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Research article

Age, learning abilities, and internet use as correlates of mental resilience in nursing students: An exploratory comparative study

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Abstract: Mental resilience is crucial for nursing students navigating academic and clinical challenges. While educational interventions aim to enhance resilience, individual characteristics and lifestyle factors may significantly influence outcomes. Thus, our objectives of this study were to: (1) Examine whether brief museum-based or empathy-video interventions affected resilience relative to a no-intervention control; (2) identify correlates of resilience, with particular attention to age, learning abilities, and internet use; and (3) explore the methodological implications of baseline imbalance in post-test-only designs. Fifty-four first-year nursing students (mean age 23.6 years, 85% female) were allocated on a non-random basis to three groups: a single, approximately 2-hour museum-based guided tour (n = 19), a roughly 12-minute empathy education video (n = 19), and a no-intervention control (n = 16). Post-intervention assessments included the Connor-Davidson Resilience Scale (CD-RISC-25), a self-reported learning-abilities scale, and lifestyle factors. Our primary finding was that neither the museum-based intervention nor the empathy video produced significant differences in resilience compared to control [intervention: 88.1 ± 13.5; video: 88.8 ± 15.8; control: 93.1 ± 13.7; $F(2,51) = 0.613$, $p = 0.545$, $\eta^2 = 0.023$]. However, the control group was substantially older (26.4 ± 13.2 vs. ≈ 22.4 years), potentially confounding comparisons. Significant correlations emerged between resilience and age ($r = 0.560$, $p < 0.001$), learning abilities ($r = 0.485$, $p < 0.001$), and daily internet-use hours ($r = -0.294$, $p = 0.031$). Age and learning abilities thus emerged as strong positive correlates of resilience, while greater internet use showed a moderate negative association. The absence of intervention effects

most plausibly reflects baseline age imbalance and insufficient intervention intensity rather than a failure of the underlying approaches. These findings underscore the importance of baseline assessment in intervention research and suggest that resilience programs should be developmentally tailored and incorporate digital-wellness components.

Keywords: mental resilience; nursing students; age; learning abilities; internet use; cultural intervention; empathy education

1. Introduction

Mental resilience, defined as the capacity to adapt successfully to adversity, trauma, or significant sources of stress, represents a critical psychological resource for healthcare professionals [1,2]. In nursing education, resilience enables students to navigate the substantial challenges inherent in rigorous academic coursework, emotionally demanding clinical experiences, and the developmental transition to professional identity [3,4]. Students with higher resilience demonstrate better stress management, sustained academic motivation, reduced burnout risk, and improved clinical performance [5,6]. Understanding factors that influence resilience development is therefore essential for designing effective educational interventions and support systems in nursing programs.

The nursing education environment presents unique stressors that test students' adaptive capacities. Nursing students frequently report higher stress levels compared to students in other health-related disciplines, attributed to combined demands of theoretical learning, high-stakes clinical rotations, emotional exposure to patient suffering, and responsibility inherent in direct patient care [7,8]. Research conducted during and after the COVID-19 pandemic has illuminated the protective role of resilience against psychological distress, with resilient students demonstrating better coping mechanisms and maintained academic performance despite unprecedented disruptions [9,10]. A concept analysis of nursing student resilience identified three major attributes: Individual factors, including self-efficacy and emotional regulation, educational factors such as learning environment and faculty support, and situational factors involving the ability to navigate unexpected challenges [11].

Research in gerontology consistently demonstrates that psychological resilience often increases with age, with older adults showing enhanced emotion regulation, greater acceptance of uncertainty, and more effective coping strategies compared to younger individuals [12,13]. This 'age-resilience paradox', wherein older individuals demonstrate greater resilience despite physical vulnerabilities, has been attributed to accumulation of life experience and coping repertoires, enhanced emotional regulation capacities, more realistic goal-setting and selective optimization, stronger social support networks developed over time, and wisdom derived from navigating previous adversities [14–16]. However, whether similar age-related increases occur within university student populations, where age range is typically more restricted, has received limited empirical attention.

Academic resilience, defined as the capacity to sustain high levels of motivation and achievement despite academic adversity, represents a related but distinct construct from general psychological resilience [17,18]. Several studies document positive associations between academic resilience and academic performance across educational contexts [19,20]. Students demonstrating higher academic resilience show greater persistence in the face of setbacks, more effective study strategies, better stress management, and improved problem-solving when confronting learning challenges [21,22]. The

relationship between learning abilities and psychological resilience likely operates bidirectionally: Students with stronger cognitive and metacognitive learning skills may experience fewer academic setbacks, enhancing confidence and self-efficacy, while resilient students persist through learning difficulties, seek help appropriately, and engage in reflective practices that enhance learning effectiveness [23,24].

The proliferation of internet and social media use among young adults has sparked considerable concern regarding potential mental health implications [25,26]. Multiple large-scale studies document associations between excessive social media use and increased rates of depression, anxiety, and loneliness in adolescents and young adults [27,28]. The U.S. Surgeon General's 2023 advisory on social media and youth mental health highlighted 'ample indicators' that social media platforms may pose risks to mental well-being [29].

Mechanisms through which excessive internet use may undermine resilience include displacement of health-promoting activities such as physical exercise and face-to-face interaction, exposure to social comparison and fear of missing out, sleep disruption due to evening screen time and blue light exposure, and development of passive consumption patterns reducing engagement with real-world challenges that build resilience [30–32]. A longitudinal study revealed that increased social media use during the COVID-19 pandemic had significant negative effects on college students' mental health, with effects most pronounced among socially isolated students [33].

Given resilience's protective effects, numerous intervention programs have been developed and tested in nursing education contexts [34,35]. These interventions employ diverse approaches, including cognitive-behavioral techniques, mindfulness training, peer support systems, reflective practice exercises, and skills-building workshops [36,37]. Moreover, experiential and arts-based interventions have emerged, grounded in theories suggesting that cultural engagement, perspective-taking, and empathy development may enhance resilience through broadened worldviews and enhanced emotional capacities [38,39].

Museum-based educational programs have been explored for their potential to promote reflection, historical perspective, and connection to collective human experience [40]. Similarly, film-based interventions focusing on emotional narratives and empathy have been investigated for their capacity to enhance emotional intelligence and interpersonal understanding [41,42].

Furthermore, a critical methodological consideration in intervention research is study design. The post-test-only control group design, while simpler and more cost-effective than pre-post designs, carries the inherent limitation of inability to verify baseline equivalence between groups [43,44]. Even with random assignment, which theoretically produces equivalent groups on average, specific implementations may yield groups that differ meaningfully on key characteristics, particularly with small sample sizes [45,46]. Without baseline measurements, researchers cannot determine whether observed post-intervention differences reflect true treatment effects, pre-existing differences, or both [47,48].

Within the European context, research conducted among Greek nursing students has similarly documented associations between individual characteristics, lifestyle factors, and resilience levels [49], underscoring the relevance of culturally-situated investigation of these relationships.

Building on our previous cross-sectional research examining resilience correlates in nursing students [49], here we employed an exploratory intervention design using cultural and empathy-based educational approaches. Our aims were to: (1) Examine whether brief museum-based or empathy video interventions influenced resilience levels compared to a no-intervention control condition; (2) identify correlates of mental resilience among nursing students, with particular attention to age, learning

abilities, and internet use patterns; and (3) explore methodological implications of baseline imbalance in post-test-only intervention designs.

We hypothesized that both active interventions would enhance resilience relative to control through distinct mechanisms, the museum visit through broadened historical and cultural perspective, the empathy video through enhanced emotional awareness, and that age, learning abilities, and internet use would show significant correlations with resilience independent of group assignment.

2. Materials and methods

2.1. Study design

We employed a three-arm, post-test-only comparison-group design conducted at the Department of Nursing, University of Thessaly, Greece, in October 2025. A post-test-only design was deliberately selected for pragmatic and exploratory reasons. The study was conceived as a low-cost pilot embedded within regular academic scheduling, and the brief, single-exposure nature of the interventions made a full pre–post protocol impractical within the available class time. In addition, repeated administration of the resilience instrument over a short interval can introduce testing and sensitization effects; a single post-intervention measurement was therefore also intended to limit pretest reactivity. Allocation to the three conditions was non-random. No formal randomization sequence was generated; assignment was determined on a convenience basis according to practical scheduling constraints of the participating class groups. We explicitly acknowledge that this non-random allocation does not guarantee baseline equivalence across arms, a limitation that materialized as the between-group age difference reported in Section 3 and discussed as a confounder in Section 5. Accordingly, this study should be interpreted as a quasi-experimental comparison rather than a randomized controlled intervention study. Owing to the overt, educational nature of the interventions, blinding of participants and facilitators to condition was not feasible. To limit facilitator influence on the outcome, however, the primary measure was collected through an anonymous, self-administered online questionnaire completed individually after each activity, rather than through any facilitator-rated assessment. The research protocol received approval from the Ethics Committee of the Department of Nursing, University of Thessaly (Protocol 1451/7–10–2022) and adhered to the principles of the Declaration of Helsinki. All participants provided written informed consent after receiving detailed information about study procedures, voluntary participation, and data confidentiality.

2.2. Participants

Inclusion criteria were: Ccurrent enrollment as a first- or second-year nursing student, age 18 years or older, Greek language proficiency, and the ability to provide informed consent. Exclusion criteria included a diagnosed psychiatric disorder requiring ongoing treatment and current leave of absence from studies. Recruitment proceeded by convenience sampling: The study was presented to first-year students during scheduled class sessions, and participation was voluntary, with no course credit or other compensation offered. Because the protocol involved a single post-intervention assessment rather than repeated follow-up, no longitudinal attrition occurred; all students who attended their allocated activity and provided informed consent completed the assessment. The final analytic sample comprised 54 participants: an intervention group (n = 19), a video group (n = 19), and a control

group (n = 16). Sample size was determined by the pragmatic constraints of classroom availability and student volunteer rates rather than a formal a priori power analysis, consistent with an exploratory pilot study. Post-hoc power calculations indicated that, with N = 54 and $\alpha = 0.05$, the study had less than 30% power to detect a medium effect (Cohen's d = 0.5) for between-group comparisons, substantially increasing the risk of Type II error and limiting the ability to detect true intervention effects if present. It should be noted at the outset that the control group was, on average, older than the two intervention groups (M = 26.4 vs. ≈ 22.4 years). Although this difference did not reach statistical significance given the small samples and large within-group variance, it is non-trivial in light of the strong age–resilience association reported below, and it is revisited as a primary internal-validity threat in Section 5.

2.3. Interventions

The intervention group participated in a single, approximately 2-hour guided tour of the permanent collection of the Diachronic Museum of Larissa, conducted in groups of up to 19 students. The museum's permanent exhibition is organized into eight chronological sections, Palaeolithic, Neolithic, Bronze and Iron Age, Archaic and Classical, Hellenistic and Roman, Early Christian, Byzantine, and Ottoman, and presents a continuous narrative of human habitation in the Thessalian plain across roughly ten millennia, framed around the long-term organization of communities through the lens of state, institutions, and powers. The guided tour followed this standard chronological route, led by the museum's professional educational and archaeological guides, and emphasized themes of human resilience, adaptation to change, cultural continuity despite adversity, and historical narratives of collective coping with challenges including wars, migrations, and social transformations. Thessaly's status as a cradle of the oldest Neolithic culture in Europe, including the largest collection of Neolithic figurines in Greece, provided concrete material illustrating long-term human persistence. Students were encouraged to reflect on connections between historical resilience and contemporary psychological resilience, considering how understanding past human experiences might inform their own capacity to navigate challenges in nursing education and professional life. The intervention was grounded in theories suggesting that cultural engagement, historical perspective-taking, and recognition of humanity's persistent adaptation across millennia might enhance individual psychological resilience through a broadened worldview, reduced present-centered anxiety, and connection to larger patterns of human experience [40,50]. The video group viewed, on a single occasion, an educational film entitled Empathy in Nursing: An Educational Film (duration approximately 12 minutes), focusing on empathy and emotional understanding in healthcare contexts. The film presented narratives designed to evoke empathic responses, emotional awareness, and perspective-taking regarding others' experiences. Viewing took place under standardized conditions (the same room, equipment, and instructions across sessions) and was facilitated by a member of the Department of Nursing teaching staff. To minimize facilitator and group-dynamic effects, the facilitator's role was restricted to introducing the film and ensuring uniform viewing conditions; no structured post-viewing discussion was conducted. This approach enabled standardized delivery of empathy-focused content while controlling for variability in group dynamics. The intervention was predicated on established links between emotional intelligence, empathy, and resilience, whereby enhanced capacity for understanding and regulating emotions, one's own and others', theoretically supports adaptive coping, effective interpersonal relationships, and psychological flexibility under stress [41,42]. The film was an internal teaching resource of the Department of Nursing, University of

Thessaly, selected for its focus on empathy and emotional understanding in healthcare settings; as it is not commercially distributed or publicly archived, it is not available through a citable external source. The viewing protocol is provided in the Supplementary Materials (Supplement Appendix 1). The control group continued regular academic activities without receiving either intervention, serving as a comparison condition, and completed only the post-intervention assessment, receiving no special programming. All participants were informed that they could access similar educational experiences after the study period if desired.

2.4. Measures

Following completion of intervention or control activities, all participants completed an anonymous online questionnaire via a secure survey platform. The survey required approximately 30–40 minutes to complete. Mental resilience was assessed using the Greek-validated Connor-Davidson Resilience Scale (CD-RISC-25) [51,52], a widely used 25-item instrument measuring the ability to cope with stress and adversity. Items were rated on a 5-point Likert scale from 1 to 5, yielding total scores ranging from 25 to 125, with higher scores indicating greater resilience. The scale assessed multiple resilience dimensions, including personal competence, tolerance of negative affect, positive acceptance of change, control, and spiritual influences. The CD-RISC-25 has demonstrated robust psychometric properties across populations and clinical contexts. In our sample, the scale showed excellent internal consistency (Cronbach's $\alpha = 0.89$). We developed an 8-item learning-abilities scale assessing self-reported cognitive and metacognitive learning capacities. The items evaluated were: comprehension on first reading, reading-speed satisfaction, difficulty with multisyllabic words, use of punctuation, satisfaction with handwriting, frequency of spelling errors, left–right spatial orientation, and satisfaction with study outcomes. Each item was rated on a 5-point Likert scale, with total scores ranging from 8–40, where higher scores indicated better self-perceived learning abilities. The scale demonstrated acceptable internal consistency in our sample (Cronbach's $\alpha = 0.71$). While this scale has not been formally validated against objective learning-performance measures, it provided a brief assessment of students' subjective learning-competence perceptions. The full item set is reproduced in the Supplementary Materials (Supplement Appendix 2). Participants also reported demographic characteristics including age, gender, and year of studies, and lifestyle variables, including body mass index (calculated from self-reported height and weight), family size, smoking status (yes/no), typical alcohol consumption (drinks per week), typical sleep duration (hours per night), internet-use hours per day, social-media use hours per day, number of friends with regular contact, participation in team sports (yes/no), participation in individual sports (yes/no), and overall life satisfaction (5-point scale).

2.5. Statistical analysis

Descriptive statistics characterized the sample overall and by group using means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Normality of continuous variables was assessed using Shapiro-Wilk tests. Group comparisons for continuous variables employed one-way ANOVA for normally distributed variables or Kruskal-Wallis tests for non-normal distributions. For significant omnibus tests, post-hoc pairwise comparisons used independent t-tests with Bonferroni correction. Cohen's d effect sizes were calculated for pairwise comparisons. Chi-square or Fisher's exact tests compared categorical variables across groups. Pearson

correlation coefficients examined bivariate relationships between CD-RISC-25 total scores and continuous predictor variables, including age, learning-abilities total score, internet-use hours, social-media hours, sleep duration, number of friends, and alcohol consumption. Spearman rank correlations were computed as sensitivity analyses for variables showing non-normal distributions. Independent t-tests compared CD-RISC-25 scores between binary groups (gender, smoking status, sports participation). Effect sizes for ANOVA (eta-squared), t-tests (Cohen's d), and correlations (Pearson r) were calculated and interpreted using conventional benchmarks (small: $\eta^2 = 0.01$, $d = 0.2$, $r = 0.1$; medium: $\eta^2 = 0.06$, $d = 0.5$, $r = 0.3$; large: $\eta^2 = 0.14$, $d = 0.8$, $r = 0.5$). Statistical significance was set at $\alpha = 0.05$ (two-tailed). Statistical analyses were performed using SPSS version 29.0 (IBM Corp., Armonk, NY, USA).

2.6. Ethical considerations

The research protocol complied with the ethical standards described in the Declaration of Helsinki and was approved by the Ethics Committee of the Department of Nursing, University of Thessaly (protocol number 1451/7–10–2022). Eligible students received written and verbal information describing the study aims, procedures, the voluntary nature of participation, their right to withdraw at any time without academic consequence, and the handling of their data, before providing written informed consent. Participation entailed no more than minimal risk: The interventions were educational and non-invasive, and the questionnaire contained no clinically sensitive or distressing items; the principal benefit was the educational experience. Data were collected anonymously through a secure online survey platform, contained no direct identifiers, were accessible only to the research team, and were stored on password-protected files in accordance with the EU General Data Protection Regulation (2016/679) and Greek data-protection legislation. As nursing students may be considered a potentially vulnerable group given the teacher–student relationship, recruitment and consent were structured to avoid any coercion: Participation was decoupled from course assessment, no incentives were offered, and non-participation carried no academic disadvantage.

3. Results

The final sample ($N = 54$) was predominantly female (85.2%, $n = 46$) with a mean age of 23.6 years ($SD = 10.3$, range 18–50 years). The large age standard deviation and range reflect a bimodal distribution, with most students aged 18–25 but several mature-age students in their 30s–40s. Nearly all participants were first-year students (98.1%, $n = 53$). Table 1 presents baseline characteristics by group. A substantial age difference existed between groups, with the control group older ($M = 26.4$, $SD = 13.2$) compared to the intervention ($M = 22.3$, $SD = 8.8$) and video ($M = 22.5$, $SD = 8.9$) groups. While this 4-year difference did not reach statistical significance (Kruskal-Wallis $H = 1.71$, $p = 0.426$) due to large within-group variability and small sample size, it represents a potentially meaningful difference given the strong age–resilience correlation described below. Female proportions were similar across groups (intervention: 89.5%, video: 89.5%, control: 75.0%; Fisher's exact $p = 0.457$). Lifestyle characteristics showed general similarity across groups. Approximately one-fifth of the students reported current smoking (20.4% overall), two-thirds consumed alcohol occasionally (mean 1.3 drinks/week overall), and about half participated in individual sports (53.7%). Mean sleep duration was 6.8 hours per night ($SD = 1.1$), slightly below recommended levels for young adults. Students reported spending substantial time online,

with a mean of 4.0 hours daily internet use (SD = 2.0) and 2.9 hours daily social-media use (SD = 2.0). Students maintained regular contact with an average of 7.6 friends (SD = 4.2). None of these lifestyle variables differed significantly between groups (all $p > 0.10$).

Table 1. Sample characteristics by group.

Characteristic	Intervention (n = 19)	Video (n = 19)	Control (n = 16)
Age, years, mean (SD)	22.3 (8.8)	22.5 (8.9)	26.4 (13.2)
Female, n (%)	17 (89.5)	17 (89.5)	12 (75.0)
Sleep hours, mean (SD)	6.8 (1.2)	6.8 (1.2)	6.9 (0.8)
Internet hours/day, mean (SD)	4.1 (1.7)	3.7 (1.4)	4.1 (3.2)
Social media hours/day, mean (SD)	3.3 (1.7)	2.5 (1.0)	3.1 (3.3)
Number of friends, mean (SD)	7.1 (3.2)	6.5 (3.5)	8.5 (5.4)
Alcohol drinks/week, mean (SD)	1.6 (2.3)	1.5 (1.8)	0.8 (0.8)
Current smoker, n (%)	3 (15.8)	3 (15.8)	1 (6.2)
Team sports participation, n (%)	6 (31.6)	5 (26.3)	2 (12.5)
Individual sports participation, n (%)	11 (57.9)	11 (57.9)	8 (50.0)
CD-RISC-25 Total, mean (SD)	88.1 (13.5)	88.8 (15.8)	93.1 (13.7)
Learning abilities total, mean (SD)	25.1 (2.8)	25.5 (2.9)	25.6 (2.9)

Primary Analysis: Group Comparisons. Mean CD-RISC-25 total scores were: intervention group 88.1 (SD = 13.5), video group 88.8 (SD = 15.8), and control group 93.1 (SD = 13.7). One-way ANOVA revealed no statistically significant difference between groups [$F(2,51) = 0.613$, $p = 0.545$, $\eta^2 = 0.023$]. The effect size was negligible, indicating that group assignment explained only 2.3% of variance in resilience scores. Table 2 presents complete group-comparison results for all study variables. Post-hoc pairwise comparisons using independent t-tests showed the control group scored numerically higher for resilience than the intervention (mean difference = 5.07, 95% CI: −3.96 to 14.11, $t = -1.10$, $p = 0.279$, $d = 0.374$) and video groups (mean difference = 4.34, 95% CI: −5.42 to 14.09, $t = -0.86$, $p = 0.396$, $d = 0.292$). Neither comparison approached statistical significance, and effect sizes were small. The intervention and video groups showed nearly identical resilience scores (mean difference = 0.74, 95% CI: −8.61 to 10.08, $t = -0.16$, $p = 0.878$, $d = 0.050$), with a negligible effect size.

Table 2. Group comparisons for primary and secondary outcomes.

Variable	Test	Statistic	p-value	η^2 / Sig.
Age, years	Kruskal-Wallis	1.709	0.426	ns
CD-RISC-25 Total Score	ANOVA	0.613	0.545	0.023 / ns
Learning Abilities Total	ANOVA	0.157	0.855	0.006 / ns
Sleep hours	Kruskal-Wallis	0.277	0.871	ns
Internet hours/day	Kruskal-Wallis	0.522	0.770	ns
Social media hours/day	Kruskal-Wallis	2.136	0.344	ns
Number of friends	Kruskal-Wallis	0.511	0.774	ns
Alcohol drinks/week	Kruskal-Wallis	1.814	0.404	ns

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns = not significant.

Similarly, no significant group differences emerged for learning-abilities total score [intervention: M = 25.1, SD = 2.8; video: M = 25.5, SD = 2.9; control: M = 25.6, SD = 2.9; $F(2,51) = 0.157$, $p = 0.855$, $\eta^2 = 0.006$]. Table 3 presents complete pairwise-comparison results. Groups also showed no significant differences in age ($p = 0.426$), sleep hours ($p = 0.871$), internet use ($p = 0.770$), social-media use ($p = 0.344$), number of friends ($p = 0.774$), or alcohol consumption ($p = 0.404$).

Table 3. Post-hoc pairwise comparisons for CD-RISC-25 total score.

Comparison	Mean diff.	95% CI	t	p-value	Cohen's d	Effect size
Intervention vs control	−5.07	(−14.11, 3.96)	−1.101	0.279	−0.374	Small
Video vs control	−4.34	(−14.09, 5.42)	−0.860	0.396	−0.292	Small
Intervention vs video	−0.74	(−10.08, 8.61)	−0.155	0.878	−0.050	Negligible

Secondary analysis: Correlates of resilience. Given the null finding for group effects, we examined correlates of resilience across the full sample, combining all three groups. Several significant associations emerged (Table 4). Age showed a strong positive correlation with resilience ($r = 0.560$, $p < 0.001$), representing the largest effect observed in this study. Figure 1 panel D illustrates this relationship, with older students demonstrating substantially higher resilience levels across the observed age range (18–50 years). The relationship remained robust when examined via non-parametric correlation (Spearman $\rho = 0.284$, $p = 0.038$). Learning-abilities total score correlated moderately-strongly with resilience ($r = 0.485$, $p < 0.001$; Spearman $\rho = 0.596$, $p < 0.001$). Figure 1 panel E shows this relationship, with students reporting better comprehension, study effectiveness, and fewer learning difficulties showing higher resilience scores. Internet-use hours per day demonstrated a significant negative correlation with resilience ($r = −0.294$, $p = 0.031$; Spearman $\rho = −0.417$, $p = 0.002$). Figure 1 panel F illustrates this relationship, with students reporting greater daily internet use tending toward lower resilience levels. Other variables showed non-significant associations with resilience: social-media use hours ($r = −0.162$, $p = 0.246$), sleep hours ($r = 0.094$, $p = 0.501$), number of friends ($r = 0.106$, $p = 0.459$), and alcohol consumption ($r = −0.102$, $p = 0.467$).

Table 4. Correlations between CD-RISC-25 total score and study variables.

Variable	N	Pearson r	p-value	Spearman ρ / Sig.
Age, years	54	0.560	<0.001	0.284 / ***
Learning Abilities Total	54	0.485	0.0002	0.596 / ***
Internet hours/day	54	−0.294	0.031	−0.417 / *
Social media hours/day	53	−0.162	0.246	−0.231 / ns
Sleep hours	54	0.094	0.501	0.116 / ns
Number of friends	51	0.106	0.459	0.134 / ns
Alcohol drinks/week	53	−0.102	0.467	−0.094 / ns

Note: * $p < 0.05$, *** $p < 0.001$, ns = not significant.

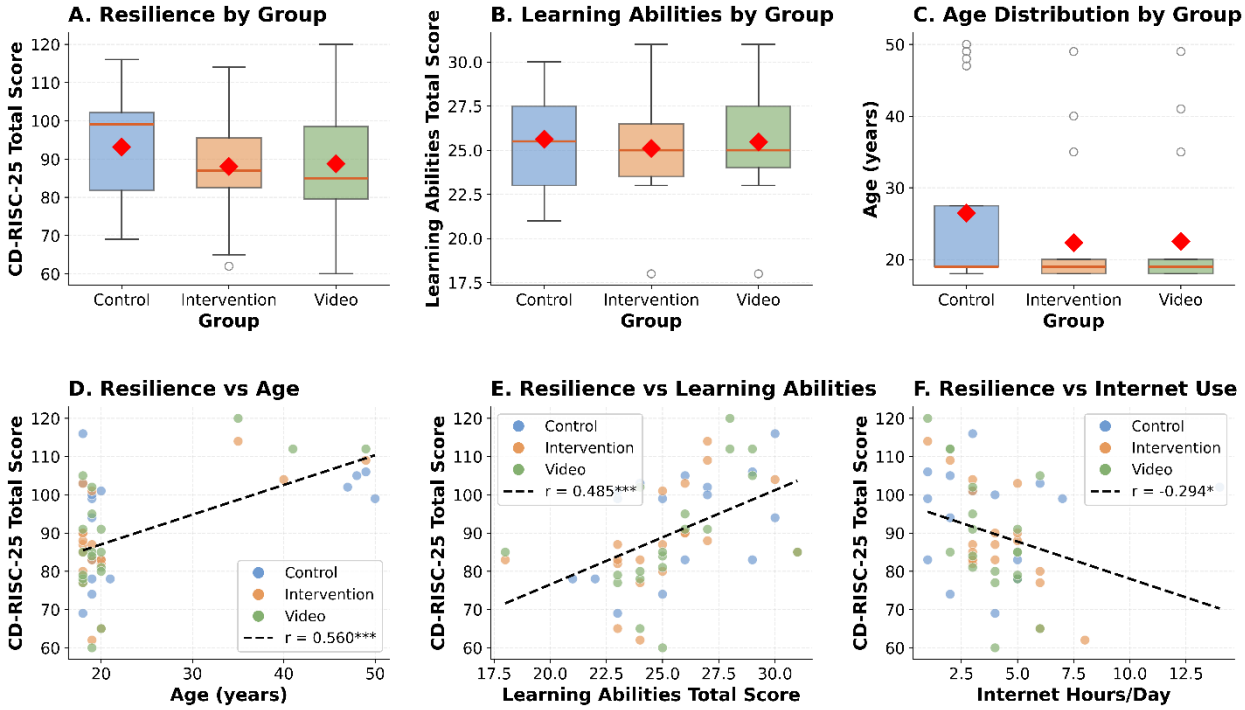


Figure 1. Distributional and correlational analyses of mental resilience (CD-RISC-25) in nursing students (N = 54). Panels A–C present box-and-whisker plots of resilience, learning-abilities total score, and age by study group (Control, Intervention, Video); red diamonds indicate group means. Panels D–F show the associations between resilience and age ($r = 0.560$, $p < 0.001$), learning abilities ($r = 0.485$, $p < 0.001$), and daily internet-use hours ($r = -0.294$, $p = 0.031$); points are color-coded by group and dashed lines represent the linear regression for the overall sample. CD-RISC-25: Connor-Davidson Resilience Scale.

4. Discussion

In this exploratory study, we examined the effects of brief museum-based and empathy video interventions on mental resilience in nursing students while investigating individual and lifestyle correlates of resilience. The primary hypothesis, that cultural engagement or empathy-focused education would enhance resilience relative to control, was not supported. However, important correlational findings emerged regarding age, learning abilities, and internet use as predictors of resilience. We discuss the null intervention findings and the significant correlates, along with methodological lessons and practical implications. Neither the museum visit nor the empathy video produced measurable resilience differences compared to the control. Several factors likely contributed to this null finding. First, the control group was substantially older (26.4 ± 13.2 years) than both intervention groups (approximately 22.4 years on average). Given the very strong positive correlation between age and resilience observed in our data ($r = 0.560$, $p < 0.001$), it is plausible that the control group possessed higher baseline resilience prior to any intervention. Without baseline resilience measurements, we cannot determine whether all groups started with similar resilience, or whether the control group's older age masked potential intervention benefits. Second, meta-analyses of resilience interventions typically reveal that longer, more intensive programs produce larger effects than brief,

single-session interventions [35,37]. Our interventions may have been insufficient in dose, duration, or depth of experiential engagement to produce measurable changes in a relatively stable psychological construct. Alternative modalities, such as sustained museum-based learning with reflective journaling, interactive empathy training with role-playing, or integration into existing coursework, may better activate the theoretical mechanisms proposed. The strong positive association between age and resilience ($r = 0.560$, $p < 0.001$) represents a key finding with theoretical and practical implications. This relationship aligns with extensive gerontological literature demonstrating that psychological resilience often increases across the lifespan [12–14]. Several mechanisms may contribute: life-experience accumulation, enhanced emotion regulation through neurodevelopmental maturation and experiential learning [14,15,53], and more stable social-support networks developed over time [54,55]. The discrepancy between Pearson and Spearman coefficients warrants methodological comment: Given the bimodal age distribution in our sample, Pearson's r is sensitive to the leverage exerted by the small subgroup of mature-age students (ages 35–50), while Spearman's ρ provides a more conservative estimate. Both coefficients reached statistical significance ($p < 0.05$), and their divergence reflects the sample's age structure rather than an inconsistency in the data. These findings suggest that resilience interventions should be tailored to developmental stage. Younger nursing students (ages 18–22) may particularly benefit from targeted resilience training, while mature-age students entering nursing as a second career may require different forms of support. Educators should recognize that students enter programs with very different resilience baselines depending on age and life experience. The moderate-to-strong correlation between self-reported learning abilities and resilience ($r = 0.485$, $p < 0.001$) suggests an important interplay between academic competencies and psychological adaptation. This relationship likely operates bidirectionally: Students with stronger learning skills experience fewer academic setbacks and develop higher self-efficacy, a core resilience component [56,57], while resilient students demonstrate persistence, help-seeking, and reflective practices that enhance learning effectiveness [23,24,58]. Programs that simultaneously address cognitive/metacognitive learning skills and psychological resilience may leverage this bidirectional relationship for synergistic benefits. The negative correlation between daily internet hours and resilience ($r = -0.294$, $p = 0.031$), though moderate, aligns with growing evidence linking excessive digital-technology use to mental-health risks [25–27]. Interestingly, general internet use correlated significantly with resilience while social-media use ($r = -0.162$, $p = 0.246$) did not, though the trend was in the same direction. Mechanisms may include time displacement from health-promoting activities, passive consumption reducing opportunities for mastery experiences, and social-comparison dynamics [30,31,59,60]. However, the cross-sectional nature of our data precludes causal inference: Reverse causation, whereby students with lower resilience turn to internet use as a coping mechanism, remains plausible, as does a bidirectional relationship. These findings suggest that digital-wellness education merits integration into nursing curricula.

5. Strengths, limitations, and future directions

This study's strengths include the use of a validated resilience measure (CD-RISC-25, $\alpha = 0.89$), assessment of multiple potentially relevant predictors, examination of an understudied population, and transparent reporting of null intervention findings alongside positive correlational results. Several limitations require careful acknowledgment. First, the post-test-only design, with absence of baseline measurements, prevents determination of baseline equivalence, calculation of change scores, and confident causal attribution, representing the study's most significant methodological limitation; the

design is therefore quasi-experimental rather than a randomized controlled trial [43,44]. The small sample size (16–19 per group), determined by pragmatic rather than statistical considerations, provided substantial underpowerment to detect small-to-medium effects (post-hoc power <30% for Cohen's d = 0.5) and substantially increased the risk of Type II error; that is, failing to detect true intervention effects if present [45,46]. Second, the substantial age difference between the control group (M = 26.4 years) and intervention groups (M ≈ 22.4 years), combined with the strong age–resilience correlation observed ($r = 0.560$, $p < 0.001$), constitutes a significant confounding factor that cannot be adequately controlled in the absence of baseline measurements. This confound represents a primary threat to the internal validity of the between-group comparisons. Third, the interventions employed, a single 2-hour museum visit and a brief empathy video, were likely insufficient in dose and duration to modify a relatively stable psychological construct such as resilience. This limitation of intervention intensity and brevity should be interpreted as a methodological constraint rather than as evidence against the theoretical validity of cultural or empathy-based approaches. In future studies, researchers should employ multi-session, sustained interventions with active participation components. Fourth, our 8-item learning-abilities scale was developed ad hoc and has not been formally validated against objective measures of learning performance. Furthermore, the scale combines conceptually heterogeneous dimensions, including reading comprehension, spelling accuracy, spatial orientation, and handwriting satisfaction, which may reduce its construct validity despite acceptable internal consistency ($\alpha = 0.71$). Thus, researchers should employ validated instruments or objective performance measures. Fifth, several potentially relevant confounding variables were not assessed, including subclinical psychological history, prior exposure to academic stress, and objective academic-performance indicators. The absence of these measures limits the ability to isolate resilience correlates from pre-existing individual differences. Sixth, the wide age range of participants (18–50 years) resulted in a markedly heterogeneous sample with a bimodal age distribution. Within a small study (N = 54), this heterogeneity complicates interpretation, as results may reflect the influence of a small number of mature-age students rather than patterns generalizable to the broader nursing-student population. Additional limitations include reliance on self-report, introducing potential social-desirability bias and shared-method variance; restriction to a single Greek nursing school, limiting generalizability; and cross-sectional correlations that cannot establish temporal precedence or causation. Researchers should address these limitations through longitudinal designs examining how resilience develops across nursing education, pre-post intervention studies with adequate sample sizes and stratified randomization for key variables (particularly age and baseline resilience), longer multi-session interventions, and objective measures of learning abilities and sleep quality.

6. Conclusions

In this exploratory study, we found that brief museum-based and empathy video interventions did not produce measurable resilience differences among nursing students, likely due to insufficient intervention intensity and baseline age imbalance in a post-test-only design. However, important resilience correlates emerged: Age showed a strong positive relationship ($r = 0.560$), learning abilities demonstrated a moderate-to-strong positive association ($r = 0.485$), and internet-use hours evidenced a negative correlation ($r = -0.294$). These findings advance our understanding of factors influencing resilience in nursing students and highlight critical methodological considerations for intervention research. In future studies, researchers should employ pre-post designs with adequate power, longer-

duration interventions, and developmentally-tailored approaches to effectively support resilience development in nursing education.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Authors' contributions

Conceptualization: Magdalini Christodoulou; Maria Antoniou; Dimitrios Papagiannis; Methodology: Maria Antoniou, Evangelos C. Fradelos; and Dimitrios Papagiannis. Software: Magdalini Christodoulou; Maria Antoniou; Vasiliki Vaitsi; and Dimitrios Papagiannis; Validation, Maria Antoniou, Evangelos C. Fradelos and Dimitrios Papagiannis; Formal analysis: Evangelos C. Fradelos, and Dimitrios Papagiannis; Investigation: Maria Antoniou, Evangelos C. Fradelos, and Dimitrios Papagiannis; data curation, Vasiliki Vaitsi; Evangelos C. Fradelos and Dimitrios Papagiannis; writing original draft preparation: Magdalini Christodoulou, Evangelos C. Fradelos, and Dimitrios Papagiannis; writing, review and editing: Magdalini Christodoulou; Evangelos C. Fradelos; Maria Antoniou; Vasiliki Vaitsi; Foteini Malli; Ioanna V. Papathanasiou and Dimitrios Papagiannis; supervision: Dimitrios Papagiannis; project administration: Dimitrios Papagiannis. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

Evangelos C. Fradelos is an editorial board member for AIMS Public Health and was not involved in the editorial review or the decision to publish this article. All authors declare that there are no competing interests.

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