protecting health as well as appears to be its main determinant. Lifestyle changes are getting more and more recognition as important ways to prevent and treat CVDs. The need to promote healthy lifestyle in adolescence and throughout adulthood in CHD patients shall also be indicated. The efforts may directly decrease the risk of CVDs and improve general quality of life in the population [25, 27, 46]. The general index of health behaviours in the respondents of the self-reported study was insignificantly higher (83.16 ± 12.94) than the value for general adult population in Poland (81.82 ± 14.16) but definitely lower than the one developed for diabetics (92.44 ± 11.59) [32]. The study, however, researched mainly the mediation role of health-related behaviours (HBI), including eating habits, prophylactic behaviours, positive mental attitude, health practices and general indicator of the intensity of the behaviours in correlation with mental resilience and the CVD risk factors scale. It was confirmed that eating habits have an indirect impact on the correlation. Greater mental resilience determined healthier eating habits which, in turn, lowered the CVD risks. Mental resilience, as the ability to adapt to difficulties and stress, plays an important role in shaping eating habits. Individuals with higher levels of mental resilience are more likely to choose healthier food options because they can more effectively cope with emotional impulses and stressful situations, which can lead to unhealthy eating behaviours and, as a result, to diseases such as obesity and cardiovascular disease [19, 47]. The key finding of the study is the result demonstrating that the mediation of health behaviours, such as eating habits, in the relationship between openness, sense of humor, tolerance for failure, optimism, mobilization, overall resilience, and the risk factors scale was complete. What is more, there is a direct correlation between perseverance and determination in action and the CVD risk factors scale. The conclusions above highlight the importance of a heart-healthy, balanced diet in the health education process for this patient group.

Prophylactic behaviours mainly refer to following medical recommendations and collecting data on health status and disease. It ought to be emphasised that gaining information about the course of the disease, its treatment and severity helps to adhere to health recommendations. Some reviews report on the improvement in check-up examinations in those patients who put more effort to gain information on their disease and were more engaged during doctor's consultations. The research also showed that lack of expectations in the matter determines lower quality of life results [48]. It is assumed that young CHD patients have good knowledge on their health condition, treatment applied and prophylactic practices. However, according to the existing studies, their knowledge is poor or of average level [46]. The self-reported study found that greater mental resilience facilitates higher evaluations of prophylactic practices. High psychological resilience facilitates better health-related decision-making, including adherence to preventive practices such

as screenings, vaccinations, and lifestyle changes. Individuals with high resilience are more effective in managing anxiety associated with medical procedures, which enhances their engagement in preventive actions. Greater mental resilience promotes a positive perception of the efficacy of preventive measures, thereby strengthening the motivation to adopt them. Moreover, psychological resilience supports evidence-based decision-making, facilitating the acceptance of modern preventive methods [49–52]. The examination also proved a significant role of health practices as they played a full mediation role in the relation between mental resilience and the CVD risk. The data collected require more precise attention on this matter and suggest further research in the subject.

It was also reported that positive attitude has a direct and positive impact on various aspects of mental resilience such as perseverance, openness, sense of humour and coping with adversities or optimism. What is more, it has a positive influence on the condition of the heart and may facilitate the decrease of the CVD risk [53]. The relation observed in the self-reported study between mental resilience and positive attitude proved the significance of behavioural and psychological aspects of health management. Positive mental attitudes play a key role in building mental resilience and may facilitate the decrease in the development of the CVD risks. Optimistic individuals have been found to have up to 50% lower risk of cardiac events compared to those with less optimistic outlooks. Positive emotions are also associated with beneficial biological indicators, such as lower blood pressure and healthier lipid profiles. Moreover, a positive attitude promotes healthier habits, including regular physical activity, a balanced diet, and avoiding harmful behaviours like smoking, which directly contribute to improved cardiovascular health. Positive thinking also helps mitigate the adverse effects of stress on the cardiovascular system [54]. The findings of this study affirm that mental health should be an integral component of strategies aimed at protecting cardiovascularhealth.

Existing reports indicate that basic health practices such as improving physical activity, proper diet, maintaining proper body mass, avoiding tobacco smoking and stress reduction play a crucial role not only in reducing the CVD risk but improving the general quality of life as well [21]. It should be noted that adolescence and early adulthood is the time when young people reach greater autonomy and independence which is frequently related to lifestyle changes. Unfortunately, they most often mean unhealthy foods consumption and physical activity drop, which may result in obesity and a higher CVD risk in later periods of life [55]. Greater mental resilience was associated with higher evaluation of health practices in the categories mentioned above. The results seem to be of great value as they indicate that the intensification of actions promoting health practices among CHD patients characterised with low mental resilience, may have important benefits in CVDs prevention. What is more, health practices played the role of a mediator in the relation between mental resilience and the CVD risk, which may modify the impact of various aspects of the resilience to cope with illness on the cardiovascular condition of health. The issue requires further research for better understanding of the interaction between health practices and mental resilience as well as developing precise individualized and effective interventions for CHD patients in order to prevent the CVD risk.

The study also found that greater perseverance and determination in action, openness to new experience and sense of humour, tolerance to failure and perceiving life as a challenge as well as optimism and mobilization in difficult situations were linked to a higher general index of the intensity of health behaviours. The mediation through health behaviours showed how important combining strong mental resilience with a proactive approach to health behaviours is in preventing CVD risk in patients with CHD. These two factors are particularly important, as they improve both mental well-being and physical health [54].

Expanding mental resilience may facilitate the improvement in the level of health behaviours in young adults with CHDs which, in turn, may decrease the cardiovascular risk. There are several mechanisms that may explain this process. Namely, high psychological resilience is often associated with a greater sense of control over one's health, which can lead to more informed decisions regarding a healthy lifestyle. Accordingly, younger individuals with CHD who feel they have control over their health may be more likely to engage in activities that reduce cardiovascular risk. Additionally, people with strong mental resilience tend to show greater motivation to adopt healthy habits [54]. This, in turn, may improve overall cardiovascular health in individuals with CHD.

Mental resilience may be improved by learning to cope with difficulties more effectively, motivating individuals to undertake new actions and changing behaviours (from anti-health ones to pro-health ones) as well as strengthening self-confidence, effectiveness and creativity [14]. What is more, the metanalysis by Joyce et al. shows that positive impact on mental resilience of an individual is affected by interventions based on the combination of cognitive-behavioural therapy and mindfulness techniques [56].

To conclude, the interaction between mental resilience and health promoting behaviours may have serious implications on the examination results in CHD patients including the reduction of the CVD risk. There is a strong need for further research to understand the correlations between mental resilience and the CVD risk in this group

of patients much better, as well as for the development of effective interventions in order to promote healthy habits, which may maximalize beneficial effects.

Strengths and limitations of the study

There are a few limitations of the study. The first one falls into a small target group and examining patients in one medical institution in Poland. This fact may significantly reduce the generalization value of the results regarding the whole population of CHD patients. What is more, limited access to a wide group of adult patients with CHDs may affect the study's reliability and representation of the collected results. Another issue concerns the health behaviour measurement performed with the use of a self-assessment tool. It might be subjective and the results may be less accurate and reliable. Nevertheless, the results collected may provide clinicians, researchers and CHD patients with valuable information emphasising the significance of complex healthcare which combines both medical and behavioural aspects to improve cardiovascular condition. In addition, the data may be used as supportive interventions in developing comprehensive models of healthcare for CHD patients. Therefore, we suggest more extensive research on a wider group of subjects and institutions as well as a more frequent application of the resilience measurement in CVD patients.

Conclusions

Health-related behaviours play a role of a mediator between mental resilience and the CVD risk in the group of young adults with a congenital heart defect. Mental resilience as a factor of mental health prevention and promotion is of a great importance in developing medical programmes targeted at decreasing the cardiovascular risk in patients with a congenital heart defect. The evaluation of resilience may facilitate better understanding of a patient and may provide them with more adequate healthcare.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22094-8.

Supplementary Material 1

Supplementary Material 2

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Author contributions
R.M. - development of the concept of research / scientific work, data compilation, methodology, analysis and interpretation of data, literature review, writing an article. E.S.C. - analysis and interpretation of data, literature review, writing an article and overseeing the final article. K.S. - analysis and interpretation of data and overseeing the final article. R.F. - development of the concept of research / scientific work and overseeing the final article. All authors reviewed the manuscript.

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Data availability
The data that support the findings of this study are available from Elżbieta Szlenk-Czyczerskaa upon reasonable request.

Declarations

Ethics approval and consent to participate
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the in compliance with the requirements of the Declaration of Helsinki of 1975 (amended in 2013). Informed verbal consent was obtained from all individual participants included in the study after providing information about the study content, procedures and data protection in writing, according to good epidemiological practice. This procedure was approved by the Bioethical Committee at the Silesian Medical University in Katowice (dated from 15/06/2015, no KNW/0022/KB/159/15).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Institute of Health Sciences, University of Opole, Katowicka 68 Street, Opole 45-060, Poland
[2]Division of Scientific Research Methodology, Department of Nursing, Faculty of Nursing and Midwifery, Wroclaw Medical University, ul. K. Bartla 5, Wroclaw 51-618, Poland
[3]Department of Paediatric Cardiology and Congenital Heart Defects, Faculty of Medical Sciences in Zabrze, Medical University of Silesia in Katowice, Curie-Sklodowskiej 9 Street, Zabrze 41-800, Poland

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