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Psychometric properties and normative data of the 10-item Connor–Davidson Resilience Scale among Chinese adolescent students in Hong Kong

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Abstract
This study aimed to assess the psychometric properties of the 10-item Connor–Davidson Resilience Scale (CD-RISC10) and generate normative data for Chinese adolescents. A total of 24,499 participants (male 52.1%, mean age 13.3 years) were enrolled in the school-based survey among 132 secondary schools in Hong Kong during 2017. The CD-RISC10 showed high reliability and confirmatory factor analysis supported a unidimensional structure. Metric invariance across the gender, age, and grade subgroups was demonstrated. CD-RISC10 scores were positively correlated with psychological well-being and negatively correlated with mental distress. Male and younger students had higher resilience scores. There were significant interaction effects of gender and age/grade, with CD-RISC10 scores decreasing with age/grade in females while similar trends were not observed in males. Overall, the findings suggest that CD-RISC10 is appropriate for use in Chinese adolescents. The availability of normative data will facilitate the interpretation and comparison of research results in future studies.

Keywords Adolescence · Resilience · Assessment · Gender · Normative data

Introduction

Adolescence is a period of stressful challenges, during which individuals undergo extensive physical, psychological, emotional, and personality formation. Adolescents are exposed to various risks and stressors related to relationships, academic stress, violence, and health threats [1]. Mental health problems affect 10–20% of children and adolescents worldwide and have long-lasting effects [2, 3]. The situation in Hong Kong is no less worrying: evidence has shown that 16.4% of adolescents in Grades 7–9 were diagnosed as having mental disorders and an additional 22% had related symptoms [4]. Adolescents in Hong Kong might be extremely vulnerable to mental distress, as living in a fast-paced and competitive international city well known for its high-density population

and housing. Parents always have high expectations of their children and young people are raised to excel due to a high-pressured, exam-oriented education system [5]. Lack of sleep is often reported among students and the increasing rate of suicide ideation and attempts amongst Hong Kong students in the past decade has aroused considerable concern [6]. It is hence especially essential for Hong Kong adolescents to learn positive adaption and successful coping with negative events and stressors to attain personal well-being.

In recent mental health research, the concept of resilience has received increasing attention as an important area of positive psychology [7]. Resilience is associated with reduced risks of mental disorders (e.g., depression, anxiety, and post-traumatic stress disorder) and risky health behaviors (e.g., substance use, unprotected sex, and violence behavior) in spite of adversities among adolescents [8]. Adolescents with weaker resilience are more likely than others to report interpersonal conflict (e.g., disconnection with others) and poor academic performance [9, 10]. Resilience has been commonly defined as a personality trait [11] or a cognitive process [1]. Some researchers suggested that resilience should be considered as a positive trait which represents the abilities to bounce back or recover from negative events and adversities [11]. Other researchers described resilience as the

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process of overcoming the negative effects of risk exposure, coping successfully with traumatic experiences, and avoiding negative trajectories associated with risks [1]. Another angle is to consider both the trait and process aspects, which view resilience as a stable trajectory of healthy functioning across time following adversity that includes the capacity for the processes of generative experiences, cognitive flexibility, and positive emotions [12].

The Connor-Davidson Resilience Scale (CD-RISC) is one of the most commonly used instruments for measuring resilience, which focuses on the personal trait and ability to endure difficult experiences [13]. It has undergone extensive validation that have shown adequate psychometrics performance in clinical and community settings, and has been translated into several languages (e.g., Indian [14] and Chinese [15]). The original version includes 25 items and five factors: (1) personal competence, high standard, and tenacity, (2) trust in one's instincts, tolerance of negative affect, and the strengthening effects of stress, (3) positive acceptance of change and secure relationships, (4) control, and (5) spiritual influences. Subsequent studies involving different age groups and cultures however, revealed unstable factor structures. Campbell-Sills and Stein therefore made a series of empirically driven modifications, resulting in a 10-item unidimensional scale that demonstrated excellent psychometric properties, which was highly correlated with the original version (r = .92) [16]. This short version has been easily adapted and implemented in large scale epidemiology studies [17, 18] and validated in different populations, including Spanish university students [19], French women [20], Chinese earthquake victims [18], and Australian athletes [21]. Strong associations between the 10-item CD-RISC scores and a wide range of constructs related to mental health and affect were found [18, 21]. To our knowledge, no population-based studies have investigated the psychometric properties of the 10-item CD-RISC in Chinese adolescents.

Resilience is determined in a diverse array of genetic, biological, psychological, social and cultural factors [16]. The level of resilience may vary across countries and populations [22]. Population-based norms on resilience measures are therefore potentially useful. Specifically, in the absence of defined cut-off points, as in the cases of resilience and many psychopathology measures, normative data of resilience facilitates interpretation of individuals' scale scores or group mean scores. Deviations from the norm's central tendency can be used to identify at-risk persons or tracking population shifts in resilience over time [23]. Population norm can also be used for comparing different subpopulations (e.g., gender, age, education), regions, and countries. Age and gender differences in resilience have been noted in previous studies [18, 19]. Men and younger age groups reported higher resilience scores, and identifying if there is a similar phenomenon in Hong Kong adolescents would be

of interest. In addition, population norms are widely used for reporting the effects of some interventions, especially when control groups are not available [24, 25]. For instance, the proportion meeting an external criterion (i.e., return to the health level of population norm) could be used to evaluate the clinic case studies and treatment programs, such as those targeting people with trauma or mental illness. Thus, a number of psychological scales (e.g., Depression Self-Rating Scale [26], Social Anxiety Scale [27], and Rosenberg Self-Esteem Scale [28]) have been normed among adolescent populations. However, to our best knowledge, only one study has provided normative data of the Resilience Scale (RS-11) in a German general population [22].

The study has two major objectives. First, we validated the 10-item CD-RISC (CD-RISC10) in a Hong Kong adolescent population-based student sample to establish its psychometric properties by analyzing its dimensionality, reliability and concurrent validity. We hypothesized that the total CD-RISC10 scores would be positively associated with positive mental health outcomes (e.g., optimism, social support, positive affect) and negatively associated with mental distress (e.g., depressive symptoms, loneliness). Second, we generated normative distribution data for CD-RISC10 and the effects of gender, age, and grade were investigated. It was hypothesized that boys would exhibit higher levels of resilience than girls, and adolescents with younger age and lower grade would have higher scores.

Methods

Study Sample

A school-based survey was conducted among the secondary 1 to 4 (7th to 10th year of formal education) students of 132 secondary schools (out of a total of 450) in the 18 districts of Hong Kong during September to November, 2017. Parents were informed about the survey and its purpose; they could return a form to the teachers if they wanted their students to opt-out but no objection was received. Participants were further explained that the participation was voluntary and anonymous, and the return of the completed questionnaire implied informed consent, which took about 15 min. No incentives were given. Two research assistants implemented the survey in classrooms in the absence of teachers. In total, 24,529 (98.8%) out of 24,817 students who were invited to join the study returned their questionnaire; 30 of those were excluded due to missing information on gender, grade, and psychosocial measurements, leaving 24,499 participants for the current analysis. A subset of 20 schools comprising of 7119 students were invited by convenience sampling to participate an additional survey for the validation study, which included a range of psychosocial measurements (i.e.,

depressive symptoms, optimism, and social support). Ethics approval was obtained from the Survey and Behavioral Research Ethics Committee in the relevant institution.

Measures

Resilience

The 10-item version of the Connor–Davidson Resilience Scale was used to measure resilience [16]. Participants rated items that referred to the situation during the last month on a 5-point Likert scale [0 (not true at all) to 4 (true nearly all the time]. The summative scale yields a score that ranges from a minimum of 0 to a maximum of 40 (the highest level of resilience).

Potential Correlates Used in the Validation Study

Self-esteem was assessed using the 10-item Rosenberg Self-Esteem Scale (RSES) [29] [4-point Likert scale: 1 (strongly disagree) to 4 (strongly agree)]. Higher scores reflected higher self-esteem. It has been validated and widely used in adolescent populations [30]. The Cronbach's α was 0.82 in this study.

Positive affect was measured by the 5-item Chinese version of the Positive Affect Subscale of the Positive and Negative Affect Schedule, which has been validated in adolescent populations [31, 32]. Participants were asked to rate the extent to which they had experienced each particular emotion within the last week, with reference to a 5-point Likert scale (1 = not at all or very slightly to 5 = extremely). Higher mean scores indicate higher levels of positive affect. Its Cronbach's alpha in the current sample was 0.87.

Optimism was assessed by the validated Chinese version of Life Orientation Test-Revised [33]. The scale has been widely applied in adolescent populations [34]. Sample item includes "In uncertain times, I usually expect the best". Responses were rated on a 5-point Likert-type scale ranging from strongly disagree (1) to strongly agree (5), with higher score indicating higher level of optimism. Coefficient alpha was 0.60.

Social support was measured by four self-constructed items ("I receive the support and help that I need from my family/friends" and "I can share my happiness and worries with my family/friends"). Items were rated on a 4-point Likert scale (strongly disagree to strongly agree). Coefficient alpha was 0.78 in the current study.

Happiness in life and meaning in life were assessed by a single item, respectively, "Do you feel that your life is happy?" and "Do you feel that your life is meaningful?" "No" was coded as 0 and "Yes" was coded as 1.

Depressive symptoms were measured by the validated Chinese version of 20-item Center for Epidemiology Studies Depression scale (CES-D) [35]. Symptoms include sleep disturbances, shifts in appetite, and feelings of sadness and loneliness, which are assessed on a 4-point Likert-type scale ranging from none of the time/rarely (0) to almost all the time/most (3). The total score ranges from 0 to 60, with higher scores reflecting higher risk for having depression. The Cronbach's alpha was 0.90.

Loneliness was assessed by the 3-item short form UCLA Loneliness Scale [36] on Likert scales (1 = I never feel in this way to 4 = I often feel in this way). Higher scores reflect higher levels of loneliness. The scale has been used in adolescent study [37]. The Cronbach's alpha was 0.88 in the current sample.

Negative experiences were measured by three self-constructed items. Items included "Do you often experience conflicts with other students;" "Do you often experience conflicts with family;" "Do you often experience academic pressure?" Items were rated on a Likert scale ranging from 1 = often to 4 = none.

Data Analysis

The factor structure of the 10-item CD-RISC was tested with confirmatory factor analysis (CFA), using the maximum likelihood approach. The goodness of model fit was evaluated using indices including the goodness-of-fit-index (GFI), the comparative fit index (CFI), root-mean-square error of approximation (RMSEA), and standardized root mean square residual (SRMR). For each index, the following criteria was applied to indicate a relatively good fit between the hypothesized model and the observed data [38, 39]: (1) GFI and CFI values greater than 0.95; (2) RMSEA value less than 0.06; (3) for SRMR, a value less than 0.08. Multiple-group analyses were performed to investigate whether the factor from CFA were invariant across gender, age, and grade groups. Each set of multigroup CFA included two models: an unconstrained model with no impositions of equality constraints (M1, configural invariance) and a constrained model that assumed all factor loadings being equal (measurement weights) across groups (M2, metric invariance). The fit of these two nested model is compared, with the following fit indices suggesting non-significant differences between groups (invariance): ΔCFI > −0.01 and ΔRMSEA < 0.015 [40]. The minimum discrepancy divided by its degrees of freedom (CMIN/DF) and chi-square difference test ($\Delta\chi^2/\Delta$df) between nested models were presented for completeness. However, as χ^2 is highly sensitive to sample size, a small misspecification might lead to a rejection of the hypothesis in case of a large sample size as in this study, CMIN/DF and $\Delta\chi^2/\Delta$df were thus only used as complimentary indicators [41]. For reliability, Cronbach's alpha of scales used in this study was reported. Finally, Pearson correlation coefficients between

resilience and other psychosocial measures were calculated for males and female separately to assess construct validity among the subsample of 7,119 individuals.

Descriptive statistics of scale scores were presented as mean, standard deviations (SD), median and interquartile ranges (IQR). In addition, two-way ANOVAs (analysis of variance) and linear regression models were used to test the differences in CD-RISC scores relative to gender, age and grade. To provide normative data for the CD-RISC10, we generated age-subgroup specific percentiles for the total score within male and female. Statistical significance was taken at $p < 0.05$. SPSS 24.0 (IBM Corp. Released 2016, IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) and Amos were used for all data analyses.

Results

Dimensionality: Internal Reliability and Confirmative Factor Analysis

The scale demonstrated satisfactory internal consistency, with Cronbach's alpha of 0.87 for male and 0.88 for female students. The unidimensional structure of the 10 item CD-RISC was supported by the confirmative factor analysis. The fit indices indicated an excellent model fit (CFI = .961, GFI = .972, RMSEA = 0.063, SRMR = 0.029). The standardized factor loadings ranged between 0.55 and 0.74 (all $p < 0.001$). Additionally, the measurement equivalency was tested by using multiple group comparisons with nested models. As shown in Table 2, the unconstrained models yielded satisfactory fit to the data across gender, age and grade groups. The results revealed that all the ΔCFI and ΔRMSEA between each set of nested models were less than 0.01 and 0.015, respectively, and that the chi-square difference tests were always non-significant (except for gender groups), which generally indicated no significant improvement in model fit by adding constraints in the factor loadings.

Construct Validity

The pattern of Pearson's correlations between the CD-RISC10 and the other psychosocial scales in the subsample is shown in Table 1, stratified by gender. As expected, CD-RISC10 was negatively correlated with the measures of loneliness, depressive symptoms and negative experiences, and positively correlated with optimism, social support, self-esteem, positive affect, happiness in life and meaning in life. The correlation coefficients ranged from − 0.26 (negative experience) to 0.53 (positive affect) for males and from - 0.27(negative experience) to 0.53 (positive affect) for

Table 1 Correlation of CD-RISC10 scores and psychosocial variables (n = 7119)

Variables	CD-RISC10		
	Total	Male	Female
Loneliness	− 0.304*	− 0.297*	− 0.300*
Depressive symptoms	− 0.466*	− 0.434*	− 0.491*
Negative experiences	− 0.269*	− 0.259*	− 0.271*
Optimism	0.458*	0.425*	0.514*
Social support	0.308*	0.326*	0.314*
Self−esteem	0.515*	0.499*	0.524*
Positive affect	0.536*	0.528*	0.533*
Happiness in life	0.312*	0.295*	0.340*
Meaning in life	0.298*	0.287*	0.319*

*$p < 0.001$

females, respectively. All correlations were statistically significant, with $p < 0.001$ (Table 2).

Descriptive and Normative Data

In the sample of the 24,499 participants, 12,756 (52.1%) were males. Their age ranged between 11 to 18 years and the mean (SD) age of the participants was 13.3 (1.3) years. Table 3 shows the mean (SD) and median (IQR) of the 10 item CD-RISC scores by age and grade for males and females. The mean (SD) of resilience scale scores for boys and girls were 25.1 (6.7) and 24.3 (6.1), respectively.

Age and Gender Differences

The two-way ANOVA (gender × age) revealed a significant main effect of gender ($F = 120.4$, d.f. = 1, $p < 0.001$), age group ($F = 14.4$, d.f. = 3, $p < 0.001$), together with a significant gender × age group interaction ($F = 22.1$, d.f. = 3, $p < 0.001$) for the CD-RISC10 scores. In general, males had higher CD-RISC10 score than females across different age subgroups (except for the youngest group). Regression model indicated that the CD-RISC10 score declined with increasing age among females (regression coefficient = − 0.412, $p < 0.001$) but the association was non-significant among males. As expected, both the main effects for gender ($F = 120.2$, d.f. = 1, $p < 0.001$) and grade ($F = 13.2$, d.f. = 3, $p < 0.001$) as well as their interaction effect were statistically significant ($F = 22.5$, d.f. = 3, $p < 0.001$), with CD-RISC10 score decreased with grade among girls (regression coefficient = − 0.574, $p < 0.001$) but not boys (Fig. 1). In the presence of such gender-age differences and interactions, we presented the percentiles of the CD-RISC scores by age and gender subgroups in Table 4.

Table 2 Measurement invariance: multi-group CFA fit indices for the CD-RISC10 across sex, age and grade groups

	Fit indices					Model comparison		
	χ^2/df	CFI	GFI	RMSEA	SRMR	$\Delta\chi^2$/Δdf	ΔCFI	ΔRMSEA
Total sample (N = 24,499)	98.4	0.961	0.972	0.063	0.029	–	–	–
Multi-group analysis by gender								
M1: unconstrained	51.8	0.959	0.971	0.046	0.026	–	–	–
M2: all loadings constrained	47.0	0.958	0.970	0.043	0.028	9.68	− 0.001	− 0.003
Multi-group analysis by age								
M1: unconstrained	25.3	0.949	0.964	0.032	0.035	–	–	–
M2: all loadings constrained	24.2	0.949	0.964	0.031	0.035	1.72	0.000	− 0.001
Multi-group analysis by grade								
M1: unconstrained	27.0	0.946	0.962	0.033	0.032	–	–	–
M2: all loadings constrained	25.8	0.946	0.962	0.032	0.032	1.54	0.000	0.000

CFI comparative fit index, *GFI* goodness-of-fit index, *RMSEA* root mean square error of approximation, *SRMR* standardized root mean square residual

Table 3 Descriptive data of CD-RISC10 scores by sex and age/grade subgroups

N (%)		Total (n = 24,499)			Male (n = 12,756)			Female (n = 11,743)		
		Mean(SD)	Median	IQR	Mean(SD)	Median	IQR	Mean(SD)	Median	IQR
Age groups (years)[a]										
≤ 12	7567 (31.3)	25.1 (6.5)	25	8	25.0 (6.7)	25	9	25.1 (6.3)	25	8
13	7492 (31.0)	24.6 (6.4)	25	9	25.0 (6.7)	25	9	24.2 (6.1)	24	8
14	4749 (19.6)	24.7 (6.3)	25	9	25.4 (6.6)	26	9	24.1 (6.0)	24	8
≥ 15	4385 (18.1)	24.4 (6.4)	24	9	25.2 (6.6)	25	9	23.5 (6.0)	23	8
Secondary grade										
1	9076 (37.0)	25.0 (6.6)	25	9	25.0 (6.8)	25	9	25.1 (6.3)	25	8
2	8936 (36.5)	24.6 (6.4)	25	9	25.0 (6.8)	25	10	24.1 (6.1)	24	6
3	4190 (17.1)	24.6 (6.2)	25	9	25.4 (6.4)	25	9	23.8 (6.0)	24	8
4	2297 (9.4)	24.3 (6.1)	25	8	25.2 (6.3)	25	8	23.4 (5.8)	23	7

[a]The numbers for the age groups do not add up to the totals due to missing data

Fig. 1 Mean score of CD-RISC10 for male and female students by age and grade subgroups
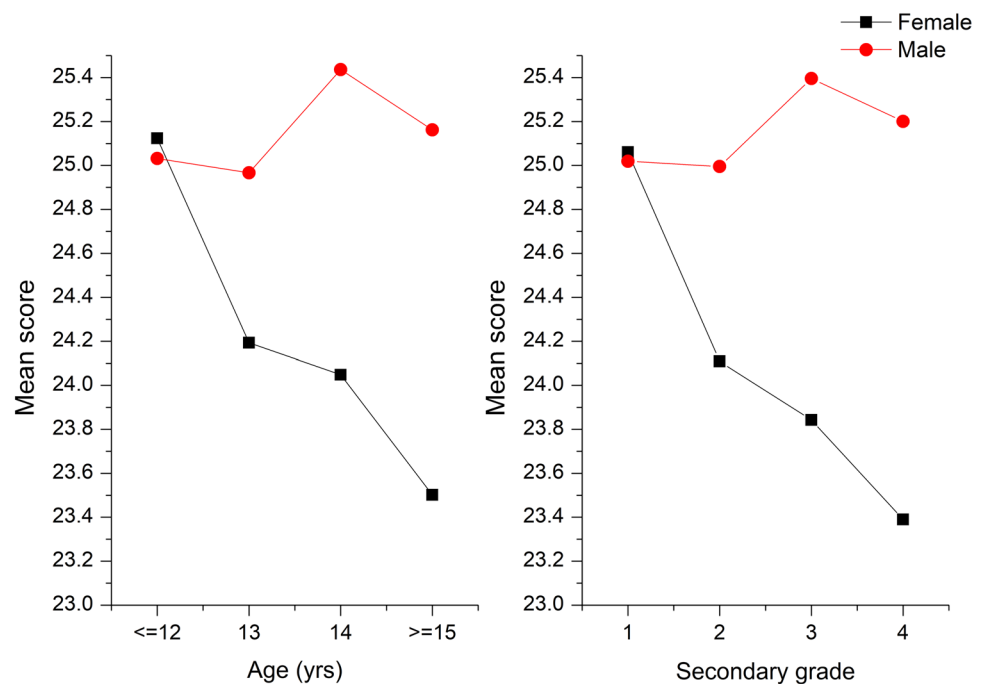
Table 4 Percentile rank of CD-RISC10 scores by gender and age subgroups

Age group	Total	Male					Female				
	11–18 years	≤ 12 years	13 years	14 years	15 years	≥ 16 years	≤ 12 years	13 years	14 years	15 years	≥ 16 years
Sum score	Percentile										
0	0.2	0.2	0.3	0.5	0.5	0.1	0.2	0.1	0.1	0.2	0.0
1	0.2	0.2	0.3	0.5	0.5	0.1	0.2	0.1	0.2	0.2	0.0
2	0.3	0.3	0.3	0.5	0.5	0.1	0.3	0.1	0.2	0.2	0.0
3	0.3	0.3	0.3	0.5	0.5	0.2	0.3	0.2	0.3	0.3	0.0
4	0.4	0.4	0.5	0.5	0.5	0.3	0.3	0.2	0.3	0.6	0.0
5	0.5	0.5	0.6	0.7	0.7	0.4	0.4	0.3	0.4	0.7	0.0
6	0.7	0.8	0.7	0.9	0.7	0.5	0.5	0.4	0.6	0.9	0.3
7	0.9	1.0	1.1	1.0	0.8	0.6	0.7	0.6	0.8	1.1	0.3
8	1.1	1.2	1.4	1.3	1.0	0.7	1.0	0.7	0.9	1.3	0.4
9	1.4	1.6	1.7	1.3	1.2	1.0	1.3	1.2	1.2	1.6	0.8
10	1.9	2.3	2.2	2.0	2.1	1.7	1.6	1.6	1.6	2.0	1.6
11	2.4	2.8	2.8	2.3	2.7	2.1	2.0	2.2	2.0	2.4	1.7
12	3.2	3.4	3.6	2.9	3.4	2.9	2.8	3.1	3.0	3.3	2.7
13	4.3	4.7	4.4	3.6	4.5	3.6	3.9	4.4	4.1	5.1	3.1
14	5.5	6.0	5.6	4.6	5.1	4.3	5.2	5.6	5.5	6.6	4.7
15	7.0	7.6	7.2	5.6	6.7	5.5	6.5	7.2	7.6	8.4	7.3
16	9.0	9.6	9.1	7.4	8.9	6.8	8.3	9.3	9.8	10.8	9.8
17	11.7	11.9	11.4	9.4	11.7	9.1	10.8	12.3	12.7	13.8	13.8
18	15.2	14.9	14.7	12.4	13.8	12.4	13.8	16.6	17.1	19.4	18.4
19	18.9	18.6	18.5	15.7	16.9	15.6	16.8	21.1	20.8	24.7	23.7
20	25.4	24.0	25.3	23.1	24.3	23.8	21.1	27.5	27.5	32.0	33.3
21	30.5	28.8	30.4	27.6	28.7	29.0	26.3	32.9	33.2	37.1	39.1
22	36.1	34.7	35.7	33.2	34.5	34.2	31.9	38.5	38.8	44.1	45.3
23	41.9	40.4	40.7	38.4	39.8	40.5	38.0	44.8	45.4	49.5	51.7
24	47.8	46.7	46.1	43.6	45.5	44.5	44.7	50.8	51.6	55.1	58.2
25	54.3	52.5	52.3	49.5	51.8	52.3	51.6	57.8	58.4	62.1	63.4
26	60.3	58.2	58.3	54.7	58.0	57.8	58.6	64.3	64.9	68.0	68.8
27	66.4	64.1	64.1	60.8	63.1	64.7	64.7	70.6	70.6	74.5	75.8
28	72.1	69.4	69.7	67.3	69.7	70.2	70.7	76.2	76.3	79.7	80.6
29	77.1	74.5	75.3	72.4	74.7	74.3	75.8	80.5	82.0	84.0	84.0
30	82.9	79.7	80.9	79.2	82.0	81.4	81.1	86.0	87.6	89.9	88.8
31	86.5	83.8	84.7	83.5	85.1	84.4	85.0	89.7	90.8	92.0	91.8
32	89.5	87.0	88.3	87.5	87.9	87.3	88.1	92.0	93.5	93.8	94.1
33	91.9	90.0	90.7	89.9	90.7	89.7	90.9	93.9	95.3	95.7	95.4
34	93.7	92.3	92.5	92.1	92.9	91.7	93.3	95.6	96.4	96.9	96.0
35	95.3	94.3	94.3	93.8	93.8	93.1	95.5	96.8	97.3	97.9	97.1
36	96.6	95.8	95.7	95.4	95.2	95.0	97.1	97.8	98.2	98.4	98.0
37	97.6	96.9	96.7	96.6	96.2	96.3	98.4	98.4	98.6	98.9	98.7
38	98.2	97.7	97.2	97.3	97.3	97.1	98.9	99.0	99.0	99.3	99.0
39	98.6	98.2	97.8	97.9	97.6	97.4	99.4	99.4	99.4	99.3	99.0

Note percentile indicate the rank of the subject compared to other subjects of the same age subgroups within sex

Discussion

In summary, the present study, with a large sample of about 24,000 adolescents, shows that the 10-item CD-RISC is a reliable and valid unidimensional self-report measurement of resilience in Chinese adolescents. We have generated normative data for CD-RISC10, stratified by gender and age subgroups. Furthermore, we find that males were more resilient than females, and that resilience decrease with age/grade among females but not males.

Consistent with the original design of the 10-item CD-RISC, the confirmatory factor analysis supported a single-factor model with superior model fit indices. Furthermore, metric invariance of the CD-RISC10 could be confirmed across gender, age, and grade groups, which indicated that adolescents had a similar CD-RISC factor structure and similar interpretation of the scale items regardless of gender and age. The internal reliability of this scale was satisfactory ($\alpha = .87$) and comparable to previous studies [18, 21]. Resilience has positive correlations with psychological well-being and negative correlations with vulnerability including depression, loneliness and negative life events, which is in accordance with prior studies [10, 22, 42]. These findings were relatively consistent across different subgroups, supporting the reliability and validity of the scale in the current sample. However, further psychometric evaluation is warranted if the scale is applied in different cultures or societies to increase the generalizability of the measure.

Corroborating previous studies [10, 19], male students had higher resilience scores relative to female students. In traditional Chinese culture, there was a strong gender preference for males, and this preference still persisted in Hong Kong [43]. The lower resilience among the female adolescents might be attributed to the gender prejudice in traditional Chinese culture. Nevertheless, the existence of gender-related differences in resilience is not consensual in the literature [44]. This may be partially due to variation in the definition and measurement of resilience used in various studies. In the present study, the measurement of resilience mainly focused on individual's ability and characteristics that enhances adaption, whereas some studies reported higher scores on social resources and family cohesion among girls [8, 45]. Boys may be more likely than girls to react to stressors at the individual-level such as personal competence and less likely to worry or ruminate [46] while girls' responses may employ more interpersonal and social skills (e.g. communication and seeking help from others) [8, 45]. Further studies may look at gender differences in specific domains under the general concept of resilience.

Our finding about the negative significant main effect of age on resilience was consistent with that reported in a previous study [7]. The significant interaction effect further introduced a new finding that the negative age trend was significant for females but not males. Males and females may have similar resilience level at age 11–12 and in Form 1; males' resilience remained stable along age/grade but females' resilience declined rather sharply with age (Fig. 1). Thus the development and changes in reslience seem to divert between male and female adolescents. Previous studies indicate that pubertal transition has greater negative psychological and social effects among girls [47], who are also are more likely to adopt dysfunctional attitudes and negative cognitive styles in response to negative event [48].

Our findings are consistent with the observed emerging sex differences in adolescent depression [49]. Further studies need to explain better the differential age trends. It is also important to see whether the observation remains true for older adolescents and youths.

The findings suggest that female adolescents have strong needs for resilience intervention when they get older. Some school based resilience promotion programs were found effective in reducing mental health problems including depressive symptoms for adolescents [50]. Key factors including positive family functioning and peer relationships, connections to supportive adults, playfulness, self-discipline, and cognitive ability, all contribute to a more successful transition to adulthood and more resilient functioning [51, 52].

The study has some potential limitations. Although the program included almost one third of total secondary schools in Hong Kong, selection bias may still exist. Since this study was conducted in Hong Kong, and its results therefore may only be relevant to this region and not to other countries in Asia or even to Mainland China. Secondly, the sample mainly confined to those aged between 12 and 16 years and cannot be extrapolated to other age groups. Thirdly, due to the nature of cross-sectional study, the results cannot establish predictive validity of the resilience scale. Lastly, the Cronbach's alpha for measure of optimism was relatively low.

Summary

We assessed the psychometric properties of the 10-item CD-RISC among a large sample of Chinese adolescent secondary students, including confirmatory factor analysis, reliability, and construct validity. The results suggest that CD-RISC10 is an appropriate measurement for resilience in Chinese adolescents. Male students' resilience remained stable during secondary school years while female students showed sharp decline of resilience scores with age/grade. The diverted trend of resilience with age across genders could have important implications for the psychological health and development of adolescents. Mental health interventions might focus more on vulnerable female students with lower level of resilience. In addition, the availability of age and gender specific normative data can be used by researchers and clinicians as reference data for comparisons and may be helpful in the interpretation of future resilience studies.

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Compliance with Ethical Standards

References

1. Fergus S, Zimmerman MA (2005) Adolescent resilience: a framework for understanding healthy development in the face of risk. Annu Rev Public Health 26:399–419
2. Kieling C, Baker-Henningham H, Belfer M, Conti G, Ertem I, Omigbodun O et al (2011) Child and adolescent mental health worldwide: evidence for action. Lancet 378:1515–1525
3. Kim-Cohen J, Caspi A, Moffitt TE, Harrington H, Milne BJ, Poulton R (2003) Prior juvenile diagnoses in adults with mental disorder: Developmental follow-back of a prospective-longitudinal cohort. Arch Gen Psychiatry 60:709–717
4. Leung PW, Hung S, Ho T, Lee C, Liu W, Tang C et al (2008) Prevalence of DSM-IV disorders in Chinese adolescents and the effects of an impairment criterion. Eur Child Adolesc Psychiatry 17(7):452–461
5. Tam VC, Chan RM (2010) Hong Kong parents' perceptions and experiences of involvement in homework: a family capital and resource management perspective. J Fam Econ Issues 31(3):361–370
6. Wong JP, Stewart SM, Claassen C, Lee PW, Rao U, Lam TH (2008) Repeat suicide attempts in Hong Kong community adolescents. Soc Sci Med 66(2):232–241
7. Seligman MEP, Steen TA, Park N, Peterson C (2005) Positive psychology progress: empirical validation of interventions. Am Psychol 60:410–421
8. Hjemdal O, Vogel PA, Solem S, Hagen K, Stiles TC (2011) The relationship between resilience and levels of anxiety, depression, and obsessive-compulsive symptoms in adolescents. Clin Psychol Psychother 18:314–321
9. Shumow L, Vandell DL, Posner J (1999) Risk and resilience in the urban neighborhood: predictors of academic performance among low-income elementary school children. Merrill-Palmer Quart 1982:309–331
10. Yu X, Lau JT, Mak WW, Zhang J, Lui WW (2011) Factor structure and psychometric properties of the Connor-Davidson Resilience Scale among Chinese adolescents. Compr Psychiatry 52:218–224
11. Carver CS (1998) Resilience and thriving: Issues, models, and linkages. J Soc Iss 54:245–266
12. Bonanno GA (2005) Resilience in the face of potential trauma. Curr Dir Psychol Sci 14(3):135–138
13. Connor KM, Davidson JR (2003) Development of a new resilience scale: the Connor-Davidson resilience scale (CD-RISC). Depress Anxiety 18:76–82
14. Singh K, Yu X (2010) Psychometric evaluation of the Connor-Davidson Resilience Scale (CD-RISC) in a sample of Indian students. J Psychol 1:23–30
15. Yu X, Zhang J (2007) Factor analysis and psychometric evaluation of the Connor-Davidson Resilience Scale (CD-RISC) with Chinese people. Sol Behav Personal 35:19–30
16. Campbell-Sills L, Stein MB (2007) Psychometric analysis and refinement of the Connor-Davidson Resilience Scale (CD-RISC): validation of a 10-item measure of resilience. J Trauma Stress 20:1019–1028
17. Aloba O, Olabisi O, Aloba T (2016) The 10-item Connor-Davidson Resilience Scale: factorial structure, reliability, validity, and correlates among student nurses in Southwestern Nigeria. J Am Psychiatr Nurses Assoc 22:43–51
18. Li W, Zhanbiao S, Yuqing Z, Zhen Z (2010) Psychometric properties of the 10-item Connor-Davidson Resilience Scale in Chinese earthquake victims. Psychiatry Clin Neurosci 64:499–504
19. Notario-Pacheco B, Solera-Martínez M, Serrano-Parra MD, Bartolomé-Gutiérrez R, García-Campayo J, Martínez-Vizcaíno V (2011) Reliability and validity of the Spanish version of the 10-item Connor-Davidson Resilience Scale (10-item CD-RISC) in young adults. Health Qual Life Outcomes 9:63
20. Scali J, Gandubert C, Ritchie K, Soulier M, Ancelin ML, Chaudieu I (2012) Measuring resilience in adult women using the 10-items Connor-Davidson Resilience Scale (CD-RISC). Role of trauma exposure and anxiety disorders. PLoS ONE 7:e39879
21. Gucciardi DF, Jackson B, Coulter TJ, Mallett CJ (2011) The Connor-Davidson Resilience Scale (CD-RISC): dimensionality and age-related measurement invariance with Australian cricketers. Psychol Sport Exerc 12:423–433
22. Kocalevent R-D et al (2015) Resilience in the general population: standardization of the resilience scale (RS-11). PLoS ONE 10:e0140322
23. HÅvard Loge J, Kaasa S (1998) Short form 36 (SF-36) health survey: normative data from the general Norwegian population. Scand J Soc Med 26:250–258
24. Hawthorne G, Osborne R (2005) Population norms and meaningful differences for the Assessment of Quality of Life (AQoL) measure. Aust N Z J Public Health 29:136–142
25. Norman R, Church J, van den Berg B, Goodall S (2013) Australian health-related quality of life population norms derived from the SF-6D. Aust N Z J Public Health 37:17–23
26. Ivarsson T, Gillberg C (1997) Depressive symptoms in Swedish adolescents: normative data using the Birleson Depression Self-Rating Scale (DSRS). J Affect Disord 42:59–68
27. Inderbitzen-Nolan HM, Walters KS (2000) Social anxiety scale for adolescents: normative data and further evidence of construct validity. J Clin Child Psychol 29:360–371
28. Bagley C, Mallick K (2001) Normative data and mental health construct validity for the Rosenberg self-esteem scale in british adolescents. Int J Adolesc Youth 9:117–126
29. Rosenberg M (1965) Rosenberg self-esteem scale (RSE). Acceptance and commitment therapy, Measures package, p 61
30. Ciarrochi J, Heaven PC, Davies F (2007) The impact of hope, self-esteem, and attributional style on adolescents' school grades and emotional well-being: a longitudinal study. J Res Pers 41:1161–1178
31. Watson D, Clark LA, Tellegen A (1988) Development and validation of brief measures of positive and negative affect: the Panas Scales. J Pers Soc Psychol 54:1063–1070
32. Melvin GA, Molloy GN (2000) Some psychometric properties of the positive and Negative Affect Schedule among Australian youth. Psychol Rep 86:1209–1212

33. Scheier MF, Carver CS, Bridges MW (1994) Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): a reevaluation of the Life Orientation Test. J Pers Soc Psychol 67:1063

34. Creed PA, Patton W, Bartrum D (2002) Multidimensional properties of the LOT-R: effects of optimism and pessimism on career and well-being related variables in adolescents. J Career Assess 10:42–61

35. Song Y, Huang Y, Liu D, Kwan JS, Zhang F, Sham PC et al (2008) Depression in college: depressive symptoms and personality factors in Beijing and Hong Kong college freshmen. Compr Psychiatry 49:496–502

36. Russell DW (1996) UCLA Loneliness Scale (Version 3): reliability, validity, and factor structure. J Pers Assess 66:20–40

37. Lemmens JS, Valkenburg PM, Peter J (2009) Development and validation of a game addiction scale for adolescents. Media Psychol 12:77–95

38. Lt Hu, Bentler PM (1999) Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Model 6:1–55

39. Hooper D, Coughlan J, Mullen M (2008) Structural equation modelling: Guidelines for determining model fit. Electron J Bus Res Methods 6:53–60

40. Chen FF (2007) Sensitivity of goodness of fit indexes to lack of measurement invariance. Struct Equ Model 14(3):464–504

41. Jöreskog KG (1993) Testing structural equation models. Sage Focus Ed 154:294–294

42. Smith BW, Dalen J, Wiggins K, Tooley E, Christopher P, Bernard J (2008) The brief resilience scale: assessing the ability to bounce back. Int J Behav Med 15:194–200

43. Kwan YK (2008) Life satisfaction and family structure among adolescents in Hong Kong. Soc Indic Res 86(1):59–67

44. Coleman J, Hagell A (2007) Adolescence, risk and resilience: Against the odds. Wiley, New York

45. Sun J, Stewart D (2007) Age and gender effects on resilience in children and adolescents. Int J Ment Health Promot 9:16–25

46. Guilera G, Pereda N, Paños A, Abad J (2015) Assessing resilience in adolescence: the Spanish adaptation of the Adolescent Resilience Questionnaire. Health Qual Life Outcomes 13:100

47. Conley CS, Rudolph KD (2009) The emerging sex difference in adolescent depression: Interacting contributions of puberty and peer stress. Dev Psychopathol 21:593–620

48. Hamilton JL, Stange JP, Abramson LY, Alloy LB (2014) Stress and the development of cognitive vulnerabilities to depression explain sex differences in depressive symptoms during adolescence. Clin Psychol Sci 3:702–714

49. Hankin BL, Abramson LY (2001) Development of gender differences in depression: an elaborated cognitive vulnerability–transactional stress theory. Psychol Bull 127:773

50. Dray J, Bowman J, Freund M, Campbell E, Wolfenden L, Hodder RK et al (2014) Improving adolescent mental health and resilience through a resilience-based intervention in schools: study protocol for a randomised controlled trial. Trials 15:289–289

51. Burt KB, Paysnick AA (2012) Resilience in the transition to adulthood. Dev Psychopathol 24:493–505

52. Wu G, Feder A, Cohen H, Kim JJ, Calderon S, Charney DS et al (2013) Understanding resilience. Front Behav Neurosci 7:10