

INVESTIGATIVE REPORT

Casting Shadows on the Prevalence of Tanning Dependence: An Assessment of mCAGE Criteria

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Recently, more and more studies have reported high prevalence rates for a ‘tanning dependence’ among tanning bed users. The authors of these studies base their argumentation on a modified (m) version of the CAGE (Cut-down, Annoyed, Guilty and Eye-opener) Criteria, initially used for alcohol addiction. By means of cognitive interviews and a large population survey, we tested the validity of the mCAGE Criteria and the above-mentioned prevalence that was deduced on the basis of rather small collectives. Firstly, it seems that the mCAGE Criteria wording used so far is inconsistent, misleading and intrinsically invalid. Secondly, our population-based data show a much lower percentage (15%) of current sunbed users with potential dependence symptoms than the above-mentioned previously published studies. Thirdly, the usage parameters for most of the supposed ‘addicts’ do not indicate a substance addiction: 38% of the users with positive scores reported not having visited a tanning studio at all in the previous month, 39% did not use sunbeds regularly and 89% did not show signs of tolerance to UV radiation. The mCAGE Criteria do not seem suitable for assessing tanning dependence. Key words: addictive behaviour; ultraviolet radiation; tanning; skin cancer; prevention.

Accepted Jun 5, 2014; Epub ahead of print Jun 10, 2013

Acta Derm Venereol 2015; 95: 162–168.

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UV radiation is carcinogenic. Despite this well-known fact, many people purposely expose themselves to UV rays; in some cases to such an extent that they can be considered to be addicted to UV light. Dermatologists were the first to recount anecdotes about cases of such supposed UV addiction (1). However, in recent years more and more studies have been published on the symptomatic commonly termed ‘tanning dependence’

(sometimes also referred to as UV dependence) (2–8). The mass media has recently begun referring to this phenomenon as ‘Tanorexia’ (9).

The aetiology of ‘tanning dependence’ is the subject of ongoing discussion (5, 10, 11). The most common conceptualisation is that reinforcement mechanisms are involved: UV light induces the production of pro-opiomelanocortin (POMC), which is thought to contribute to the regulation of stress, sleep patterns and energy homeostasis via the release of hormones (MSH, ACTH) and β -endorphin (12). Additionally, β -endorphin has been shown to have anti-inflammatory, pain-relieving and relaxant effects (5, 7, 13–15). A different explanation claims that UV light increases the body’s serotonin levels. Serotonin in turn reduces the level of melatonin, which is responsible for the regulation of fear, sleep patterns and an individual’s circadian rhythm (12). Other conceptualisations see tanning dependence as a form of either seasonal affective, body dysmorphic, obsessive-compulsive or impulse control disorder (16). No gold standard for categorising tanning dependence has yet been established (17, 18).

Many studies published so far on tanning dependence have relied on the so-called ‘CAGE Criteria’ to identify and characterise the condition. The CAGE Criteria were originally developed as a tool to characterise alcohol addiction and include 4 criteria (19). The acronym refers to these 4 criteria: Cut-down, Annoyed, Guilty and Eye-opener. The validity of the CAGE Criteria for use in characterising alcohol addiction has been clinically proven (20) and, despite a low detection rate in non-clinical populations (including students, women and the general population), the CAGE Criteria have meanwhile become the most commonly used instrument for alcohol addiction screening (21).

Recently, several studies have used a modified version of the CAGE Criteria (mCAGE) to screen sunbed users for possible tanning dependence. According to common practice, the fulfillment of at least 2 of the mCAGE Criteria is taken to indicate a case of tanning dependence (2–8). These studies have attracted a lot of attention as their use of the mCAGE Criteria has resulted in the identification of a very high prevalence

of tanning dependence among indoor tanners. The first study was published by Poorsattar & Hornung in 2007 (7) and reported that 28% of the 112 indoor tanners screened had positive mCAGE scores. In 2010, Mosher et al. (6) screened a total of 229 indoor tanners, 31% of whom scored positive for tanning dependence according to the mCAGE Criteria. In the same year, Harrington and colleagues (4) also categorised 31% of their sample of sunbed users as problematic tanners. More recently, Cartmel et al. (2) reported that 41% of the 178 indoor tanners who participated in their study had positive mCAGE scores.

Other studies looked at both indoor and outdoor tanning habits (3), or only focused on outdoor tanning (13), and found that 19% and 26% of the participants, respectively, scored positive for tanning dependence using the mCAGE Criteria. The findings on mCAGE scores among sunbed users published in 2 further studies must be disregarded here due to methodological errors (8) or a lack of differentiation (5)¹.

All studies on tanning dependence published so far were carried out in the USA and the number of indoor tanners included in each was quite low ($n=44-229$). With the exception of the studies by Cartmel et al. (2) and Harrington et al. (4), all the collectives studied consisted entirely of students or members of university communities. Heckman and colleagues (18) recently summarised the current state of research by saying: "Tanning dependence research is still nascent"². Moreover, a standard screening method has not yet been established (18). In our opinion, this situation is problematic because; 1) the suitability of the original CAGE Criteria for the investigation of sunbed use is untested, 2) the sample sizes used in the studies published so far were small and non-representative, and 3) most of the studies published did not include a control group of non-sunbed users. Therefore, there have been calls for cognitive interviews (5) and large representative studies (6, 13) to test the content and face validity of the mCAGE Criteria.

The study detailed in this paper had the following aims: (i) To check whether participants understood the mCAGE Criteria and interpreted them as intended by carrying out cognitive interviews; (ii) to test whether the high prevalence of positive mCAGE scores identi-

fied in the non-representative studies published so far could also be identified in a representative sample and (iii) to find out whether quantitative indicators (usage parameters and motives) of sunbed users with positive mCAGE scores correlate with the positive mCAGE-based tanning dependence findings.

METHODS

The SUN-Study 2012 was conducted in Germany by the Mannheim Institute of Public Health (MIPH; Heidelberg University, Germany) in cooperation with the Association of Dermatological Prevention (ADP; Hamburg, Germany). Approval was obtained from the ethics committee of the Heidelberg University (ANr2007-269E-MA) and all participants consented to take part in the study. The SUN-Study 2012 consisted of preliminary cognitive interviews and a subsequent population-based survey. We deemed this two-step procedure necessary, as in previous studies mCAGE Criteria had been used in a thoughtless manner, without testing if the items are valid and if the questions are interpreted as intended.

Cognitive interviews

Study design and study participants. In March 2011, 15 cognitive interviews were carried out in cooperation with the GESIS Leibniz Institute for the Social Sciences in Mannheim, Germany, an independent public institution which specialises in the development and evaluation of scientific surveys. Cognitive interviews allow the content validity of medical scores to be tested (22). Our interviews aimed to test whether the 4 central criteria included in the mCAGE score were interpreted by participants as intended. Eight of the 15 people interviewed were female, and the participants' age ranged between 19 and 44 years. All German education levels were represented.

Operationalisation. Due to the fact that a standard set of mCAGE questions has yet to be established, we based our questions on the original wording of the CAGE Criteria for alcohol consumption as developed by Mayfield in 1974 (23). In order to adapt the questions to gather information on tanning habits, we referred to the mCAGE version used by Poorsattar & Hornung (7), as this was the first documented use of the CAGE Criteria for this purpose and these authors adhered closely to the original wording of the questions (see Table S1³). In correspondence with our research question, we replaced the term 'tanning' with 'indoor tanning'. We also added the word 'ever' in the second criteria, as we considered the original question used by Poorsattar and Hornung to be too unspecific, whereas their questions on the other three criteria always asked if a person had ever exhibited such behaviour (7).

Analysis methods. The cognitive interviews each lasted approximately one hour and were carried out by a trained interviewer in a cognitive laboratory using both an evaluation questionnaire which had been developed in advance and the Think-Aloud- and Verbal-Probing-Techniques (24). The videotaped and recorded interviews were subsequently transcribed and evaluated by the authors.

Population survey

Study design and study participants. The quantitative study included 4,851 German residents between 14 and 45 years

¹In the study by Von Gunten, the first item ("Cut-down") had been deleted accidentally in the course of the data analysis and could thus not be evaluated by this author (8). In the study by Heckman et al. (5) both outdoor and indoor tanning behaviour was assessed simultaneously and tanning dependence was established on the basis of a combination between the mCAGE criteria and specific mDSM-IV-TR criteria (Diagnostic and Statistical Manual of Mental Disorders IV Text Revision).

²An aetiology model is yet to be developed and tanning dependence is not an official disorder listed in the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders.

³<https://doi.org/10.2340/00015555-1907>

of age, independent of their possible sunbed use. Data was collected by means of computer-assisted telephone interviews (CATI). A multistage sampling process was used to randomly select study participants in accordance with the highest national survey standards (25, 26). Firstly, a pool of telephone numbers was generated using a random algorithm to contact households (25, 26). Secondly, if there was more than one person from the target population in a household, the person with the next birthday was chosen to participate. Finally, data were weighted by age, sex, educational level and federal state using official national data from the German Microcensus 2010 to ensure national representativeness.

Operationalisation. The interdisciplinary author group was supported by an external expert group of dermatologists, epidemiologists, psychologists, sociologists and statisticians in developing the questionnaire, which was then evaluated and pretested several times before the field research was conducted (27). The reliability of the questionnaire items was tested in advance and showed a very high reliability rate for the questions assessing sunbed use (correlation coefficients between 0.83 and 1.00). During the telephone interviews, all 4,851 participants were asked if they had ever used a sunbed. In the analysis, a current sunbed user was defined as someone having used a sunbed at least once during the last 12 months, according to international standards (current users). Ex-sunbed users were defined as those who had used one more than 12 months ago (past users). Past and current users of sunbeds (ever users) were additionally asked about the mCAGE Criteria. Sunbed users who responded to 2 or more of these criteria with 'yes' were combined into a group with a positive mCAGE score, according to standard practice. Correspondingly, participants who gave less than 2 affirmative responses to the mCAGE Criteria were given a negative mCAGE score. The variable 'Usage throughout the year' stipulates the use of a sunbed at least once every season, so once per quarter. A person is considered to be a year-round sunbed user when he or she uses a sunbed at least 4 times a year, at least twice every half year and at least once every quarter. Development of objective tolerance was assumed when an individual's exposure time had increased and an individual was assumed to have developed subjective tolerance when he or she answered yes to the question; "Do you think that you need to expose yourself longer and longer to UV light to achieve a tan?"

Analysis methods

Due to a right-skewed data distribution, Kruskal–Wallis tests were used to compare median values for onset age and sunbed exposure with mCAGE score results. To assess the age at sunbed use initiation in the total sample, we used survival analysis, a technique that accounts for right-censored data to permit comparison of time to event (i.e. first use of sunbeds) between users with and without a positive score (28). We used a Kaplan–Meier curve to model the initiation age based on data from both groups. The non-censored time until event was represented by the initiation age in ever users of sunbeds, whereas the censored time until event was represented by the age at the time of the interview in non-users.

Chi²-tests were used to analyse motivational differences between current sunbed users with and without a positive mCAGE score. Analyses were conducted with SPSS 21 (IBM Corp., Armonk, U.S.A.) and Stata 12 (StataCorp LP, College Station, TX, U.S.A.) using the predefined level of significance of $p < 0.05$. Given the exploratory nature of our analyses, we did not apply a correction for multiple comparisons.

RESULTS

Cognitive evaluation of the mCAGE Criteria

Before the large-scale survey using questions on the 4 mCAGE Criteria was conducted, we tested their content validity and subjective interpretation by means of cognitive interviews. Whereas the first criterion "Have you ever felt you should cut down on your indoor tanning?" was easily understood by all 15 participants, the original wording of the second criterion "Have people ever annoyed you by criticising your indoor tanning habits?" caused some confusion. Four out of 15 participants answered that they had been criticised in the past for their sunbed use, but that they had not thought much of it and were certainly not annoyed by such comments. Three of these 4 people were thus unsure if they should answer the question with yes or no. The fifth participant complained that the question implied that indoor tanning was objectionable. As this question was intended to be answered positively only if both conditions were fulfilled – a person had been criticised and felt annoyed by the criticism – the item was subsequently divided into 2 questions in the nationwide survey: ("Have people ever criticised your indoor tanning habits?", if yes: "Have you been annoyed by that criticism?"). The 2 other mCAGE Criteria were easier to understand and therefore the original wording was not altered. However, one participant claimed to simply not understand criterion number 3: "Have you ever felt bad or guilty about your indoor tanning?" Another person understood the question to refer to feeling guilty about wasting money on tanning. The fourth criterion, "Have you ever thought about indoor tanning first thing in the morning?" was subject to a broad range of interpretations: For example, 3 sunbed users answered that they thought about their visit to the tanning studio because they had had to fit it into their schedules. Although they answered the question with yes, the participants were not reporting the symptom of interest, namely the craving (e.g. known from alcohol or tobacco abuse).

Nationwide mCAGE scores

In the nationwide sample the overall prevalence of ever sunbed use was 39.2% ($n = 1,898$). Within the total sample, 24.7% reported past sunbed use and 14.6% current use. A large majority of the current users did not answer even one of the mCAGE Criteria with yes (57.0%, see Table I). Fifteen out of 100 current users had a positive mCAGE score, meaning ≥ 2 positive mCAGE Criteria (14.5%, see Table I). A comparison with past users showed that 12% of ex-sunbed users had 2+ mCAGE scores, which is not significantly different to current users ($p > 0.05$, see Table I).

Table I. Affirmative responses to mCAGE items for a representative sample of current and past sunbed users in Germany (SUN-Study 2012)

mCAGE item	Affirmative response ("yes")		p-value
	Past users n=1.145	Current users n=700	
Do you try to cut down on the time you spend on sunbeds?	28.5%	27.8%	0.748
Have people ever criticized your indoor tanning habits and have you been annoyed by that criticism?	2.6%	5.0%	0.007
Do you ever feel guilty because of your sunbed usage?	20.2%	19.9%	0.887
Is using a sunbed one of the first things you think about when waking up in the morning?	2.1%	7.5%	<0.001
<i>Sum score of mCAGE items</i>			0.448
0 affirmative response	60.1%	57.0%	
1 affirmative response	28.2%	28.5%	
2 affirmative responses	9.9%	11.9%	
3 affirmative responses	1.7%	2.3%	
4 affirmative responses	0.1%	0.3%	
<i>Positive mCAGE score</i>			0.088
Affirmative responses to ≥ 2 mCAGE items	11.7%	14.5%	

Data refer to the subsample of 1,845 participants who reported ever having used a sunbed during their lifetime (weighted data according to German Microcensus 2010 regarding age, sex, education and region). Percentages are based on valid cases providing complete data only and may not total 100% due to rounding. mCAGE: modified CAGE (Cut down, Annoyed, Guilty, Eye-opener) Questionnaire.

Plausibility analyses

Table II illustrates the quantitative usage parameters of current users with positive and negative mCAGE scores, respectively. Sunbed users with positive scores were found to have visited a tanning studio for the first time 3 years earlier than those with negative scores, a finding which is also illustrated in the Kaplan-Meier curve (Fig. 1).

Four out of 10 users (43.1%) with positive scores reported not having visited a tanning studio at all in the previous 4 weeks. Current users with positive scores reported visiting tanning studios approximately 0.5 ti-

mes a week, 61.0% reported using sunbeds year-round. 11.2% stated that their sunbed exposure had increased over time (objective tolerance, see Table II). Of current users with positive mCAGE scores, 27.3% reported that they had needed progressively longer periods of UV exposure to achieve their desired tan (subjective tolerance, see Table II). The 3-month (61.4% vs. 55.2%, $p=0.245$) and monthly use prevalence rates (43.1% vs. 35.5%, $p=0.142$), as well as year-round regular use rates (61.0% vs. 59.6%, $p=0.821$) of current users with positive scores and current users with negative scores did not differ significantly.

Finally, a comparison of the motives of both groups revealed that current users with positive scores differ from those with negative scores only in that they were slightly more likely to name the desire to be more attractive as the reason for their sunbed use (see Fig. S1³; $p=0.001$).

Table II. Quantitative utilization parameter according to the mCAGE score for a representative sample of current and past sunbed users in Germany (SUN-Study 2012)

	Affirmative responses		p-value
	≥ 2 mCAGE items n=101	<2 mCAGE items n=599	
	Median (IQR)	Median (IQR)	
Onset age, years	17.0 (15.0–20.0)	20.0 (17.0–23.0)	<0.001
Tanning sessions within last			
12 months	9.7 (3.5–24.0)	5.4 (2.0–15.0)	0.007
6 months	4.0 (1.0–12.0)	2.0 (1.0–6.0)	0.016
3 months	3.0 (0.6–6.4)	2.0 (0.0–5.0)	0.096
4 weeks	1.7 (0.0–2.0)	1.0 (0.0–2.0)	0.133
Sessions per week, n	0.5 (0.2–1.5)	0.2 (0.1–0.6)	<0.001
Mean exposure/year, min	468.0 (129.0–936.0)	150.0 (50.0–459.0)	<0.001
Usage throughout the year ^a , %	61.0	59.6	0.821
Objective tolerance ^b , %	11.2	4.1	0.003
Subjective tolerance ^c , %	27.3	12.2	<0.001

Data refer to the subsample of 700 participants who reported current sunbed use and answered the mCAGE items (weighted data according to Microcensus 2010 regarding age, sex, education and region). Percentages are based on valid cases providing complete data only. mCAGE: modified CAGE (Cut down, Annoyed, Guilty, Eye-opener) Questionnaire.

^aUsed a sunbed at least once per month in the past year. ^bIntensification of exposure time during tanning biography. ^cAgreement with the question: "Do you think you need to continuously increase the time of UV light exposure in order to keep your tan?". IQR: Interquartile range.

DISCUSSION

To our knowledge, this study represents the first test of the mCAGE Criteria in a cognitive laboratory. The results presented here have shown that the mCAGE Criteria wording used so far can be misinterpreted. Criterion 2 was shown to be the most problematic, as it incorporated 2 relevant aspects into one question. We therefore found it necessary to divide the item into 2 questions. Criterion 3 was also able to be interpreted in a range of different ways, as was criterion 4; many of the positive answers given were not actually referring to the craving symptoms the question was aimed at identifying.

Our first conclusion is therefore that, in our opinion, the mCAGE Criteria are not internally valid. We believe that further academic discus-

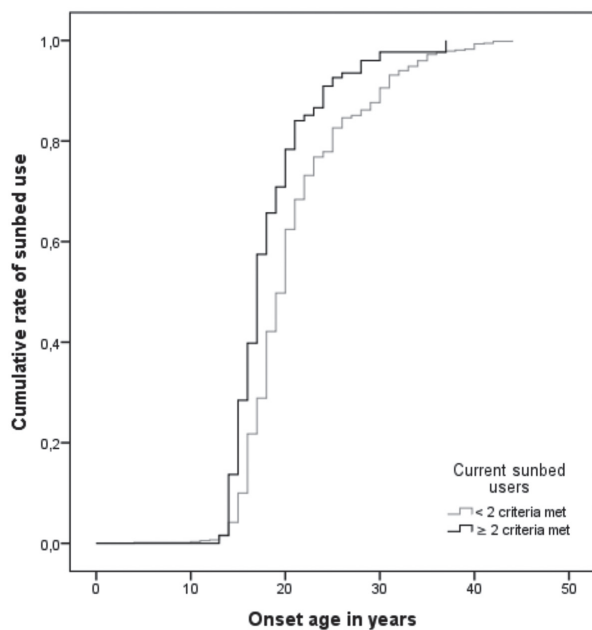


Fig. 1. Onset age of current sunbed users with affirmative responses to ≥ 2 or < 2 mCAGE items (modified CAGE (Cut down, Annoyed, Guilty, Eye-opener) Questionnaire; $n = 700$).

sion is essential to achieve a consensus on an improved and more internally valid set of mCAGE Criteria. This is especially important given that no agreement has even been achieved so far concerning the exact wording of the criteria. This has resulted in the use of various different versions of the criteria in numerous studies (see Table S1¹).

Additionally, we identified much lower tanning dependence rates than reported in numerous previously published selective-sample studies. The population-based, representative data gathered from over 4,800 participants presented here have shown that only 15% of all current sunbed users (and 12% of all past users) fulfill at least 2 mCAGE Criteria.

Moreover, we find it very questionable to assume that an individual is tanning dependent solely on the basis of 2 positively answered mCAGE questions.

Especially since diagnoses of well established substance dependence is not solely based on CAGE questions but on the detailed exploration of DSM-IV criteria, e.g., excessive time spent with substance consumption, repeated unsuccessful attempts to cut down or stop, diminished control over, tolerance, withdrawal, and adverse psychosocial consequences (29).

Further results question the external validity of the mCAGE as a useful instrument in identifying tanning dependence. Referring to clinical research on alcohol addiction it would be assumed that drinkers who have successfully managed to quit drinking would show lower scores on current CAGE Criteria when compared to current drinkers. However, in our study the scores of both groups did not differ significantly. The recently published study by Cartmel et al. (2) similarly reported

finding no significant difference between the mCAGE scores of current and past users.

Surprisingly, 56.9% of current users with positive mCAGE scores reported not having visited a tanning studio at all in the 4 weeks prior to the survey. In addition, 39% of participants with positive scores did not report using tanning studios year-round (Table II).

Both findings made us skeptical and seem to contradict the assumption that these participants were suffering from a substance addiction, which is generally characterised by the abovementioned criteria and associated with constant craving for the addictive substance (alcohol, nicotine) and/or withdrawal symptoms. Thus, we would expect the dependent individuals to visit tanning studios much more regularly (5, 16).

We identified the development of both subjective and objective tolerance over time only among a minority of sunbed users (27% and 11% of the positive cases respectively, see Table II). This also contradicts what is known about other addiction patterns (such as alcohol addiction), where dependence is associated with an increase in the time spent with substance consumption and the daily dosage as the addiction progresses. Accordingly, data from the USA, Korea and Germany have shown that drinkers with ≥ 2 positive CAGE scores drink more and more often than drinkers with < 2 positive CAGE items (30, 31).

Reports made in the framework of cognitive interviews suggest that sunbed use is often instigated by events such as graduation ceremonies, weddings, holidays or fashion trends. These statements from our qualitative study part are supported by our quantitative findings regarding the motivation behind sunbed use. The most common aetiologic explanations (referring to tanning influencing mood-related emotional processes) indicate that participants should more frequently name feelings of relaxation, warmth and light as motivations for sunbed use. Instead participants with positive mCAGE scores significantly more frequently named the desire to be more attractive as the reason for their sunbed use. In contrast, research on alcohol addiction has shown that the motives of non-addicted alcohol consumers differ greatly from those of addicts. Whereas the former mostly name positive reinforcement motives (e.g. improving social interaction), the latter commonly name negative reinforcement motives (e.g. relaxation, mood improvement) (32).

In conclusion, the wording of the mCAGE Criteria is most importantly unclear. Secondly, our population-based data show a much lower percentage (15%) of current sunbed users with potential dependence symptoms than previously published studies. And thirdly, the usage parameters identified for most of the supposed 'addicts' do not seem to indicate a substance addiction: 38% of the users with positive scores reported not having visited a tanning studio at all in the previous month, 39% did

not use sunbeds regularly and 89% did not show any signs of having developed an objective tolerance to UV radiation. As Heckman et al. (5) have previously stated, a lack of association between dependence indicators and usage parameters would raise serious validity concerns. Our data have shown that such a lack of association is evident.

Strengths and limitations

The SUN-Study 2012 is the largest representative study so far to survey sunbed users by means of the mCAGE Criteria. Additionally, this study represents the first and only study on this topic outside the USA. Furthermore, the highest survey standards were followed in carrying out a pilot study and an extensive reliability study. Additional strengths are that the sample also included unlisted telephone numbers, the study involved a high number of contact attempts, and that interviewers were provided with extensive training and supervision.

Nevertheless, some limitations have to be considered. We cannot exclude the chance that some participants did not correctly recall if and when they used a sunbed (recall bias). However, the pretest (including a reliability test) and the cognitive interviews showed that recall bias was negligible. Additionally, sunbed users might have been more willing to participate in the study (non-participation bias). To reduce this potential weakness, the real aim of the study was not disclosed to the participants at the beginning of the telephone interview, which started with several innocuous questions (about lifestyle, sports and nutrition) to avoid subjects who had never used sunbeds declining to participate. Also, data was weighted by age, sex, educational level, and federal state. As a result of this representative weighting, the structure of the sample reflects the German population structure.

Conclusion

Tanning is self-destructive (4): There is no doubt about this fact. We have often pointed out the risks of exposure to artificial UV radiation and have regularly discussed the urgent need for preventative measures (27, 33, 34). There is a chance that tanning can also be addictive; we do not doubt that it is possible that tanning dependence exists. However, in this paper we aimed to point out that the mCAGE score, often used to prove the existence of tanning dependence, does not appear to be a valid instrument. Due to both the selectivity of previous samples and the mCAGE Criteria's lack of internal and external validity, we believe that recently published findings regarding very high tanning dependence rates should be assessed critically, a point which the authors themselves have emphasized. We share the opinion expressed by Hillhouse et al.

that "current assessments tend to over-identify tanning dependence" (17) (p. 815).

Due to mentioned weaknesses of the mCAGE Criteria, some studies have opted to (exclusively or additionally) use criteria from the DSM-IV. However, this does not solve the problem, as studies applying DSM-IV Criteria report even less consistent findings than those using mCAGE Criteria (6, 11, 18). The research group around Hillhouse recently developed an alternative tool called the Structured Interview for Tanning Abuse and Dependence (SIDAT) to gather information about possible cases of tanning dependence (17). More recently, Heckman and colleagues have also introduced another instrument called the Tanning Pathology Scale (TAPS) to identify cases of tanning dependence (18). The results of our analyses suggest that the content and face validity of the newly developed SIDAT and TAPS criteria should also be tested. They could possibly provide researchers with more valid alternatives to the commonly used mCAGE Criteria.

ACKNOWLEDGEMENTS

We thank Miranda Böttcher, qualified translator, for her helpful comments and language support in the preparation of this manuscript.

Funding/Support: This study was supported by the German Cancer Aid (grant no. 109091).

We acknowledge the financial support of the Deutsche Forschungsgemeinschaft and Ruprecht-Karls-Universität Heidelberg within the funding programme "Open Access Publishing".

Role of the Sponsors: The sponsors had no role in the design and conduct of the study; in the collection, analysis, and interpretation of data; nor in the writing, review, or approval of the manuscript.

The authors declare no conflict of interest.

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