Tanning Addiction: Conceptualisation, Assessment, and Correlates

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What's already known about this topic; what does this study add?

- A number of recent studies suggest that tanning has the potential to be addictive.
- This study describes a new brief screening tool for assessing tanning addiction based on contemporary addiction theory and core addiction criteria.
- Use of the scale can facilitate treatment and estimate the prevalence of tanning addiction in general populations worldwide.

Abstract

Background: Research into problematic tanning (or 'tanning addiction') has markedly increased over the past few years. Although several excessive tanning instruments exist, most of these are psychometrically poor, not theoretically anchored, and have mainly been used on small samples.

Objective: Against this background, a new tanning addiction scale was developed based on a specific theoretical approach utilising core addiction criteria.

Methods: A scale comprising seven items (i.e. salience/craving, mood modification, tolerance, withdrawal, conflict, relapse/loss of control, and problems) was administered online to a cross-sectional convenience sample of 23,537 adults (M_{age}=35.8 years, *SD*=13.3), together with an assessment of demographic factors, the five-factor model of personality, and symptoms of obsessive-compulsive disorder, anxiety and depression.

Results: A confirmatory factor analysis showed that a one-factor model showed an optimal fit with the data collected (RMSEA=.050 [90% CI=.047–.053], CFI=.99, TLI=.99). High factor loadings (.781–.905, all p<.001) and coefficient omega indicator of reliability (ω=.941 [95% CI=.939–.944]) were also found using the new scale. In a multiple linear regression analysis, tanning addiction was positively associated with being female, not being in a relationship, extroversion, neuroticism, anxiety and obsessive-compulsiveness. It was also found that educational level, intellect/openness and depression were inversely associated with tanning addiction.

Conclusions: The new scale, Bergen Tanning Addiction Scale (BTAS), showed good psychometric properties, and is the first scale to fully conceptualise tanning addiciton within a contemporary addiction framework. Given this, the BTAS may potentially assist future clinical practice in providing appropriate patient care, prevention and disease management.

INTRODUCTION

Tanned skin is often viewed as more attractive than untanned skin,[1] and being tanned has been associated with increased energy and self-confidence.[2] Additionally, sunbathing has been shown to provide pleasant feelings of warmth and relaxation to most individuals.[3] However, sunbathing and tanning to excess are associated with an increased risk of a variety of negative outcomes such as skin cancers, specific eye diseases and immune system alterations.[4] Excessive tanning can be viewed from different perspectives and as such reflect, among others, obsessive-compulsive behaviours, body dysmorphic disorder and impulsive control disorders.[5] Still, much evidence suggests that excessive tanning should be regarded as a behavioural addiction,[4-8] which represents the overarching approach in the present paper. For instance, one study found that frequent tanners blinded to condition preferred sun beds with ultraviolet radiation compared to beds where it was filtered out.[6] A follow-up study of compulsive tanners showed increased cerebral blood flow in the mesostriatal reward pathway when exposed to ultraviolet radiation compared to the ultraviolet filtered condition.[7] Other studies have shown that β-endorphin is synthesised in the skin following ultraviolet exposure both in rodents[8] and humans.[9] Related to this, a randomised controlled trial of opioid blockade among frequent tanners demonstrated that four of eight frequent tanners (compared to zero of eight infrequent tanners) developed withdrawal-like symptoms following naltrexone injections.[10] These studies suggest that tanning appears to have the potential to be addictive, most probably mediated by brain circuits and neurotransmitters that are known to be involved in the experience of reward and euphoria. Overall, excessive tanning seems to conform to clinical features that are typical of addictions (e.g. loss of control, tolerance and withdrawal). Patterns of age of initiation, frequency of use, and similarities between excessive tanning and substance use further suggest that excessive tanning can be understood within a behavioural addiction framework.[11]

Research into frequent and persistent tanning behaviour, also known as *excessive tanning*,[12] *melainomania*,[13] *sunscreen abuse*,[14] *tanning abuse*,[15] *tanning addiction*,[16] *tanning dependence*,[17] *tanorexia*[18] and *ultraviolet light dependence*,[19] appears to have been receiving increased attention. Several instruments have been developed in order to assess problematic tanning as a potential behavioural addiction such as the *Tanning Problem Index*,[20] *Craving to Tan Questionnaire*,[21] *Tanning-CAGE*,[22] *Tanning-DSM*,[22] *Tanning Passion Scale*,[21] *Structured Interview for Tanning Abuse and Dependence*,[15] *Tanning Pathology Scale*,[23] *Behavioral Addiction Indoor Tanning Screener*,[24] *Comprehensive Indoor Tanning Expectations Scale*[25] and the *Mood-based Indoor Tanning Scale*.[26]

However, many of the aforementioned scales are psychometrically poor, and have mainly been developed and used on relatively small samples. Although several of the existing scales are adapted from instruments developed for assessing other addictions, they appear to have a poor theoretical anchoring, with only a few being based on a specific theoretical approach. Given the many limitations of these instruments (see Table 1 for an overview), there is clearly a need for a reliable and valid measure for assessing tanning addiction that is built upon contemporary addiction theory and diagnostic criteria.

Understanding and identifying possible risk factors of tanning addiction are of value in terms of tailoring preventive efforts and to help clinicians in their work. Any new tanning addiction instruments should also correlate in expected ways with well-known risk factors. Regarding this research has shown tanning addiction to be related to being female,[16,27-29] having obsessive tendencies,[13,21,29,30] having dysmorphic concerns,[13,29,31] abusing illicit drugs,[17,29,30,32,33] anxiety,[30,32,33] depression[33] and engaging in anaerobic exercise.[17] It is currently unknown how addictive tanning is related to personality using the five-factor model, representing neuroticism (e.g. being nervous and sensitive), extroversion (e.g. being social and outgoing), conscientiousness (e.g. being organised and efficient), agreeableness (e.g.

being sympathetic and friendly) and openness (e.g. being imaginative and inventive).[34] Previous studies have typically shown addictions to be negatively associated with conscientiousness and agreeableness and positively associated with neuroticism.[35,36]

Against this background, the present study aimed to explore the psychometric properties of a tanning addiction measure developed on the basis of core addiction criteria that have been emphasised in several behavioural addictions,[36-39] and to explore the associations of various factors (i.e. demographics, key personality traits, obsessive-compulsiveness, anxiety and depression) with addictive tanning using multivariable analyses. As the study was exploratory, there were no specific hypotheses.

METHODS

Procedure

A web-based cross-sectional survey examining excessive behaviours was published in the online edition of five nationwide Norwegian newspapers during March–May 2014. Respondents were asked to click on a link to access the survey. Information about the study was given on the first page. Participants' responses were stored on a server administered by a company with special expertise for this purpose. After one week of study initiation, all collected data were sent to the research team. Only completed surveys were retained in the final data file. All data were collected anonymously, no intervention was conducted, and the study was carried out in accordance to the Helsinki Convention and the Norwegian Health Research Act. The Institutional Review Board of the Faculty of Psychology, University of Bergen, approved the study.

Sample

The sample comprised 23,537 Norwegians including 15,301 women (65%) and 8,236 men (35%). In terms of relationship status, 15,376 (65.3%) were currently in a relationship and 8,161 (34.7%) were not. In terms of education, 2,350 had completed primary school

(10%), 5,949 had completed secondary school (25.3%), 3,990 had completed vocational school (17%), 7,633 had a Bachelor's degree (32.4%), 3,343 had a Master's degree (14.2%) and 272 had a PhD (1.2%). The mean age of the sample was 35.8 years (*SD*=13.3), ranging from 16 to 88 years of age.

A total of 20,433 individuals had answered some parts of the survey. When investigating differences between those who completed the survey and those with partial responses, those who dropped out were significantly more likely to be men rather than women (χ^2=70.98, *df*=1, *p*<.001; continuity correction), younger rather than older (*t*=10.54, *df*=43876, *p*<.001), people not in a relationship rather than those in a relationship (χ^2=58.73, *df*=1, *p*<.001; continuity correction), and people with lower education rather more than those with higher education (χ^2=453.80, *df*=5, *p*<.001). Furthermore, the sample differed significantly from the general Norwegian population with respect to gender (50.3% men vs. 49.7% women; χ^2=2206.2, *df*=1, *p*<.0001) and age groups (16–30 years [40.7% in the present sample vs. 25.0% in the population], 31–45 years [35.0% vs. 26.3%], 46–60 years [19.8% vs. 24.5%], and 61–88 years [4.5% vs. 24.2%]; χ^2=6974.5, *df*=3, *p*<.0001). Detailed data on marital status and education were not available for comparison on the population level.

Instruments

Demographic data were collected using a closed response format concerning *age* (year of birth alternatives from 1997=1 to 1900=98), *sex* (male=1/female=2), *relationship status* (married, common law partner, partner, boyfriend, girlfriend=1/single, divorced, separated, widow, widower=2), and completed *education* (primary=1/secondary=2/vocational=3/ Bachelor's degree=4/Master's degree=5/PhD degree=6).

Bergen Tanning Addiction Scale (BTAS) was developed utilising the seven addiction criteria emphasised by Griffiths[39] and Brown[38] and the American Psychiatric Association.[37] One item was constructed for each of the seven addiction criteria (Table 2). More specifically,

the criteria involve *salience/craving* (preoccupation with tanning), *mood modification* (tanning improves mood), *tolerance* (more tanning is required in order to be satisfied), *withdrawal* (reduction or preclusion from tanning create restlessness and negative feelings), *conflict* (tanning creates conflicts), *relapse/loss of control* (return to old tanning patterns after a period of control or absence) and *problems* (tanning cause harm or some sort of problems). The time frame concerned the past month and the response format adhered to a 5-point Likert scale (0=*never*, 4=*always*). The total score of the BTAS thus ranged from 0 to 28.

Mini-International Personality Item Pool (Mini-IPIP) comprises 20 items for assessing personality.[40] Four items reflect each of the personality traits of the established five-factor model of personality[34]: *extraversion*, *agreeableness*, *conscientiousness*, *neuroticism*, and *intellect/imagination*, the latter being equal to the openness dimension. All items are answered on a 5-point scale (1=*very inaccurate*, 5=*very accurate*).[40] Cronbach's alphas for the five subscales in the present study were .81, .76, .70, .73 and .69, respectively.

Obsessive-Compulsive Inventory-Revised (OCI-R) comprises 18 items assessing six common OCD-symptoms[41]: *checking*, *ordering*, *neutralising*, *washing*, *obsessing* and *hoarding*. All items are answered on a 5-point Likert scale (0=*not at all*, 4=*extremely*). High scores indicate the individual is bothered by their symptoms. Cronbach's alphas for the six subscales in the present study were .72, .80, .68, .65, .85 and .77, respectively.

Hospital Anxiety and Depression Scale (HADS) is a 14-item two-factor scale that measures non-vegetative symptoms of *anxiety* and *depression.*[42,43] Seven items assess anxiety symptoms, and seven items assess symptoms of depression. All items are answered along a 4-point frequency scale ranging from *0* to *3*. Cronbach's alphas for the anxiety and the depression subscale of the HADS in the present study were .82 and .75, respectively.

Statistical analyses

A one-factor solution of the BTAS was investigated with a confirmatory factor analysis using the robust weighted least square estimator for categorical data, as implemented in Mplus v7.3. The root mean square error of approximation (RMSEA), the comparative fit index (CFI) and the Tucker-Lewis index (TLI) were used as indicators of model fit. For a good fit these values should be <.06, >.95 and >.95, respectively.[44] In addition, local modification indices[45] were used to identify specific model misfit. Scale reliability was assessed using the coefficient omega.[46]

To make valid score comparisons across groups, the BTAS should be measurement invariant.[47,48] In line with standard procedures[49] for categorical data the BTAS was tested for configural, metric and scalar invariance in a series of nested model comparisons. In the configural model, the only model restriction was that the indicators of the BTAS should load on the same factor. In the metric invariance model all factor loadings were restricted to be equal across groups. In the scalar invariance model, factor loadings and item category thresholds were constrained to equality across groups. Due to the large dataset the ΔCFI<.010 criterion was used to signify invariance.[50] If the restricted assumptions of the metric or scalar model did not fit the data, model fit would be expected to deteriorate when moving from a configural model to metric or scalar invariance model. In contrast, when assumptions of the scalar model are in line with the data, model fit will remain high when moving from the configural model to the scalar invariance model.

The other analyses were conducted with SPSS, v22. Correlation coefficients were calculated in order to assess the interrelationships between all study variables. In order to investigate factors related to tanning addiction, a linear regression analysis was conducted. As the dependent variable had a positive skew it was transformed according to recommendations by Tabachnic and Fidell[51] in order to be suitable for linear regression. Preliminary analyses were conducted to ensure no violation of the assumption of normality, linearity,

multicollinearity and homoscedasticity. The independent variables were entered simultaneously and comprised sex, age, relationship status, education, the five subscales of the Mini-IPIP, the six subscales of the OCI-R, as well as the score on the anxiety and the depression subscale of the HADS. Education was dummy coded so that the largest category (i.e. Bachelor's degree) comprised the reference category.

RESULTS

Table 2 shows descriptive statistics of responses on the seven BTAS items. The mean score in the sample was 2.27 (*SD*=3.42). The one-factor model of tanning addiction achieved a good global model fit [CFI=.98], but the RMSEA of .08 suggested some degree of model misspecification. Modification indices revealed a local dependence between Item 1 (on 'salience/craving') and Item 2 (on 'tolerance'). The item stems of Items 1 and 2 did not superficially overlap, but both items were concerned the magnitude and frequency of tanning behaviours. The two items were also the items with highest level of endorsement in the sample. Based on these conceptual and statistical similarities, a respecified model including a local error correlation between Items 1 and 2 was estimated. The χ^2 for the respecified model was significant (χ^2=782.6, *df*=13, *p*<.001). The model had good fit with the data (RMSEA=.050 [90% CI=.047–.053], CFI=.99, TLI=.99). The standardised factor loadings (all *p*<.001) ranged from .781 (Item 1) to .905 (Item 6) (Fig. 1). The coefficient omega indicator of consistency was .941 (95% CI=.939–.944). Models of configural, metric and scalar invariance were examined and compared in sequence, moving from the unrestricted configural model to a restricted scalar invariance model. For the gender comparison, using the configural model as a reference, the more restricted scalar invariance model achieved a good fit to the data, and was essentially identical to the configural model (see Appendix). For the age group comparison, the restricted scalar model had a marginally poorer fit than the configural model as indicated by a delta CFI of .002, which was clearly lower than the

prescribed .010 cut-off. Thus, tests of measurement invariance supported scalar invariance across gender, and across age groups (i.e. for the same score on the latent variable, sex and age groups do not have different thresholds on the observed variables). The zero-order correlation coefficients between study variables ranged from −.40 (between secondary school and Bachelor's degree) to .64 (between neuroticism and anxiety) (Table 3).

Table 4 presents the results from the multiple linear regression analysis. Multicollinearity was assessed (for all predictors) by calculated variance inflation factors (ranging from 1.03 to 2.46). The model as a whole was significant ($F_{21,23532}$=132.66, p<.001) and explained a total of 10.5% of the variance (R^2=.105). Tanning addiction was positively associated with female sex (β=.08), younger age (β=−.11) and not being in a relationship (β=.03). Compared to the reference category (Bachelor's degree), Master's and PhD degree (β=−.02) reduced the risk of reporting tanning addiction. Furthermore, tanning addiction was positively associated with extroversion (β=.13), neuroticism (β=.04), the six OCD-symptoms (β=.02–.06) and anxiety (β=.08), whereas intellect/imagination (β=−.09) and depression (β=−.06) were inversely related to tanning addiction.

DISCUSSION

The psychometric properties of the Bergen Tanning Addiction Scale (BTAS) were good. The assumed one-factor solution fitted very well with the data and all factor loadings were high. The construction process of the present scale was based on components which theoretically reflect all core dimensions of the addiction construct,[38,39] thus care was taken to ensure the content validity of the scale. However, further studies examining the convergent validity and the test-retest reliability of BTAS are needed. The distribution of the scores was strongly skewed to the left, which appears reasonable as the scale assessed tanning addiction symptoms in a large unselected population-based sample.

Results from the multiple regression analyses showed that tanning addiction was associated with being female. This is in line with several previous studies[16,21,27-29] and probably reflects that women put more emphasis than men on achieving an ideal appearance.[52] Age was inversely related to tanning addiction. This has also been reported previously[16] and corresponds to empirical evidence demonstrating that being of a young age is a vulnerability factor for addiction due to delayed frontal cortical development.[53] Not being in a relationship was also associated with tanning addiction, probably because being single means participants are more motivated to improve their physical appearance compared to those who are in a relationship.[54] Overall, the results suggest that compared to the reference category (having a Bachelor's degree), those with higher education (having a Master's degree and/or PhD) were less likely to have a high score on BTAS, supporting general findings showing that educational level is positively related to good health behaviours.[55]

In terms of personality, extroversion was positively associated with tanning addiction which probably reflects the tendency of extroverts to be concerned about expressing their individuality and to enhance their personal attractiveness.[56] Neuroticism, as well as symptoms of anxiety, was also positively associated with tanning addiction. This corroborates findings from previous studies[30,32,33] and is congruent with the assumption that tanning may have an anxiolytic effect.[30,32] Intellect/imagination was inversely related to tanning addiction. One explanation for this finding is that tanning can be regarded as a conventional activity, which is at odds with central features of the intellect/imagination trait such as openness, curiosity and unconventional values.[57]

A positive association between obsessive-compulsive tendencies and tanning addiction was found. This has been consistently reported in the literature[13,21,29,30] and it has been suggested that tanning may be a way of counteracting OCD-symptoms. Another possibility is that OCD-symptoms may reflect cravings to tan.[29] Interestingly, and in

opposition to other studies,[33] an inverse relationship was found between symptoms of depression and tanning addiction. One explanation is that depression often causes inactivity as well as loss of interest in own appearance,[58] something that would be incompatible with addictive tanning behaviour. It should be noted that depression was positively related to tanning addiction in the zero-order correlation analysis. This relationship was reversed in the multivariable analysis. Analysis (results not shown but available on request) showed that this reversal took place when the anxiety-related scales (neuroticism, HADS-anxiety and OCD) were included. The inverse relationship between depression and tanning addiction should therefore be interpreted with caution caution as the flipped sign may reflect a high overlap between depression and anxiety,[59,60] biasing the estimated relationship between depression and tanning addiction.

The BTAS needs further evaluation in terms of test-retest reliability and its cultural adaptability. Longitudinal studies are warranted in order to investigate the directionality between tanning addiction and other constructs, and is currently lacking in this field. It should also be noted that to date, the BTAS has not been validated against other tanning addiction instruments nor against objective indicators of excessive tanning. Consequently, it is currently unknown if the BTAS is psychometrically more robust than other tanning addiction scales. These limitations should be addressed in future studies.

Due to the cross-sectional nature of the present study, the results may have been influenced by the common method bias. Therefore, it cannot be ruled out that this may have caused inflated relationships between study variables.[61] Self-selection may have also influenced the results, as indicated by the preponderance of women and young people in the present sample. Overall, these limitations put restrictions on the generalisability of the findings to other populations both in and outside of Norway. However, as the survey was

broadcasted in national (not local) newspapers with very different contents and followers/readers, the sample probably represents a wide range of the Norwegian population.

The large sample size represents one of the study's key strengths, providing high statistical power to the analyses—and is argubly the largest study carried out on tanning addiction thus far. The sizeable sample could, however, have caused associations to be significant in the absence of theoretically meaningful relationships. However the findings complement many of the previous small-scale studies in the field.[62] Another strength of the present paper that deserves noting is the inclusion of specific and core addiction criteria in the scale construction process.

In conclusion, the present study suggests that a new scale for assessing addictive tanning, the Bergen Tanning Addiction Scale, possesses good psychometric properties in terms of factor solution, factor loadings and reliability. Tanning addiction, as assessed by BTAS, was associated with being female, not being in a relationship, extroversion, neuroticism, anxiety and obsessive-compulsiveness. Furthermore, BTAS score was inversely related to age, educational level, intellect/imagination and depression. Researchers and clinicians in this field are welcome to use the BTAS freely in their future work in improving patient care and disease prevention.

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Figure Legend

Figure 1. The factor structure of Bergen Tanning Addiction Scale showing standardised factor loadings (double-headed arrow implies correlation between item errors).

Table 1. Existing tanning addiction instruments and an overview of their strengths and limitations

Scale	Sample[a]	Strengths	Limitations
Behavioral Addiction Indoor Tanning Screener[24]	University student sample (N = 164).	Based on the behavioural addiction disorder model described in DSM-5 and is validated against the Structured Interview for Tanning Abuse and Dependence. The scale has 7 items and is thus suitable for epidemiological studies. A cut-off score is available for diagnostic purposes.	Focuses on indoor tanning specifically. The response alternatives (yes/no) restrict range of scores.
Comprehensive Indoor Tanning Expectations Scale[25]	University student sample (N = 706).	Based on studies on motives for indoor tanning. Each item is rated on a 5-point scale providing a good range of scores. The scale assesses positive (28 items; 6 subscales) and negative (21 items; 5 subscales) outcome expectations. Validated against indoor tanning intention and behaviour. The scales have good reliability.	The scale does not assess tanning addiction as such. Focuses on young women exclusively.
Craving to Tan Questionnaire[21]	University student sample (N = 421).	The scale is short, thus suitable for epidemiological studies. Each item is rated on a 7-point scale providing scores with a specific range. Validated against several other tanning addiction scales. Internal consistency is high.	Only assesses cravings rather than other addiction criteria.
Mood-based Indoor Tanning Scale[26]	Student sample (N = 743) and	Based on the control theory of mood regulation. Contains 4 items rated on a 7-point scale, thus providing a good range of scores.	Assesses mood effects related to indoor tanning only.

	mechanical turk (N = 296).	Suitable for epidemiological studies.	
Structured Interview for Tanning Abuse and Dependence[15]	University student sample (N = 325).	Based on modification of criteria for opiate abuse and dependence in the Structured Clinical Interview for DSM-IV. The interview can be self-administered. Validated against different tanning behaviours. Scores provide categories for tanning dependence and tanning abuse.	Scale is lengthy (14 items with up to 11 sub-items). The response alternatives (yes/no) restrict range of scores. The reliability of the tanning abuse classification is mediocre.
Tanning–CAGE[22]	Beachgoers (N = 145).	Based on 4 questions for alcohol screening. A cut-off score is available for diagnostic purposes. Suitable for epidemiological studies.	Does not cover all addiction criteria. Limited psychometric evidence exists. Response alternatives (yes/no) restrict range of scores.
Tanning–DSM[22]	Beachgoers (N = 145).	Based on 7 substance related disorder found in the DSM-IV-TR. A cut-off score is available for diagnostic purposes. Suitable for epidemiological studies.	Limited psychometric evidence exists. Response alternatives (yes/no) restrict range of scores.
Tanning Passion Scale[21]	University student sample (N = 421).	Based on a 10-item scale assessing obsessive and harmonious gambling, respectively. Each item is rated on a 7-point scale providing a range of scores. Suitable for epidemiological studies.	Does not cover all addiction criteria. Appears to have only been used for validation of the Craving to Tan Questionnaire, therefore has limited psychometric evidence.

Tanning Pathology Scale[23]	More than 300 young adults.	Based on scales reflecting addictive behaviours and opiate-like responses to tanning. Contains 16 items, loading on 4 factors: perceived problem (6 items), tolerance (3 items), opiate-like reactions (4 items), and dissatisfaction with skin tone (4 items). The scales have good reliability. Responses are provided on a 5-point Likert scale, providing a range of scores.	Original psychometric data are unpublished. The scale does not cover all addiction criteria.
Tanning Problem Index[20]	University student sample (N = 414).	Based on a scale assessing alcohol problems. Contains 11 items with response frequency response alternatives (5-point scale) providing a range of scores. Validated against other tanning addiction scales. Has good internal consistency.	Covers most, but not all addiction criteria.

[a] Original validation sample. DSM, Diagnostic and Statistical Manual of Mental Disorders (currently in its fifth edition, DSM-5, is the standard classification of mental disorders used by mental health professionals in the U.S.A.).

Table 2. The items of the Bergen Tanning Addiction Scale, mean score (*M*), standard deviation (*SD*), and distribution of scores

Items	***M***	***SD***	**Frequency (%)**				
How often during the past month did you…			**0**	**1**	**2**	**3**	**4**
1. …think a lot of becoming as tanned as possible? (SALIENCE/CRAVING)	0.89	1.05	49.6	22.3	18.8	8.0	1.3
2. …sunbathe or did other things in order to tan to a greater extent than you had planned? (TOLERANCE)	0.54	0.86	65.2	20.2	10.5	3.5	0.6
3. …sunbathe or did other things in order to tan because you felt restless or sad? (MOOD MODIFICATION)	0.24	0.63	83.9	9.9	4.4	1.3	0.4
4. …experience that others became worried because of your obsessiveness with tanning? (RELAPSE/CONTROL LOSS)	0.09	0.40	93.5	4.5	1.5	0.5	0.2
5. …become stressed or restless if you felt your skin was becoming paler? (WITHDRAWAL)	0.29	0.69	80.7	11.9	5.1	1.7	0.6
6. …spend so much time and effort on tanning that it negatively affected hobbies, spare time activities, and exercise? (CONFLICT)	0.07	0.34	95.1	3.5	1.0	0.3	0.1
7. …sunbathe or did other things in order to tan to such an extent that you think it is unhealthy? (PROBLEMS)	0.14	0.48	90.2	6.6	2.4	0.6	0.2

BTAS contains seven items reflecting core addiction elements (salience, tolerance, mood modification, relapse, withdrawal, conflict, problems). Participants (*N*=23,537) completed the BTAS using a 5-point scale (0=’Never’, 1=’Rarely’, 2=’Sometimes’, 3=’Often’, 4=’Always’; 7 items: *M*=2.27, *SD*=3.42, range 0–28, α=.84).

Table 3. Correlation coefficients (Pearson product-moment correlation, point-biserial correlation, phi-coefficient) between study variables

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Bergen Tanning Addiction Scale																						
2	Sex (1=♂, 2=♀)	.103																					
3	Age	-.179	.031																				
4	Relationship status[a]	.066	-.065	-.218																			
5	Primary school	.078	-.028	-.205	.149																		
6	Secondary school	.067	.016	-.197	.094	-.194																	
7	Vocational school	-.034	-.123	.138	-.049	-.150	-.263																
8	Bachelor's degree	-.031	.095	.118	-.081	-.231	-.403	-.313															
9	Master's degree	-.063	.015	.097	-.073	-.136	-.237	-.184	-.282														
10	PhD degree	-.030	-.018	.057	-.035	-.036	-.063	-.049	-.075	-.044													
11	Extroversion	.085	.088	.013	-.064	-.050	-.019	-.021	.049	.024	-.001												
12	Agreeableness	.027	.343	.048	-.048	-.049	-.017	-.061	.073	.031	.001	.296											
13	Conscientiousness	-.043	.141	.200	-.130	-.085	-.052	.052	.032	.041	-.010	.093	.131										
14	Neuroticism	.155	.234	-.116	-.005	.059	.041	-.021	-.024	-.041	-.022	-.098	.092	-.157									
15	Intellect/imagination	-.067	-.105	-.036	.042	-.045	-.042	-.066	.026	.109	.062	.163	.116	-.116	-.003								
16	OCD-Washing	.182	-.057	-.181	.064	.114	.061	.015	-.081	-.075	-.021	-.053	-.082	-.051	.138	-.015							

17	OCD-Obsessing	.195	.022	-.238	.109	.127	.087	-.034	-.074	-.071	-.030	-.126	-.046	-.256	.462	.035	.386					
18	OCD-Hoarding	.096	-.012	.083	.026	.042	-.006	.017	-.019	-.026	.015	-.067	-.032	-.239	.140	.039	.236	.293				
19	OCD-Ordering	.178	.012	-.099	-.016	.080	.039	.022	-.053	-.063	-.023	-.059	-.080	.147	.248	-.054	.417	.372	.280			
20	OCD-Checking	.172	-.035	-.150	.069	.082	.047	-.013	-.051	-.044	-.006	-.081	-.049	-.100	.237	-.014	.400	.411	.343	.436		
21	OCD-Neutralising	.185	-.057	-.157	.067	.130	.056	-.002	-.076	-.072	-.012	-.035	-.077	-.085	.161	-.011	.419	.398	.271	.442	.434	
22	Anxiety	.186	.123	-.201	.054	.089	.065	-.034	-.057	-.036	-.026	-.118	.031	-.231	.641	.025	.225	.608	.210	.297	.334	.259
23	Depression	.071	-.093	-.087	.105	.113	.057	.029	-.085	-.077	-.024	-.298	-.225	-.264	.417	-.081	.166	.463	.209	.213	.220	.198	.548

[a] 1 = in relationship, 2 = not in relationship. $-.012 \geq r \leq .012$ not significant, $-.016 \geq r \geq -.013$ $p < .05$, $.013 \leq r \leq .016$ $p < .05$, $-.017 \geq r$ $p < .01$, $r \geq .017$ $p < .01$.

Table 4. Regression analysis summary for demographic, personality, obsessive-compulsive, anxiety and depression variables predicting tanning addiction

Variable	*B*	*SE*	β	*t*	*p*	VIF
Sex (1=♂, 2=♀)	.179	.016	.078	11.07	***	1.295
Age	- .009	.001	- .114	- 16.13	***	1.306
Relationship status (1=in, 2=not in)	.074	.015	.032	4.97	***	1.099
Education[a]						
Primary school	.022	.026	.006	0.87	ns	1.292
Secondary school	.019	.018	.008	1.05	ns	1.407
Vocational school	- .021	.021	- .007	- 1.02	ns	1.309
Master's degree	- .063	.022	- .020	- 2.94	**	1.246
PhD degree	- .207	.064	- .020	- 3.22	**	1.031
Extroversion	.038	.002	.126	18.73	***	1.196
Agreeableness	- .002	.003	- .006	- 0.82	ns	1.320
Conscientiousness	- .004	.002	- .012	- 1.63	ns	1.393
Neuroticism	.012	.003	.040	4.74	***	1.870
Intellect/imagination	- .033	.002	- .094	- 14.48	***	1.118
OCD-Washing	.036	.005	.059	7.93	***	1.497
OCD-Obsessing	.013	.004	.032	3.61	***	2.070
OCD-Hoarding	.011	.003	.024	3.30	***	1.345
OCD-Ordering	.025	.004	.054	6.79	***	1.691
OCD-Checking	.014	.004	.029	3.82	***	1.549
OCD-Neutralising	.032	.005	.049	6.46	***	1.511
Anxiety	.021	.003	.075	7.72	***	2.455
Depression	- .021	.003	- .060	- 7.26	***	1.801

B, un-standardised regression coefficient; *SE*, standard error of B; β, standardised regression coefficient; *t*, t-value; *p*, probability level; VIF, variance inflation factor; ns, not significant. [a] Bachelor's degree = reference.

*$p < .05$, **$p < .01$, ***$p < .001$.

Appendix. Model summary for tests of measurement invariance

	Chi-square	RMSEA	RMSEA LO	RMSEA HI	CFI	delta CFI
Age						
Configural	741.52	0.048	0.045	0.051	0.995	.
Metric	1059.26	0.052	0.050	0.055	0.993	0.002
Scalar	1074.56	0.041	0.039	0.043	0.993	0.002
Sex						
Configural	772.18	0.049	0.046	0.052	0.995	.
Metric	926.78	0.049	0.046	0.051	0.994	0.001
Scalar	792.47	0.035	0.033	0.037	0.995	0.000

RMSEA, root mean square error of approximation; CFI, comparative fit index.