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Short communication

Perinatal depression and sun safety behaviors: Results of a pilot intervention trial

Omar U. Anwar [a], Yelena P. Wu [b,c], Janessa M. Mendoza [a], Muriel R. Statman [a], William J. Tanguy [b], Marcelo M. Sleiman Jr. [a], Douglas Grossman [b,c], Lauren H. Theilen [d], Kenneth P. Tercyak [a,*]

[a] Lombardi Comprehensive Cancer Center, Georgetown University, United States
[b] Huntsman Cancer Institute, University of Utah, United States
[c] Department of Dermatology, University of Utah, United States
[d] Department of Obstetrics and Gynecology, University of Utah, United States

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ABSTRACT

Objective: To examine changes in perinatal sun safety behavior and co-occurring minor depression in a pilot intervention trial.

Methods: Pregnant women ($N = 58$) in a sun safety program completed baseline and depression symptom surveys during their second or third trimesters. They then underwent two 30-min sun safety counseling sessions. Follow-up surveys were completed one- and two-months postpartum. Differences in pre- and postpartum sun safety and depression were evaluated.

Results: At baseline, participants' mean sun safety score was 23.2/32 (SD = 4.4): 34.5 % were identified as likely depressed and had lower sun safety ($t = 1.8$, df = 56, $p < .05$). The mean sun safety score rose to 26.5 at the first follow-up ($t = 5.8$, df = 57, $p < .001$) and 26.9 ($t = 5.7$, df = 57, p < .001) at the second. Participants who were likely depressed at baseline experienced less improvement in sun safety at the first and second follow-ups ($t = 3.1$, df = 19, $p < .01$, Cohen's d = 4.3; $t = 2.8$, df = 19, p < .01, Cohen's d = 4.1, respectively) than those not depressed ($t = 4.9$, df = 37, $p < .001$, Cohen's d = 4.3; $t = 5.0$, df = 37, p < .001, Cohen's d = 5.4, respectively). In an income-adjusted regression model of sun safety at the second follow-up, baseline sun safety remained associated (B = 0.5, SE B = 0.1, $p = .001$) but not depression (B = -0.4, SE B = 0.2, $p = .09$).

Conclusions: The counseling program increased sun safety adherence, regardless of depression risk.

1. Introduction

Skin cancer is the most common cancer in the United States, with ultraviolet radiation (UVR) constituting its leading preventable cause (American Cancer Society, 2024; U.S. Department of Health and Human Services, 2014; Wu et al., 2014). Women have higher skin cancer rates than men before age 50 (Al-Dujaili et al., 2017). Pregnant women are particularly vulnerable to UVR, as excess exposure can deplete folate–a B vitamin crucial to the development of the fetal nervous system (Copp et al., 2013). UVR-induced folate depletion is associated with fetal neural tube defects that may lead to complications such as paralysis, learning disabilities, or stillbirth (Copp et al., 2013; Borradale and Kimlin, 2012; Borradale et al., 2014; Frey and Hauser, 2003).

Pregnancy provides clinicians with "teachable moments" to promote healthy sun safety behaviors, as expectant mothers are motivated to protect both their own and their babies' well-being (McBride et al., 2003). However, prenatal depression (affecting up to 40 % of pregnancies) can undermine motivation to follow recommended health practices (Jahan et al., 2021; Slomian et al., 2019). Given the paucity of research on the associations among pregnancy, depression, and sun safety behaviors, it would be valuable to investigate whether depressive symptoms impact whether pregnant women may benefit from a skin cancer prevention intervention.

This study analyzed data from SUNRISE (*Sun* Protection *I*ntervention for Mothers and Babies), a peer-led intervention delivered perinatally for expectant mothers (Tanguy et al., 2024). In the pilot trial, participants

* Corresponding author at: Cancer Prevention and Control Program, Georgetown University Lombardi Comprehensive Cancer Center, 2115 Wisconsin Avenue, NW #300, Washington, DC 20007, United States.
E-mail address: tercyakk@georgetown.edu (K.P. Tercyak).

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reported improved understanding and practice of sun protection behaviors (e.g., wearing sunscreen), as well as fewer barriers to their implementation (Tanguy et al., 2024). However, that report did not explore how depressive symptoms might affect pregnant women's and their babies' sun safety behaviors. The current study is a secondary data analysis to investigate this potential effect.

2. Methods

2.1. Participants and procedures

To participate in this study, women were at least 18 years-old, pregnant with a singleton, and in their second or third trimester of pregnancy during enrollment. Exclusion criteria included the inability to read/write in English, a previous history of skin cancer, and/or having any health condition that may prolong their or their baby's hospitalization postpartum. Participants were recruited through clinical and community settings in a midwestern metropolitan city in the United States, including an obstetric clinic at an academic medical center, using four methods: 1) emailing study information prior to or following expectant mothers' prenatal appointments, 2) reviewing expectant mothers' electronic health records, followed by emails and text messages with study information, 3) distributing study information flyers to community organizations supporting families, and 4) a university-based platform designed for recruiting research participants. Women interested in the study completed a screening questionnaire electronically or verbally via telephone; eligible women provided informed consent electronically before receiving a baseline survey. Participants then received the single-arm perinatal (pregnancy to one year postpartum) intervention by attending two live, virtual meetings with a trained peer coach, the first prepartum, and the second one-month postpartum. Peer coaches provided information (e.g., skin cancer's causes and risk factors, prevention tips) and counseling (e.g., social support, problem-solving, overcoming barriers, action planning) for sun safety behavior change with attention to cognitive-affective and behavioral states, including pregnant women's mood. Electronic follow-up surveys were sent one- and two-months following child's birth, with expectant mothers receiving gift cards for each survey completed (Tanguy et al., 2024). The research protocols used in this research were approved by the Institutional Review Board of the University of Utah, Salt Lake City, Utah (#00150970).

2.2. Measures

Sun protection behaviors and minor depression were assessed longitudinally. The first data collection occurred prenatally (baseline), followed by one-month postpartum and two-months postpartum. During participant screening, gestational age and anticipated delivery date were collected; at baseline, participants' sociodemographics were collected. Participants also completed a modified Sun Habits Survey at all time points (Glanz et al., 2008), which measured the frequency of eight sun protection behaviors (e.g., sunscreen use). Each was rated on a five-point Likert scale from one (never) to five (always): scores were summed into an index with higher scores indicating greater sun safety. Affect was assessed using the Patient Health Questionnaire-2 (PHQ-2) – a validated, two-item self-report measure to screen for minor depression (depressed mood, anhedonia). In a screening context, this indicates depressive symptoms that are present but not severe enough to meet diagnostic criteria. The PHQ-2 is adapted from the PHQ-9 and the Primary Care Evaluation of Mental Disorders Patient Questionnaire (PRIME-MD PQ) (Tamburrino et al., 2009): responses were recorded on a study-specific four-point Likert scale (one="not at all", four="nearly every day"). The two items were intercorrelated (r's = 0.32–0.85, p's = 0.01- < 0.001) at each of the time points and summed to create a total score (range of two to eight). Using sensitivity and specificity data from a reference study, a score of three or higher was considered indicative of minor depression (Kroenke et al., 2003).

2.3. Data analysis plan

The sample's demographic characteristics were examined using descriptive statistics. Given the small sample size, missing data had a large impact on these analyses. As such, in cases where the follow up data were missing (<10 % of cases), the last observation carried forward (LOCF) statistical method was used to retain data. Similarly, in cases where the baseline data were missing (<10 % of cases), the inverse of LOCF was used where the follow-up one data were used in place of the baseline data to further maximize data retention. Subsequently, *t*-tests were performed to evaluate changes in sun safety scores over time: from baseline to follow-up one, baseline to follow-up two, and follow-up one to follow-up two. To assess whether baseline depression influenced changes in sun safety over time, additional *t*-tests were performed stratifying participants based on if they were likely depressed at baseline or not. Finally, an income-adjusted multivariable regression model was used to evaluate if depression at baseline predicted sun safety scores at follow-up two. All data were entered, cleaned, and screened for statistical assumption using the SPSS version 29 program.

3. Results

As shown in Table 1, among the $N = 59$ pregnant women in the study (17.2 % non-white, 17.2 % Latine), 62.7 % had a skin complexion that was fair or very fair. Participants were generally educated and middle-class (36.2 % of participants held postgraduate degrees and 45.8 % reported annual household incomes of $100,000+). Expectant mothers with scores indicative of minor depression were identified (34.5 % at baseline compared to the 21.3 % and 25.5 % at follow-ups one and two, respectively). Most participants (91.4 %) were recruited during their third trimester of pregnancy, and 48.3 % were first-time expectant mothers.

Following the perinatal intervention, in which 81 % of mothers attended both sessions (Tanguy et al., 2024), participants' sun safety scores were modest, but increased over time (means of 23.2, 26.5, and 26.9 at baseline, follow-up one, and follow-up two, respectively). Compared to initial sun safety scores, those at one-month postpartum were greater ($t = 5.8$, df = 57, $p < .001$), as well as those at two-months ($t = 5.7$, df = 57, p < .001). Notably, participants who were not above the screening threshold for minor depression at baseline demonstrated a further increase in sun safety scores from follow-up one to two (rising from 28.5 to 29.2). In contrast, participants who were above the threshold at baseline exhibited a decline in scores from follow-up one to two (28.5 to 23.7), although both follow-up scores remained higher than their baseline value (21.8).

Further analysis regarding the effect of depression on sun safety revealed that participants who were above the threshold for minor depression at baseline had significantly lower sun safety scores compared to those who were below the threshold ($t = 1.8$, df = 56, $p < .05$). When stratifying sun safety scores by depression at baseline, women who were above the threshold for minor depression showed less improvement in sun safety scores compared to those who were not. Specifically, women who met criteria for minor depression showed a smaller increase in sun safety scores from baseline to follow-up one ($t = 3.1$, df = 19, $p < .01$, Cohen's d = 4.3) and from baseline to follow-up two ($t = 2.8$, df = 19, p < .01, Cohen's d = 4.1). Women who were not above the minor depression threshold experienced greater sun safety improvements over time (baseline to follow-up one: $t = 4.9$, df = 37, $p < .001$, Cohen's d = 4.3; baseline to follow-up two: $t = 5.0$, df = 37, p < .001, Cohen's d = 5.4).

Sun safety and minor depression at baseline were examined as predictors of post-intervention sun protection practices. In an income-adjusted regression model, sun safety scores at baseline significantly predicted sun safety scores at follow-up two (B = 0.5, SE B = 0.1, $p =$

Table 1
Participant demographics, minor depression, and sun safety behaviors over time among pregnant women enrolled in a trial of perinatal skin cancer prevention ($N = 59$)[a].

Variable	Level	Mean (SD)	N (%)
Race			
	White		49 (83.1)
	Not White		10 (17)
Ethnicity			
	Hispanic/Latine		10 (16.9)
	Not Hispanic/Latine		49 (83.1)
Education			
	≤College		38 (64.4)
	>College		21 (35.6)
Annual Household Income			
	<$100 k		29 (51.8)
	≥$100 k		27 (48.2)
Number of Other Children			
	0		28 (48.3)
	1–4		30 (51.7)
Skin Complexion			
	Very Fair		11 (18.6)
	Fair		26 (44.1)
	Olive		18 (30.5)
	Light Brown		4 (6.8)
Gestational Age			
	Second Trimester		5 (8.6)
	Third Trimester		53 (91.4)
Minor Depression[b]			
Baseline	Yes	3.9 (0.9)	21 (36.2)
	No	2.0 (0)	37 (63.8)
Follow-up One			
	Yes	3.0 (1.3)	10 (20.8)
	No	2.2 (0.7)	38 (79.2)
Follow-up Two			
	Yes	3.1 (1.1)	12 (25.0)
	No	2.1 (0.4)	36 (75.0)
Sun Safety Index[c]			
Baseline	< Minor depression	23.8 (4.6)	37 (64.9)
	≥ Minor depression	21.8 (3.6)	20 (35.1)
Follow-up One			
	< Minor depression	28.3 (4.4)	31 (67.4)
	≥ Minor depression	28.5 (4.9)	15 (32.6)
Follow-up Two			
	< Minor depression	29.2 (4.5)	31 (68.9)
	≥ Minor depression	23.7 (4.5)	14 (31.1)

[a] Data may not sum to 100 % due to missingness. [b]Minor depression was assessed by the PHQ-2: scores of three were indicative of minor depression and four to eight indicated moderate to major depression. [c]Sun safety was assessed by the Sun Habits Survey (range = 8–40), where higher scores indicate greater engagement in sun-safe behaviors.

.001). However, minor depression at baseline was not a significant predictor of sun safety at follow-up two (B = -0.4, SE B = 0.2, $p = .09$). These data suggest that baseline sun safety behaviors may be a stronger indicator of future sun safety behaviors than affect at baseline for expectant mothers.

4. Discussion

This study examined the relationship between sun safety behaviors and minor depression over time in pregnant mothers participating in a perinatal behavioral intervention trial focused on skin cancer risk and prevention. Income-adjusted regression analyses revealed that sun safety behaviors during pregnancy significantly predicted safety behaviors postpartum, whereas minor depression did not. This suggests that past cancer prevention behavior is a stronger determinant of future behavior than mood among expectant mothers. The study did show, however, a decline in minor depression over time and following intervention and birthing: rates dropped from 34.5 % among pregnant women who were above the minor depression threshold initially to 21.3 % and 25.5 %, respectively, postpartum. Coincident with this finding, sun safety scores increased over time and women who were below the threshold for minor depression appeared to benefit most from the intervention, as their sun safety scores improved substantially. Although women who were above the threshold for minor depression also achieved gains in their sun safety behaviors, these findings were less pronounced. Taken together, these data indicate that the SUNRISE intervention was uniformly beneficial to women who participated, but cognitive-affective symptoms of depression can attenuate the impact among some.

These findings are pertinent, as they suggest that perinatal behavioral counseling to improve women's sun safety adherence is effective regardless of minor depression. Considering UVR's adverse health effects, interventions that seek to limit UVR exposure may help promote maternal and fetal health (Copp et al., 2013; Borradale and Kimlin, 2012; Borradale et al., 2014). Counseling about this topic must be undertaken judiciously, as outdoor sun exposure offers numerous benefits, including enhanced mood and increased vitamin D levels (Chalcraft et al., 2020; Taniguchi et al., 2022). Inadequate vitamin D levels during pregnancy can lead to health complications such as preeclampsia or placenta-mediated complications in the mother, and rickets in newborns (Mulligan et al., 2010; Raia-Barjat et al., 2021). Given the complexity of the relationship between UVR and pregnancy, it is important for expectant mothers to achieve a balance of UVR exposure that is sufficient in promoting fetal and infant growth, but not too excessive to damage their own skin or harm embryonic development. The SUNRISE intervention carefully balances its messaging about this topic in a manner that is consistent with good perinatal care and cancer prevention practices; it also does so with attention to women's cognitive-affective and behavioral states, including their mood, using a peer coaching model that offers social support and practical guidance for navigating sun safety (Tanguy et al., 2024). These data further highlight the potential of peer-led interventions to effectively shape health behavior for cancer control and prevention (Rini et al., 2018).

There are several limitations of the study. The analyses were conducted on a modest sample of expectant mothers without substantial racial/ethnic and socioeconomic diversity, and both the sun safety and minor depression measures were self-reported. Although the trial showed promising short-term outcomes, larger and more diverse populations followed longer are needed to track sustained intervention effect. Furthermore, mothers in the early postpartum period may have reduced UVR exposure due to caregiving responsibilities. However, seasonally-timed follow-ups measured changes in sun protection behaviors rather than UVR dose. Lastly, the single-arm design prevents establishing causality for the observed decline in depressive symptoms which may stem from other factors (e.g., improved outlook following the birth of a healthy newborn).

5. Conclusion

The results of this small-scale pilot trial indicate the promise of a peer-led intervention to promote sun safety among pregnant women regardless of their prepartum mood state, and with favorable changes in both cancer prevention and minor depression outcomes. Given the potential benefits of reducing excess UVR exposure in expectant mothers, future research to extend these findings appears warranted.

Author Contribution

All authors were involved in the study's conceptualization. KPT was responsible for data curation, methodology development, resource provision, supervision, and jointly oversaw project administration with MRS. Formal analysis was conducted by OUA, MRS, WJT, MMS, DG, LHT, and KPT. YPW and KPT secured funding and, along with YPW, contributed to the study's investigation. All authors contributed to the writing of the original draft. OUA, YPW, JMM, MRS, WJT, MMS, DG, and LHT participated in reviewing and editing the manuscript.

CRediT authorship contribution statement

Omar U. Anwar: Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Yelena P. Wu:** Writing – review & editing, Writing – original draft, Investigation, Funding acquisition, Conceptualization. **Janessa M. Mendoza:** Writing – review & editing, Writing – original draft, Conceptualization. **Muriel R. Statman:** Writing – review & editing, Writing – original draft, Project administration, Formal analysis, Conceptualization. **William J. Tanguy:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Marcelo M. Sleiman:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Douglas Grossman:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Lauren H. Theilen:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Kenneth P. Tercyak:** Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Due to the sensitive nature of the questions asked in this study, survey respondents were assured raw data would remain confidential and would not be shared.

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