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Validity and Reliability of the Connor-Davidson Resilience Scale (CD-RISC) in Competitive Sport

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Validity and Reliability of the Connor-Davidson Resilience Scale (CD-RISC) in Competitive

Sport: Further Support of the 10-item Connor Davidson Resilience Scale (CD-RISC-10)

by

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Abstract

Objective: This study replicates and extends the work of Gucciardi and colleagues (2011) in relation to the validity of the Connor-Davidson Resilience Scale (CD-RISC; Connor & Davidson, 2003) in sport. Three primary aims were explored: 1) Examine the factor structure and fit of three versions of the CD-RISC: the original 25-item CD-RISC, both as a 25-item five factor scale and as a 25-item unidimensional scale, and the 10-item CD-RISC-10; 2) examine gender invariance of the best fitting version of the CD-RISC; and 3) examine the validity of the best fitting CD-RISC by relating it to affect and performance anxiety in a sample of competitive American distance runners (N= 409).

Design: Cross-sectional.

Methods: Multiple self-report questionnaires were delivered through an online medium.

Results: Using confirmatory factor and item level analyses, the CD-RISC-10-item scale was psychometrically superior to the unidimensional 25-item and the five factor 25-item CD-RISC versions. The CD-RISC-10-item exhibited measurement invariance for gender, with significant configural, strong, and weak analyses. Using structure equation modeling, the CD-RISC-10-item scale moderately and positively correlated with positive affect and was inversely related to negative affect and performance anxiety, establishing convergent and divergent validity.

Conclusion: The findings support Gucciardi and colleagues' 2011 findings that the CD-RISC-10 is a valid and reliable instrument to assess resilient qualities in sport.

Key Words: *measurement, athletics, psychometrics, scale, instrument, adversity, runners*

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Sport: Further Support of the 10-item Connor Davidson Resilience Scale (CD-RISC-10)

Psychological resilience, or the ability to experience adversity and adapt positively

(Luthar & Cicchetti, 2000), has been identified as a desirable characteristic for athletes and

coaches in sport (Fletcher & Sarkar, 2012; Galli & Vealey, 2008; Hosseini & Besharat, 2010;

Gucciardi, Jackson, Coulter, & Mallett, 2011). Unfortunately, research involving resilience in the

sport context is limited (Gucciardi et al, 2011; Sarkar & Fletcher, 2013). One reason for this

deficiency is the lack of a valid and reliable construct specific measure of resilience in sport

(Gucciardi et al., 2011; Sarkar & Fletcher, 2013). Indeed, recent sport psychology researchers

note that one challenge of assessing resilience is that measurements developed for populations

other than athletes might not adequately assess resilience in sport settings (Sarkar & Fletcher,

2013). Recognizing the potential of resilience research to advance the knowledge base in sport

psychology and the inherent measurement limitations, our study examined the validity and

reliability of the Connor Davidson Resilience Scale (CD-RISC; Connor & Davidson, 2003),

including both the original 25-item and the 10-item version (Campbell-Sills & Stein, 2007;

Gucciardi et al., 2011).

Self-report assessments of resiliency originated in the field of developmental psychology

in the 1980s. Originally thought to be trait-like, resilience was first measured by Block and

Block (1980) who were interested in personality development from a psychoanalytic theory

perspective in young school children. Block and Block named their personality construct Ego

Resiliency (ER), but ER measurement was limited in scope to stable personality features

(Windle, Bennett, & Noyes, 2011). Since Block and Block's (1980) work, contemporary

resilience researchers agree that resilience is a dynamic process and the ability to become resilient can be learned and cultivated as opposed to a rigid personality trait (Bonanno, 2004; Kumpfer, 1999; Luthar & Cicchetti, 2000; Masten, 2001). With a need for a self-report measure congruent with contemporary resilience theory, Connor and Davidson (2003) created the CD-RISC, a 25-item measurement of resilient qualities thought to help individuals mitigate stress.

The CD-RISC was developed using constructs previously related to resilience, such as hardiness (Kobasa, 1979) and characteristics derived from the presence of protective factors found in research on resilient individuals (Lyons, 1991; Rutter, 1985). Items from the CD-RISC where tested in general and clinical populations, specifically individuals from a typical American community, primary care outpatients, general psychiatric outpatients, individuals with generalized anxiety disorders, and individuals with post-traumatic stress disorder (PTSD). The CD-RISC is comprised of five subscales (components of resilience) thought to encompass resilient qualities and behaviors in individuals who positively adapt despite adversity: personal competence and tenacity (8 items; e.g., "Even when things look hopeless, I don't give up"), trust in one's instincts and strengthening effect of stress (7 items; e.g., "Having to cope with stress can make me stronger"), accepting of change positively (5 items; e.g., "Past successes give me confidence in dealing with new challenges and difficulties"), control (3 items; e.g., "I feel in control of my life"), and spiritual influences (2 items; "When there are no clear solutions to my problems, sometimes fate or God can help"). Participants are instructed to indicate how much they agree with each statement as it applies to their life experience. If a situation has not happened to them, then they are to speculate how they would react. Responses to each item are on a five point Likert Type Scale (0- *not at all true* to 4- *true nearly all the time*). The range of the total scale is 0-100 with higher totals indicating greater resilience. An overall summary score

is calculated. Researchers examining the efficacy of resilience training have utilized the CD-RISC to trace resilience changes over time (Davidson, et. al., 2005), supporting validity of the instrument in an application context.

The 10-item version of the CD-RISC emerged from analyses conducted by Campbell-Sills and Stein (2007) while examining the psychometric structure of the original CD-RISC in multiple samples totaling over 1700 college students (74% female). Exploratory factor analyses (EFA) of the 25-item CD-RISC in two subsamples did not support the five factors originally proposed by Connor and Davidson. Several issues emerged, namely, inconsistent item loading across the EFAs, an item failed to load on a factor, a factor being defined by too few items, and factors being difficult to interpret because the items focused on more than one theme. This led the authors to examine shorter versions of the CD-RISC. What emerged was a unidimensional 10-item CD-RISC. A CFA analysis confirmed the construct validity of the 10-item CD-RISC, χ^2 (35)= 176.10, $p<$ .001, RMSEA= .050, 90% CI= .043-.057, CFit= 0.50, SRMR .028, CFI= .97, and determinacy= .93 (p. 1025; Campbell-Sills & Stein, 2007). The 10-item CD-RISC exhibited adequate internal reliability ($\alpha=$ .85). Concurrent validity was supported by the finding that resilience (measured with the 10-item CD-RISC) moderated the relationship between self-reported trauma and the expression of psychiatric symptoms. Participants rating themselves as higher in resilient qualities reported less symptomology. Campbell-Sills and Stein concluded, "...the 10-item CD-RISC measures a characteristic that differentiates individuals who are functioning well after adversity from those who are not" (p. 1026).

Further support for a shortened unidimensional version of the CD-RISC was found by Burns and Anstey (2010). The structural validity of the original 25-item five factor CD-RISC was examined by conducting a CFA in a population-based sample of 1,775 young adults in

Australia. Findings revealed a number of large Modification Indices, items that did not suitably differentiate the factors, a problematic GFI (.858) and a substantial amount of overlap between four of the five factors. The authors conducted further statistical analyses on a unidimensional CD-RISC by using an EFA with an oblique Direct Oblimin rotation with Parallel Analysis to allow any emerging factors to correlate with one another. The results of the EFA revealed that most items loaded on a single dimension, supporting the findings Campbell-Stills and Stein (2007); however, using Parallel Analysis to extract factors and noticing a lower than desired General Fit Index (GFI), Burns and Anstey settled on a slightly longer 22-item CD-RISC. Overall, the authors concluded that the two unidimensional versions of the CD-RISC were comparable and that the brevity of the 10-item version (Campbell-Stills & Stein, 2007) may be appealing to researchers.

Given the benefits of being resilient in sport, researchers have begun to explore the validity and reliability of the CD-RISC in athletic populations. Hosseini and Besharat (2010) are credited with the first use of the original 25-item CD-RISC in a sport context. In a sample of 139 (*n*= 96 male and *n*= 43 female) Iranian athletes, the CD-RISC was used to differentiate athletes on psychological well-being and performance. Athletes with more self-reported resilience had better psychological well-being and performances than athletes with less resilience. The authors did not explore the psychometrics of the scale outside of calculating Cronbach's alpha, which was reported to be sufficient (no numerical value was provided).

In the only psychometric study of the CD-RISC in sport to date, Gucciardi and colleagues (2011) examined the original 25-item CD-RISC (both as a five dimensional scale and a unidimensional 25-item scale), the 22-item scale recommended by Burns and Anstey (2010), and Campbell-Sills and Stein's 10-item CD-RISC in a sample of adult (*n*= 321) and youth (*n*= 199)

male and female Australian cricket athletes. Using CFAs, age variance testing, and convergent and divergent validity assessments, the 10-item version of the CD-RISC (Campbell-Sills & Stein, 2007) was deemed the best instrument for use with athletes. Specifically, the 10-item CD-RISC had better item level statistics and factor structure than all other CD-RISC versions for both adult, χ^2 (35)= 80.10, p= .001, RMSEA= .063, 90% CI= .045-.082, CFI= 0.947, TLI= .932, IFI= .947, and adolescents, χ^2 (35)= 61.34, p= .001, RMSEA= .062, 90% CI= .035-.087, CFI= 0.948, TLI= .934, IFI = .949 (p. 6). The original 25-item, five factor and the unidimensional 22-item CD-RISCs had poor model fit and exhibited poor item level analyses across adults and adolescents. These findings echo previous concerns about CD-RISC, namely poor clarity and labeling of the five factors and the use of an orthogonal rotation in the original EFA (Ahern et al. 2006). In summary, the 10-item unidimensional CD-RISC was the only version of the CD-RISC that emerged as a reliable and valid measure of resilience in a sport population.

While Gucciardi and colleagues' study was instrumental in finding support for a psychometrically sound measure of resilience, more than one study with one sport sample is needed to support the CD-RISC-10 as an appropriate measurement of resilience in sport. The purpose of our study was to partially replicate as well as extend the work of Gucciardi and colleagues (2011). We explored the factor structure of three versions of the CD-RISC in a sample of competitive post-collegiate American long distance runners. Specifically, we examined the validity and reliability of the original 25-item five factor CD-RISC, the 25-item unidimensional CD-RISC, and the 10-item version of the CD-RISC supported by Campbell-Sills and Stein (2007) and Gucciardi and colleagues (2011). The 22-item scale developed by Burns and Anstey (2010) was not included in this analysis because of its poor fit to the athlete population when compared to the original and 10-item CD-RISC (Gucciardi et al., 2011).

Furthermore, the psychometrics of the 22-item scale have yet to be replicated in studies outside of Campbell-Sills and Stein's (2007) original paper. Based on prior research (Gucciardi et al., 2011) it was hypothesized that the CD-RISC-10 would exhibit the strongest psychometric properties.

We also investigated how well the resultant best fitting CD-RISC predicted affect and performance anxiety, two hypothesized constructs associated with exhibiting resilience. This study extends current understanding by addressing three shortcomings noted by Gucciardi and colleagues (2011). Notably, a larger sample size was solicited, the association between resilience and positive adaptation was examined for validity purposes, and gender invariance testing was utilized to compliment the age invariance testing conducted by Gucciardi and colleagues (2011).

Affect and performance anxiety were included as outcomes of resilience for the present study given the strong conceptual and empirical support of these constructs (Fletcher & Sarkar, 2012; Southwick, Ozbay, Charney, & McEwen, 2008; Tugade, & Fredrickson, 2007; Waugh, Tugade, & Fredrickson, 2008) as evidence of positive adaptation, the hallmark of resilience (Lepore & Revenson, 2006; Luthar & Cicchetti, 2000). In sport it is theorized that positive adaptation following adversity involves coping well with anxiety (Martin-Krumm, Sarrazin, Peterson, & Famose, 2003) as well as maintaining positive affect (Galli & Vealey, 2008). To capture these variables, this study employed the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) and the Sport and Anxiety Scale-2 (SAS-2; Smith, Smoll, Cumming, & Grossbard, 2006) to measure affect and performance anxiety, respectively. The PANAS includes two subscales, positive affect and negative affect, and the SAS-2 includes three subscales, somatic anxiety, cognitive anxiety (worry), and concentration disruption. It was hypothesized that the strongest version of the CD-RISC should have a strong and positive

correlation with positive affect and a negative and strong correlation with negative affect, somatic anxiety, cognitive anxiety, and concentration disruption.

Methods

Participants

Participants were 405 (54.8% male and 45.2% female) competitive post-collegiate long distance runners from throughout the United States of America who were at least 18 years of age (M= 34.84, SD= 10.05). The sample was predominantly Caucasian (92.8%), with Hispanic (2.2%) and Asian (1.7%) individuals also represented more than others in the sample. Participants had a mean of 10.53 years of running experience (SD=8.73). In order to qualify as "competitive," participants had to have run at least three races in the past year with the minimum distance being 5,000 meters (5k) and the maximum distance being a marathon, as these race distances are some of the more contested distances in the United States. Over half of the sample self-indicated that they were generally successful in competing for an overall top five (22.3%) or age group top five (33.5%) placing when racing. The remaining participants (44.1%) were not as consistently successful in placing in the top five despite reporting themselves as competitive runners. Data collection took place via online survey. Runners were recruited by contacting running stores and running clubs and requesting the survey be posted via a link to their websites.

Measures

Resilience. The Connor Davidson Resilience Scale (CD-RISC; Connor & Davidson, 2003) was used to measure resilience. The CD-RISC (Connor & Davidson, 2003) contains 25 items and assesses five components of resilience (see introduction for item examples and number of items per component). Participants are instructed to indicate how much they agree with statements made in each item as they apply to their life experience. If a situation has not

happened to them, then they are to speculate how they would react. Responses are indicated on a

five point Likert Type Scale (0= *not at all true* to 4= *true nearly all the time*). The range of the

total scale is 0-100 with higher totals indicating greater resilience. Consistent with past research

(Hosseini & Besharat, 2010; Gucciardi, Jackson, Coulter, & Mallett, 2011) a sum resilience

score was calculated for the analysis. The CD-RISC has demonstrated good reliability ($\alpha = .88$

and .89), test-retest reliability (.87), and convergent and divergent validity in the development of

the scale (Connor & Davidson, 2003; Gucciardi et al., 2011).

Performance Anxiety. The Sport Anxiety Scale-2 (SAS-2; Smith, Smoll, Cumming, &

Grossbard, 2006) is a 15-item scale with three, five-item subscales: somatic anxiety (e.g., "My

body feels tense"), worry (e.g., "I worry that I will let others down"), and concentration (e.g., "I

cannot think clearly during the game"). Items are measured on a four point scale (1= *not at all* to

4= *very much*). Participants were prompted in the instructions to indicate reflectively how they

generally feel while racing and items were modified to reflect running (i.e, "game" was changed

to "race"). Subscale responses were summed (range 3-20). Smith and colleagues reported much

stronger validity and reliability for the SAS-2 in comparison to the original SAS and

recommended its use for both child and adult populations (Smith et al., 2006). Cronbach's alpha

for the SAS-2 in this study was .92, with alphas ranging from .77 to .86 for the subscales. The

SAS-2 subscales were used for the analysis.

Affect/Emotion. The Positive and Negative Affect Schedule (PANAS; Watson et al.,

1988) was used to assess affect and emotion. The PANAS is a 20-item questionnaire that

measures Positive and Negative Affect using adjectives to describe different feelings and

emotions. Participants were asked *in general* to rate their running experience. Positive and

negative affect subscales each have 10 adjectives that participants rate on a five point Likert

scale (1= *very slightly or not at all* to 5= *extremely*). Example items for positive affect include

"interested and strong" and for negative affect include "distressed and irritable." Reliability was

borderline acceptable, as Cronbach's alphas were .69 for positive affect and .65 for negative

affect for this study.

Procedures

Upon receiving IRB approval, participants were recruited primarily from running clubs,

running stores, and other running organizations. Interested athletes who met the criteria provided

above were given access an online web link via Survey Monkey. All participants provided

passive consent and completed the measures. Once the predetermined sample size was recruited

the web link was closed. At the end of the survey, all interested participants who wished to be

included in a drawing for a free pair of running shoes had their email addresses put into a hat and

a winner was chosen at random.

Data Analysis

MPlus 6.11 (Muthen & Muthen, 2014) was used to a conduct confirmatory factor

analysis (CFA) on the three versions of CD-RISC instrument and to model the CD-RISC to

affect/emotion and performance anxiety using structural equation modeling (SEM). CFA with

Maximum Likelihood estimation was used. All other analyses (normality analyses, descriptive

statistics, and demographics) were computed using SPSS 20.0 (IBM, 2012).

Results

All data were assessed for normality by examining skewness and kurtosis data, and all

measures had no univariate or multivariate normality issues as seen in Q-Q plots, histograms,

and Shapiro-Wilks tests. Missing data points, which were less than 8 percent of all data reported,

were accounted for using Expected Maximization (Tabachnick & Fidell, 2007). The means,

standard deviations, and Cronbach's alphas for all the variables and subscales in this study are displayed at the bottom of Table 1. The Cronbach's alphas for most of measures and subscales were all greater than or equal to .70, the recommended criteria when working in early stages of research (Nunnally, 1978). The only exceptions were the PANAS subscales and the spirituality scale from the 25-item five factor CD-RISC. Thus, findings in relation to these constructs should be interpreted with some caution.

Univariate Simple Comparisons

Table 1 displays the Pearson product correlations among the factors for the various forms of the CD-RISC. All were significant and positive ($r = .57 - .90$), with the exception of the spirituality factor (see factor 5 in the five factor CD-RISC). Spirituality was nominally related to the CD-RISC-10, as well as factor 2 – strengthening effect of stress – of the five factor CD-RISC ($r = .05$). A majority of the relationships between the factors of the versions of the CD-RISC and the outcome variables (affect and performance anxiety) were significant and in the expected direction (see Table 1). Greater resilience was related to more positive affect and less performance anxiety. Negative affect exhibited the weakest, and in most cases, non-significant, relationships with the versions of the CD-RISC. The CD-RISC-10 exhibited nominally stronger relationships in each regard. Collectively, these findings cast initial suspicion on the utility of the five factor CD-RISC and provide initial support for CD-RISC-10 as a measure of resilience in sport.

Confirmatory Factor Analyses (CFAs) of the CD-RISC

CFAs were conducted on the three variations of the CD-RISC (see the top portion of Table 2). In evaluating the fit indices for the models, the following parameters were used as recommended by Hu and Bentler (1997, 1999) and Bentler (2007): SRMR of .05 or less, TLI

of .95 or higher, RMSEA of .05 or less, and a CFI of .95 or higher. The CD-RISC-10 met all of the above indices recommendations for relative fit (TLI), absolute fit (SRMR), and non-centrality based fit (CFI and RMSEA). In contrast, the fit indices for the five factor model and the unidimensional model did not meet any of the adequacy criteria for model fit. These findings provide initial support for the validity of the CD-RISC-10 and suggest the five factor model and the unidimensional model might not be valid in sport.

The fixed factor method was utilized to compute standardized loadings (lambdas) and error terms (thetas) for each item of the CD-RISC versions in Table 3. Of the three models, the CD-RISC-10 had the most consistency in factor loading strength, and lower or comparable error terms, compared to both the original five factor CD-RISC and the unidimensional version of the CD-RISC. These findings provide further support for the validity of the 10-item version of the CD-RISC in sport. Because the CD-RISC-10 had the best emerging factor structure, item level analyses for this instrument were conducted (see Table 4). The CD-RISC-10 items had suitable corrected item-total correlation consistency and the Cronbach's alpha if item deleted remained consistently between .84 and .86, demonstrating that the items were equally good indicators of resilience. Finally, the factor loadings for all the CD-RISC-10 items were moderate to high, which further supports the internal validity of the measure.

Gender Invariance of the CD-RISC-10

Gender invariance testing was conducted on the CD-RISC-10, because it emerged as the best fitting model. The purpose of this invariance testing was to confirm there was no difference in measurement functioning by gender. The two group (males and females) configural CD-RISC-10 model was significant ($\chi^2 = 2094.25$; $p < .001$; see the bottom portion of Table 2). To test the loading structure of the CD-RISC-10 indicators, item loadings were equated across

gender to attain measurement weak invariance. The CD-RISC-10 model passed the weak invariance test based upon the change in CFI (ΔCFI = .004). Finally, the CD-RISC-10 indicator intercepts were equated across males and females to test for strong measurement invariance. This model passed the strong invariance test, based upon the change in CFI (ΔCFI = .008). As a result, measurement invariance was achieved between males and females on the CD-RISC-10. Importantly, gender invariance provides further support for the validity of the CD-RISC-10.

Structural Equation Model (SEM) of the CD-RISC-10 to the SAS-2 and the PANAS

To explore the predictive validity of the CD-RISC-10 it was modeled to positive and negative emotion, as well as performance anxiety (somatic, worry, and concentration disruption). It is important to note that at the configural level, three items of the negative affect subscale of the PANAS (ashamed, nervous, and jittery) exhibited poor standardized loadings. These items were removed at one time and the model fit was reevaluated. Hofmann (1995) justified this process as it retains the general hypothesized model but only with the best available indicators. The subsequent model had a good fit, χ^2= 3491.48, p= .001), NFI= .96, IFI= .97, CFI= .69, GFI= .97, TLI= .67, and SRMSR= .14, and the RMSEA was acceptable at 0.08 (Kline, 2011). The regression weights and item loadings for the measures are displayed in Table 5. As expected and depicted in Figure 1, resilience predicted affect and performance anxiety (R^2=76%). More specifically, greater resilience predicted less somatic anxiety (r= -.24), less cognitive anxiety (r= -.58), less cognitive disruption (r= -.38), greater positive affect (r= .67) and less negative affect (r= -.57). The relationships of the CD-RISC-10 to affect and performance anxiety were as hypothesized. Collectively these findings support the validity of the CD-RISC-10. Convergent validity was established with the relationship of the CD-RISC-10 to positive affect, and

divergent validity was established with the relationship of the CD-RISC-10 to negative affect, somatic anxiety, cognitive anxiety, and concentration disruption.

Discussion

The primary purpose of this study was to further assess the factor structures of various forms of the CD-RISC in a sample of competitive male and female distance runners. The supplemental purposes were to then test the best fitting scale's measurement properties for gender invariance and test hypothesized convergent and divergent validity. Overall, the CD-RISC-10 (Campbell-Sills & Stein, 2007; Gucciardi et. al., 2011) emerged as the most promising instrument, in comparison to the five factor CD-RISC (Connor & Davidson, 2003) and the unidimensional CD-RISC (Connor & Davidson, 2003). The CD-RISC-10 exhibited the best fitting factor structure, was internally reliable and invariant to the gender of the respondents. Furthermore, the resultant relationships of the CD-RISC-10 to pertinent outcome variables were consistent with resilience theory. Resilient qualities in male the female runners were able to predict a large amount of the variance in affect and performance anxiety.

The emergence of the CD-RISC-10 as the best instrument to assess resilient qualities supports previous research (Burns & Anstey, 2010; Gucciardi et al., 2011). Our findings replicate those of Gucciardi and colleagues (2011) and support concerns raised by Ahern and colleagues (2006) in relation to the original 25 item, five factor CD-RISC. It terms of concerns, the original five factor model did not fit the data, the item-factor linkage is a bit confusing, and the existence of only two questions tapping the spirituality dimension of resilience is problematic (Ahern, Kiehl, Sole, & Byers, 2006). Supporting the findings of Gucciardi and colleagues (2011), the CD-RISC-10 correlated quite strongly with the unidimensional model ($r = .90$) and

each of the five factors of the original model (r= .57 − 90) with the exception of spirituality (r= .05), suggesting a rather high degree of similarity between the measures (Gucciardi et al, 2011). In concert with previous research (Gucciardi et al, 2011) item number 6, "see the humorous side of things" exhibited the lowest loading (.459) on CD-RISC-10. However, the item exhibited a stronger loading in our study than reported in Gucciardi and colleagues' (2011) research (.34/.31). Furthermore, the reliability findings (corrected item-total correlation and alpha if item deleted) supported the integration of the item. Optimism and positive emotions are important components of exhibiting and building resilience (Tugade & Frederickson, 2004; 2007), but humor appears to be a factor that does not easily transfer to the sport context. Collectively, these mixed findings suggest the need to further examine the relevance of 'humor' in relation to assessment of resilience in sport.

We concur with Gucciardi and colleagues' (2011) contention that the CD-RISC-10 assesses personal qualities linked with resilience but not resilience per se. Traditional views of resilience contain two elements, namely, the ability to experience adversity and the ability to cope or adapt positively to such adverse experiences (Luthar & Cicchetti, 2000). The CD-RISC-10 contains three items that assess the ability to experience adversity ("deal with whatever comes," "not easily discouraged by failure," and "can handle unpleasant feelings"). It also contains three items that tap into positive adaptation ("adapt to change," "coping with stress strengthens" and "bounce back after illness or hardship") (Gucciardi et al., 2011). Thus, 60% of the instrument items tap into the components of resilience. The remaining items ("achieve goals," "see the humorous side of things," "under pressure focus and think clearly" and "think of self as a strong person") address qualities that might accompany resilience. No items capture the process of the experience of adversity plus positive coping. Thus, collectively the 10 items seem

to resilient qualities and behaviors rather than resilience. Statistically our findings and those of Gucciardi and colleagues (2011) support the unidimensional nature of the construct. There remains, however, some questions related to the conceptual coherence of the measure.

Prior research established the age invariance of the CD-RISC-10 (Gucciardi et al, 2011). We found support for the gender invariance of the measure. The CD-RISC-10 passed both the weak and strong invariance tests. These findings suggest that responses to the CD-RISC-10 do not vary across genders. Previous use of the CD-RISC has not found differences between males and females, but this was only determined by a t-test in a small sample of male and female Iranian athletes (Hosseini & Besharat, 2010). In sum, our findings relative to gender invariance suggest, importantly, that differences between the genders found at the latent level will be due to actual differences and not represent artifacts of measurement.

Findings related to the relationship between resilient qualities and predicted outcomes provided conceptual and validity support for the CD-RISC-10. Resilient qualities, as assessed with the CD-RISC-10, exhibited a moderate and positive relationship with positive affect and a moderate and negative relationship with negative affect. Thus, runners with resilient qualities are more likely to experience emotions such as excitement, enthusiasm, and interest. They are less likely to self-report being upset, distressed, and irritable. Our findings in relation to positive affect are logical given the conceptual importance of positive emotions in the resilience process (Tugade & Fredrickson, 2004). Positive emotions play a key role in an individual's ability to bounce back from adversity.

The findings relative to negative affect are cause for a bit of concern. This is due the measurement issues that arose in negative affect subscale of the PANAS in the measurement model of the SEM. A number of negative items did not load on negative subscale. Our finding

highlights the complexity of emotions in sport and how self-report assessments from general psychology (e.g., the PANAS) may not adequately translate to the sport context. For example, in this study the emotions that did not load on negative affect (ashamed, nervous, and afraid) may be interpreted in a facilitative way in the sport setting (Hanin, 1999). Emotion researchers in sport have documented that being nervous and fearful are often perceived as facilitative emotions that are used to prime athletes for competitions (Hanin, 1999). Simply categorizing emotions as negative or positive might be too simplistic for understanding emotional consequences of having resilient qualities. Further exploration of the negative emotional response pattern of athletes with resilient qualities is necessary to fully understand this issue.

We found that the CD-RISC negatively predicted performance anxiety. Specifically, the CD-RISC-10 inversely predicted somatic anxiety, cognitive anxiety, and concentration disruption. The relationships were weak to moderate with the strongest relationship emerging with worry (i.e. cognitive anxiety). Thus, runners with resilient qualities are less likely to experience body tension, shaky muscles, worry associated with not running well or letting down others, and are less apt to lose focus while running. Our findings support previous research (Fletcher & Sarkar, 2012; Martin-Krumm, Sarrazin, Peterson, & Famose, 2003) in relationship to resilience and competitive anxiety and stress. In general, resilient qualities may equip individuals with the ability to consistently approach competitive running events with generally less anxiety. Given that the sample had an average of just over 10 years of running experience, it is possible that many repetitions of running races and training provided these individuals confidence in their ability to handle demands both foreseen or unforeseen when competing. Indeed, previous experience is a predictor of developing resilience (Lepore & Revenson, 2006) and this may have contributed to the relationship of resilience and anxiety observed herein.

Several limitations should be noted. Our data was gathered online. While this is a very convenient method of data collection it is biased toward those with Internet access and it is possible that measurement error was inflated because we could not control or oversee survey completion. Our participants were runners with variable experience. Research thus far has examined the CD RISC in cricketers and runners. While examining team sport participants and individual sport participants is a plus, the total number and variety of samples examined in the literature remains quite low.

In summary, our findings, in combination those of Gucciardi and colleagues (2011), suggest that the CD-RISC-10 is a valid and reliable instrument in the sport setting. The CD-RISC-10 exhibited a strong factor structure and gender invariance, was internally reliable, and predicted both affect and anxiety in the expected directions. We concur with Gucciardi et al. (2011) in recommending it be used to assess resilient qualities and not resilience in sport.

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Table 1.

Means, Standard Deviations, Cronbach's Alphas, and Pearson Product Correlations Among Major Measures.

Measures	1	2	3	4	5	6	7	8	9	10	11	12
CD-RISC 5- Factor Scale												
1. CD-RISC Factor 1 (Competence)	-----											
2. CD-RISC Factor 2 (Strengthening effect of stress)	.67**	-----										
3. CD-RISC Factor 3 (Positive acceptance of change)	.69**	.67**	-----									
4. CD-RISC Factor 4 (Perceptions of Control)	.62**	.52**	.54**	-----								
5. CD-RISC Factor 5 (Spirituality)	.16**	.05	.14**	.32**	-----							
6. CD-RISC 25-item Scale	.88**	.84**	.82**	.77**	.36**	-----						
7. CD-RISC-10-item Scale	.81**	.90**	.84**	.57**	.05	.90**	-----					
8. Positive Affect	.40**	.20**	.26**	.24**	.20**	.33**	.67**	-----				
9. Negative Affect	.19**	.02	.10	.03	.10	.13*	.08	.26**	-----			
10. Somatic	-.13**	-.21**	-.12*	-.13**	-.03	-.14**	-.21**	.17**	.42**	-----		
11. Worry	-.19**	-.24**	-.24**	-.26**	-.02	-.21**	-.29**	.17**	.38**	.52**	-----	
12. Concentration	-.30**	-.25**	-.34**	-.27**	-.01	-.27**	-.34**	.04	.21**	.42**	.50**	-----
Mean	26.45	20.57	16.41	9.27	5.18	78.12	31.14	31.52	26.36	9.20	9.51	6.54
Standard Deviation	3.80	3.80	2.53	2.06	2.28	10.91	5.08	3.85	3.89	2.80	3.39	1.85
Cronbach's Alpha	.84	.78	.75	.72	.67	.89	.87	.69	.65	.82	.91	.77

Note: ** Correlations are significant at *p* < .01. * Correlations are significant at *p* < .05. Shaded area reflects CD-RISC-10-item scale and correlations amongst other constructs.

Table 2
Goodness of fit indices for the three CD-RISC models and Gender Invariance of the 10-item CD-RISC.

Model	χ^2	df	p	RMSEA(90%)	SRMR	CFI	TLI
Original 5-Factor CD-RISC	837.615	265	<.001	.073(.068-.097)	.064	.838	.816
Unidimensional 25-item CD-RISC	1150.411	275	<.001	.089(.083-.094)	.075	.752	.729
Unidimensional 10-item CD-RISC	69.446	35	.005	.049(.032-.066)	.032	.971	.963
Gender Invariance Testing	χ^2	df	p	RMSEA(90%)	SRMR	CFI	TLI
Configural Two Group	2094.247	1368	<.001	.052(.047-.056)	.080	.909	.866
Weak Two Group	2158.461	1401	<.001	.052(.048-.056)	.086	.905	.863
Strong Two Group	2254.405	1434	<.001	.054(.049-.058)	.086	.898	.855

Note: Residual error terms were not correlated. RMSEA is the Root Mean Square Error of Approximation, SRMR is the Standardized Root Mean Square Residual, CFI is the Comparative Fit Index, and TLI is the Tucker Lewis Index.

Table 3
Standardized factor loadings (λ) and error terms (θ) of the three CD-RISC models using fixed factor method.

CD-RISC Items	Model 1 λ	Model 1 Θ	Model 2 λ	Model 2 Θ	Model 3 λ	Model 3 Θ
1. Adapt to change	.595	.037	.542	.037	.599	.036
2. Close and secure relationships	.390	.047	.394	.044	----	----
3. Sometimes fate or god can help	.661	.061	.071	.052	----	----
4. Can deal with whatever comes	.719	.030	.655	.031	.701	.030
5. Past success gives confidence for new challenge	.656	.034	.605	.034	----	----
6. See humorous side of things	.448	.044	.416	.044	.459	.043
7. Coping with stress strengthens	.565	.038	.559	.036	.589	.037
8. Tend to bounce back after illness or hardship	.606	.036	.573	.036	.580	.037
9. Things happen for a reason	.780	.067	.202	.050	----	----
10. Best effort no matter what	.552	.039	.511	.039	----	----
11. You can achieve your goals	.653	.033	.621	.033	.549	.039
12. When things look hopeless, I don't give up	.656	.033	.617	.033	----	----
13. Know where to turn for help	.582	.040	.476	.041	----	----
14. Under pressure, focus and think clearly	.723	.028	.673	.030	.694	.030
15. Prefer to take the lead in problem-solving	.603	.036	.561	.036	----	----
16. Not easily discouraged by failure	.603	.035	.603	.034	.588	.037
17. Think of self as strong person	.770	.025	.772	.023	.731	.028
18. Make unpopular or difficult decisions	.657	.033	.587	.035	----	----
19. Can handle unpleasant feelings	.667	.032	.610	.034	.656	.033
20. Have to act on a hunch	.351	.048	.374	.045	----	----
21. Strong sense of purpose	.759	.032	.564	.036	----	----
22. In control of your life	.688	.035	.625	.033	----	----
23. I like challenges	.686	.030	.671	.030	----	----
24. You work to attain your goals	.353	.047	.312	.047	----	----
25. Pride in your achievements	.454	.043	.420	.043	----	----

Note: Model 1: Original 5-Factor CD-RISC, Model 2: Unidimensional 25-item CD-RISC, & Model 3: Unidimensional 10-item CD-RISC.

Table 4

Item statistics for the CD-RISC-10-item model of resilience.

CD-RISC-10 Items	Mean	S.D.	Skewness	Kurtosis	Corrected Item-Total Correlation	Alpha if Item Deleted
Adapt to change	3.03	.71	-.53	1.04	.57	.85
Can deal with whatever comes	3.26	.71	-.50	-.51	.66	.85
Tries to see humorous side of problems	3.10	.84	-.57	-.45	.46	.86
Coping with stress can strengthen me	3.05	.78	-.46	-.14	.55	.86
Tend to bounce back after illness of hardship	3.27	.71	-.72	.32	.55	.86
Can achieve goals despite obstacles	3.36	.65	-.72	.44	.53	.86
Can stay focused under pressure	2.97	.73	-.09	-.67	.66	.85
Not easily discouraged by failure	2.89	.85	-.50	.27	.55	.86
Thinks of self as a strong person	3.28	.73	-.79	.24	.68	.84
Can handle unpleasant feelings	2.93	.82	-.61	.39	.62	.85

Note: Full 10-item CD-RISC Cronbach's alpha = .87.

Table 5.
SEM Standardized Loadings for All Measures and Regression Weights for Resiliency to Somatic Anxiety, Worry, Concentration Disruption, Positive Affect, and Negative Affect.

Scale and Items	Loadings (Female/Male)	R
Somatic Anxiety		-.24
My body feels tense.	0.65 / 0.66	
I feel tense in my stomach.	0.67 / 0.60	
My muscles feel shaky.	0.66 / 0.69	
My stomach feels upset.	0.62 / 0.55	
My muscles feel tight because I am nervous.	0.75 / 0.75	
Worry		-.58
I worry that I will not play well.	0.86 / 0.82	
I worry I will let others down.	0.65 / 0.62	
I worry I will not play my best.	0.90 / 0.91	
I worry that I will play badly.	0.92 / 0.91	
I worry that I will mess up during the game.	0.79 / 0.80	
Concentration Disruption		-.38
It is hard to concentrate on the game.	0.59 / 0.54	
It is hard for me to focus on what I am supposed to do	0.68 / 0.68	
I lose focus on the game.	0.60 / 0.68	
I cannot think clearly during the race.	0.69 / 0.70	
I have a hard time focusing on what my coach tells me.	0.64 / 0.68	
Positive Affect		.67
Interested.	0.69 / 0.76	
Excited.	0.74 / 0.75	
Strong.	0.55 / 0.55	
Enthusiastic.	#9 = -0.27 / -0.04	
Proud.	0.80 / 0.80	
Alert.	#12 = -0.26 / -0.0	
Inspired.	#14 = -0.19 / -0.1	
Determined.	0.64 / 0.71	
Attentive.	0.64 / 0.62	
Active.	0.65 / 0.61	
Negative Affect		-.57
Distressed.	0.63 / 0.73	
Upset.	0.70 / 0.69	
Guilty.	0.70 / 0.70	
Scared.	0.27 / 0.34	
Hostile.	0.46 / 0.55	
Irritable.	0.67 / 0.62	
Interested.	0.20 / 0.32	
Resilience (formative construct)		N/A
Adapt to change.	0.60 / 0.63	
Can deal with whatever comes.	0.69 / 0.70	
See humorous side of things.	0.44 / 0.49	
Coping with stress strengthens.	0.57 / 0.59	
Tend to bounce back after illness/hardship.	0.58 / 0.65	
You can achieve your goals.	0.55 / 0.57	
Under pressure, focus and think clearly.	0.72 / 0.68	
Not easily discouraged by failure.	0.57 / 0.64	
Think of self as strong person.	0.73 / 0.71	
Can handle unpleasant feelings.	0.64 / 0.68	

Note: Fit Statistics for the Structural Equation Model (SEM): χ^2= 3491.48; df= 933; p= .001; NFI= .96; IFI= .97; CFI= .69; GFI= .97; TLI= .67; RMSEA= .08; SRMSR= .14; R^2=76%.

Figure 1.
Sport Resilience Model (SRM)