RESEARCH PAPER

How and When Resilience can Boost Student Academic Performance: A Weekly Diary Study on the Roles of Self-Regulation Behaviors, Grit, and Social Support

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Abstract

Resilience has been found to have positive impacts on college students' well-being and mental health. However, we still lack knowledge on how and under what conditions resilience can help to facilitate college students' academic performance. Based on the conservation of resources theory, this study investigated how resilience could be positively linked to college students' academic performance through increasing self-regulation behaviors, and to what extent this indirect effect could be strengthened by individual grit and social support. Using 74 Chinese college students with a four-week longitudinal survey (296 observations in total), we confirmed our hypotheses. The results of multilevel moderated mediation showed that weekly self-regulation behaviors mediated the positive relationship between weekly resilience and college students' weekly academic performance and that this positive indirect effect became stronger for those who had a higher level of grit and perceived a higher level of social support. Further, we found that weekly resilience was also positively related to the next week's self-regulation behaviors, which in turn, increased next week's academic performance. Social support can strengthen such a carry-over impact of resilience on next week's self-regulation behaviors (but not for grit). To conclude, our study uncovered the short-term fluctuations of resilience and its impacts on students' study outcomes. We highlight the important roles of personal resources (grit) and social resources (social support) that can leverage the positive effects of resilience on students' weekly basis.

Keywords Resilience · Academic performance · Self-regulation behaviors · Grit · Social support

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1 Introduction

College students face a wide range of ongoing stressors related to academic performance (Lee, 2017). Compared with high school, the learning environment and learning methods of universities have undergone significant changes. Subject knowledge has increased, and learning requirements have become more stringent. These changes have resulted in many students experiencing adaptation problems and a decreased interest in learning (Glennie, 2022). These changes may also lead to emotional instability and declines in self-confidence, which seriously affects students' academic performance (Frazier et al., 2019). Therefore, scholars suggest that students need to equip themselves with the resilience ability to fit the changing situations (Li, 2017). Studies found that resilience was positively related to one's adaptability (Clinton, 2008), goal attainment (Connor & Davidson, 2003), subjective well-being (Yubero et al., 2021), and academic performance (Ayala & Manzano, 2018).

Recent research provides valuable insights into how resilience affects college students' academic performance through affective and cognitive mechanisms (Bell et al., 2020). For example, resilience could be linked to a higher level of subjective well-being (Yubero et al., 2021), mental health (Hartley, 2013), growth mindsets (Zeng et al., 2016), and self-regulation (Pillay et al., 2022), which in turn, improved their academic performance. However, few studies to date have used a longitudinal design to explore the behavioral mechanism by which resilience can heighten students' academic performance, which might be a major omission in the existing literature. A behavioral mechanism is also worth our attention because only knowing how resilience regulates one's affect and cognition may not be able to uncover a complete resilient process. We still do not know whether resilience can activate any specific personal actions. It is essential to gain insights into how resilience can lead to meaningful self-regulatory behaviors, and in turn, achieve satisfactory academic performance on a daily basis. In addition, research shows that resilience is not always fixed, but constantly fluctuating and dynamic within individuals (Chmitorz et al., 2020), which means that an individual may exhibit varying self-regulatory behaviors to respond to different environmental hassles during his/her resilient process. Thus, it is meaningful to investigate a short-term fluctuation among one's resilience, self-regulation behaviors, and academic performance. Recognizing this research gap, based on the conservation of resources (COR) theory (Hobfoll, 1989), we aimed to examine how student resilience benefitted academic performance through self-regulation behaviors on a weekly basis.

Furthermore, we suspect that the student weekly resilient process may be influenced by individual differences. That is, not all students may benefit from the process of resilience through self-regulation behaviors on academic performance equally. In a recent study in grade 4 school students, it was found that the impact of social support on academic performance was mediated by psychological capital (including resilience) and then study engagement (Siu et al., 2021). In other words, college students with more personal and social resources may have more capabilities to deal with various study stressors and environmental hassles and engage in self-regulation behaviors more successfully. Thus, based on the COR theory (Hobfoll, 1989), we further proposed two types of resources, i.e., grit (personal resources) and social support (social resources). The literature suggests that social support helps individuals cope with life adversity and stress and helps individuals to get through tough situations (Wang et al., 2014), and that grit helps students maintain perseverance and enthusiasm for long-term goals and control their emotions and desires in challenging or

difficult situations (Kannangara et al., 2018). We attempted to test whether the mediating effect of student resilience on academic performance through self-regulation behaviors was stronger for those with high levels of grit and social support.

To sum up, the current study aimed to examine by what mechanism and under what conditions student resilience could improve college students' academic performance over time. Using a weekly diary study design, we conducted a multilevel moderated mediation model and examined the mediating role of weekly self-regulation behaviors and the moderating roles of grit and social support. Our study contributes to the literature in three ways. First, we explored a behavioral mechanism to understand the relationship between resilience and academic performance, while this line of research predominantly focused on the affective and cognitive mechanisms (Bell et al., 2020). Examining the mediating role of self-regulation behaviors, we provided insights into how resilience can activate a self-regulatory process in which individuals plan, monitor, and reflect on various situational events, and in turn, obtain desirable outcomes. Second, we explored a short-term dynamic relationship among resilience, self-regulation behaviors, and academic performance, shedding light on a resilient process that unfolds over time within individuals (rather than between individuals). By contrast, previous studies primarily adopted a cross-sectional in nature treating resilience as a fixed factor (Al Omari et al., 2023) and examining how a fixed resilience level affected mental health (Wu et al., 2018), self-esteem (Al Omari et al., 2023), and well-being (Siu et al., 2009; Yubero et al., 2021). Finally, we particularly highlight the important role of grit in one's resilient process. While previous studies have revealed many individual-level moderators in facilitating resilience processes, such as positive emotions (Sher, 2019), self-control (Liang et al., 2022), and self-efficacy (Santoro et al., 2020), only a few scholars have investigated the moderating role of grit as an important personal resource. We underscored the importance of grit in unleashing the full potential of a resilience process and enhancing the successful execution of weekly self-regulation behaviors.

2 Literature Review and Hypothesis Development

2.1 Resilience and Academic Performance

Academic performance is one of the most important learning outcomes for students (Dogan, 2015). Academic performance refers to the level of success a student achieves in their educational pursuits (Kuh et al., 2006; York et al., 2015). It encompasses academic achievement, attainment of learning objectives, acquisition of desired skills and competencies, satisfaction, persistence, and post-college performance (Kuh et al., 2006; York et al., 2015). To maximize academic performance, scholars indicate that students need to cultivate and develop different study abilities, such as cognitive ability, memory ability, innovation ability, and problem-solving ability (Rodríguez-Fornells & Maydeu-Olivares, 2000). Previous studies have demonstrated that a higher level of academic performance can lead to higher self-esteem and self-confidence as well as lower levels of anxiety and depression (Tadese et al., 2022). Also, some studies indicated that a higher level of academic performance can predict students' early career success and career satisfaction (Van Dierendonck & Van der Gaast, 2013).

Recently, positive psychologists have suggested that resilience is a crucial ability for enhancing student academic performance. Masten and Reed (2002) referred to resilience "as a class of phenomena characterized by patterns of positive adaptation in the context of significant adversity or risk" (p.75), and they argued that resilient individual could thrive through positive adaptation to adversities encountered. In an academic context, resilience refers to a student's ability to overcome and recover from academic adversities that may influence a student's academic advancement (Martin, 2013). Previous research pointed out that resilience can lead to academic goal attainment (Connor & Davidson, 2003) and subjective well-being (Yubero et al., 2021). Berdida (2023) found that resilience positively influenced self-directed learning and academic motivation. Besides, some studies showed that being resilient can reduce test anxiety and academic stress (Hartley, 2013) and allow students to adapt to and recover from negative experiences (Clinton, 2008). Based on the conservation of resources (COR) theory (Hobfoll, 1989), we argued that resilience is positively related to academic performance. This is because COR theory posits that individuals tend to conserve, protect, and acquire resources. Therefore, individuals strive to utilize existing resources to acquire new resources in order to minimize resource loss and avoid psychological issues that may impact academic performance. Resilience, as a positive affective resource, can enable individuals to act positively to gain more (study) resources and avoid resource loss. Resources, as Hobfoll (1989) suggested, refer to things that individuals consider valuable and functional to them or ways that can help them obtain valuable things, such as material resources, conditional resources, individual characteristic resources, and energy resources (Hobfoll, 1989). With a higher level of affective resources, students will be able to relieve their stress and inject a higher level of motivation to learn, finally improving academic performance (Hobfoll, 1989). Focusing on student weekly context, we hypothesize:

H1: Weekly resilience is positively related to college students' weekly academic performance.

2.2 The Mediating Role of Self-Regulation Behaviors

We further examined by what behavioral mechanism resilience can help to improve academic performance on a weekly basis. In an academic context, self-regulatory behaviors refer to the alteration of behaviors (or other states) to bring them into closer alignment with a specific standard, or goal (Baumeister & Vohs, 2006). We believe that weekly resilience is positively related to weekly self-regulatory behaviors. Based on the COR theory (Hobfoll, 1989), individuals are motivated to preserve, protect, and acquire resources. Students actively construct and maintain their current resource reserves to cope with possible future scenarios of resource loss. This helps students alleviate the negative psychological state caused by resource loss. Thus, resilient people would like to take proactive actions (e.g., self-regulatory behaviors) to invest in acquiring new resources and avoid the loss of existing resources (e.g., cognitive resources, conditioned resources, personal resources), as suggested by the COR theory (Hobfoll, 1989). Resilient individuals are capable of identifying situational cues such as challenges, stress, and opportunities, and then planning their actions based on personal goals, preferences, and interests. Previous research demonstrated a strong

association between resilience and various self-regulatory components. Including (a) the ability to recognize and predict potentially threatening situations in an academic context, (b) the development of goals and regulation of behaviors to pursue these goals over time, and (c) the promotion of positive beliefs regarding one's self-regulatory capacity and the implementation of decisions using appropriate skills (Dillon et al., 2007). Moreover, some studies have shown that resilience-related variables, such as self-motivation and volitional regulation (Valenzuela, 2020), can affect the self-regulation behaviors of college students. Pichardo et al. (2014) found that perseverance, decision-making, and learning from mistakes (the key components of resilience) were positively associated with self-regulatory behaviors.

Subsequently, we expect that weekly self-regulation behaviors will be positively related to weekly academic performance. According to the self-regulation theory (Zimmerman & Kitsantas, 2014), students with higher levels of self-regulation behaviors tend to exhibit greater motivation to learn, set realistic goals for themselves, and employ effective strategies to achieve their academic objectives. Consequently, we argued that self-regulation behaviors are likely to be associated with an elevated level of academic performance. This is because, based on the self-regulation perspective, students who frequently engage in self-regulating behaviors can monitor and manage their own learning process in alignment with their goals (Greene et al., 2012). A goal orientation process can guide individuals toward goal attainment and motivate them to capitalize on their existing resources (e.g., energy, knowledge, networks) to achieve different study objectives (Hobfoll, 1989). Previous studies found that self-regulation capacity is a crucial individual factor that impacts academic success (e.g., transmitting from elementary school to higher education; McClelland & Cameron, 2011). Self-regulation behaviors are associated with improved academic achievement (Nota et al., 2004). Additionally, other studies have documented self-regulation behaviors in general as a robust predictor of social and behavioral adjustment in the school context (Fosco et al., 2013). Taking altogether:

H2: Weekly self-regulation behaviors mediate the positive relationship between weekly resilience and college students' weekly academic performance.

2.3 Grit as a Moderator

We further discuss how the impact of weekly resilience (through weekly self-regulation behaviors) on weekly academic performance depends on individual differences. We propose two individual-level moderators – grit and social support. Duckworth et al. (2007) defined grit as working strenuously towards challenges, maintaining effort and interest despite failure, adversity, and plateaus in progress. Based on the COR theory (Hobfoll, 1989), personal resources include various skills and traits that individuals possess and that contribute to their ability to resist stress. We believe that grit (personal resources) moderates the indirect effect of weekly resilience on academic performance through self-regulation behaviors on both within-person and between-person levels. This is because grit, as a personal resource, can help students to prevent the loss of resources and decrease the perceived situational threats when confronted with a stressful situation. At the within-person level, highly gritty individuals can be more successful to utilize their existing resources to demonstrate proactivity

and enhance, sustain, or adapt their current behaviors in response to ever-changing external circumstances over time. At the between-person level, compared to those who are low in grit, students with high grit are generally more motivated and energetic to deal with academic difficulties (Hobfoll, 1989). Research has demonstrated that gritty individuals tend to invest sustained effort in achieving their goals (Kannangara et al., 2018). Thus, individuals with high levels of grit can enlarge the positive impact of resilience on self-regulating behaviors. By contrast, when the level of grit is low, individuals may struggle to persist and venture beyond their comfort zone (Kannangara et al., 2018). Therefore, for individuals with low levels of grit, the beneficial effects of their self-regulatory behaviors may be constrained due to a lack of perseverance and motivation in pursuing long-term objectives (Muenks et al., 2017).

Emerging evidence suggests that grit buffers against adverse circumstances for mentally ill people (Blalock et al., 2015). For example, Lam et al. (2020) found that grit can buffer the negative impact of children's aggressive behaviors. Ma et al. (2020) revealed that grit strengthened the relationship between student adaptability and self-control, highlighting its role as a potent and positive force for promoting continuous self-control, self-regulation, and self-motivation in the face of difficulties and setbacks. Kundu (2017) argued that compared to students with low levels of grit, students with high levels of grit are more likely to possess the confidence to take personal initiative in confronting anticipated failures, surmount the barriers in the pursuit of academic and career achievements, to explore diverse tasks within their future occupations and academic pursuits, encourage themselves to social adaptation under unfavorable circumstances. Thus, we hypothesize:

H3(a): Grit moderates the within-person level indirect effect of weekly resilience on weekly academic performance through weekly self-regulation behaviors, such that the within-person level indirect effect will be stronger for those who have high grit (vs. low).

H3(b): Grit moderates the between-person level indirect effect of weekly resilience on weekly academic performance through weekly self-regulation behaviors, such that the between-person level indirect effect will be stronger for those who have high grit (vs. low).

2.4 Social Support as a Moderator

In addition to the moderating role of individual resources, our study also attempted to explore the moderating role of social resources. Social support refers to friends, family, and significant others who can provide instrumental, informational, or emotional assistance (House et al., 1988). Conservation of resources theory posits that social support is an important resource that facilitates the building of positive psychological resources (Hobfoll, 2002; Newman et al., 2018). Based on COR theory (Hobfoll, 1989), social resources play an important role in supporting and safeguarding the future development and growth of individuals, helping them unleash their potential and achieve their life goals and values. Therefore, we believe that social support (social resources) moderates the indirect effect of weekly resilience on academic performance through self-regulation behaviors on both within-person and between-person levels. This is because, at the within-person level, when

students receive greater social resources from their peers, teachers, and families, they are more likely to leverage these external resources to turn the current predicament into a solvable situation over a longer period of time. At the between-person level, compared to those who receive less social support, students who receive more social support can have a more stable and harmonious social environment where people help and encourage each other, which can promote the development and maintenance of effective self-regulation strategies, and thereby improve academic performance. Thus, students with high levels of social support, students are better equipped to overcome challenges and have access to more social resources for managing their self-regulatory behaviors on a daily basis. In contrast, students with low levels of social support, individuals have less resources to use (e.g., ask whom for help or feedback) to solve the difficulties. As a result, achieving their set goals becomes increasingly difficult due to the absence of adequate external support.

Previous evidence showed that people with high levels of social support are generally more psychologically and physically healthy than those with low levels of support (Szkody et al., 2021). Wang et al. (2014) found that social support can moderate the relationship between adversity environment and psychological state, enabling individuals to adopt proactive behaviors to alleviate negative emotions and increase positive evaluations of their abilities. However, individuals with insufficient social support tend to experience more negative emotions such as loneliness, helplessness, and depression (Guo et al., 2022). Furthermore, they are less capable of employing proactive self-regulatory behaviors to overcome challenging situations and may need more time to recover from difficulties, compared to those with high levels of social support (Wang et al., 2014). In addition, Demaray et al. (2005) found that teacher and peer support (as key indicators of social support) can boost student adaptability. The emotional support received can moderate the relationship between academic stress and mental well-being, suggesting that university students who face academic stress but receive ample emotional support can be able to attain greater mental well-being compared to those with weak emotional support (Green et al., 2021). Thus, we hypothesized:

> *H4(a): Social support moderates the within-person level indirect effect of weekly resilience on weekly academic performance through weekly self-regulation behaviors, such that the within-person level indirect effect will be stronger for those who perceive high social support (vs. low).*
> *H4(b): Social support moderates the between-person level indirect effect of weekly resilience on weekly academic performance through weekly self-regulation behaviors, such that the between-person level indirect effect will be stronger for those who perceive high social support (vs. low).*

3 Methods

3.1 Procedure and Participants

We used a weekly diary design to test our hypotheses. Following the recommended procedure (Ohly et al., 2010), our weekly diary research is divided into two parts: an initial gen-

eral questionnaire and four weekly diaries. In the general questionnaire, we gathered basic information, including age, gender, and our moderating factors (i.e., grit and social support). At the end of this questionnaire, we asked participants to create a unique identification code that would be used for matching with the next four-week diaries. We emphasized that this study would examine how their activities and moods evolved over time and that there was no right or incorrect answer (i.e., we hide the real research purposes to reduce demand social desirability). The confidentiality and anonymity were guaranteed. After that, we distributed weekly diary questionnaires in which we tested our focal variables (i.e., resilience, self-regulation behaviors, and academic performance). The weekly diary questionnaires were delivered to participants every Wednesday for consecutive four weeks. We expected participants to finish the weekly diary questionnaire by Sunday.

Additionally, we conducted a power analysis to determine sufficient statistical power before recruiting people. The results of the power analysis indicated that a sample size of 36 with four-time repeated measurements was able to get 95% statistical power. Gabriel et al. (2018) reviewed 90 diary studies and recommended recruiting at least 83 participants for a three-day diary study. Based on power analysis and previous suggestions, we decided to recruit no fewer than 80 students for our study. Ultimately, we matched 74 individuals who filled both in the general questionnaires and four weekly diary questionnaires (296 data points in total). Our sample contained around 57% men. The ages ranged from 19 to 24 (SD = 0.77).

3.2 Measurement Instruments

The surveys were distributed in Chinese. 5-point Likert scale was used for all measurements (1 = strongly disagree, 5 = strongly agree). To ensure the validity of the content, we followed a back translation procedure (Brislin, 1970).

Weekly Resilience was assessed with a scale developed by Mueller (2023). We used 8 items to measure weekly resilience and adjusted the items to fit the weekly context. An example item was "This week, when challenged with troubles I do not give up easily". Cronbach's α was 0.935, 0.930, 0.935, and 0.927 respectively.

*Weekly self-regulation behavior*s were assessed with a scale developed by Gaumer and Noonan (2018). We used 13 items to measure weekly self-regulation behaviors and adjusted the items to fit the weekly context. Examples are "This week, I planned out projects that I want to complete" (plan), and "This week, I kept track of how my projects are going" (monitor). Cronbach's α was 0.720, 0.816, 0.772, and 0.789 respectively.

Weekly academic performance was assessed with a scale developed by Williams and Anderson (1991). We used 2 items to measure weekly academic performance and adjusted the items to fit the weekly context. An example item is "This week, I fulfilled all the requirements of my study work". Cronbach's α was 0.782, 0.839, 0.800, and 0.830 respectively.

Social support was measured with the scale developed by Zimet et al. (1988). We used 4 items to measure social support. Note that social support was only measured once. An example item is "My friends really try to help me". Cronbach's α is 0.929.

Grit was assessed with a selected 4-item scale developed by Duckworth and Quinn (2009). An example item is "I am ambitious to achieve certain things during my lifetime". Cronbach's α is 0.834. Note that grit was only measured once.

Control variable. We also added gender and age as the control variables in our model.

3.3 Statistical Analysis

Three sets of analyses were conducted. First, we conducted a multilevel CFA using Mplus version 8 to analyze if each of the five indicators (i.e., weekly resilience, weekly self-regulation behaviors, weekly academic performance, grit, and social support) was a distinct construct. The analysis type was TWO LEVEL. The cluster variable was participant ID. Results of multilevel CFA showed that all five variables as separate constructs showed relatively acceptable fit indices ($\chi^2(408)=652.201$; CFI$=0.91$; TLI$=0.90$; RMSEA$=0.06$; SRMR_ between$=0.05$; SRMR_within$=0.06$), indicating that all constructs were sufficiently distinct from one another. We also compared this measurement model with other alternative models. We have made a table to present our CFA results (see Table B in the supplementary document due to page limits). To conclude, the multilevel CFA results supported the discriminant validity of constructs.

We also tested a measurement invariance test of our target variables. Three types of measurement invariance were tested: configural invariance, metric invariance, and scalar invariance. Results showed that setting the factor loadings of each item equal across the four waves (i.e., models with metric invariance) did not significantly decrease model fitness compared with models with configural invariance, except that self-regulation construct did not pass the metric invariance test. Additionally, setting the intercept of each item equal (i.e., models with scalar invariance) across the four waves did not significantly decrease model fitness compared with models with metric invariance. Therefore, the scales had relatively sufficient measurement equivalence across time. We put the results in the supplementary document (see Table C), due to page limits.

In addition, to justify our multi-level analysis, we computed the ICC (intra-class correlation) to examine whether there was significant variance on the weekly level (i.e., within-person variance). Results showed that the within-person variance of weekly resilience, weekly self-regulation behaviors, and weekly academic performance were 60.8%, 45.4%, and 47.8% respectively. We concluded that our variables varied both within and between persons, which warrants an examination of predictor variables at the person and week levels.

Finally, we used MLmed macro (Rockwood & Hayes, 2017) to examine the multilevel mediation and multilevel moderated mediation effects. This approach can provide bootstrapping iterations with the confidence interval. To be noted, although grit and social support may be correlated, we argued that estimating their moderating effects separately could allow us to examine their contributions without potential confounding effects. When highly correlated variables are included in the same model as moderators, multicollinearity issues may arise, leading to unstable estimates and difficulties in interpreting the results accurately (Kyriazos & Poga, 2023). Therefore, we decided to enter grit and social support in separate models.

4 Results

Means, standard deviations, and correlations among all the study variables are reported in Table 1. Week-level variables across the 4 weeks were averaged to correlate them with measures at the person level. Since our constructs were all self-reported, which may contain the common method bias (CMB), we further conducted Harman's one-factor test. The results

Table 1 Means, S.D., and within-level (below the diagonal) and between-level (above the diagonal) correlations among the study variables

	Mean	SD	1	2	3	4	5
1. Resilience	3.8013	0.44683		0.807**	0.674**	0.620**	0.884**
2. Self-regulation Behaviors	3.7415	0.3358	0.722**		0.681**	0.493**	0.674**
3. Academic performance	3.8375	0.54402	0.622**	0.587**		0.305**	0.536**
4. Social Support	3.9125	0.63217	0.597**	0.471**	0.427**		0.488**
5. Grit	3.8818	0.58686	0.792**	0.576**	0.458**	0.417**	

*$p < .05$; ** $p < .01$; $N = 74$ participants and $N = 296$ data points

showed that there were 27.96%, 27.91%, 30.81%, and 30.75% of variance extracted at T1, T2, T3, and T4, which were all less than the threshold of 50%. Thus, we concluded that CMB might not be a serious issue in this study.

4.1 Hypothesis Testing

Table 2 showed that the direct effect of resilience on academic performance was $b = 0.4198$, 95% $CI = [0.1702, 0.6694]$ at the within-person level. This implied that weekly resilience was positively related to weekly academic performance. Hence, H1 was supported. In addition, we found that the indirect effect of resilience on academic performance via self-regulation behaviors was $b = 0.1872$, 95% $CI = [0.0617, 0.3332]$ at the within-person level (see Table 2). Hence, H2 was supported as well.

In support of Hypothesis 3, Table 3 showed that the two-way interaction term was $b = 0.2141$; $p = .0376$ at the within-person level (95% CI [0.0124, 0.4158]); and $b = 0.1676$; $p = .0062$ at the between-person level (95% CI [0.0490, 0.2862]). Furthermore, the MLmed results showed the index of moderated mediation at the within-person level was $b = 0.0941$, CI [0.0034, 0.2187], which did not include zero, but the index of moderated mediation at the between-person level was $b = 0.0653$, CI [-0.0173, 0.1798], which include zero. This means that grit is significant personal resource to moderate the effect of weekly resilience on weekly self-regulation behaviors over time. We further did a simple slope test to show the cross-level moderation effect, and results showed that resilience was more positively related to self-regulation behaviors when grit was higher (+1SD), $b = 0.623$, $p < .001$, compared to when it was lower (-1SD), $b = 0.372$, $p < .001$. We made a two-way interaction figure to visualize the moderating effect of grit (Fig. 2). In conclusion, H3(a) was supported and H3(b) was rejected.

In support of Hypothesis 4, Table 4 showed that the two-way interaction term was $b = 0.3035$; $p = .0262$ at the within-person level (95% CI [0.00365, 0.5705]); $b = 0.1762$; $p = .0134$ at the between-person level (95% CI [0.0376, 0.3148]). In addition, the MLmed results showed the index of moderated mediation at the within-person level was $b = 0.1334$, CI [0.0116, 0.3009], which did not include zero, but the index of moderated mediation at the between-person level was b $= 0.0678$, CI [-0.018, 0.1944], which include zero. This means that social support is a significant social resource to moderate the effect of weekly resilience on weekly self-regulation behaviors over time. We further did a simple slope test to show the cross-level moderation effect, and results showed that resilience was more positively related to self-regulation behaviors when social support was higher (+1SD), $b = 0.490$, $p < .001$, compared to when it was lower (-1SD), $b = 0.204$, $p = .004$. We also made a two-

Table 2 Results of the indirect effects of resilience on academic performance through self-regulation behaviors

	Effect	SE	Z	P	C.I.
Within Effect:					
Resilience -- > Academic performance	0.4198	0.1261	3.3299	0.0012	[0.1702, 0.6694]
Resilience -- > Self-regulation Behaviors	0.4261	0.0693	6.1451	0.0000	[0.2888, 0.5634]
Self-regulation Behaviors -- > Academic performance	0.4394	0.1455	3.0209	0.0031	[0.1515, 0.7274]
Resilience -- > Self-regulation Behaviors -- > Academic performance	0.1872	0.0698	2.6826	0.0073	[0.0617, 0.3332]
Between Effect:					
Resilience -- > Academic performance	0.4907	0.1727	2.8407	0.0063	[0.1446, 0.8368]
Resilience -- > Self-regulation Behaviors	0.543	0.0582	9.3266	0.0000	[0.4261, 0.6600]
Self-regulation Behaviors -- > Academic performance	0.3898	0.2553	1.5269	0.1329	[-0.1225, 0.9021]
Resilience -- > Self-regulation Behaviors -- > Academic performance	0.2117	0.1413	1.4985	0.1340	[-0.0596, 0.4938]

$N=296$; unstandardized regression coefficients are reported; bootstrap sample size = 10,000 bias corrected; LL = lower limit, UL = upper limit; significance level of confidence is at 95%

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way interaction figure to visualize the moderating effect of grit (Fig. 2). In conclusion, H4(a) was supported; H4(b) was rejected.

4.2 Lagged Effects Analyses

We also created the lagged terms, so that we can also check the carry-over effects of weekly resilience on self-regulation behaviors and academic performance in subsequent weeks. Specifically, resilience during the first three weeks was used as a predictor of academic performance in subsequent weeks. Resilience during the last week (week 4) was treated as missing in this series of analyses. Likewise, to examine the (moderated) mediation effect, we used academic performance (t+1) as the outcome variable, resilience (t) as the predictor, self-regulation behaviors (t+1) as the mediator, and the general grit and social support (only measured once) as the moderators.

Table 5 showed that the current week's resilience was not directly positively related to next week's academic performance ($b=0.1534$, $p=.1401$). However, we found that the current week's resilience was positively related to the next week's self-regulation behaviors, which in turn, improved next week's academic performance ($b=0.3018$, $CI=[0.1667, 0.4350]$). Further, the moderated mediation results (see Table 6) showed that the two-way interaction term about social support was $b=0.2084$, $p=.0071$ (95% CI [0.0578, 0.3590]). Therefore, social support is a significant moderator for this carry-over effect of resilience. However, the two-way interaction term about grit was $b=0.1099$, $p=.0896$ (95% CI [-0.0173, 0.2371]). Therefore, grit is not a significant moderator for this carry-over effect of resilience (see Table 7).

4.3 Additional Analysis

We further tested several additional models to strengthen our (causal) mediation effects. First, tested the effect of self-regulation behaviors (t+1) on academic performance (t+2). However, the results were not significant (see Table A in the supplementary document). This implied that self-regulation behaviors may only have more immediate effects on performance variables, than longer-lasting effects. This was in line with previous self-regulation study, stating that self-regulation behaviors can be enacted in the present moment and have a direct impact on immediate outcomes (Baumeister et al., 2006). Self-regulation behaviors are often task-specific and context-dependent. They are tailored to address the specific demands and challenges of a given situation or goal. As a result, their effects are more immediate and observable within the specific task or context in which they are applied (Baumeister et al., 2006). The task-specific nature of self-regulation behaviors supports the notion that their effects are more immediate and localized.

Second, we tested an alternative model with a different sequence, so that we can better determine the longitudinal mediation claim. We found that when we used the outcome variable to predict the mediator and the predictor, the results were not significant. This implied that the reverse effects were not supported. The causal mediation effect of self-regulation behaviors on the relationship between resilience and academic performance can be supported. We put the results in Table D in this letter in the supplementary document.

Third, we conducted a time series analysis to make better use of our data. Based on the data structure, we conducted a cross-lagged panel model (one form of a multivariate

Table 3 Results for indirect effects of resilience on academic performance through self-regulation behaviors (Moderated by Grit)

Outcome: Self-regulation Behaviors	Effect	SE	Z	P	C.I.
Within Effect:					
Constant	4.0134	0.9011	4.4539	0.0000	[2.2223, 5.8045]
Grit * Resilience	0.2141	0.1021	2.0975	0.0376	[0.0124, 0.4158]
Resilience	-0.4591	0.4264	-1.0766	0.2834	[-1.3015, 0.3834]
Index of Moderated Mediation: Grit	0.0941				[0.0034, 0.2187]
Between Effect:					
Grit	-0.579	0.2318	-2.4977	0.0145	[-1.0401, -0.1179]
Grit * Resilience	0.1676	0.0596	2.8115	0.0062	[0.0490, 0.2862]
Resilience	-0.1724	0.2458	-0.7015	0.4847	[-0.6604, 0.3155]
Index of Moderated Mediation: Grit	0.0653				[-0.0173, 0.1798]

N=296 Bootstrap sample size=10,000. Values statistical significance at *p*<.05. LL=lower limit, UL=upper limit; significance level of confidence is at 95%
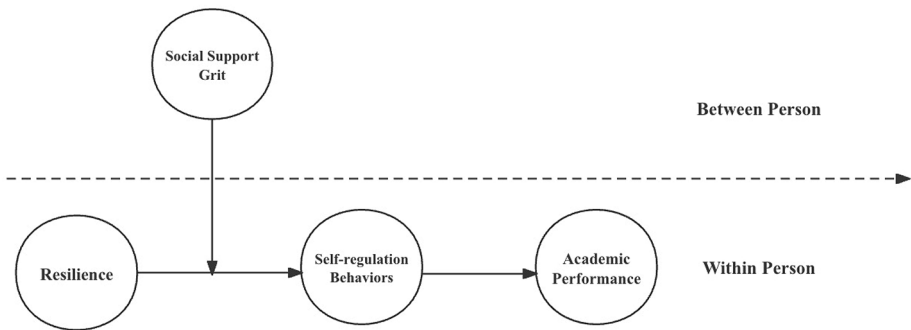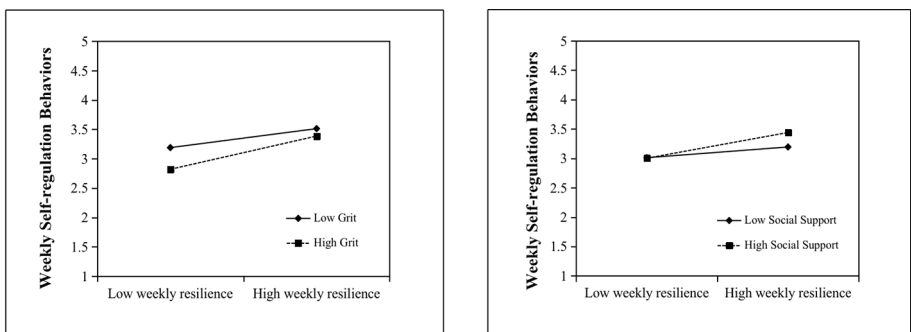

Fig. 1 Conceptual model

Fig. 2 The interaction effects between resilience and grit/social support on self-regulation behaviors

Table 4 Results for indirect effects of resilience on academic performance through self-regulation (Moderated by Social Support)

Outcome: Self-regulation Behaviors	Effect	SE	Z	P	C.I.
Within Effect:					
Constant	4.1922	1.0544	3.9761	0.0002	[2.0943, 6.2902]
Social Support * Resilience	0.3035	0.1351	2.2468	0.0262	[0.0365, 0.5705]
Resilience	-0.8442	0.5508	-1.5326	0.1276	[-1.9329, 0.2445]
Index of Moderated Mediation: Social Support	0.1334				[0.0116, 0.3009]
Between Effect:					
Social support	-0.6108	0.261	-2.3405	0.0219	[-1.1308, -0.0909]
Social Support * Resilience	0.1762	0.0696	2.5317	0.0134	[0.0376, 0.3148]
Resilience	-0.2233	0.2919	-0.7651	0.4463	[-0.8038, 0.3572]
Index of Moderated Mediation: Social Support	0.0687				[-0.018, 0.1944]

$N=296$ Bootstrap sample size$=10,000$. Values statistical significance at $p<.05$. LL$=$lower limit, UL$=$upper limit; significance level of confidence is at 95%

time series model). This model can testify more causal direct effect and mediation effect over time. The results showed that resilience at T1 was positively related to self-regulation behaviors at T2 (b$=0.402$, $p<.05$); self-regulation behaviors at T2 was positively related to academic performance at T3 (b$=0.551$, $p<.05$). Similarly, we found that resilience at T2 was positively related to self-regulation behaviors at T3 (b$=0.277$, $p<.05$); and self-regulation behaviors at T3 was positively related to academic performance at T4 (b$=0.395$, $p<.05$). These findings are in line with our hypothesis and our multilevel regression results. To check the reverse model, we found that academic performance at T1 was not significantly related to self-regulation behaviors at T2 (b$=0.277$, $p=.07$); self-regulation behaviors at T2 was not significantly related to resilience at T3 (b$=0.069$, $p=.59$). Likewise, we found that academic performance at T2 was not significantly related to self-regulation behaviors at T3 (b $= -0.040$, $p=.83$); and self-regulation behaviors at T3 was not significantly related to resilience at T4 (b$=0.206$, $p=.13$). We presented the results in Table E in the supplementary document.

5 Discussion

Resilience is an important personal resource for students to successfully navigate a school life. Based on the conservation of resources theory and the self-regulation theory, the current study investigated how and when resilience can facilitate student academic performance on a weekly basis. Drawing a multilevel moderated mediation model, we found that weekly resilience was positively related to weekly self-regulation behaviors, which subsequently linked to improved student weekly academic performance. Further, this positive indirect effect was found to be stronger for those who possessed a higher level of grit and social support. Social support can strengthen such a carry-over impact of resilience on next week's self-regulation behaviors. Finally, our lagged analysis results also revealed that resilience was not only positively related to the current week's self-regulation behaviors, but also with the following week's self-regulation behaviors, consequently improving next

Table 5 Results of the *carry-over* indirect effects of resilience on academic performance through self-regulation behaviors

	Effect	S.E.	t	p	C.I.
Resilience (t) --> Academic performance (t+1)	0.1534	0.1033	1.4861	0.1401	[-0.2601, 1.4978]
Resilience (t) --> Self-regulation behaviors (t+1)	0.4262	0.0546	7.8005	0.0000	[0.3179, 0.5344]
Self-regulation behaviors (t+1) -- >Academic performance (t+1)	0.7082	0.1433	4.9404	0.0000	[0.4241, 0.9922]
Resilience(t) -- >Self-regulation behaviors(t+1) -- >Academic performance (t+1)	0.3018	0.0698			[0.1608, 0.4349]

N=296 Bootstrap sample size=5000. Values statistical significance at $p < .05$. LL=lower limit, UL=upper limit; significance level of confidence is at 95%

Table 6 Results for the carry-over indirect effects of resilience (t) on academic performance (t+1) through self-regulation behaviors (t+1) (Moderated by Social Support)

Outcome:	Self-regulation Behaviors (t+1)					Academic performance (t+1)				
	Effect	SE	Z	P	C.I.	Effect	SE	Z	P	C.I.
Constant	5.0731	1.1727	4.3260	0.0000	[2.7493, 7.3968]	0.6188	0.4436	1.3950	0.1658	[-0.2601, 1,4978]
Resilience (t)	-0.5612	0.3204	-1.7516	0.0826	[-1.1962, 0.0737]	0.1534	0.1033	1.4861	0.1401	[-0.511, 0.3580]
Social Support	-0.5814	0.2834	-2.0513	0.0426	[-1.1430, -0.0198]					
Resilience (t) * Social Support	0.2084	0.0760	2.7427	0.0071	[0.0578, 0.3590]					
Self-regulation Behaviors (t+1)						0.7082	0.1433	4.9404	0.0000	[0.4241, 0.9922]
Index of Moderated Mediation: Social Support	0.1476	0.0517			[0.0596, 0.2654]					

N=296 Bootstrap sample size=5000. Values statistical significance at p<.05. LL=lower limit; UL=upper limit; significance level of confidence is at 95%

Table 7 Results for the carry-over indirect effects of resilience (t) on academic performance (t+1) through self-regulation behaviors (t+1) (Moderated by Grit)

Outcome:	Self-regulation Behaviors (t+1)					Academic performance (t+1)				
	Effect	SE	Z	P	C.I.	Effect	SE	Z	P	C.I.
Constant	3.5973	0.9900	3.6338	0.0004	[1.6357, 5.5590]	0.6188	0.4436	1.3950	0.1658	[-0.2601, 1.4978]
Resilience (t)	-0.1495	0.2583	-0.5787	0.5640	[-0.6612, 0.3623]	0.1534	0.1033	1.4861	0.1401	[-0.0511, 0.3580]
Grit	-0.227	0.2544	-0.8925	0.3740	[-0.7311, 0.2770]					
Resilience (t) * Grit	0.1099	0.0642	1.7127	0.0896	[-0.0173, 0.2371]					
Self-regulation Behaviors (t+1)						0.7082	0.1433	4.9404	0.0000	[0.4241, 0.9922]
Index of Moderated Mediation: Grit	0.778	0.0582			[-0.0544, 0.1790]					

N=296 Bootstrap sample size=5000. Values statistical significance at $p<.05$. LL=lower limit, UL=upper limit; significance level of confidence is at 95%

week's academic performance. The theoretical and practical implications of these findings are discussed below.

5.1 Theoretical Implications

First, our multilevel results showed that weekly resilience was positively related to college students' weekly academic performance at both within-person and between-person levels. This implies that not only those who were more resilient (vs. those not) tended to have a higher level of academic performance (i.e., at the between-person level), but also those who were more resilient can predict a higher level of academic performance over a short period of time (i.e., at the within-person level). Thus, we underscore that resilience is indeed a vital personal ability that can help students bounce back from potential academic setbacks, failures, and challenges, ultimately leading to academic achievements in the school setting over time. This finding echoes the previous studies indicating that academic resilience is a strong predictor of academic effort (Kotzé & Kleynhans, 2013). This finding can contribute to the student academic performance literature (Ayala & Manzano, 2018) by highlighting the significant positive role of resilience within a school environment.

Second, our multilevel mediation results showed that weekly self-regulation behaviors mediated the positive relationship between weekly resilience and college students' weekly academic performance. This implies that self-regulation behaviors are an important behavioral process that can transform one's metacognition, motivation, and vision (the components of resilience) into appropriate learning strategies. In other words, resilient individuals are able to take goal-oriented, self-regulatory actions to achieve study outcomes. This finding aligns with previous studies revealing that high levels of self-regulation predicted better academic achievement (Zimmerman & Kitsantas, 2014), greater professional success (Van Hooft et al., 2021), and stronger interpersonal relationships (Fitzsimons & Finkel, 2010). Unlike previous studies mainly examining the cognitive mechanism of resilience (Mak et al., 2011; Bell et al., 2020), we contribute to the resilience literature (Kotzé & Kleynhans, 2013; Johnson et al., 2014) by suggesting a behavioral mechanism by which resilience can improve academic performance over time.

Third, our multilevel moderator mediation results showed that grit moderated the indirect effect of weekly resilience on weekly academic performance through weekly self-regulation behaviors, in such a way that the indirect effect became stronger for those who have high grit (vs. low). This implies that grit as a personal resource, can amplify the positive effects of resilience. High-grit individuals may have more stamina and energy to adopt proactive behaviors to persevere through adversity, hone personal abilities, execute plans, break through barriers to learning, and excel in future challenges to achieve academic excellence (Ayala & Manzano, 2018). This finding echoes previous studies, for example, Lan and Moscardino (2019) noted that high levels of grit can sustain students' school well-being (e.g., academic engagement and school satisfaction). Hodge et al. (2017) pointed out that grit can moderate the relationship between engagement and academic outcomes for university students, which means that students with higher grit may have more energy to put into the learning process, thus leading to higher academic outcomes. Therefore, we highlight the relevance of grit as a desirable student characteristic. We contribute to student self-regulation literature (Webb et al., 2018) by highlighting the beneficial role of grit during the self-regulation process.

Fourth, the results further indicated that social support moderated the indirect effect of weekly resilience on weekly academic performance through weekly self-regulation behaviors. This implies that people with higher social support can feel cared for by others (e.g., teachers and parents), which in turn stimulates persistent and proactive behavior in pursuit of their learning goals (Jolly et al., 2020). According to COR theory, social support as an external environmental resource can help to increase students' social connections and sense of belonging (Jolly et al., 2020) and reduce stress and improve wellbeing (Poots & Cassidy, 2020). Conversely, people with limited social support are prone to give up or make poor decisions when facing difficulties. This finding echoes previous studies revealing that social support can make students more perseverant (Song et al., 2021), and buffer the negative impacts of adverse environments on students (Demaray et al., 2005). Therefore, we contribute to the student self-regulation literature (Webb et al., 2018) by highlighting the important beneficial role of social support during the self-regulation process. Social support can facilitate the continuous adjustment of goals and plans for success.

Fifth, we used the weekly diary approach to examine a short-term dynamic relationship among resilience, self-regulation behaviors, and academic performance. We indicate that resilience and self-regulation behaviors are dynamic and are not static, that is, undulate over time. Thus, it is worthwhile examining such a dynamic relationship. This finding was consistent with previous studies, for example, Turner (2006) proposed that the process of self-regulation is dynamic rather than fixed; Koo and Fishbach (2008) elaborated on the importance of dynamic self-regulation from socio-cognition and intrinsic motivation perspectives. Thus, the current study provides empirical evidence on the fluctuating effect of resilience on individual behaviors and outcomes.

Sixth, our lagged analysis results showed that resilience can also have a lasting effect on the next week's self-regulation behaviors, which in turn, increased next week's academic performance. This implies that resilience has carry-over effects on individual behaviors and outcomes. This can be explained by the COR theory (Hobfoll, 1989) stating that when individuals are driven to preserve existing (personal) resources and obtain new resources, they can achieve a gain spiral or cycle, which has long-lasting beneficial effects. This is also in line with the broaden-and-build perspective (Fredrickson, 2001) suggesting that positive psychological states broaden an individual's thought-action repertoires, which can lead to the building of personal resources that can continue to be used to engage in meaningful personal actions and goals (Fredrickson, 2001). Thus, when individuals exhibit resilience in the current week, they can accumulate their positive psychological resources and gain more sense of accomplishment and meaningfulness. Subsequently, such positive states will continue to facilitate positive behaviors (e.g., self-regulation behaviors), and in turn, obtain positive outcomes (e.g., academic performance). With this in mind, we highlight that resilience is a dynamic and evolving process through which one can take lasting self-regulatory actions to acquire the knowledge, abilities, and skills necessary to achieve goals. This finding also aligns with some previous studies. For example, Wu et al. (2020) found that resilience could significantly predict positive mental health status one year later. Fan et al. (2022) found that resilience predicted subjective well-being (i.e., life satisfaction, positive and negative affect) over five months. This finding adds to the resilience literature (Ayala & Manzano, 2018; Kotzé & Kleynhans, 2013) by highlighting the carry-over effect of resilience.

Finally, we also examined the moderating roles of grit and social support on the carry-over effects of resilience through self-regulation behaviors on next week's academic performance. Our results showed that social support can strengthen such a positive carry-over effect, but not for grit. This finding implied that social support is a crucial environmental booster that can help students reap more benefits from the long-lasting effect of resilience. With a higher level of social support, students will feel more secure and energized to accumulate their personal resources and then engage in self-regulatory behaviors in a more frequent and proactive manner. That said, a socially supportive environment can encourage resilient people to engage in longer-lasting self-regulation behaviors. Unfortunately, previous studies did not pay attention to the moderating role of social support on the *carry-over* effects of self-regulations behaviors (or other goal-oriented behaviors), except that Liu et al. (2021) found a buffering effect of social support in a two-year longitudinal study. Thus, we highlight that social support can help individuals develop and maintain resilience ability over a short period of time, so as to reinforce more self-regulation strategies on a daily basis. Therefore, we contribute to the resilience literature (Ayala & Manzano, 2018; Kotzé & Kleynhans, 2013) by highlighting the moderating role of social support on the longer-term effect of resilience on self-regulation behaviors.

5.2 Limitations and Future Research

First, all the constructs in our study were self-reported, which raises the question of whether common method bias (CMB) can explain the results (Podsakoff et al., 2003). Although Harman's one-factor test showed that CMB was not a serious issue in this study, we recommend future research to take more objective measures of the study variables. For example, academic performance could be measured by students' test scores.

Second, we collected diary data from second-year college students at a single university in China, which may limit the generalizability of the results. It is well known that college students at different levels (e.g., freshmen and seniors) may exhibit different attitudes, behaviors, and performance (Lehmann, 1963). The inclusion of college students at different levels would increase the generalizability of the study. Therefore, future studies should consider enrolling more diverse students.

The third limitation is the region setting. China is a collectivist cultural environment in which group orientation and interpersonal harmony are valued, which may differ from the Western culture. Previous study pointed out that resilience has universal as well as culturally and contextually specific aspects and exerts differing amounts of influence on a person's life (Ungar, 2008). For example, social support networks may be more emphasized in the collectivistic culture (Burholt et al., 2017). Power distance (e.g., hierarchy) may also influence individual behaviors and attitudes (Kanter, 1976), which may influence the generalizability of our results. Therefore, it is unclear whether our findings are specific to the Chinese context or can be generalized to other contexts. We suggest that future research involves the investigation of whether the effects of resilience and self-regulation behaviors differ in other cultural settings.

5.3 Practical Implications

Our study presents three main practical implications. First, our results suggest that resilience, through self-regulation behaviors, is positively associated with academic performance for university students. Thus, we recommend that students need to learn to be resilient in the school setting. For example, students can learn to take feedback positively, develop patience and tolerance, learn from mistakes, and build confidence in themselves. There is evidence showing that resilience training may lead to positive outcomes for students: Boardman's (2016) study found that resilience could be built through self-efficacy and self-regulation behaviors over a 13-week period. Thus, we suggest universities can help students improve resilience by organizing intervention programs, such as adaptation skills for challenges, building psychological capacities, communication skills, and relaxation techniques.

Our results suggest that grit reinforces the indirect effect of resilience on college students' academic performance. This implies that students who are more grit are more likely to engage in self-regulatory behaviors and to experience positive feelings. Therefore, according to COR theory (Hobfoll, 1989), universities and educational practitioners need to pay more attention to the development of personal resources such as grit. More training courses on developing grit could be considered to guide college students to maintain adequate personal resources to cope with stressful events. For example, Hwang and Nam (2021) developed an intervention to cultivate grit from cognitive, behavioral, and emotional domains.

Social support is another important (environmental) resource. Teachers should be proactive in creating a supportive environment and provide both tangible and intangible assistance to students in formal and informal learning arenas. For example, universities should provide positive emotional support to students when they cope with stress and challenges; encourage students to express their negative learning experiences, and seek help from teachers and classmates when needed (Babicka-Wirkus et al., 2021). These forms of social support will help improve students' resilience so that they can deal with difficulties or adversities encountered in the learning processes and continue to invest energy in learning through self-regulating behaviors.

Data Availability The data can be obtained via request from the corresponding author.

Declarations

Conflict of Interest The authors have no conflict of interest to disclose. We declare that we do not have any potential conflict of interest in this study.

Ethical of Approval All procedures performed in this study were in accordance with American Psychological Association (APA) ethical regulations regarding the treatment of human participants. This study was conducted in accordance with the ethical guidelines of the Ethics Committee of Lingan University, with written informed consent from all subjects. All the participants were asked to read and approve this ethical consent before taking part in the present study and followed it in the process of research. The protocol was approved by the Ethics Committee of Lingnan University.

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