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The effect of nurse-led, culturally tailored education on parental anxiety and caregiver burden in the neonatal intensive care unit

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ABSTRACT

This quasi-experimental, time-block controlled study evaluated the effectiveness of a nurse-led, culturally tailored educational program in reducing parental anxiety and caregiver burden among parents of infants admitted to a neonatal intensive care unit (NICU) in Egypt. A total of 100 parents were assigned to either an intervention group that received structured, theory-based educational sessions or a control group that received standard care. Validated Arabic versions of the Beck Anxiety Inventory and the Caregiver Burden Scale were administered at baseline, after two weeks, and after three months. Parents in the intervention group showed significantly greater reductions in anxiety and caregiver burden compared with those in the control group, and these improvements were maintained at three months. Regression analysis identified participation in the educational program as the main predictor of improved psychological outcomes. These findings indicate that a structured, nurse-led educational intervention adapted to the local cultural context and based on psychological theory is associated with reduced parental anxiety and caregiver burden in a resource-limited NICU setting. However, the quasi-experimental design limits causal interpretation. Overall, the results highlight the important role of neonatal nurses in providing culturally appropriate psychosocial education and support, and support the integration of such interventions into routine NICU practice to strengthen family-centered care and parental well-being.

1. Introduction

Parents of infants admitted to neonatal intensive care units (NICUs) often confront acute psychological stress marked by anxiety, helplessness, and emotional disequilibrium that undermine both well-being and caregiving capacity. These psychological disruptions extend beyond individual distress to affect family function and infant recovery trajectories, particularly within low- and middle-income contexts where systemic limitations constrain psychosocial care (Hendy et al., 2024; Rambod et al., 2023). In Egypt, this compounded vulnerability reflects structural inequities, including resource scarcity and minimal integration of culturally attuned psychosocial interventions in hospital systems.

Although numerous studies affirm the effectiveness of educational interventions in reducing NICU-related anxiety and burden, much of the empirical evidence emerges from high-income countries whose sociocultural assumptions do not align with the dynamic realities of LMIC populations. The direct importation of these models risks conceptual misalignment and diminished engagement, thus necessitating rigorous cultural adaptation that attunes educational content, delivery modes, and caregiver participation frameworks to the linguistic and psychosocial milieu of Egyptian families (Costas-Muniz et al., 2023).

The present study synthesizes Lazarus and Folkman's Stress and Coping Theory (Folkman and Lazarus, 1985) and Bandura's (2000) Social Cognitive Theory to form a theoretically coherent foundation for intervention design. Stress and coping principles guide efforts to recalibrate parental appraisal of NICU challenges by fostering adaptive reinterpretation of threat and strengthening cognitive-behavioral coping strategies. Concurrently, the self-efficacy mechanisms within social cognitive theory, rooted in guided mastery, observational

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modeling, and verbal reinforcement, promote parental confidence and agency in caregiving roles, thereby alleviating emotional burden and enhancing adaptive functioning.

Within such psychosocially charged contexts, nurses serve as critical mediators between evidence and care, positioned to deliver interventions that integrate psychological theory with cultural sensitivity. This study thus seeks to evaluate the association between a context-adapted, theoretically grounded, nurse-led educational intervention and parental anxiety and caregiving burden within an Egyptian NICU setting. By embedding cultural resonance within a theoretical structure, the study advances the global nursing mandate to cultivate equitable, family-centered care models that mitigate psychological distress and fortify resilience in vulnerable caregiving populations (Abukari and Schmollgruber, 2024; Rochefort et al., 2016).

2. Methodology

A quasi-experimental, time-block controlled design was utilized to assess the association between a structured, theoretically informed, and context-adapted educational intervention and parental anxiety and caregiver burden among families of neonates hospitalized in an Egyptian NICU. This design was selected due to practical and ethical constraints, though it inherently limits causal inference compared to randomized controlled trials. The study was conducted in the neonatal intensive care unit of El-Senbellawein General Hospital, a prominent public tertiary care center serving a diverse population from both urban and rural settings. Reflective of typical neonatal care environments across many low- and middle-income countries (LMICs), this unit experiences high patient throughput, limited staffing, scarce psychosocial support resources, and a wide range of neonatal health complexities. Such contextual realities provide an authentic and pragmatic setting to evaluate the clinical significance and operational feasibility of context-adapted psychosocial interventions within resource-constrained healthcare systems.

Sample size determination was conducted using G*Power version 3.1, a robust tool for statistical power analysis. Based on an expected medium effect size (Cohen's d = 0.6) for primary outcomes, parental anxiety measured by the Beck Anxiety Inventory and caregiver burden assessed via the Caregiver Burden Scale, alongside an alpha level of 0.05, statistical power of 0.80, and a two-tailed hypothesis, the calculated minimum sample size was 45 participants per group. Accounting for an estimated 10% attrition rate, enrollment targets were adjusted to 50 parents per group, resulting in an overall sample size of 100 participants.

Parents of neonates admitted to the NICU between August and November 2024 were recruited using a convenience sampling approach. Eligible participants were mothers or fathers aged ≥18 years, whose infants had been hospitalized for at least 48 hours, and who demonstrated sufficient Arabic proficiency to engage with study procedures. Parents of neonates with major congenital anomalies, terminal conditions, or an anticipated discharge within 48 hours were excluded to ensure meaningful engagement with the intervention.

2.1. Participant recruitment and consent

Eligible parents were approached by the researcher, who thoroughly explained the study's objectives, procedures, potential risks, and expected benefits. The voluntary nature of participation and strict confidentiality measures were emphasized. Written informed consent was obtained in accordance with established ethical standards for human subjects research. Recruitment proceeded until the predetermined sample size was achieved, with participants allocated evenly between intervention and control groups using the specified time-block method.

2.2. Instrument 1: Demographic and clinical data

This instrument captured parents' sociodemographic and neonates' clinical characteristics to describe the sample and control confounding factors. Parental data included age, gender, education, and prior NICU exposure, while neonatal data covered gestational age, birth weight, Apgar score, and primary diagnosis. These variables provided a comprehensive baseline and ensured methodological rigor (Shaban Mohamed and Hamed Tawfik, 2020; Whitehill et al., 2021).

2.3. Instrument 2: Beck anxiety inventory (BAI)

The Beck Anxiety Inventory is a widely used 21-item self-report measure designed to assess the severity of anxiety symptoms over the past week, encompassing both somatic (e.g., palpitations, dizziness) and cognitive (e.g., fear, difficulty relaxing) dimensions. Responses are rated on a 4-point Likert scale ranging from 0 ("Not at all") to 3 ("Severe"), producing a total score between 0 and 63 that reflects anxiety levels from minimal to severe (Beck et al., 1988).

For this study, the BAI underwent meticulous forward–backward translation and cultural adaptation for Arabic-speaking Egyptian parents, followed by expert panel review and pilot testing to ensure clarity and contextual relevance within the NICU environment. Psychometric evaluation revealed excellent internal consistency (Cronbach's $\alpha = 0.91$), consistent with previous Arabic validation studies in Egyptian healthcare settings.

2.4. Instrument 3: Caregiver burden scale (CBS)

The Caregiver Burden Scale is a validated 22-item self-report instrument that assesses multiple

dimensions of caregiver strain, including physical, emotional, social, and financial burdens. Items are scored on a 5-point Likert scale from 0 ("Never") to 4 ("Nearly always"), with total scores ranging from 0 to 88; higher scores denote greater caregiving burden. Severity is classified into ascending categories: none/mild, mild/moderate, moderate/severe, and severe.

For this study, the CBS was meticulously translated and context-adapted into Arabic, tailored specifically for Egyptian NICU parents. This process included forward–backward translation and evaluation by an expert panel to ensure semantic accuracy and cultural relevance in the neonatal intensive care context. Pilot testing confirmed the tool's comprehensibility and acceptability within the target population. Psychometric analysis demonstrated strong internal consistency (Cronbach's $\alpha = 0.88$), consistent with previous Arabic validations in Egyptian cohorts, supporting its appropriateness for assessing caregiver burden in resource-limited NICU settings (Bachner, 2013).

Intervention fidelity was maintained through adherence checklists completed by the nurse and periodic direct observations by the author to ensure protocol compliance. Participant adherence was tracked via self-report logs reviewed regularly by the author to provide feedback and support, promoting sustained engagement and optimal intervention delivery. Data was collected via direct, face-to-face assessments in private NICU rooms at El-Senwein Hospital to ensure confidentiality and promote honest reporting. Assessments occurred at baseline, two weeks, and three months post-intervention. Staff reiterated study aims and confidentiality before each session.

All instruments were context-adapted and translated for the Arabic-speaking Egyptian NICU population, with anonymity ensured through coded identifiers and secure, encrypted data storage. Double data entry and validation enhanced accuracy. Missing data were analyzed for randomness using Little's MCAR test and addressed with multiple imputations to maintain statistical robustness.

The intervention consisted of a meticulously designed, two-session educational program grounded in established psychological theories and adapted to the Egyptian cultural context. Each 45-minute session, spaced one week apart, was delivered face-to-face by neonatal nurses specifically trained in both theoretical principles and cultural sensitivity.

2.5. Theoretical framework integration

The curriculum systematically integrated Lazarus and Folkman's Stress and Coping Theory by targeting both primary appraisal (helping parents reframe NICU experiences as manageable challenges rather than overwhelming threats) and secondary appraisal (enhancing perceived coping resources through knowledge and skill building). The intervention incorporated both emotion-focused coping strategies (relaxation techniques, emotional expression) and problem-focused coping approaches (practical caregiving skills, resource navigation) (Folkman and Lazarus, 1985).

Bandura's (2000) Social Cognitive Theory was operationalized through observational learning (nurse demonstrations), guided practice (hands-on skill building), and mastery experiences (successful completion of caregiving tasks). The intervention systematically built parental self-efficacy through four sources: performance accomplishments (successful caregiving experiences), vicarious experiences (observing other parents), verbal persuasion (encouragement from nurses), and emotional arousal management (anxiety reduction techniques).

2.6. Nurse training program

Nurses underwent a comprehensive 16-hour training program delivered over four sessions, covering: (1) theoretical foundations of stress, coping, and self-efficacy; (2) cultural competency in Egyptian family dynamics and communication styles; (3) adult learning principles and interactive teaching techniques; and (4) standardized delivery of intervention content with role-playing and practice sessions. Training materials included detailed facilitator guides, cultural adaptation guidelines, and competency checklists to ensure consistent, high-quality delivery.

2.7. Session 1: NICU orientation and cognitive reframing

- **Content:** NICU environment orientation, equipment explanation (incubators, monitors, ventilators), infection control procedures, staff roles, visiting policies, and communication strategies
- **Cultural Adaptations:** Materials presented in colloquial Egyptian Arabic, incorporation of Islamic perspectives on healing and patience, acknowledgment of extended family involvement in decision-making, and respect for traditional gender roles while encouraging both parents' participation
- **Theoretical Application:** Targeted primary appraisal modification by providing concrete information to reduce uncertainty and perceived threat; enhanced secondary appraisal through introduction of available resources and support systems

2.8. Session 2: Practical skills and coping enhancement

- **Content:** Hands-on caregiving skills (kangaroo care, feeding techniques, diaper changing), infant behavioral cues recognition, medication safety, emergency procedures, and stress management techniques

- **Cultural Adaptations:** Integration of traditional Egyptian infant care practices where medically appropriate, consideration of religious practices (prayer times, dietary restrictions), and a family-centered approach acknowledging grandparents' advisory roles
- **Theoretical Application:** Self-efficacy building through guided practice and mastery experiences; emotion-focused and problem-focused coping strategy development; observational learning through peer modeling

Supplementary materials included culturally adapted illustrated pamphlets featuring Egyptian family representations, pocket-sized reference cards with key information in Arabic script, and visual aids using familiar cultural symbols and contexts. Materials were designed for diverse literacy levels, incorporating pictorial elements and simple language while maintaining medical accuracy.

The control group received routine NICU care without added educational or psychosocial support, serving as a practical comparator to the intervention group.

2.9. Data analysis

Data analysis was performed using IBM SPSS Statistics 26. Descriptive statistics summarized sample characteristics, with baseline equivalence between groups confirmed by t-tests and chi-square tests. Associations between the intervention and parental anxiety and caregiver burden at two-week and three-month follow-ups were evaluated using ANCOVA, controlling for baseline scores and covariates. Within-group changes were analyzed via paired t-tests or Wilcoxon tests, revealing significant reductions in the intervention group only. Effect sizes (Cohen's d) indicated a strong association with the intervention. Missing data were assessed with Little's MCAR test and addressed through multiple imputations. Statistical significance was set at $p < 0.05$ (two-tailed).

3. Results

Table 1 presents the baseline demographic characteristics of participants in both the intervention and control cohorts, demonstrating no statistically significant differences and thereby confirming the comparability of the groups. The average parental age was 30.2 ± 5.1 years for the intervention group and 29.8 ± 5.5 years for controls ($p = 0.67$). Gender distribution remained balanced, with females representing 56% and 58% of the intervention and control groups, respectively ($p = 0.84$). Educational levels were comparable across groups, with roughly half of participants having completed secondary education and approximately 30% possessing higher education qualifications ($p = 0.83$). Additionally, prior NICU exposure was reported by 24% of the intervention group and 22% of controls ($p = 0.82$), further reinforcing group equivalence.

Table 2 delineates the baseline neonatal profiles across both study cohorts, revealing no significant differences in key clinical parameters and thereby affirming group comparability. The mean gestational age was 34.1 ± 3.2 weeks for the intervention group versus 33.8 ± 3.5 weeks for controls ($p = 0.61$). Birth weights were closely aligned, measuring 2100 ± 350 g and 2150 ± 400 g, respectively ($p = 0.54$). Five-minute Apgar scores exhibited similar averages of 7.8 ± 1.1 in the intervention arm and 7.7 ± 1.2 in the control arm ($p = 0.78$). The distribution of primary neonatal diagnoses was predominantly prematurity (~81%), followed by sepsis/infection (13%) and miscellaneous conditions (6%), with no significant intergroup differences observed ($p = 0.79$).

Table 1: Baseline demographic characteristics of parents (n=100)

Characteristic	Intervention group (n=50)	Control group (n=50)	Total (n=100)	p-value
Age, years (mean ± SD)	30.2 ± 5.1	29.8 ± 5.5	30.0 ± 5.3	0.67
Gender				0.84
- Male	22 (44%)	21 (42%)	43 (43%)	
- Female	28 (56%)	29 (58%)	57 (57%)	
Educational level				0.83
- Primary or less	10 (20%)	12 (24%)	22 (22%)	
- Secondary	25 (50%)	24 (48%)	49 (49%)	
- Higher education	15 (30%)	14 (28%)	29 (29%)	
Prior NICU experience	12 (24%)	11 (22%)	23 (23%)	0.82

SD: Standard deviation

Table 2: Neonatal clinical characteristics (n=100)

Characteristic	Intervention group (n=50)	Control group (n=50)	Total (n=100)	p-value
Gestational age (weeks, mean ± SD)	34.1 ± 3.2	33.8 ± 3.5	33.95 ± 3.3	0.61
Birth weight (grams, mean ± SD)	2100 ± 350	2150 ± 400	2125 ± 375	0.54
Apgar score at 5 minutes (mean ± SD)	7.8 ± 1.1	7.7 ± 1.2	7.75 ± 1.15	0.78
Primary diagnosis				0.79
- Prematurity	40 (80%)	41 (82%)	81 (81%)	
- Sepsis/infection	7 (14%)	6 (12%)	13 (13%)	
- Other	3 (6%)	3 (6%)	6 (6%)	

Table 3 demonstrates significant associations between the intervention and reductions in parental anxiety and caregiver burden among participants who received the structured educational intervention. Initial baseline measurements indicated no significant differences between the

intervention and control groups on the Beck Anxiety Inventory (BAI) (27.8 ± 7.6 vs. 28.3 ± 7.4; p = 0.72) and the Caregiver Burden Scale (CBS) (35.6 ± 8.4 vs. 36.0 ± 8.6; p = 0.82).

Table 3: Parental anxiety and caregiver burden scores (n=100)

Outcome measure	Time point	Intervention group	Control group	p-value (ANCOVA)
Beck anxiety inventory (BAI)	Baseline	27.8 ± 7.6	28.3 ± 7.4	0.72
	2 weeks post	14.5 ± 5.2	27.0 ± 7.2	< 0.001
	3 months follow-up	12.8 ± 4.9	26.2 ± 7.0	< 0.001
Caregiver burden scale (CBS)	baseline	35.6 ± 8.4	36.0 ± 8.6	0.82
	2 weeks post	20.2 ± 6.0	35.5 ± 8.5	< 0.001
	3 months follow-up	18.7 ± 5.8	34.8 ± 8.3	< 0.001

At two weeks post-intervention, the intervention cohort demonstrated substantial decreases in anxiety (14.5 ± 5.2) and caregiver burden (20.2 ± 6.0), significantly differing from the control group, which reported scores of 27.0 ± 7.2 and 35.5 ± 8.5, respectively (p < 0.001). These associations not only persisted but further progressed by the three-month follow-up, with anxiety and burden scores reducing to 12.8 ± 4.9 and 18.7 ± 5.8 in the intervention group, whereas the control group's scores remained relatively stable. Table 4 reveals that participation in the structured educational intervention emerged as the sole significant predictor associated with reductions in parental anxiety. Engagement in the program was strongly associated with a decrease in Beck Anxiety Inventory (BAI) scores (β = −12.8, SE = 2.1, p < 0.001; 95% CI: −17.0 to −8.6), indicating a pronounced association with the intervention. Other examined variables, including parental age, educational level, prior NICU experience, and infant gestational age, did not demonstrate significant associations with anxiety reduction (p > 0.05), thereby minimizing the likelihood of confounding influences from demographic or clinical factors.

4. Discussion

This quasi-experimental, time-block controlled investigation critically examined the relationship between a theory-informed, culturally adapted psychoeducational intervention and parental psychological outcomes within the demanding environment of an Egyptian NICU. The findings reveal strong and sustained associations between the intervention and reductions in both anxiety and caregiver burden, suggesting that strategically designed, nurse-led psychosocial programs can meaningfully alleviate parental distress in resource-limited clinical contexts. These results reinforce the growing consensus that culturally grounded, evidence-informed nursing interventions are pivotal to optimizing family well-being in neonatal care (Loutfy et al., 2024; Sabnis et al., 2019).

Table 4: Predictors of reduction in anxiety and caregiver burden (n=100)

Predictor variable	Outcome variable	β coefficient	SE	p-value	95% CI
Educational intervention (yes)	Change in anxiety score (BAI)	-12.8	2.1	<0.001	-17.0 to -8.6
	Change in caregiver burden	-15.3	2.8	<0.001	-20.8 to -9.8
Parent age	Change in anxiety score	0.2	0.18	0.24	-0.15 to 0.55
Parent education level	Change in anxiety score	-1.5	1.4	0.28	-4.3 to 1.3
Prior NICU experience	Change in anxiety score	-0.8	1.6	0.63	-3.9 to 2.3
Infant gestational age	Change in anxiety score	0.5	0.37	0.18	-0.28 to 1.28

β: Regression coefficient; SE: Standard error; CI: Confidence interval

Rigorous efforts were undertaken to ensure baseline equivalence across groups, with matching on parental (e.g., age, gender, education, prior NICU exposure) and neonatal characteristics (e.g., gestational age, birth weight, diagnosis). Such methodological diligence enhances interpretive confidence that the observed outcomes are attributable to the intervention rather than extraneous variation, thereby strengthening the study's internal validity and alignment with best practices in nursing research design.

4.1. Mechanisms of anxiety reduction: A theoretical synthesis

The observed reductions in parental anxiety can be interpreted through an integrated theoretical lens combining Folkman and Lazarus's (1985) Stress and Coping Theory and Bandura's (2000) Social Cognitive Theory. The intervention appeared to modulate both primary and secondary appraisal processes central to stress regulation. By providing culturally relevant, transparent information about the NICU environment, such as clarifying medical equipment functions, professional roles, and procedural routines, parents' perceptions shifted from one of overwhelming threat to one of manageable challenges. This reappraisal likely diminished uncertainty, a well-documented precipitant of anxiety in acute care settings.

Simultaneously, the program enhanced secondary appraisal by strengthening perceived coping capacity through structured education, skill-building, and supportive dialogue. The integration of both emotion-focused (e.g., guided relaxation, opportunities for emotional expression) and problem-focused coping (e.g., hands-on caregiving practice, practical guidance on resource navigation) aligns with the theoretical premise that a flexible coping repertoire mitigates psychological distress. From a social cognitive perspective, these gains may have been further consolidated by the progressive

enhancement of parental self-efficacy through mastery experiences, observational learning, positive verbal reinforcement, and emotional regulation mechanisms consistent with Bandura's (2000) four sources of efficacy information.

These patterns resonate with emerging evidence that mindfulness-based and relaxation-oriented interventions can effectively reduce anxiety and depressive symptoms among NICU parents (Ginsberg et al., 2023) and that family-centered education combined with expressive or creative modalities produces enduring reductions in distress (Sabnis et al., 2019). By contrast, Mendelson et al. (2017) found that cognitive-behavioral approaches, while beneficial for depressive symptoms, yielded mixed effects on anxiety, underscoring the importance of contextual and cultural alignment in intervention design. Overall, these studies underscore the critical necessity of adopting context-responsive, multifaceted interventions to achieve lasting and meaningful reductions in anxiety among NICU parents.

4.2. Caregiver burden reduction: Strengthening self-efficacy and cultural congruence

The reduction in caregiver burden observed in this study further underscores the functional utility of Bandura's (2000) self-efficacy framework in nursing interventions. Through structured, nurse-facilitated skill development, parents transitioned from passive recipients of medical care to active, confident participants in their infants' recovery process. This transformation likely attenuated perceived burden by enhancing parents' sense of control, competence, and relational connection to their infants' care trajectory.

Cultural adaptation played a decisive role in this mechanism. By embedding culturally salient caregiving practices and acknowledging the extended family's caregiving role elements intrinsic to Egyptian sociocultural life, the intervention fostered authenticity and emotional resonance. This contextual attune may have amplified engagement, adherence, and outcome durability. The finding aligns with evidence that self-efficacy–based interventions enhance maternal involvement and reduce stress in neonatal contexts (Heidary et al., 2023; Lee et al., 2012). Conversely, less culturally or theoretically grounded programs, such as those reported by Rabiei et al. (2020), tend to yield weaker or short-lived outcomes, underscoring the necessity of contextual sensitivity in psychosocial intervention design.

4.3. Intervention as a key predictor: Implications for nursing practice

Regression analyses identified the nurse-led educational intervention as the principal factor associated with reductions in both anxiety and burden, independent of demographic or clinical covariates. This emphasizes the centrality of structured, context-adapted education as a modifiable determinant of psychosocial well-being in NICU families. Previous studies similarly demonstrate that nurse-delivered educational interventions significantly mitigate maternal stress and enhance knowledge and confidence (Morey and Gregory, 2012), while Chen et al. (2016) highlighted the moderating influence of demographic characteristics on intervention responsiveness. Taken together, these findings underscore the essential role of tailored, nurse-facilitated educational interventions in addressing the psychosocial needs of NICU parents across diverse populations.

4.4. Theoretical and practical contributions

Theoretically, this study substantiates the integration of stress appraisal and self-efficacy frameworks within a culturally adaptive intervention paradigm, contributing to the refinement of psychosocial nursing models applicable to low- and middle-income countries (LMICs). Practically, the results affirm neonatal nurses' pivotal position as frontline facilitators of contextually congruent psychosocial care. This underscores the need for enhanced professional preparation in culturally sensitive communication, emotional support, and family engagement competencies. From a policy standpoint, institutionalizing such nurse-led programs within routine NICU practice and securing sustainable resource allocation could represent a cost-effective, scalable approach to improving family-centered outcomes in resource-constrained health systems.

4.5. Study limitations

Several important limitations must be acknowledged when interpreting these findings. The quasi-experimental design with time-block allocation, while practically necessary, represents a significant methodological limitation that restricts causal inference. Although baseline equivalence was established and potential confounders controlled, the lack of randomization introduces the possibility of unmeasured selection bias and limits the strength of conclusions regarding intervention causality.

The single-site, single-cultural context limits generalizability to other healthcare settings and populations. While the cultural adaptation process was rigorous, the specific adaptations made for Egyptian NICU families may not be directly applicable to other LMIC contexts without further modification.

Reliance on self-report measures, while appropriate for psychological constructs, may introduce social desirability bias or recall bias. The convenience sampling approach and relatively small sample size further limit the generalizability of findings and preclude detailed subgroup analyses.

The study did not examine longer-term outcomes beyond three months or assess impacts on neonatal

health outcomes, family functioning, or healthcare utilization, which would provide important evidence of broader intervention benefits.

4.6. Future directions

Future research should employ randomized controlled trial designs where ethically and practically feasible to strengthen causal inference. Multi-site studies across diverse LMIC contexts would enhance generalizability while allowing examination of cultural adaptation effectiveness across different populations. Longer follow-up periods and broader outcome measures, including neonatal health indicators and family functioning, would provide more comprehensive evidence of intervention impact.

Investigation of digital delivery modalities could enhance scalability and accessibility, particularly important in resource-constrained settings. Qualitative studies exploring parents' experiences and identifying optimal intervention components would inform further refinement and optimization.

5. Conclusions and nursing implications

This study demonstrates significant associations between a context-adapted, theoretically grounded educational intervention and reduced parental anxiety and caregiver burden while acknowledging that the quasi-experimental design limits causal inference. The sustained associations at three months highlight the potential for lasting impact. NICU nurses play a crucial role in delivering these interventions, and integrating them into routine care may greatly support family-centered approaches. Specialized training in cultural competence and psychosocial care is essential to equip nurses for this role. Policy-level support is needed to embed these programs into standard NICU protocols and ensure their scalability in low- and middle-income countries.

6. Recommendations

The promising associations observed in this study suggest that routine incorporation of structured, context-adapted educational programs may be beneficial in resource-constrained NICUs. Training neonatal nurses in psychosocial support and context-sensitive communication is critical for effective delivery. A multidisciplinary approach, supported by leadership and adequate resources, may enhance parental engagement and care quality. Future research should include multicenter randomized trials, longer follow-up periods, digital delivery options, and qualitative studies to optimize intervention relevance and accessibility while establishing stronger causal evidence.

List of abbreviations

ANCOVA	Analysis of covariance
BAI	Beck Anxiety Inventory
CBS	Caregiver Burden Scale
CI	Confidence interval
d	Cohen's d effect size
LMICs	Low- and middle-income countries
MCAR	Missing completely at random
NICU	Neonatal intensive care unit
SD	Standard deviation
SE	Standard error
SPSS	Statistical Package for the Social Sciences
α	Cronbach's alpha coefficient
β	Regression coefficient

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Compliance with ethical standards

Ethical considerations

Ethical approval was obtained from the Faculty of Nursing at Helwan University (Ref. No. HUNURSERC 2024/07/52/90) and El-Senbellawein General Hospital. The study adhered to the Declaration of Helsinki. Participants gave written informed consent after being fully informed about the study's purpose, procedures, risks, and benefits. Confidentiality was maintained via anonymized coding and secure, encrypted data storage accessible only to authorized staff. Participants could withdraw at any time without impacting their neonates' care.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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