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Negative Life Events as a Mediator of the Relationship Between Optimism and Cardiovascular Reactivity

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ABSTRACT

Blunted cardiovascular reactivity (CVR) is associated with adverse health outcomes such as depression, obesity, and increased carotid intima-media thickness. Research indicates that significant negative life events (NLE) contribute to reduced CVR and related health issues, with individual perceptions and coping mechanisms playing a crucial role. Optimism, which is linked to fewer reported NLEs and better cardiovascular health, may improve coping processes, thereby reducing NLE's impact on CVR. This study investigated how NLEs mediate the relationship between optimism and CVR. The sample consisted of 199 adults recruited from universities in Ecuador. Participants completed psychological assessments prior to a controlled 45-min experimental session, which included baseline cardiac activity measurements followed by the PASAT task. The findings indicated that the number of NLEs mediates the relationship between optimism and diastolic blood pressure (DBP) reactivity, while optimism also exerts a direct effect on CVR beyond this mediation. Specifically, a significant inverse relationship was observed between the number of NLEs and DBP reactivity, alongside a positive relationship between optimism and DBP reactivity. Additionally, pessimism was associated with reduced systolic blood pressure (SBP) reactivity, though neither pessimism nor NLEs showed any effect on heart rate. These results highlight the protective role of optimism in modulating stress-related impacts on CVR and align with previous research suggesting that low CVR might be a result of maladaptive stress responses.

1 | Introduction

Blunted cardiovascular reactivity (CVR) has been associated with adverse health outcomes, including depression (Brugnera et al. 2019), obesity (Carroll et al. 2008), and increased carotid intima-media thickness (Ginty et al. 2016). Research on maladaptive CVR patterns has emphasized the role of stressful life events in reduced CVR (Ginty and Conklin 2011). These events represent instances of exceptionally high stress that may persist over time. Significant negative life events (NLEs) are likely associated with heightened physiological distress, leading to diminished CVR and subsequent health complications (Alvarenga and Byrne 2016). The perception of NLEs is influenced by individuals' perspectives and coping mechanisms, both of which are closely tied to personality traits (Oshio et al. 2018).

In this context, research has shown that optimistic individuals tend to report fewer NLEs and perceive these events as less impactful (Bayrami et al. 2012; Chang and Sanna 2003; Puig-Perez et al. 2017). In the context of cardiovascular diseases, heightened optimism has been associated with a reduced risk of heart failure, a lower incidence of cardiovascular diseases, and improved cardiovascular health (Kim et al. 2011, 2014; Krittanawong et al. 2022). The mechanisms by which optimism may protect against cardiovascular disease are not fully understood (Amonoo et al. 2021). It is possible that optimism strengthens coping processes during stressful situations, reducing the impact of NLEs on CVR (Fournier et al. 2002). This implies that optimism's effect on CVR may be mediated by its role in coping with NLEs. Therefore, this study aimed to explore the mediating effect of NLEs in the relationship between optimism and CVR.

1.1 | Cardiovascular Reactivity

Cardiovascular reactivity (CVR) refers to the physiological changes in blood pressure, heart rate, and cortisol levels in response to various internal and external stimuli. CVR is quantified through measurements of systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR; Allen 2013). Prospective studies suggest that maladaptive CVR responses to psychological stress, especially pronounced ones, may contribute to the pathogenesis of cardiovascular diseases, such as coronary heart disease (CHD), hypertension, strokes, atherosclerosis, and increased mortality (Allen 2013; Chida and Steptoe 2008; Turner et al. 2020).

Similarly, diminished CVR also indicates cardiovascular dysregulation (Carroll et al. 2017) and is associated with negative health outcomes such as obesity (Carroll et al. 2008), impaired cognitive function (Ginty et al. 2012), substance abuse (Lovallo 2005), depression (Brugnera et al. 2019), increased carotid intima-media thickness (Ginty et al. 2016), and self-reported poor health (Turner et al. 2020). Overall, elevated blood pressure, hypertension, and cardiovascular disease represent a significant global health burden, accounting for approximately 32% of all deaths worldwide, highlighting the vital role of CVR in health and mortality (WHO 2021).

1.2 | Negative Life Events and Cardiovascular Reactivity

A meta-analysis of studies from 1988 to 2008 revealed that individuals experiencing NLE exhibited an anomalous reduction in CVR during episodes of psychological stress (Chida and Hamer 2008), suggesting that repeated exposure to life challenges may contribute to a blunted cardiovascular response to acute stressors. These findings are consistent with previous research indicating an inverse correlation between the number of NLE and parameters such as DBP and HR during mental arithmetic tasks, video games, cold pressor tests, and simulated driving tasks (Chida and Hamer 2008).

Overall, individuals experiencing a higher number and perceived stressfulness of NLE are predisposed to various pathologies, including attenuated cardiovascular responses, diminished cognitive abilities, depression, addictive behaviors, and antisocial tendencies (Allen 2013). For instance, in a study involving young adults, Ginty and Conklin (2011) observed that individuals who perceived their lives as relatively more stressful exhibited reduced CVR to acute stressors. Furthermore, young and middle-aged adults with higher chronic stress scores demonstrated attenuated SBP responses during tasks involving mental arithmetic and public speaking (Matthews et al. 2001).

The perception of NLE is modulated by individuals' perspectives and their coping mechanisms, both of which are intricately linked to personality traits (Oshio et al. 2018). Drawing from the cognitive stress model (Lazarus and Folkman 1984), personality exerts a significant influence over how individuals manage and cope with stress. Laboratory studies investigating stress-inducing stimuli have consistently demonstrated the impact of personality styles on stress appraisals, effort exertion, and motivation levels (Harper et al. 2016; Kemper et al. 2008), underscoring their pivotal role in studying CVR.

1.3 | Optimism and Negative Life Events

Optimism, conceptualized as a stable expectation that positive outcomes will occur in the future (Scheier and Carver 1985), plays a crucial role in self-regulation, motivating active efforts to achieve goals despite obstacles. Higher levels of optimism are associated with reduced psychopathology, enhanced well-being, and overall improvements in health across various populations (Chida and Steptoe 2008; Lee et al. 2019). Specifically, optimism has been found to moderate the relationship between stress and both psychological and physical adjustment. Studies have shown that the negative effects of stress on depressive and psychological symptoms are more pronounced in those with higher levels of pessimism (Bayrami et al. 2012; Marton et al. 2022). This could be because positive cognition mitigates the impact of stress, serving as a buffer.

In the context of NLE, optimism has been shown to exert a protective effect against psychological distress (Gungor et al. 2021; Kleiman et al. 2018). Studies suggest that individuals with higher levels of optimism exhibit greater resilience, characterized by reduced psychological distress and a lower likelihood of experiencing depressive episodes, even when faced with significant NLE (Hirsch et al. 2007; Lai 2009). Optimists often reframe NLE as opportunities for growth or constructive experiences (Sleijpen et al. 2016). This reframing may influence their perception of what constitutes an NLE, potentially leading to lower self-reports of the number of NLEs experienced.

Additionally, optimistic individuals are known to cultivate better interpersonal relationships and maintain a goal-oriented mindset (Carver and Scheier 2014), factors that could contribute to fewer reported NLEs and their diminished perceived impact. However, emerging evidence suggests that the protective effects of optimism may be more nuanced, with its benefits potentially diminishing under conditions of extreme stress (Hirsch et al. 2007). Elucidating the intricate interactions between optimism and NLEs is crucial for understanding how optimism influences cardiovascular reactivity (CVR). These insights may provide a more comprehensive framework for examining the role of optimism in adaptive coping mechanisms and physiological responses to stress.

1.4 | Optimism and Cardiovascular Reactivity

In the realm of cardiovascular diseases, heightened optimism correlates with a reduced risk of myocardial infarction, slower progression of coronary disease, lower cardiovascular event mortality, decreased stroke risk, and diminished heart failure risk (Kim et al. 2011, 2014; Krittanawong et al. 2022; Kubzansky et al. 2001; Matthews et al. 2004). Optimism has also been linked to a higher cardiovascular response to stressors among young adults (Bajaj et al. 2019; Parra-Gaete and Hermosa-Bosano 2023). This association could be attributed to the more intense stress response and better emotional regulation demonstrated by optimistic individuals (Muazzam et al. 2021).

In contrast, pessimism has been associated with poor cardiovascular health and an elevated risk of mortality (Felt et al. 2020; Pänkäläinen et al. 2016; Whitfield et al. 2020), as well as poorer CVR to stressors (Krittanawong et al. 2023). This association may arise because individuals with higher pessimism often struggle with effective stress management and tend to face challenges with a defeatist attitude rather than actively addressing problems (Baumgartner et al. 2018). That said, it is important to note that the mechanisms by which optimism may prevent cardiovascular disease remain unclear (Amonoo et al. 2021). A possible explanation, as it was previously discussed, involves the enhanced coping processes in stressful situations, which optimism may facilitate, thereby reducing the impact of NLEs on CVR (Fournier et al. 2002).

Building on previous research, the present study aimed to investigate the relationship between optimism and CVR, with a particular focus on the potential mediating role of NLE in this relationship. Specifically, the study sought to determine whether the influence of optimism on NLE could explain its impact on CVR. It was hypothesized that optimism would continue to exert a direct effect on CVR, even after accounting for the mediating role of NLE. To test this hypothesis, the study first examined the association between optimism and CVR, followed by an analysis of the relationship between NLE and CVR, and finally, an evaluation of the extent to which NLE mediates the effect of optimism on CVR.

2 | Methods

2.1 | Participants

This study involved a sample of 199 adults, comprising 133 women and 66 men. The sample size was determined based on a 95% confidence level, a statistical power of 0.80, an expected medium effect size of 0.15, and a margin of error of 0.07, resulting in a minimum required sample of 196 participants. Participants' ages ranged from 18 to 32 years, with a mean age of 21.52 years (SD = 3.43). The average body mass index (BMI) was 23.66 kg/m^2 (SD = 4.04). Regarding lifestyle and health habits, 22.11% of participants identified as current smokers, and 15.56% reported using electronic cigarettes. A majority (69.35%) indicated having contracted COVID-19 prior to the study. Recruitment efforts were conducted at private universities with similar socioeconomic profiles in Quito, Ecuador. However, individual participant's university affiliations were not disclosed. Participants were recruited through internal campus announcements, emails, and a research credit system.

Exclusion criteria included having a family history of heart disease or hypertension, intellectual disabilities, pregnancy, as well as ongoing medical or psychological conditions. Participants were instructed to abstain from alcohol consumption, intense physical exercise, smoking, and caffeine intake for 24 h prior to their assessment, due to the potential effects on blood pressure (Potter et al. 1986; Somers et al. 1991). Informed written consent was obtained, clarifying the study's objectives and the absence of medical risks.

2.2 | Instruments

2.2.1 | Sociodemographic and Clinical Questionnaire

An online survey was administered using Microsoft Forms, encompassing questions on participants' gender, age, smoking and vaping behaviors, as well as any prior history of COVID-19. The survey also included variables pertinent to the inclusion and exclusion criteria.

2.2.2 | Paced Auditory Serial Addition Test (PASAT)

Developed by Gronwall (1977), this mental calculation task involves sequentially adding random numbers from 1 to 9. Employed as a stress-inducing stimulus during experimental sessions, its consistent ability to evoke controlled changes in cardiovascular activity in laboratory settings has been extensively validated and utilized in numerous studies focusing on CVR (e.g., Chauntry et al. 2022; Howard et al. 2023; McMahon et al. 2020; Tyne et al. 2024). In the present study, a four-minute version of the PASAT was employed, with the interval between numbers progressively decreasing each minute from 2.4 s to 2.0 s, 1.6 s, and finally 1.2 s.

2.2.3 | Life Orientation Test-Revised (LOT-R)

Developed by Scheier et al. (1994), this scale assesses two distinct factors: optimism and pessimism, which combine to generate a total score. The scale consists of six items rated on a 5-point Likert scale, with three items corresponding to each factor. A common scoring procedure involves reversing the pessimism scores and summing them with the optimism scores to derive the total score. In the present study, we used the Spanish adaptation by Remor et al. (2006), which has been previously validated for its use in Ecuador (Parra-Gaete and Hermosa-Bosano 2025). Reliability analysis in this study yielded an omega value of 0.72 and an alpha value of 0.73 for the optimism factor and an omega of 0.59 and an alpha of 0.54 for the pessimism factor. These findings align with prior research, which has reported alpha values of approximately 0.72 for optimism and below 0.65 for pessimism (Parra-Gaete and Hermosa-Bosano 2025; Remor et al. 2006). It is important to note that the structural validity of this scale remains a topic of debate. While some evidence supports a two-factor structure, other studies suggest a hierarchical model with a single overarching factor. To address this issue, all analyses in the present study were conducted using both approaches: treating optimism and pessimism as separate factors and considering a hierarchical model.

2.2.4 | Student Life Events Scale (ESVE-R)

The Spanish version (Martínez Correa and Reyes del Paso 2003) of the questionnaire created by Linden (1984) was used to measure stressful events in the lives of university students over the past two years. This version includes 44 items that measure different types of stressful events (death of a close family member, accident or serious illness, drug or alcohol abuse, being incarcerated, etc.). Participants were required to indicate (1) the number of life events they had experienced over the past year from the list, ranging from 0 (Never) to 10 or more events, and (2) their rating of the perceived stressfulness of each event on a scale ranging from 0 (Not stressful at all) to 10 (Very stressful). The scale has reported test–retest reliability of 0.77 (Martínez Correa and Reyes del Paso 2003).

2.2.5 | Cardiovascular Response Assessment

Participants SBP, DBP, and HR were recorded using the A&D blood pressure medical monitor (UA-651). After instructing participants to relax, this device was attached to their arms. Previous research using this device has consistently obtained reliable measurements (Benetti et al. 2014).

2.3 | Procedures

Before participating in the experimental session, volunteers were asked to complete the sociodemographic and clinical questionnaire and agreed to an online informed consent. Once their eligibility was confirmed according to inclusion criteria, they were instructed to complete the ESVE-R and LOT-R questionnaires online. Following the completion of these assessments, participants were contacted via email to schedule their experimental sessions. These sessions were arranged to take place one to three weeks after the online assessments and were conducted between November 2022 and September 2023, from Monday to Saturday.

During the experimental phase, participants who consented to take part attended a 45-min session in the psychology laboratory at the Universidad de las Américas. Sessions were scheduled between 10:30 AM and 12:30 PM, and 2:30 PM and 4:30 PM, to mitigate the effects of circadian rhythms on cardiovascular reactivity (CVR). Additionally, to control for the influence of food intake, participants were instructed to abstain from eating for at least two hours prior to the study. Laboratory windows and curtains were closed to minimize potential distractions, ensuring adequate lighting and a controlled temperature of 19°C. During the session, study objectives were reviewed, and participants signed informed consent forms for the experimental session. Subsequently, their weight and height were measured to calculate BMI.

Participants were seated at a desk with a computer, with their feet placed inside a cardboard box to prevent involuntary movements, a procedure validated by Gallagher et al. (2018) and Jennings et al. (2007). The researcher and an assistant attached a heart monitor to the participant's left arm and conducted an initial heart rate (HR) measurement to ensure proper functioning and participant comfort. They positioned themselves on the opposite side of the table and explained the study objectives, addressing any questions the participants had.

Following a 20-min rest period, baseline cardiac activity was measured in three two-minute intervals to establish a baseline. Then participants were asked to rate how difficult they thought the task would be, their stress levels, and their anxiety levels on a 7-point scale. After baseline measurements were completed, participants were given instructions for the PASAT task, including a practice test with ten numbers to ensure they understood the instructions and assessed their ability to accurately listen to the number sequences generated by the computer. The sound volume of the stressor recording was kept constant for all participants, and none reported difficulty hearing the recording. Participants were reminded that the task required verbal responses and that they had the option to withdraw from the study at any time.

The stress-inducing stimulus, the PASAT, was administered through a computerized recording, and cardiovascular reactivity (CVR) was assessed at three time points: 1 min, 2 min 30 s, and 3 min 30 s. Participants remained seated while the researcher and an assistant silently recorded cardiac measurements and documented participants' errors through exaggerated arm movements, marking an "X" with a red pen in a paper directly in front of them. These conditions were intentionally designed to amplify participants' stress levels by incorporating socio-evaluative components.

Upon completing the task, participants rated the task difficulty, their stress levels, and anxiety during the task on a 7-point scale. Subsequently, three additional cardiac measurements were taken at two-minute intervals to confirm whether SBP, DBP, and HR had returned to baseline levels. Finally, the heart monitor was removed, participants were asked to remove their feet from the cardboard box, thanked, and escorted out of the laboratory by the research assistant.

2.4 | Data Analysis

All analyses were conducted using the R statistical program (R Core Team 2023). Initially, the dataset was examined for missing values and outliers in both dependent and independent variables. After this screening, the final sample consisted of 179 participants. To calculate the reactivity variables, the three cardiac measurements recorded during the task were first averaged for SBP, DBP, and HR. The same averaging process was applied to the baseline measurements. Reactivity scores for SBP, DBP, and HR were then obtained by subtracting the baseline average from the task average for each respective variable. Before conducting analyses, a Shapiro–Wilk test was applied to the data to confirm that statistical normality assumptions were met. Then, to assess whether the stress-inducing stimulus effectively altered cardiovascular reactivity (CVR), paired t-tests were conducted to compare CV measures between baseline (SBP, DBP, HR) and during the task (TSBP, TDBP, THR). Additionally, changes in self-reported stress, perceived difficulty, and anxiety before and after the task were analyzed as supplementary evidence of the PASAT's efficacy as a stress-inducing stimulus.

Subsequently, the effect of categorical sociodemographic and clinical variables on CVR variables was assessed using mean difference tests. This step was carried out to explore possible associations between control variables and dependent and independent variables. Next, correlation analyses were conducted to evaluate relationships between LOT-R factors, NLE results, and CVR variables. The primary purpose of this analysis was to identify any significant associations between the two sets of variables. PASAT scores were excluded from the analyses, as they were not relevant to the study's objectives.

Finally, stepwise linear regressions were performed in a sequential manner. In the first step, sociodemographic variables were included as predictors. In the second step, NLE variables were introduced in terms of number and perceived stressfulness; in the third step, two different models were evaluated: one with optimism and pessimism variables as two different factors and a second model with the total score of LOT-R (LOT-R total); this has been done based on the doubts of the structural model of the test. In the fourth step, if the NLE variables and LOT-R factors exhibited significant effects, their mediation was included in the model. The Average Causal Mediation Effect (ACME) and Average Direct Effect (ADE) were calculated using the R *mediation* package (Tingley et al. 2014).

3 | Results

3.1 | Stress Task Effectiveness

Baseline and PASAT-induced CVR variables followed a normal distribution; therefore, their differences were analyzed using Student's t-test. Additionally, differences between cardiac activity during and after the task were examined to further validate the PASAT as a stress-inducing task. Statistically significant differences were observed, with cardiac activity being higher during the task across all three variables: SBP ($t=-12.71$, df=178, $p<0.01$), DBP ($t=-14.12$, df=178, $p<0.01$), and HR ($t=-8.2$, df=178, $p<0.01$).

Additionally, differences between during-task and post-task cardiac activity were assessed to further validate the PASAT as a stress-inducing task. Statistically significant differences were found, with cardiac activity being higher during the task for all three variables: SBP ($t=22.1$, df=178, $p<0.01$), DBP ($t=17.24$, df=178, $p<0.01$), and HR ($t=14.03$, df=178, $p<0.01$). These findings confirm that the PASAT reliably elevated cardiac activity and that cardiac measures began to decrease once the task was completed.

The self-reported psychological measures of task effectiveness demonstrated non-normal distribution patterns. Subsequent Wilcoxon signed-rank tests revealed statistically significant elevations across multiple psychological dimensions following PASAT administration compared to baseline measurements. Specifically, participants reported heightened levels of perceived difficulty (v=868, $p<0.01$), stress (v=550, $p<0.01$), and anxiety (v=1223.5, $p<0.01$) relative to pre-task assessments. These results provide robust evidence of the PASAT's effectiveness in inducing both physiological and psychological stress responses. The descriptive statistics for the study variables are presented in Table 1.

TABLE 1 | Descriptive statistics for cardiovascular, stress control, psychological, and physical variables.

Variable	*M*	SD	min	max
Cardiovascular				
BSBP	109.95	11.58	86.5	148
BDBP	70.61	8.32	50	95
BHR	79.82	12.33	54	113.5
TSBP	115.9	12.51	89.33	154.67
TDBP	75.6	8.68	51.67	103.67
THR	83.82	11.86	61	117
SBP reactivity	5.95	6.26	−8.83	23
DDP reactivity	4.99	4.72	−7.33	20.17
HR reactivity	4.01	6.54	−25.33	25.67
Stress control				
Pre-Task Difficulty	4.51	0.97	0	6
Pre-Task Stress	4.26	1.37	0	6
Pre-Task Anxiety	3.82	1.44	0	6
Post-Task Difficulty	5.26	0.77	3	6
Post-Task Stress	4.91	1.07	1	6
Post-Task Anxiety	4.84	1.08	1	6
Psychological and physical				
Optimism	10.08	2.4	3	15
Pessimism	7.64	2.17	3	14
LOT-R Total	20.45	3.51	9	28
Number of NLE	31.83	23.26	2	176
Perceived Stressfulness NLE	60.97	44.38	0	212
BMI	23.78	4.12	15.4	36.77

Abbreviations: BDBP, base diastolic blood pressure; BHR, base heart rate; BMI, body mass index; BSBP, base systolic blood pressure; M, mean; max, maximum; min, minimum; NLE, negative life events; SD, standard deviation; TDBP, task diastolic blood pressure; THR, task heart rate; TSBP, task systolic blood pressure.

3.2 | Correlation Between Cardiovascular, NLE, and Psychological Variables

The results revealed a statistically significant but mild positive correlation between optimism and DBP reactivity ($r=0.23$, $p<0.01$). Pessimism, on the other hand, showed a statistically significant weak negative relationship with both SBP ($r=-0.18$, $p=0.02$) and DBP reactivity ($r=-0.17$, $p=0.02$). Additionally, pessimism had a weak direct relationship with the number of NLEs ($r = 0.16$, $p = 0.03$). For LOT-R total, a statistically significant direct relationship was observed with both SBP ($r = 0.16$, $p = 0.03$) and DBP reactivity ($r = 0.26$, $p < 0.01$). There was also a weak inverse relationship with the number of NLEs ($r = -0.17$, $p = 0.02$). Furthermore, the number of NLEs showed a statistically significant mild inverse relationship with DBP reactivity ($r = -0.16$, $p = 0.03$). However, the perceived stressfulness of NLEs was not related to any of the reactivity variables. Regarding the psychological control variables for the PASAT, a significant positive correlation was observed among difficulty, stress, and anxiety, regardless of whether they were measured pre-task or post-task, as shown in Table 2. Optimism and pessimism showed a weak negative correlation ($r = -0.17$, $p = 0.02$). The LOT-R total score demonstrated a strong positive correlation with optimism ($r = 0.79$, $p < 0.001$) and a strong negative correlation with pessimism ($r = -0.74$, $p < 0.001$). This was expected, given that the LOT-R total score represents an aggregate measure incorporating both factorial components. To address potential multicollinearity concerns, distinct regression analyses were performed independently for the two-factor and hierarchical LOT-R models. Additionally, a strong positive correlation was found between the number of NLEs and their perceived stressfulness ($r = 0.60$, $p < 0.001$). Complete correlation results for all study variables are presented in Table 2.

3.3 | Influence of Sociodemographic and Clinical Variables on CVR

To examine the effects of sociodemographic and clinical variables on CVR, Student's t-tests were conducted. No statistically significant effects of the sociodemographic variables smoking, vaping, gender, and having had COVID-19 were found on the CVR variables. Therefore, these factors were not included in the regression model. The complete results are presented in Table 3.

3.4 | Regression and Mediation Analysis of Psychological Variables on CVR

In the stepwise regression analysis for RSBP, BSbp ($b = -0.12$, $p = 0.01$) and gender ($b = -2.66$, $p = 0.02$) had significant effects in the first step. BMI ($b = 0.08$, $p = 0.47$) did not show a significant effect and was removed from the model. In the second step, NLE variables were included; neither the number of events ($b = -0.03$, $p = 0.27$) nor perceived stressfulness ($b = 0.01$, $p = 0.44$) had significant effects. In the third step, optimism and pessimism (measured by the LOT-R) were included. Only pessimism exhibited a statistically significant small negative effect ($b = -0.56$, $p = 0.008$, $\eta^2 = 0.04$), while optimism ($b = 0.04$, $p = 0.82$) didn't present a significant effect. This first model with separated factors ($F = 4.91$, df = 175, $p = 0.002$) had a size effect of $R^2 = 0.06$. When using the total LOT-R score in the final step instead of treating optimism and pessimism as separate factors, the total score had a statistically significant effect on RSBP ($b = 0.28$, $p = 0.04$, $\eta^2 = 0.03$), resulting in a second model ($F = 3.98$, df = 175, $p = 0.009$) with $R^2 = 0.05$. Given that the first model had a greater effect size, it was retained as the final model. Diagnostic checks confirmed the model's assumptions, including normality of residuals (W = 0.99, $p = 0.3$), homoscedasticity (BP = 1.82, $p = 0.61$), and absence of multicollinearity (VIF < 1.6).

For RDBP, in the first step, BDbp ($b = -0.12$, $p = 0.007$) had a significant effect, while BMI ($b = 0.03$, $p = 0.35$) and gender ($b = -0.59$, $p = 0.43$) did not, leading to their exclusion from the model. In the second step, after controlling for BDBP, the number of NLEs showed a small but significant negative effect ($b = -0.03$, $p = 0.025$, $\eta^2 = 0.03$), whereas perceived stressfulness ($b = -0.01$, $p = 0.08$) did not. In the third step, optimism and pessimism were examined as separate factors. Optimism had a significant positive effect ($b = 0.37$, $p = 0.008$, $\eta^2 = 0.04$), while pessimism did not ($b = -0.23$, $p = 0.15$). This first model ($F = 6.9$, df = 175, $p < 0.001$) had an effect size of $R^2 = 0.09$. When using the total LOT-R score, a statistically significant effect was also found ($b = 0.3$, $p = 0.003$, $\eta^2 = 0.05$), giving a second model ($F = 7.57$, df = 175, $p < 0.001$) with an effect size of $R^2 = 0.1$. As the second model demonstrated a larger effect size, it was selected as the final model. Diagnostic checks confirmed the model's assumptions, including the normality of residuals (W = 0.99, $p = 0.63$), homoscedasticity (BP = 5.88, $p = 0.12$), and the absence of multicollinearity (VIF < 1.06).

For RHR, in the first step, only BHR ($b = -0.2$, $p < 0.001$, $\eta^2 = 0.11$), showed a significant effect, while BMI ($b = 0.03$, $p = 0.35$) and gender ($b = -0.59$, $p = 0.43$), did not. In the second step, the inclusion of NLE variables number of events ($b = -0.03$, $p = 0.26$) and Perceived Stressfulness ($b < 0.001$, $p = 0.95$) did not result in significant effects. In the third step, neither optimism ($b = -0.02$, $p = 0.91$) nor pessimism ($b = -0.14$, $p = 0.49$) as separate factors, nor the total LOT-R score ($b = 0.05$, $p = 0.67$) showed significant effects. Notably, the Shapiro–Wilk test revealed a significant deviation from normality of residuals (W = 0.95, $p < 0.001$). However, the assumptions of homoscedasticity (BP = 0.26, $p = 0.61$), and absence of multicollinearity (VIF < 1.6) were met. To address the issue of non-normality, a robust regression approach with heteroscedasticity-consistent standard errors was employed to ensure more reliable inference. This analysis yielded results consistent with the initial linear model, with only a slight difference in the estimated coefficients ($b = -0.15$, SE = 0.03, $Z = -5.42$, $p < 0.001$). The final linear model ($F = 22.37$, df = 177, $p < 0.001$) with only BHR as a predictor, explained 11% of the variance ($R^2 = 0.11$). Complete statistics for all final linear models are reported in Table 4.

Given the observed influence of the number of NLE and the overall LOT-R score on DBP reactivity, a mediation analysis was conducted, positioning NLE as the mediating variable in the relationship between LOT-R Total and DBP reactivity. The analysis revealed a statistically significant Average Causal Mediation Effect ($B = 0.029$, $p = 0.03$). Additionally, a statistically significant Average Direct Effect of LOT-R on RDBP was observed ($B = 0.293$, $p < 0.01$). Together, these findings indicate a total effect of 0.323 ($p < 0.01$) on DBP reactivity. Complete results are presented in Table 5 and Figure 1.

4 | Discussion

The objective of this study was to examine the mediating effect of NLE on the relationship between optimism and CVR to

TABLE 2 | Correlation matrix between cardiovascular, NLE, and psychological variables.

	BDBP	BHR	RSBP	RDBP	RHR	Pre-Task Difficulty	Pre-Task Stress	Pre-Task Anxiety	Post-Task Difficulty	Post-Task Stress	Post-Task Anxiety	Optimism	Pessimism	LOT-R Total	Number of NLE	Perceived Stressfulness NLE	BMI
BSBP	0.60***	0.02	−0.12	−0.03	0.05	−0.07	−0.20**	−0.16*	−0.07	−0.23**	−0.14	−0.04	0.06	−0.07	0.08	0.14	0.33***
BDBP		0.37***	0	−0.21**	−0.06	0.02	0	0.06	0.02	−0.03	0.04	−0.12	0.09	−0.14	0	0.08	0.41***
BHR			−0.07	−0.17*	−0.33***	0.01	0.19**	0.14	0.06	0.16*	0.13	−0.05	−0.01	−0.03	−0.02	0.05	0.09
RSBP				0.51***	0.11	0.07	0.06	−0.03	−0.08	−0.02	0.07	0.07	−0.18*	0.16*	−0.07	0.02	−0.01
RDBP					0.33***	−0.06	−0.05	−0.11	−0.15	−0.02	−0.01	0.23**	−0.17*	0.26***	−0.16*	−0.14	−0.06
RHR						0.03	−0.1	0.02	−0.14	−0.04	0.01	0.02	−0.04	0.04	−0.1	−0.08	−0.11
Pre-Task Difficulty							0.54***	0.20**	0.32***	0.25***	0.12	0.05	0.03	0.02	0.13	0.05	−0.09
Pre-Task Stress								0.46***	0.29***	0.53***	0.38***	0	0.05	−0.04	0.1	0.07	−0.12
Pre-Task Anxiety									0.21**	0.46***	0.57***	−0.12	0.03	−0.1	0.11	0.12	−0.08
Post-Task Difficulty										0.48***	0.38***	0.15*	−0.07	0.15	0.11	0.05	−0.08
Post-Task Stress											0.66***	−0.05	−0.06	0	0.04	−0.02	−0.06
Post-Task Anxiety												−0.09	−0.05	−0.03	0.12	0.11	−0.05
Optimism													−0.17*	0.79***	−0.11	−0.04	−0.03
Pessimism														−0.74***	0.16*	0.14	0.06
LOT-R Total															−0.17*	−0.12	−0.06
Number of NLE																0.60***	0.17*
Perceived Stressfulness NLE																	0.09

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

TABLE 3 | Sociodemographic and clinical variables effect on CVR.

Variable	Freq	%	RSbp	*T (p)*	RDbp	*T (p)*	RHr	T (p)
Smoke								
No	140	78.21	5.75 (6.12)	−0.76 (0.45)	4.87 (4.75)	−0.65 (0.52)	4.16 (6.22)	0.52 (0.6)
Yes	39	21.79	6.67 (6.8)		5.42 (4.67)		3.46 (7.65)	
Vape								
No	153	85.47	5.82 (5.93)	−0.55 (0.58)	5 (4.52)	0.1 (0.92)	3.99 (6.46)	−0.1 (0.92)
Yes	26	14.53	6.73 (8.04)		4.88 (5.91)		4.13 (7.13)	
COVID								
No	55	30.73	4.83 (5.82)	−1.67 (0.1)	4.88 (4.24)	−0.21 (0.83)	3.89 (5.49)	−0.17 (0.86)
Yes	124	69.27	6.45 (6.41)		5.03 (4.94)		4.06 (6.98)	
Gender								
Men	53	29.61	6.79 (6.58)	1.12 (0.26)	5.41 (3.99)	0.84 (0.4)	4.15 (6.24)	0.2 (0.85)
Women	126	70.39	5.6 (6.12)		4.81 (5)		3.95 (6.69)	

Abbreviations: RDbp, diastolic blood pressure reactivity means (SD); RHR, heart rate reactivity means (SD); RSbp, systolic blood pressure reactivity means (SD).

TABLE 4 | Regression analysis of LOT-R variables and NLE on cardiovascular reactivity.

Variables	Factors	*B*	SE	*t*	*B std.*	*p*	ε^2
RSbp	BSbp	−0.11	0.04	−2.48	−0.1	0.01	0.01
	Gender	−2.91	1.14	−2.55		0.01	0.03
	Pessimism	−0.57	0.21	−2.68	−0.17	0.008	0.04
RDbp	BDbp	−0.1	0.04	−2.45	−0.18	0.02	0.05
	Number of NLE	−0.03	0.01	−1.99	−0.13	0.04	0.03
	LOT-R Total	0.29	0.1	2.99	0.22	0.003	0.05
RHr	BHr	−0.2	0	−4.7	−0.33	< 0.001	0.11

TABLE 5 | Mediation Analysis of NLE on the LOT-R-DBP Reactivity Relationship.

	Estimate	95% CI Lower	95% CI Upper	*p*
ACME	0.029	0.001	0.08	0.03
ADE	0.293	0.119	0.47	< 0.01
Total effect	0.323	0.153	0.5	< 0.01

stress in young adults, controlling for variables such as body mass index (BMI), gender, and baseline CVR. A statistically significant inverse relationship was found between the number of NLE and DBP reactivity. Additionally, a statistically significant positive relationship was found between optimism and DBP reactivity. The findings indicate that the number of NLE mediates the relationship between optimism and DBP reactivity; however, optimism still exerts an effect on CVR beyond the effect explained by the mediator. This means that optimism influences CVR even when accounting for the mediating effect on the number of NLE. Moreover, pessimism was found to affect SBP reactivity, with increased pessimism associated with decreased reactivity. No effects of pessimism or NLE were found on HR.

Previous research has highlighted the protective role of optimism in mitigating the impact of stress on CVR (Bajaj et al. 2019; Gallagher et al. 2014). However, this study observed an effect of optimism solely on DBP reactivity. This outcome may be attributable to optimists' tendency to perceive stressful events as temporary challenges with attainable solutions (Brissette et al. 2002), which can reduce the perceived impact of negative life events (NLE). This perspective may account for the observed relationship between optimism and the reported number of NLE, as optimists may either not interpret certain situations as negative or fail to recall them due to their minimal psychological impact. Moreover, optimism is associated with an approach-oriented problem-solving style during stressful situations, which likely enhances psychological resilience by mobilizing resources for direct coping with stressors (Lee et al. 2019). Optimists are also characterized by higher motivation and lower stress levels during tasks, which may further influence CVR by reducing the physiological burden of stress.

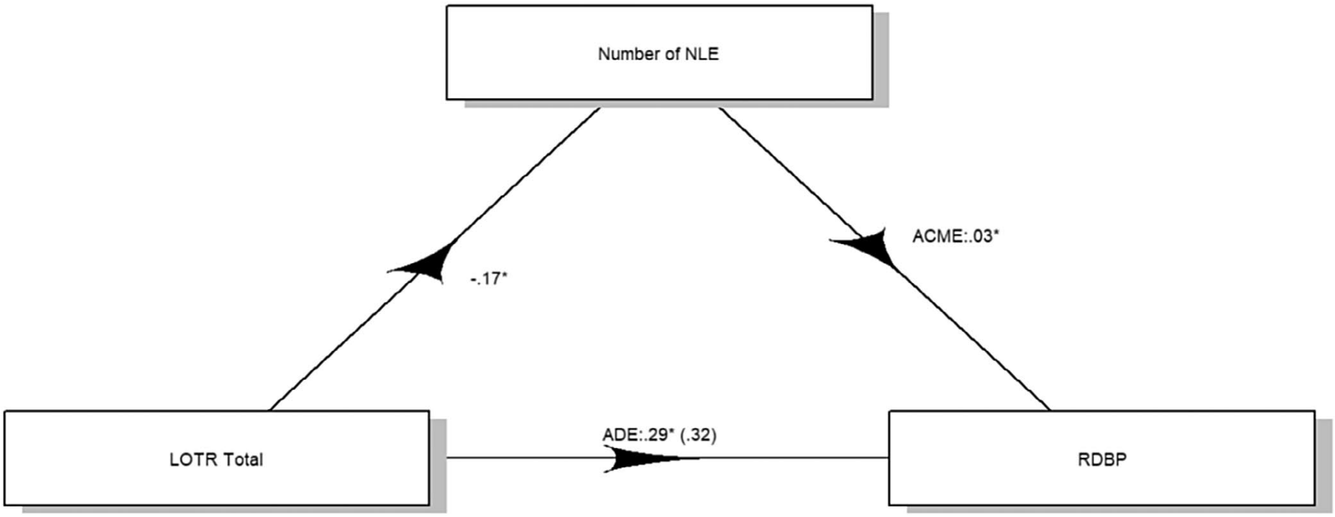

FIGURE 1 | Mediation analysis of NLE on the LOT-R-RDBP.

Furthermore, a mediating effect of NLE on the relationship between optimism and CVR was found. However, the effect of optimism is not solely explained by its mediation on NLE but also has a direct effect once the mediator's effect is controlled. Thus, optimism may exert its effects on CVR not only by moderating the impact of NLE but also by fostering life satisfaction (Oriol et al. 2020), reducing negative affect (Rand et al. 2020) and amplifying motivation and resource mobilization for effective problem-solving (Carver and Scheier 2014; Solberg Nes and Segerstrom 2016). Additionally, lifestyle factors commonly associated with optimistic individuals, such as healthier behaviors, may further explain the observed results (Carver and Scheier 2014). Another plausible explanation is that individuals with high levels of optimism in the sample were more motivated to exert maximal effort during the experimental session, potentially contributing to increased CVR. These findings highlight the need for future research to consider a broader range of psychological and behavioral factors when examining the relationship between optimism and CVR. Whatever the mechanism by which optimism affects CVR, its influence extends beyond the effect of NLE.

The effect of NLE on CVR aligns with previous studies (Carroll et al. 2005; Gallagher et al. 2018). However, it is important to note that the perceived stressfulness of NLE didn't have a relationship with the CVR variables. To the best of our knowledge, this is the first study to examine the relationship between CVR and NLE in a South American context, and cultural differences may partly explain these findings. Specifically, Ecuador, the country where this research was conducted, is among the most violent countries in Latin America. High-stress experiences such as kidnappings or violent muggings are relatively common, leading to a potential normalization of violence that could influence the perception of stressful events (Ferreira 2022). Another potential explanation lies in the timing of the study, which was conducted toward the end of the COVID-19 pandemic. Ecuador experienced significant loss of life during this period, which may have influenced participants' perceptions and reporting of NLE. These contextual and cultural factors highlight the need for further research to explore how regional and temporal influences shape the relationship between NLE and CVR.

Regarding the effects found on SBP, only pessimism showed a slightly significant effect. This could be because the most drastic changes in CVR and the prediction of potential pathologies before the age of 30 are observed in DBP. As individuals age, SBP reactivity becomes more important (Schwartz and Sheps 1999). However, in the present study, the sample consisted of individuals under 30 years old, which may explain the absence of an effect on SBP.

In general, positive psychology variables like optimism have been associated with elevated CVR (Boehm et al. 2018; Krittanawong et al. 2022; McMahon et al. 2020; Rozanski et al. 2019; Wiebe et al. 2018), while NLEs have been linked to decreased CVR (Carroll et al. 2005; Ginty and Conklin 2011; Lam et al. 2019). The importance of this study lies in the fact that a direct effect of optimism on CVR was found, even when controlling for the mediating effect of NLE. Both effects align with the findings in the literature, highlighting the importance of positive psychological factors in cardiovascular well-being.

Caution is necessary when interpreting these results. Although the findings are consistent with previous studies using similar procedures, it is crucial to acknowledge the existence of studies that have not found a relationship between laboratory CVR measures, such as the ones in this study, and those observed in daily life (Baucom et al. 2018; De Calheiros Velozo et al. 2023; Gerin et al. 1998), which could affect the ecological validity of the results obtained in this research.

The present investigation has several methodological limitations that warrant consideration. Foremost, the reliance on self-report measures for assessing optimism and negative life events introduces potential social desirability bias, though the anonymous nature of participation may have attenuated this effect. The ongoing debate regarding the LOT-R's factor structure (Cano-García et al. 2015; Ferrando et al. 2002; Herzberg et al. 2006; Peter et al. 2002) necessitated analyses using both unidimensional and bidimensional models of optimism.

Several procedural variables remained uncontrolled, including circadian influences on CVR, task-specific self-efficacy, and unwanted stress effects of control variables such as recording volume or the use of a cardboard box to limit foot movement. Moreover, other types of stress stimuli, such as social stimuli, could be more stressful and produce different results compared to the cognitive task employed in this study (Franzen et al. 2019; Hutchinson and Ruiz 2011; Kamarck et al. 2003).

The voluntary recruitment strategy potentially introduced selection bias, possibly overrepresenting highly motivated individuals and compromising external validity. The sample's demographic homogeneity, consisting exclusively of young adults, further constrains generalizability. Moreover, while the study was powered to detect medium to large effects, subtle relationships may have gone undetected. Although smoking status was controlled in cardiovascular analyses, its potential role as a stress-management mechanism affecting NLE remained unexamined.

Despite these limitations, a notable methodological strength of the current research was the strict control of sampling sessions, maintaining CVR measurements as accurate as possible by creating a neutral environment for data collection.

Future research should aim to elucidate the mechanisms through which optimism exerts its effects by controlling additional variables related to motivation and lifestyle, such as physical activity, healthy eating habits, and sleep quality, as well as the potential influence of task-specific self-efficacy. Moreover, future studies should include diverse age groups to assess whether these effects generalize across different life stages and to investigate whether similar findings extend to SBP. It would also be valuable to employ alternative measures of NLE to account for potential cultural influences on their perception and reporting. Finally, examining the effects of optimism and CVR under different types of stressors, such as social stressors, could enhance our understanding of the external validity of CVR theory and provide a more comprehensive evaluation of its applicability across various stress-inducing contexts.

Author Contributions

César Parra-Gaete: conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, writing – original draft, writing – review and editing. **Carlos Hermosa-Bosano:** supervision, writing – original draft, writing – review and editing.

Ethics Statement

This study was approved by the Ethics Committee of the Pontificia Universidad Católica del Ecuador (PUCE), an independent committee external to the university where data collection took place (Ethics Committee Approval Code: EO-115-2022). All procedures were conducted in accordance with ethical guidelines for research involving human participants.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the Open Science Framework Database: https://osf.io/ksw8p/.

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