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# Theory-Driven Longitudinal Study Exploring Indoor Tanning Initiation in Teens Using a Person-Centered Approach

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## Theory-Driven Longitudinal Study Exploring Indoor Tanning Initiation in Teens Using a Person-Centered Approach

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### Abstract

**Background**—Younger indoor tanning initiation leads to greater melanoma risk due to more frequent and persistent behavior. Despite this, there are no published studies exploring the predictors of indoor tanning initiation in teen populations.

**Purpose**—This longitudinal study uses latent profile analysis to examine indoor tanning initiation in indoor tanning risk subgroups from a national sample of female adolescents.

**Methods**—Latent profile analysis used indoor tanning beliefs and perceptions to identify indoor tanning initiation risk subgroups. The teens in each subgroup were reassessed on indoor tanning initiation after a year.

**Results**—Three subgroups were identified: a low-risk, Anti-Tanning subgroup (18.6%) characterized by low scores on positive indoor tanning belief scales and high scores on beliefs about indoor tanning dangers; a moderate-risk Aware Social Tanner subgroup (47.2%) characterized by high scores on positive indoor tanning belief scales but also high scores on

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**Conflict of Interest:** The Authors, Joel Hillhouse, Rob Turrisi, Michael J. Cleveland, Nichole M. Scaglione, Katie Baker, and L. Carter Florence, declare that they have no conflict of interest.

#### Compliance with Ethical Standards

**Ethical Approval:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed Consent:** Informed consent was obtained from all individual participants included in the study.

beliefs about indoor tanning dangers; and a high-risk Risky Relaxation Tanner subgroup (34.2%) characterized by high scores on positive indoor tanning belief scales and low scores on beliefs about indoor tanning dangers. Teens in the Aware Social Tanner and Risky Relaxation Tanner subgroups were significantly more likely to initiate indoor tanning in the following year.

**Conclusions**—These findings highlight the need to identify teens at risk for indoor tanning initiation and develop tailored interventions that will move them to the lowest risk subgroup. Subgroup correlates suggest parent and peer-based interventions may be successful.

### Keywords

Melanoma Risk; Indoor Tanning; Adolescents; Longitudinal Study; Person-Centered Approach; National Sample

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Skin cancer is an important public health problem with 5 million U.S. cases treated yearly (1). Of these, approximately 75,000 will be identified as melanoma resulting in nearly 12,000 deaths (2). The total annual treatment costs associated with all skin cancers exceeds \$8 billion annually (1). The major risk factors for skin cancer, including melanoma, are unprotected ultraviolet radiation exposure from the sun and artificial sources (3). One artificial source, indoor tanning, has come under increasing scrutiny due to its association with increases in melanoma (4). Research suggests that ten or more lifetime indoor tanning sessions increases melanoma risk 2 to 4 fold for adults under forty years old (5, 6). Estimates across North America, Western Europe, and Australia indicate there are more cases of skin cancer attributable to indoor tanning use than lung cancer caused by cigarette smoking (7). Due to this evidence, indoor tanning has been classified as a Type I carcinogen, the same as cigarettes, arsenic and mustard gas, by the International Agency for Research on Cancer (8).

The evidence indicates that younger indoor tanning initiation leads to more frequent and persistent use (9) and greater melanoma risk (6). This is highly concerning because studies indicate that nearly 33% of non-Hispanic white high school females in the U.S. report indoor tanning use, 20% reporting frequent exposure, and these numbers increase to 50% and 25% respectively for female university students (7, 10). Despite the high prevalence rates among young women, we could find no systematic theory-driven longitudinal studies exploring factors underlying indoor tanning initiation in teen populations. This study was designed to fill the gap in the literature.

Factors associated with indoor tanning behavior have generally been explored by examining the relationship between predictor variables (e.g., beliefs) and behavioral variables (e.g., indoor tanning behaviors). In methodological terms, these analyses are considered to be “variable centered” because they examine the relationships between variables. An alternative approach that has been gaining interest in prevention science is to identify distinct subgroups within the population based on patterns of individuals’ behaviors, attitudes, beliefs and other relevant variables. These analyses are considered to be “person-centered” because they examine how different characteristics cluster together within a person, resulting in either increased or decreased risk. A person-centered approach is able to identify subgroups that vary in risk and also identify which specific variables to use to tailor

interventions with these groups in order to: 1) keep individuals from transitioning from low risk to high risk subgroups prior to critically sensitive periods of change, and 2) move individuals from high risk to low risk subgroups once the high risk behaviors have been initiated. In our laboratories, Abar, et al. (11) and Stapleton, et al. (12) have successfully employed person-centered approaches to identify distinct subgroups among adult indoor tanners that were involved in a randomized controlled trial intervention. In other work, our laboratory has combined person-centered approaches and intervention efforts directed toward similar youthful populations and observed reductions in high risk drinking and alcohol-related consequences (13–16). Such methods have not yet been applied to adolescent indoor tanning use, but the implications of these approaches in this behavioral domain seem promising.

The current study recruited a national sample of female adolescents who had not previously reported indoor tanning at baseline and followed them for a year to identify which ones initiated indoor tanning. The teens were part of the sampling frame for a larger study testing the efficacy of an randomized controlled trial indoor tanning prevention intervention in a national sample of teens. We utilized a person-centered approach to identify initiation risk subgroups using tanning-related beliefs that predicted indoor tanning use in earlier studies (17–20). These indoor tanning beliefs include how attractive the teen believes they would be with a tan, their perception of their friends and peers views on indoor tanning (i.e., how popular indoor tanning is, and how much their friends and peers would approve of them indoor tanning), how relaxing they believe a tanning session would be and beliefs about the health and appearance damaging effects of regular indoor tanning use. To examine the validity of the subgroups, we then compared the identified risk subgroups on demographic and other baseline characteristics known to correlate with indoor tanning use (21, 22). These included age, skin type, maternal variables (i.e., maternal tanning, maternal indoor tanning permissiveness and maternal monitoring of teen behavior), perceived percent of friends and peers who indoor tan and indoor tanning intentions.

Reviews of the indoor tanning literature reveal that the primary motivators for indoor tanning are to enhance appearance, fulfill social needs and achieve stress-relief and relaxation (23–26). Primary barriers to indoor tanning include concern about possible damage to health and appearance. The belief that tanning enhances appearance is an important difference between young women oriented toward indoor tanning compared with those who are not. In addition, young women not oriented toward indoor tanning are more likely to perceive the health and appearance harm barriers. Based on this previous research, we hypothesize five subgroups of teens who have not yet initiated indoor tanning. The first subgroup will be composed of teens who do not perceive the appearance benefits of tanning but do perceive the dangers of indoor tanning. We call this group anti-tanners. Amongst the teens interested in indoor tanning, all of which we expect to perceive the appearance benefits of tanning, we anticipate four more subgroups. Some will be primarily motivated by social factors (i.e., they perceive tanning as popular and important in their peers). One group of these social tanners will be aware of and accept the health and appearance dangers of indoor tanning. We call these aware social tanners. Other social tanners will either be unaware of or will minimize indoor tanning dangers. We call these risky social tanners. Another group of teens oriented toward indoor tanning will be motivated by the mood enhancing and

relaxation aspects of tanning. This orientation may come from their previous experiences with outdoor tanning. Again, some will be aware of and accept the potential dangers, named aware relaxation tanners. Others in this group will be unaware of or minimize the potential harms. We call these risky relaxation tanners.

We expect these subgroups to differ in risk of indoor tanning initiation and also in the specific primary prevention approaches that will be most efficacious with them. The anti-tanning subgroup will have a very low risk of indoor tanning initiation in the near future. However, given developmental and other changes common in adolescents, their orientations and beliefs could readily change increasing vulnerability. Social tanners are expected to be part of a social context of tanning that increases their risk for indoor tanning initiation. Those who are unaware of or minimize the dangers (i.e., risky) will be at greater risk than aware social tanners. The relaxation tanners have an even greater increased risk of indoor tanning initiation due to their orientation toward tanning effects on mood and physiology. Again, the risky relaxation tanners exhibiting a higher risk than the aware relaxation tanners.

## Methods

### Recruitment and Sample

This study was conducted between May 2011 (baseline assessment) and May 2012 (follow-up assessment) and was approved by the appropriate Institutional Review Board. All study participants and their parents/guardians completed informed assent/consent documents before completing study materials. The participants were 414 adolescent females ( $M_{age} = 14.91$ ,  $SD = 1.73$  years) recruited out of a larger study that was testing the efficacy of an indoor tanning intervention. The majority of teens enrolled in the study were White (89.0%), lived in a metropolitan area (86.2%), lived in a household where the caregiver was married (80.7%), the caregiver had a college education (46.7%), and the annual household income was greater than or equal to \$50,000 (65.8%). Skin type was distributed as follows: I = 15.0%, II = 24.4%, III = 32.6%, IV = 15.7%, V/VI = 12.3%.

Respondents were recruited from a GfK Knowledge Networks KnowledgePanel®, an online panel based on a representative random sample of the US population (27). To be eligible for this study, participants had to be females between the ages of 12 and 18 years who were not enrolled in the intervention study and had not yet initiated indoor tanning at the time of the initial assessment. Parental consent was obtained before enrolling teen participants. Participants received \$25 for completing the first assessment and \$30 for the follow-up assessment.

### Procedures

Of the 1,041 teens offered enrollment to the larger study, 778 female teens agreed to participate (74.7% participation rate). Of these 778 teens, 143 (18.4%) reported previous indoor tanning use at baseline and were enrolled in the intervention study. Another 164 of the teens who had not yet initiated indoor tanning were also enrolled in the intervention to examine its effects on indoor tanning initiation. Of the 471 teens who completed the baseline survey who were not enrolled in the intervention study, 414 teens (87.9%) agreed to be

followed for this longitudinal study. Fifty-four teens who completed the baseline measures did not complete the 1-year follow-up assessment, leaving 360 teens with complete data (87.0% retention rate). Attrition analyses were conducted to compare the non-completers to participants who completed the follow-up assessment. Chi-square analyses and t-tests were used to examine differences between these groups on baseline measures of items assessing their age, skin type, indoor tanning tendencies, indoor tanning attitudes and beliefs, peer and media indoor tanning social norms, maternal permissiveness toward indoor tanning and maternal monitoring of the teen's behavior. These analyses indicated that the two groups differed significantly on two demographic characteristics: 1) non-completers were more likely to be non-White (38.89%), compared to those who completed the follow-up assessment (6.94%;  $\chi^2 [df = 1] = 45.52, p < 0.001$ ); and 2) non-completers reported higher mean values of the skin type measure ( $M = 3.46, SD = 1.33$ ), compared to those who completed the follow-up assessment ( $M = 2.77, SD = 1.17; t = 3.98, df = 412, p < 0.001$ ). Both these differences reflect teens who are at decreased risk of initiating indoor tanning in the future due to low rates of indoor tanning in these groups. One year later, participants were resurveyed for their indoor tanning use in the previous 12 months, thus assessing whether or not they had initiated indoor tanning during this time period.

## Measures

**Indoor Tanning Initiation (21)**—Indoor tanning initiation was assessed by asking participants whether or not they had ever used a tanning bed or booth, not including spray-on tanning booths, at baseline and then again one year later. Participants responding 'no' to this item at baseline were classified as non-tanners and recruited for this study for follow-up. Participants responding 'yes' to this item at baseline were ineligible for this study. Enrolled participants who then indicated 'yes' to this item at follow-up were considered to have initiated indoor tanning during the study period.

### Latent Profile Analyses Indicators: Indoor Tanning Beliefs

**Peer Indoor Tanning Approval Belief Scale (21)**—This was assessed using three items in which participants were asked to indicate the extent to which they agreed with statements indicating whether peers approved of indoor tanning (e.g., "*My closest friends approve of me indoor tanning*") Response options ranged from *Strongly Disagree* (1) to *Strongly Agree* (5). These three items were summed to create an overall index of peer approval beliefs ( $\alpha = 0.86$ ).

**Peer Tanning Popularity Belief Scale (21)**—This construct was assessed using five items (e.g., "*Tanning seems popular in girls my age*"). Again, response options ranged from *Strongly Disagree* (1) to *Strongly Agree* (5), and items were summed to create an overall index of popularity beliefs ( $\alpha = 0.90$ ).

**Tanning attractiveness Belief Scale (21)**—To assess tanning attractiveness beliefs, participants were instructed to "Imagine that you indoor tan regularly," then they were asked the extent to which they agreed with three statements on how attractive they would look with a tan (e.g., "*I look more attractive when I have a nice tan*"). Responses were scored on

a 5-point scale, ranging from *Strongly Disagree* (1) to *Strongly Agree* (5), and items were summed to create a composite score of tan attractiveness beliefs ( $\alpha = 0.90$ ).

**Indoor Tanning Relaxation Scale (21)**—This scale used four items to assess beliefs about the perception that indoor tanning would enhance mood and be relaxing ( $\alpha = 0.93$ ), using the same 5-point Likert-type scale as those above (e.g., “*Indoor tanning is a stress-free way to relax*”).

**Indoor Tanning Damage Beliefs Scale (21)**—This scale consisted of six items, three of which assessed beliefs about the cancer effects of regular indoor tanning use, and three of which assessed beliefs about the appearance effects of regular indoor tanning use (e.g., “*I will increase my risk for skin cancer*”; “*My appearance will be damaged*”). Participants were asked to imagine that they indoor tan regularly before responding to each item. All six items were summed to create a single index related to indoor tanning *damage beliefs* ( $\alpha = 0.94$ ).

### Baseline Associations of Subgroup Membership Measures

**Friends indoor tanning use descriptive norms (21)**—Friend descriptive indoor tanning norms were assessed by asking participants what percentage of their friends already indoor tan. Response options ranged from 0 to 100 ( $M = 8.52$ ,  $SD = 17.76$ ).

**Maternal indoor tanning descriptive norms (28)**—Maternal descriptive norms were assessed using a single item asking participants to indicate whether their mothers were non-tanners, light tanners, or heavy tanners. For the current analyses, responses were dichotomized to represent any mother tanning vs. none.

**Maternal indoor tanning permissiveness (28)**—Maternal tanning permissiveness included a scale of four items ( $\alpha = 0.87$ ) that asked participants whether their mother/guardian 1) would allow them to indoor tan; 2) thinks it’s OK for them to indoor tan; 3) would pay for them to indoor tan; and 4) would take them to indoor tan. Response options ranged from *Strongly Disagree* (1) to *Strongly Agree* (5).

**Maternal monitoring of teen behavior (28)**—Perceived maternal monitoring of the teen’s behavior was adapted from previous research from our laboratories looking at parental influence on alcohol use. Indoor tanning was divided into two subscales: one that assessed how much one’s mother *tries* to know about her daughter’s daytime, nighttime, and free time behaviors ( $\alpha = 0.85$ ); and one that assessed how much one’s mother *actually* knows about her daytime, nighttime and free time behaviors ( $\alpha = 0.81$ ).

**Behavioral intentions (21)**—On a 7-point scale, ranging from *Definitely do not intend* (1) to *Definitely intend* (7), participants indicated whether they intended to do each of the following behaviors in the future: 1) indoor tan; 2) indoor tan in the next year; 3) indoor tan next Spring (January to May). Items were summed to create a composite score of indoor tanning intentions ( $\alpha = 0.94$ ).



The baseline assessment also included a number of demographic characteristics of the teen participants including age, skin type, ethnicity, marital status, education and income level of caregiver, and whether their place of residence was located in a metropolitan or non-metropolitan area.

## Statistical Analyses

The analyses were conducted in three steps. In the first step, latent profile analysis was conducted following the procedures outlined by Lanza and colleagues (29). Latent profile analysis is a person-centered statistical approach that identifies unique subgroups of individuals similar to each other with respect to measured indicators, and estimates the probability that any individual falls into a particular subgroup. Latent profile analysis was used here to identify subgroups of adolescent girls based on their similar patterns of indoor tanning beliefs. To facilitate interpretation of the model, all indicator variables were standardized prior to entry. First, a restricted one-subgroup solution was fit to the data. Additional subgroups were then added iteratively until the best-fitting solution was determined according to the extent the given model converged and there was practical interpretability (30, 31). All latent profile analyses were conducted using MPlus Version 6.1. (32) We used the Akaike Information Criteria (AIC) (33), Bayesian Information Criteria (BIC) (34), and adjusted BIC (aBIC) fit indices to evaluate each step of model fit. Optimal fit is defined by lower AIC, BIC, and aBIC values (i.e., values closer to 0). In addition, the entropy value, which can range from 0 to 1, was considered to determine how accurately individuals were classified into the “correct” subgroup. Entropy values closer to 1 were indicative of better model fit. Additional substantive criteria included resulting subgroup sizes (i.e., subgroups smaller than 5% may be considered statistical artifacts) and model interpretability (34). The resulting latent subgroups were then described relative to each other.

Once the best-fitting solution was determined, posterior probabilities were used to assign individuals to their most likely subgroup. Hard codes for each subgroup were then assigned, creating a categorical independent variable that can be used in more traditional variable-centered analyses (i.e., ANOVA, chi-square, etc). This “classify and analyze” approach (35) was then used in the second step to examine cross-sectional associations between subgroup membership and demographic and psychosocial characteristics. These associations were examined using analysis of variance (ANOVA) with Tukey post-hoc comparisons for continuous variables and Pearson’s chi-square test for categorical variables.

## Results

### Identifying Risk Subgroups

Model fit statistics for the initial comparison model that restricted the data to a one-subgroup solution and less restrictive models (e.g., models freed to fit additional subgroups) are presented in Table 1. Results indicated that fit indices (i.e., AIC, BIC, and aBIC) decreased and entropy values increased as additional subgroups were added to the comparison latent profile analysis model. However, the additional subgroups added in the four, five, and six subgroup models did not differ substantively from the three-subgroup model, which was

more parsimonious. Moreover, each of the more complex models included at least one very small subgroup, comprising less than 5% of the total sample. Based on these practical considerations, we chose the three-subgroup solution as the optimal fit to the data.

The standardized means for the five tanning belief indicator items within each of the three subgroups are presented in Figure 1. The first subgroup (18.6% of the sample) was characterized by very low values for how attractive individuals feel they would be with a tan, beliefs about their friends' and peers' views on indoor tanning, and how relaxing they believed a tanning session would be. This subgroup also demonstrated strong beliefs about the dangers to health and appearance posed by indoor tanning. This subgroup was labeled "Anti-Tanning." The second subgroup comprised 47.2% of the sample and was distinguished by relatively high scores for how attractive individuals feel they would be with a tan and beliefs about their friends' and peers' views on indoor tanning. However, this subgroup reported below average beliefs about how relaxing they believed a tanning session would be. Similar to the Anti-Tanning subgroup, this subgroup also demonstrated strong beliefs about the dangers to health and appearance posed by indoor tanning. This subgroup was thus labeled "Aware Social Tanners." The third subgroup was characterized by relatively high levels for the perceived attractiveness of tanned skin, for the perceived popularity of indoor tanning in their peers, and for the perception that their peers approved of indoor tanning, much like the Aware Social Tanners subgroup. However, this third subgroup also reported strong beliefs that indoor tanning would be relaxing and low levels of beliefs about the potential damaging effects of indoor tanning to health and appearance. This subgroup included 34.2% of the sample and was labeled "Risky Relaxation Tanners."

### Baseline Associations of Subgroup Membership

We next examined associations between subgroup membership and demographic variables, friends' and mothers' use of indoor tanning and mothers' permissiveness toward indoor tanning as well as mothers' general monitoring of teen behavior. As seen in Table 2, subgroup membership was significantly associated with the teen's age (*overall*  $F = 6.88$ ,  $df = 2$ ,  $p = 0.001$ ). Post-hoc Tukey comparisons revealed that participants assigned to the Aware Social Tanner subgroup ( $M_{AGE} = 15.32$  years) were significantly older than those in either the Anti-Tanning ( $M_{AGE} = 14.13$  years) or Risky Relaxation Tanner ( $M_{AGE} = 14.68$  years) subgroups. Teens who reported that their mothers tan were more likely to be classified in the Risky Relaxation Tanner subgroup (17%), relative to the Anti-Tanning (4%) or Aware Social Tanner (5%) subgroups ( $\chi^2 = 14.92$ ,  $df = 2$ ,  $p < 0.001$ ) (See Table 3). There were no significant differences among the three subgroups with regard to skin type.

ANOVA tests (see Table 2) also revealed significant mean differences among the subgroups for friends' descriptive norms ( $F = 11.67$ ,  $df = 2$ ,  $p < 0.001$ ). Post-hoc Tukey tests indicated that teens assigned to the Risky Relaxation Tanner subgroup reported significantly higher friends' descriptive norms compared with teens who were assigned to either the Anti-Tanning or Aware Social Tanner subgroups. The three subgroups also reported significant differences in teens' self-reported maternal indoor tanning permissiveness ( $F = 34.33$ ,  $df = 2$ ,  $p < 0.001$ ). Post-hoc Tukey tests indicated significant differences among all 3 subgroups, with highest levels of maternal permissiveness among teens assigned to the Risky

Relaxation Tanner subgroup, followed by teens assigned to the Aware Social Tanner subgroup and then teens assigned to the Anti-Tanning subgroup. Subgroup comparisons were not significantly different for general maternal monitoring of teens' behavior.

ANOVA tests also revealed significant differences among the three subgroups for indoor tanning intentions ( $F = 51.07, df = 2, p < 0.001$ ). Post-hoc Tukey comparisons indicated that teens assigned to the Risky Relaxation Tanner subgroup reported significantly greater indoor tanning intentions, compared to teens in the Anti-Tanning and Aware Social Tanner subgroups.

### Using Subgroup Membership to Predict Initiation of Indoor Tanning

The last set of analyses compared rates of indoor tanning initiation at the follow-up assessment across the three identified subgroups. All participants in this study were considered "non-tanners" at the baseline assessment. At follow-up, 28 of the teens (8%) reported initiating indoor tanning. Cross-tabulation of subgroup membership and indoor tanning initiation status are reported in Table 4. These results indicated that none of the teens assigned to the Anti-Tanning subgroup reported initiation of tanning at the follow-up; whereas 8% and 11% of teens belonging to the Aware Social Tanner and Risky Relaxation Tanner subgroups, respectively, reported initiation of tanning at follow-up. The overall chi-square difference test indicated that subgroup membership at baseline was significantly associated with indoor tanning at follow-up ( $\chi^2 = 7.83, df = 2, p < 0.05$ ). Because none of the teens in the Anti-Tanning subgroup reported initiation of indoor tanning at follow-up, additional parametric tests (e.g., logistic regression) were not possible.

## Discussion

This study used person-centered latent profile analysis to identify subgroups of teens who had not initiated indoor tanning using their initial levels of beliefs about indoor tanning use. The teens were followed for one year to explore whether subgroup membership was predictive of indoor tanning initiation. Three subgroups were identified. One high risk subgroup, labeled Risky Relaxation Tanners, demonstrated positive beliefs about indoor tanning and low beliefs on indoor tanning health and appearance damage risks, and comprised over one-third of the teens. A second more moderate risk subgroup, encompassing almost half the sample, indicated moderately positive indoor tanning belief levels and high beliefs on indoor tanning health and appearance damage risks. They were labeled Aware Social Tanners. The last subgroup was low risk and demonstrated low positive beliefs toward indoor tanning and high beliefs about indoor tanning risks. This subgroup, comprising 18% of the sample, was labeled Anti-Tanners.

The subgroups differed by age, friends' and mother's indoor tanning use and in maternal indoor tanning permissiveness. Older teens were more likely to be in the Aware Social Tanners subgroup, with a moderate risk. This was somewhat unexpected. However, as teens age and are exposed to more information about indoor tanning, they probably become more aware of both the benefits (e.g., look more attractive, fit in better with peers) and the risks (e.g., dangers to health and appearance damage) of indoor tanning, which is exactly the pattern that defines the Aware Social Tanners subgroup. It was not surprising that teens with

more friends who indoor tan were more likely to be in the Risky Relaxation Tanner subgroup and that having a mother who uses indoor tanning, or who is permissive of indoor tanning use was more common in the Risky Relaxation Tanner subgroup. These results, together with the finding that the Risky Relaxation Tanner subgroup exhibited more intentions to indoor tan in the future, all provide some validation for the risk subgroups. While we identified three indoor tanning initiation risk subgroups, we originally hypothesized five; two relaxation tanning (aware and risky), two social tanning (aware and risky), and one anti-tanning (aware). Neither the aware relaxation tanning nor the risky social tanning subgroups emerged.

The subgroups identified in this study not only differed in terms of their indoor tanning beliefs, but they also demonstrated differences in their indoor tanning initiation rates over the year they were followed. Over 10% of the teens in the Risky Relaxation Tanner subgroup initiates indoor tanning in the year following assessment while close to 10% of the Aware Social Tanner teens initiated indoor tanning. It is interesting that there were no indoor tanning initiators in the Anti-Tanning subgroup. These results suggest that a useful primary prevention strategy would be to shift teens from the high and moderate risk subgroups (i.e., relaxation and social tanning) to the low risk Anti-Tanning subgroup before they initiate indoor tanning.

This research was not specifically designed to examine factors that may lead to membership in each subgroup, though the results provide clues. Teens in the Risky Relaxation Tanner subgroup are more likely to have friends who indoor tan, mothers who indoor tan and mothers who are more permissive toward indoor tanning use in their daughters. Thus, they appear to be immersed in a context that is quite supportive and possibly encouraging of indoor tanning use. Their social milieu is likely to inform them about the benefits of indoor tanning, and they witness firsthand the reinforcements for tanning behavior. They are also likely to hear many of the myths about indoor tanning (e.g., it is controlled UV exposure and therefore safer; it is healthy) and have indoor tanning dangers minimized by those around them.

Teens in the more moderate risk, Aware Social Tanner subgroup are older than those in the other risk subgroups. These older teens are probably aware of the potential benefits of tanning through seeing their peers reinforced for tanning or through their own outdoor tanning experiences. They are less drawn to the potentially physically pleasurable aspects of indoor tanning like relaxation and mood enhancement. However, they may be less immersed in tanning culture, being less likely to have friends or mothers who indoor tan. This may make them also more aware of the potential dangers of indoor tanning. While the awareness of the potential for indoor tanning to damage them appears to moderate their risk somewhat, they were still relatively likely to initiate indoor tanning, with almost 1 in 10 reporting indoor tanning initiation in the following year.

There are a number of potential implications for primary prevention efforts in these results. The highest risk teens, those in the Risky Relaxation Tanner subgroup, could benefit from some of the existing interventions that focus on increasing awareness and acceptance of the health and appearance dangers of tanning (21, 22, 36). These teens appear to live in a social

context favorable to tanning which points to the potential utility of directing interventions at key teen social figures, many of whom may already have initiated indoor tanning use. Key social figures recruited as peer counselors to deliver a primary prevention intervention should also prove successful. Turrisi, et al. (37) successfully utilized peer counselors to deliver a motivational interviewing intervention to young adult indoor tanners. We know of no studies attempting a peer counseling approach with teens or with individuals at high risk for indoor tanning who have not yet initiated the behavior.

The result that having mothers who tan and permit tanning was a correlate of being in the Risky Relaxation Tanner subgroup offers another possible intervention route. There are opportunities for effective interventions that focus on teens' mothers. For example, an intervention that reduced mothers' indoor tanning could also lead to reduction in indoor tanning initiation in their daughters. As with the peer counseling, using mothers to deliver interventions to their teen daughters should also be quite successful. Some preliminary work in our laboratory demonstrates the promise of using mothers to deliver anti-tanning messages to their teen daughters who are at risk of indoor tanning. Findings from a pilot study indicate informing mothers on the health and appearance risks of indoor tanning and empowering mothers to convey these messages to their teen daughters by teaching effective communication and relationship building skills result in significantly decreased perceptions of maternal permissiveness among teens (28). The same approach should be tested with mothers of teens who are at risk for indoor tanning initiation.

The Aware Social Tanner subgroup of older teens may require a different approach than the younger higher-risk teens. Since they appear to be already aware of indoor tanning dangers, traditional risk based messages may not be as effective. The specific indoor tanning motivations for moderate-risk teens needs to be better characterized and targeted. It is also interesting that many decided to indoor tan despite beliefs about its dangers. Recent research indicates that a sense of invulnerability to the dangers of indoor tanning may be associated with indoor tanning intentions in adolescents, and that various cognitive rationalizations may account for some of this disparity between beliefs and behavior sometimes seen in adolescent tanning behavior (38, 39). It is possible that targeting these invulnerability beliefs and cognitive rationalizations could prove more effective with the Aware Social Tanner group.

The Risky Relaxation subgroup shares certain features with individuals who fit the label of tanning dependence or tanning abuse (40–43) in the literature. Tanning dependent individuals have symptoms that indicate a tanning addiction potentially related to UV-exposed skin releasing endogenous opioids (44). For example, mice exposed to UV radiation show elevated circulating levels of endogenous opioids and demonstrate behavior corresponding to withdrawal and tolerance to UV light (45). Similarly, frequent indoor tanners have reported withdrawal symptoms when administered naltrexone, an opioid antagonist (46). Like the Risky Relaxation Tanners, dependent tanners tend to minimize the potential harms of tanning while being particularly motivated by the mood enhancing and relaxation aspects of the behavior. Testing this interesting conjecture would require following these teens' indoor tanning behavior longitudinally after initiation. Such a longitudinal study would also provide interesting and potentially important information on

the developmental history of indoor tanning and factors related to transitions from initiation to dependent tanning.

The typical outcome in most prevention studies involves examining differences between intervention and control participants' mean levels of the outcome behavior, a variable-centered approach. Changes in average behavioral frequency are obviously important. Another way to look at intervention impact is its ability to shift individuals from groups at high risk for a health risky behavior into groups with lower risks. For example, moving someone from the Aware Social Tanner group into the Anti-Tanner group. We would like to see future interventions take into consideration this person-centered approach by adding analyses that consider how well prevention interventions work at moving individuals from higher to lower risk subgroups.

This study used person-centered latent profile analysis to identify teens at varying risk for indoor tanning initiation in the near future. It is the first study to look at indoor tanning initiation in teens using a longitudinal design, the first to use latent profile analysis to categorize non-tanning teens into risk subgroups based on their patterns of indoor tanning beliefs and the first to explore if membership in risk subgroups predicted indoor tanning initiation. Person-centered approaches are good complements to variable-centered methods. Variable-centered approaches are very good at identifying universal aspects of behavior that need to be targeted across individuals. However, health risk behaviors often derive from a variety of motivations which do not equally impact behavior across subgroups within the population. For example, some tanners may be primarily motivated by social motives while others are driven by psychological and physiological orientations toward tanning. Person-centered approaches identify these subpopulations so that general intervention approaches may be tailored for maximum effect. Of interest is that these subgroups can be identified with only 21 items. Further work could lead to a screener with even fewer items that could identify risk subgroups in uninitiated teens and inform effective primary prevention campaigns.

Limitations include the use of self-report which may be subject to recall bias, and that the sample is limited to high school females. However, we believe that the recall of indoor tanning initiation should be minimally biased given the salience of the outcome. Future research should examine indoor tanning initiation in male teens.

It will be important to identify teens at risk for indoor tanning before they initiate indoor tanning for primary prevention purposes. Once identified, interventions can be developed that target the specific beliefs putting them at high risk. It is also clear that peer and parental, particularly maternal, influence may be important factors in being in the Risky Relaxation Tanner subgroup with the highest risk. Interventions that provide more realistic perceptions of indoor tanning use in their peers, target key peer social figures and that target mothers, particularly mothers who are current tanners and/or permissive toward tanning, will be important for effectively stopping indoor tanning use in this population before it starts. Lastly, this study demonstrates the potential for examining risk subgroup status, and movement amongst subgroups as another outcome variable in addition to behavioral initiation or frequency.

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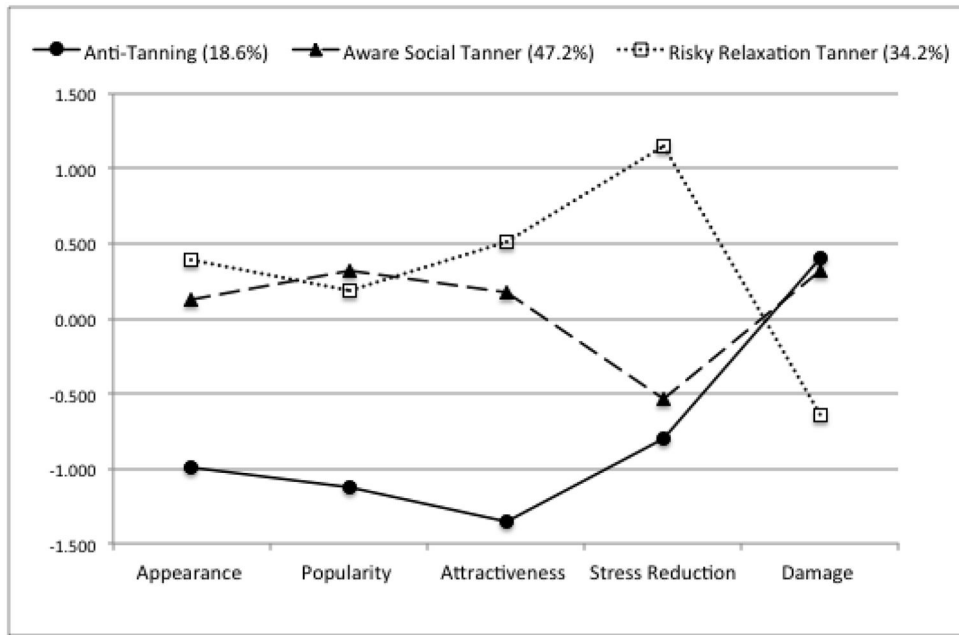
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**Figure 1.** Standardized means of the five tanning beliefs measures within each latent subgroup.

**Table 1**

## Comparison of Subgroup Solutions Model Fit

Number of Subgroups	Loglikelihood	AIC	BIC	a_BIC	Entropy
2	-2405.95	4843.90	4906.08	4855.32	0.83
3	-2326.19	4696.38	4781.87	4712.08	0.80
4	-2264.78	4585.56	4694.37	4605.54	0.84
5	-2227.77	4523.55	4655.68	4547.81	0.86

**Table 2**

## Indoor Tanning Predictor Variables Scored by Subgroup Membership

	<b>Anti-Tanning (N=66)</b>	<b>Aware Social Tanner (N=171)</b>	<b>Risky Relaxation Tanner (N=123)</b>	
<b>Variable</b>	<b><i>M (SD)</i></b>	<b><i>M (SD)</i></b>	<b><i>M (SD)</i></b>	<b><i>F</i><sub>2,357</sub></b>
Age	14.13 (1.63)	15.32 (1.76)	14.68 (1.87)	6.88 <sup>a</sup>
Friend's descriptive norms	2.29 (12.61)	6.44 (12.94)	13.28 (20.75)	11.67 <sup>b</sup>
Maternal permissiveness	7.41 (3.37)	9.08 (3.94)	12.36 (5.11)	34.33 <sup>b</sup>
Intentions	3.06 (0.42)	3.46 (1.24)	5.95 (3.66)	51.07 <sup>b</sup>

Note.

<sup>a</sup>  $p=0.01$ ,

<sup>b</sup>  $p<0.001$

**Table 3**

## Mother's Use of Indoor Tanning by Subgroup Membership

Subgroup	Mother Never Indoor Tans		Mother Indoor Tans	
	<i>N</i> (%)		<i>N</i> (%)	Total <i>N</i>
Anti-Tanning	63 (95.45%)		3 (4.55%)	66
Aware Social Tanner	156 (91.23%)		15 (8.77%)	171
Risky Relaxation Tanner	102 (82.93%)		21 (17.07%)	123
Total	321 (89.17%)		39 (10.83%)	360

Note.  $\chi^2 = 8.41$ ,  $df = 2$ ,  $p < 0.001$

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**Table 4**

## Indoor Tanning Initiation by Subgroup Membership

Subgroup	Never Indoor Tans		Initiated Indoor Tanning	
	N (%)		N (%)	Total N
Anti-Tanning	66 (100.00%)		0 (0.00%)	66
Aware Social Tanner	157 (91.81%)		14 (8.19%)	171
Risky Relaxation Tanner	109 (88.62%)		14 (11.38%)	123
Total	332 (92.22%)		28 (7.78%)	360

Note.  $\chi^2 = 7.83$ ,  $df = 2$ ,  $p < 0.05$

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