

Transdermal Continuous Alcohol Monitoring Peer-Reviewed Published Research

Alessi, S. M., Barnett, N. P., & Petry, N. M. (2017). Experiences with SCRAMx alcohol monitoring technology in 100 alcohol treatment outpatients. *Drug and alcohol dependence*, 178, 417-424. <https://doi.org/10.1016/j.drugalcdep.2017.05.031>

- This study assessed feasibility, acceptability, and adherence with SCRAM CAM in the context of two clinical research trials.
- These are the first randomized clinical trials using SCRAM CAM with alcohol treatment patients.
- Of participants, 84% provided 12 weeks of data, and 96% of bracelets were returned fully intact. Ninety-four equipment tamperers occurred, affecting 2% of monitoring days; 56% (67) of tamperers coincided with detected drinking.
- Common concerns reported by participants were skin marks (58%), irritation (54%), and interfered with clothing choices (51%), but severity ratings were generally mild.
- Eighty-one percent of participants reported that the bracelet helped them reduce drinking, and 75% indicated that they would wear it for longer.
- Researchers concluded that the study results support the viability of transdermal monitoring in voluntary substance abuse treatment participants for an extended duration.

Alessi, S., Barnett, N., & Petry, N. (2019). *Objective Continuous Monitoring of Alcohol Consumption for Three Months Among Alcohol Use Disorder Treatment Outpatients*. *Alcohol*.

- This is the first study to quantify alcohol consumption among AUD alcohol treatment outpatients (n=63) using transdermal sensor technology.
- Results indicate that 92% of patients drank while in outpatient care with self-report results at 63%
- Validation of drinking compared SCRAM monitoring to self-report as part of the study design as expected self-report continues to underreport actual drinking rates

Averill, F., Brown, T., Robertson, R., Tchomgang, A., Berbiche, D., Nadeau, L., & Ouimet, C. (2018) *Transdermal alcohol monitoring combined with contingency management for driving while impaired offenders: A pilot randomized controlled study*, *Traffic Injury Prevention*, 19:5, 455-461, DOI: 10.1080/15389588.2018.1448079

- In a pilot randomized controlled trial of contingency management (CM) and transdermal alcohol monitoring (TAM) with offenders driving while impaired by alcohol (DWI), perceptions regarding the acceptability of a TAM device, recruitment issues, and the impact of CM and TAM on alcohol use over a 6-week period were evaluated.
- The TAM device was perceived positively, with benefits for reducing drinking noted.
- Some of its inconveniences appeared to influence participant recruitment and attrition, including its large size and limited water resistance.
- It was concluded that TAM is a viable adjunct to CM with DWI offenders, though the TAM device used here may influence both study recruitment and adherence. These findings can guide the design of future studies into CM and TAM for DWI remediation.

Ayala J., Simons K., & Kerrigan S. (2009) *Quantitative Determination of Caffeine and Alcohol in Energy Drinks and the Potential to Produce Positive Transdermal Alcohol Concentrations in Human Subjects.* Journal of Analytical Toxicology. V.33(1):27-33.

- The purpose of this study was to determine whether non-alcoholic energy drinks could result in positive "alcohol alerts" in SCRAM.
- Eleven different energy drinks were quantitatively assayed, and ethanol concentrations ranged from 0.030 to 0.230% (w/v).
- A total of 15 human subjects consumed between 6 and 8 energy drinks over an 8-hour period, and SCRAM was used to determine TACs every 30 min before, during, and after consumption.
- There were no positive "alcohol alerts." TAC measurements for all subjects before, during and after the energy drink study period (16 h total) were <0.020.
- Subjects in the study consumed a quantity of non-alcoholic energy drink that greatly exceeds what would be considered typical. Based on these results, it appears that energy drink consumption is an unlikely explanation for elevated TACs that might be identified as potential drinking episodes or "alcohol alerts" using SCRAM.

Barnett, N. P., Tidey, J., Murphy, J. G., Swift, R., & Colby, S. M. (2011). Contingency management for alcohol use reduction: a pilot study using a transdermal alcohol sensor. *Drug and alcohol dependence*, 118(2-3), 391-399. <https://doi.org/10.1016/j.drugalcdep.2011.04.023>

- The purpose of this study was to evaluate the efficacy of contingency management for reduction in alcohol use, using SCRAM to provide an objective, quantitative measure of alcohol use.
- Thirteen heavy drinking adults wore SCRAM for three weeks and provided self-reports of alcohol and drug use using daily web-based surveys. Subjects were provided contingent reinforcement (i.e. they were paid) on days when alcohol use was not reported or detected by SCRAM.
- Heavy drinking participants reduced their alcohol use substantially in the weeks when contingent reinforcement was provided.
- Researchers found that AMS' confirmation criteria are conservative in nature
- Researchers modified existing confirmation criteria to improve low level detections and reduce false negative drinking days.
- SCRAM readings provided information about the volume of alcohol consumed (using the area under the transdermal curve) which breath tests cannot.
- SCRAM criteria can result in false negatives\ no false positives were reported.
- Overall, the results support the efficacy of CM for alcohol use reductions and the feasibility of using transdermal monitoring of alcohol use for clinical purposes.

Barnett N., Meade, E., & Glynn T.R. (2014) *Predictors of Detection of Alcohol Use Episodes Using a Transdermal Alcohol Sensor.* Experimental and Clinical Psychopharmacology. V.1(22): 86–96.

- The objective of this investigation was to establish the ability of SCRAM to detect different levels of self-reported alcohol consumption, and to determine whether gender and body mass index, alcohol dependence, bracelet version, and age of bracelet influenced detection of alcohol use.
- 66 heavy drinking adults wore SCRAM for 1–28 days and reported their alcohol use in daily web-based surveys.
- 690 drinking episodes were reported and 502 of those episodes (72.8%) were detected by SCRAM.

- They concluded that SCRAM sensor is very good at detecting 5 or more drinks.
- They used a more aggressive criteria than AMS for determining if drinking had taken place, requiring only one reading at or above 0.020 TAC and requiring it meet either the absorption or elimination rate criteria.
- Using this more aggressive criteria, they found a low proportion of TAC episodes that were not matched with a self-reported drinking episode (5.1% of all TAC episodes), and concluded that AMS' more conservative criteria has a very low likelihood of false positives.

Bock S. (2003) *Michigan DOC Runs BETA Test of New Remote Transdermal Alcohol Monitoring System.* Journal of Offender Monitoring. v16(1):2-6.

- This is the first published article on SCRAM technology that provides an overview of the field trail conducted in 2003.
- 19 participants wore the bracelet for total of 733 days / avg of 39 days.
- Feedback from the trail was used to evolve device functionality and evolve reporting and software functionality.

Brobbin E, Deluca P, Hemrage S, Drummond C. *Accuracy of Wearable Transdermal Alcohol Sensors: Systematic Review.* J Med Internet Res. 2022 Apr 14;24(4):e35178. doi: 10.2196/35178. PMID: 35436239; PMCID: PMC9052024.

- The objective of the systematic review was to assess wearable transdermal alcohol sensor accuracy.
- Researchers identified and analyzed 32 studies.
- The lack of consistency in the studies on wearable transdermal alcohol sensor accuracy regarding study procedures and analyses of findings, make it difficult to draw direct comparisons between them.
- Although there is some preliminary evidence suggesting the accuracy of these devices, this needs to be further investigated in clinical populations.

Dougherty D., Charles N., Acheson A., John S., Furr R.M. & Hill-Kapturczak N. (2012). *Comparing the Detection of Transdermal and Breath Alcohol Concentrations During Periods of Alcohol Consumption Ranging From Moderate Drinking to Binge Drinking.* Experimental and Clinical Psychopharmacology. V. 20(5):373-381.

- This research compares SCRAM transdermal alcohol concentration (TAC) reading to breath alcohol concentration (BrAC) readings in 22 adults consuming alcohol ranging from moderate drinking to binge drinking.
- They conclude that SCRAM TAC data is reliably related to alcohol consumption and would be an appropriate substitute in research and clinical contexts where BrAC readings are typically used.
- They were able to determine a cutoff point for peak TAC data that could reliably predict whether a participant had engaged in moderate or more than moderate drinking.
- They also state that the technology has the potential to revolutionize the treatment of alcohol use disorders by more effectively monitoring consumption.
- Note that the 12.34% false-positive rate referenced on page 6 comes from the NHTSA/PIRE study and is based on a hypothetical "virtual experiment" (reference Marques, Evaluating

Transdermal Alcohol Monitoring Devices – Final Report (DOT HS 810 875) for further explanation).

Dougherty, D. M., Hill-Kapturczak, N., Liang, Y., Karns, T. E., Cates, S. E., Lake, S. L., & Roache, J. D. (2014). Use of continuous transdermal alcohol monitoring during a contingency management procedure to reduce excessive alcohol use. *Drug and alcohol dependence*, 142, 301-306.

<https://doi.org/10.1016/j.drugalcdep.2014.06.039>

- This study examined the effectiveness of using SCRAM monitoring as a continuous measure of alcohol use to implement financial contingencies to reduce heavy drinking.
- Twenty-six male and female drinkers were assigned to one of the two treatment sequences, and when under contingency management conditions, participants were paid each week when SCRAM identified no heavy drinking days.
- Participants under contingency management conditions had fewer drinking episodes and reduced frequencies of heavy drinking.
- The researchers concluded that SCRAM monitoring can be used to implement contingency management programs to reduce excessive alcohol consumption and that SCRAM data can be used as feedback to educate problem drinkers, by concretely demonstrating their alcohol consumption and motivating behavior change.

Dougherty, D., Hill-Kapturczak, N., Liang, Y., Karns, T., Lake, S., Cates, S., & Roache, J. (2015a) *The Potential Clinical Utility of Transdermal Alcohol Monitoring Data to Estimate the Number of Alcohol Drinks Consumed*. *Addiction Disorder & Their Treatment* 14:124-130.

- Transdermal alcohol monitoring is used extensively to identify whether individuals have violated court-ordered mandates to abstain from drinking.
- Despite widespread use in that setting, comparatively few studies have explored the clinical utility of transdermal alcohol monitoring.
- Here, we explore how transdermal alcohol monitoring data can be used to estimate more clinically meaningful parameters relevant to clinical treatment programs.

Dougherty, D., Karns, T., Mullen, J., Liang, Y., Lake, S., Roache, D., & Hill-Kapturczak, N. (2015b) *Transdermal Alcohol Concentration Data Collected During a Contingency Management Program to Reduce At-Risk Drinking*. *Drug & Alcohol Dependence*. V. 148:77-84.

- Recently, we demonstrated that transdermal alcohol monitors could be used in a contingency management procedure to reduce problematic drinking; the frequency of self-reported heavy/moderate drinking days decreased and days of no to low drinking increased. These effects persisted for three months after intervention.
- In the current report, we used the transdermal alcohol concentration (TAC) data collected prior to and during the contingency management procedure to provide a detailed characterization of objectively measured alcohol use.
- TAC data indicated that episodes of heavy drinking days during the Contingency Management phase were reduced and episodes of no drinking and low to moderate drinking increased.
- These results lend further support for linking transdermal alcohol monitoring with contingency management interventions. Collectively, studies to date indicate that interventions like these may be useful for both abstinence and moderation-based programs.

Fairbairn, C., & Kang, D. (Accepted/In press). *Temporal Dynamics of Transdermal Alcohol Concentration Measured via New-Generation Wrist-Worn Biosensor*. *Alcoholism: Clinical and Experimental Research*. <https://doi.org/10.1111/acer.14172>

- The research examined the lag time between BAC and TAC using a prototype of BACtrack Skyn—a new-generation wrist-worn transdermal sensor featuring a compact design and smartphone integration—and SCRAM CAM.
- Device failure rates for Skyn prototypes were relatively high (18 to 38%) compared with SCRAM CAM devices (2%).
- Both Skyn- and SCRAM-measured TAC showed strong correlations with BrAC, and both Skyn and SCRAM devices detected alcohol within 30 minutes of first alcohol administration.
- Skyn TAC peaked 1 hour earlier than SCRAM TAC, and time-series models suggested that Skyn TAC lagged behind BrAC by 24 minutes, whereas SCRAM TAC lagged behind BrAC by 69 minutes.
- Results provide preliminary evidence for the validity of a new-generation wrist-worn transdermal sensor under controlled laboratory despite high failure rates.

Fairbairn CE, Kang D, Bosch N. *Using machine learning for real-time BAC estimation from a new-generation transdermal biosensor in the laboratory*. *Drug Alcohol Depend*. 2020 Nov 1;216:108205. doi: 10.1016/j.drugalcdep.2020.108205. Epub 2020 Aug 1. PMID: 32853998; PMCID: PMC7606553.

- Participants wore transdermal sensors while providing repeated breathalyzer (BrAC) readings.
- Researchers assessed the association between BrAC at a specific time point and eBrAC estimated based on transdermal readings collected immediately preceding time interval.
- Extra-Trees machine learning algorithms, incorporating transdermal time series features as predictors, were used to create eBrAC.
- Failure rates for the new-generation prototype sensor were high (16 %-34 %).
- Differences between eBrAC and BrAC were 60 % higher for models based on data from old-generation vs new-generation devices.
- Model comparisons indicated that both time series analysis and machine learning contributed significantly to final model accuracy.
- Results provide favorable preliminary evidence for the accuracy of real-time BAC estimates from a new-generation sensor.

Fairbairn C., Rosen I., Luczak, S., & Venerable W. (2018) *Estimating the Quantity and Time Course of Alcohol Consumption from Transdermal Alcohol Sensor Data: A Combined Laboratory-Ambulatory Study*, *Alcohol* doi: 10.1016/j.alcohol.2018.08.015 .

- Transdermal alcohol sensors offer enormous promise for the continuous, objective assessment of alcohol use.
- Using data from a combined laboratory-ambulatory study, the current research aims to examine the validity of recently developed methods for estimating BrAC directly from transdermal data.
- Results indicate strong associations between daily self-reports of drinking quantity and estimates of BrAC derived from transdermal sensors.
- Results offer promise for novel methods of estimating BrAC from transdermal data, including those taking a nomothetic (population-based) approach to this estimation, thus potentially adding to our arsenal of techniques for understanding, diagnosing, and ultimately treating alcohol use disorder.

Fairbairn, Catharine E., Kang, Dahyeon, Chapter 24 - Transdermal alcohol monitors: Research, applications, and future directions, Editor(s): Daniel Frings, Ian P. Albery, *The Handbook of Alcohol Use*, Academic Press, 2021, Pages 551-562, ISBN 9780128167205, <https://doi.org/10.1016/B978-0-12-816720-5.00014-1>.

- At the present time, transdermal alcohol monitors represent the technology that offers the greatest promise for a wearable alcohol biosensor.
- Transdermal alcohol sensors are currently used mainly as abstinence monitors, in which capacity they have proven useful within the criminal justice system, alcohol intervention programs, and also within some basic alcohol research.
- The relationship between transdermal alcohol concentration (TAC), as measured by these devices, and continuous blood alcohol concentration (BAC) is complex, likely varying based on individual and also contextual factors and also involving some degree of lag.
- The authors provide a brief review of the human subjects studies conducted to date examining the BAC-TAC relationship, provide directions for future research, and also consider future applications of transdermal alcohol monitors.

Flango V., & Cheesman F. (2009) *Effectiveness of the SCRAM Alcohol Monitoring Device: A Preliminary Test. Drug Court Review. VI(2): 109-134.*

- The National Center for State Courts (NCSC) researched how use of SCRAM affects recidivism.
- The probability of recidivism for a sample of convicted driving while impaired (DWI) offenders ordered to use SCRAM was compared to that of a matched sample of non-SCRAM-using DWI offenders and found to be lower both while wearing SCRAM and after SCRAM was removed.
- Offenders that wore SCRAM for more than 90 days recidivated at half the rate of offenders that wore SCRAM for less than 90 days.
- They conclude that SCRAM is a proven alternative to incarceration and traditional sentencing sanctions because it not only deters recidivism (behavior suppression) while on the ankle, but when used in combination with treatment, SCRAM modified behavior.

Gunn RL, Steingrimsson JA, Merrill JE, Souza T, Barnett N. Characterising patterns of alcohol use among heavy drinkers: A cluster analysis utilising alcohol biosensor data. *Drug Alcohol Rev.* 2021 Nov;40(7):1155-1164. doi: 10.1111/dar.13306. Epub 2021 May 14. PMID: 33987927.

- The study's aim is to characterise drinking episodes using data derived from a wearable alcohol biosensor.
- Cluster analysis was used to evaluate unique combinations of alcohol episode characteristics.
- Associations between clusters and self-reported person and event-level factors were also examined in univariable and multivariable models.
- Results suggested three unique clusters:
 - Cluster 1 (most common, slowest rate of rise to and decline from peak)
 - Cluster 2 (highest peak transdermal alcohol concentration and area under the curve)
 - Cluster 3 (fastest rate of decline from peak).
- Univariable analyses distinguished Cluster 1 as having fewer self-reported drinks and fewer episodes that occurred on weekends relative to Cluster 2.

- Results suggest that it is possible to distinguish drinking episodes based on several characteristics derived from wearable alcohol biosensors.

Hawthorne, J. S., & Wojcik, M. H. (2006). Transdermal alcohol measurement: A review of the literature. *Canadian Society of Forensic Science Journal*, 39(2), 65-71.

<https://doi.org/10.1080/00085030.2006.10757138>

- Published research in this field, one can conclude that measuring alcohol transdermally on a constant basis provides an effective screen for alcohol consumption and a reasonable approximation of the magnitude of that consumption.
- Key findings include a correlation of TAC to BRAC and a transdermal delay or lag exists due to the nature of transdermal alcohol emission from the human body.

Hill-Kapturczak, N., Lake, S., Roache, J., Cates, S., Liang Y, Dougherty DM (2014) Do Variable Rates of Alcohol Drinking Alter the Ability to Use Transdermal Alcohol Monitors to Estimate Peak Breath Alcohol and Total Number of Drinks? *Alc Clin Exp Res* 38:2517-2522

- Transdermal alcohol monitoring is a noninvasive method that continuously gathers transdermal alcohol concentrations (TAC) in real time; thus, its use is becoming increasingly more common in alcohol research. In previous studies, we developed models that use TAC data to estimate peak breath alcohol concentration (BrAC) and standard units consumed when the rate of consumption was tightly controlled.
- While there was considerable variation in the times it took to consume each beer, key TAC parameters were not affected by pace of drinking. TAC data were then used in combination with the previously derived equations and estimated peak BrAC and standard units of alcohol consumed.
- Transdermal alcohol monitoring can be used to reliably estimate peak BrAC and standard number of units consumed regardless of the rate of consumption, further demonstrating its usefulness in clinical research.

Hill-Kapturczak, N., Roache, J. D., Liang, Y., Karns, T. E., Cates, S. E., & Dougherty, D. M. (2015). Accounting for sex-related differences in the estimation of breath alcohol concentrations using transdermal alcohol monitoring. *Psychopharmacology*, 232(1), 115-123.

<https://doi.org/10.1007/s00213-014-3644-9>

- This study used SCRAM to characterize differences in the relationship between BrAC and TAC between men and women.
- Eleven men and ten women consumed a varying number of beers on different days.
- Peak BrAC levels were significantly higher in women than men, but sex differences were not significant in observed TAC levels.
- Positive TAC readings were recorded for all participants when two or more beers were consumed, but in a substantial percentage of cases (38%) in which only one beer was consumed, no positive TAC readings were recorded.
- They also observed an overall average lag time between peak BrAC and peak TAC of 129 minutes, and that the time lag was an increasing function of the number of beers.
- The relationship between peak TAC and actual peak BrAC differs between men and women, and these differences can be accounted for in a statistical model to better estimate peak BrAC.

Karns-Wright, T. E., Dougherty, D. M., Hill-Kapturczak, N., Mathias, C. W., & Roache, J. D. (2018). The correspondence between transdermal alcohol monitoring and daily self-reported alcohol consumption. *Addictive behaviors*, 85, 147-152. <https://doi.org/10.1016/j.addbeh.2018.06.006>

- Transdermal alcohol monitoring can passively and continuously measure alcohol consumption with minimal interference in daily life.
- The current study examines the correspondence between daily self-reported alcohol consumption and transdermal alcohol monitors.
- Thirty-two healthy men ($n = 16$) and women ($n = 16$) wore a transdermal alcohol monitor for 28 days
- The correspondence between self-reported drinking and transdermal concentrations tended to be good:
- Self-reported drinking was reported for 324 days, TAC detected drinking at 212 days (65.4%)
- Self-reported not drinking was reported for 399 days and zero TAC was reported 366 days (92%)

Karns-Wright TE, Roache JD, Hill-Kapturczak N, Liang Y, Mullen J, Dougherty DM (2017) Time delays in transdermal alcohol concentrations relative to breath alcohol concentrations. *Alcohol Alcohol* 52:35-41.

- Monitors of transdermal alcohol concentration (TAC) provide an objective measurement of alcohol consumption that is less invasive than measurements in blood, breath or urine; however, there is a substantial time delay in the onset of TAC compared to blood or breath alcohol concentrations (BrACs). The current study examined the characteristics of the delay between peak TAC and peak BrAC.
- The times-to-peak were an increasing function of the number of beers consumed. At each level of beer consumption the peak TAC averaged lower than peak BrAC and times-to-peak TAC were longer than for BrAC. The time-to-peak BrAC and TAC was longer for women than men. The congruence between peak TAC and BrAC increased as a function of the beers consumed. No sex difference in the time lag between peak BrAC and TAC was detected.
- The congruence between TAC and BrAC and time lags between TAC and BrAC are related to the number of beers consumed. Peak values of TAC and BrAC became more congruent with higher doses but the time lag increased as a function of the amount of alcohol consumed.

Kilmer, Beau & Midgette, Greg. (2020). Criminal Deterrence: Evidence from an Individual-level Analysis of 24/7 Sobriety. 10.7249/WR1190-2.

- This paper evaluates South Dakota's 24/7 Sobriety Program—a novel, large-scale intervention requiring those arrested for or convicted of an alcohol-related offense to abstain from alcohol and submit to alcohol tests multiple times daily.
- The data suggest that the individual-level probability of rearrest or probation revocation is 49% lower for 24/7 participants than nonparticipants 12 months after their DUI arrest.
- These findings provide support for “swift-certain-fair” approaches to applying sanctions in community supervision.

Kilmer B., Nicosia N., Heaton P. and Midgette G. Efficacy of Frequent Monitoring With Swift, Certain, and Modest Sanctions for Violations: Insights From South Dakota's 24/7 Sobriety Project. *Am J Public Health*. 2013;103(1):e36–e42. Published online ahead of print November 15, 2012.

- Researchers examined the public health impact of South Dakota's 24/7 Sobriety Project, which includes use of SCRAM for alcohol monitoring.
- Between 2005 and 2010, more than 17,000 residents of South Dakota, including more than 10% of men aged 18 to 40 years in some counties, had participated in the 24/7 program. At the county level, they documented a 12% reduction in repeat DUI arrests and a 9% reduction in domestic violence arrests following adoption of the program.
- Researchers concluded that in community supervision settings, and frequent alcohol testing with swift, certain, and modest sanctions for violations can reduce problem drinking and improve public health outcomes.

Leffingwell, T.R., Cooney, N.J., Murphy, J.G., Luczak, S., Rosen, G., Dougherty, D.M., & Barnett, N.P. (2013). Continuous Objective Monitoring of Alcohol Use: Twenty-First Century Measurement Using Transdermal Sensors. *Alcoholism: Clinical & Experimental Research*, 37(1), 16-22.

- This is a review article that summarizes the research around TAC devices, specifically SCRAM and a wrist monitor called WrisTAS.
- It first looked at how well TAC readings can correlate with BrAC readings. Much of the research shows that TAC readings are good indicators of drinking episodes, duration, and quantity of alcohol consumed. This also extends to the software that estimates BrAC and correlates it with TAC readings.
- They then analyzed how the use of TAC, when paired with contingency management of monetary values, influenced drinking habits. All studies found that this pairing reduced subjects' drinking frequency and quantity. However, when the implementation of SCRAM was not paired with contingency monitoring, there was not as large of an effect.
- The article concludes that the use of TAC monitoring could be very useful in clinical settings, both for people with alcohol use issues, and for people with other substance use issues.

Luczak, S.E., Hawkins, A.L., Dai, Z., Wichmann, R., Wang, C., & Rosen, I.G. (2018). Obtaining continuous BrAC/BAC estimates in the field: A hybrid system integrating transdermal alcohol biosensor, Intellidrink smartphone app, and BrAC Estimator software tools. *Addictive Behaviors*, 83, 48-55.

- This study was done to test software that these researchers have developed that converts transdermal alcohol monitoring data to breath alcohol concentrations. This software has been developed in order to solve the issue that transdermal alcohol concentration data does not relate to breath alcohol or blood alcohol concentrations across individuals, devices, or environmental conditions
- This study focused on using a drinking diary of standard drinks from subjects to calculate the BrAC with proven-calculation models. These calculations were compared to results from a breath analyzer in the laboratory.
- It was found that The BrAC calculated data was relatively similar to the data that was collected using the software in the lab. This proves that this hybrid data collection method can be a good alternative for calibrating the software to everyone. It makes it less of a burden for the individuals using the TAC device, as well as the researchers.

Luczak SE, Rosen IG (2014) Estimating BrAC from transdermal alcohol concentration data using the BrAC estimator software program. *Alcohol Clin Exp Res* 38:2243-2252.

- Transdermal alcohol sensor (TAS) devices have the potential to allow researchers and clinicians to unobtrusively collect naturalistic drinking data for weeks at a time, but the transdermal alcohol concentration (TAC) data these devices produce do not consistently correspond with breath alcohol concentration (BrAC) data. We present and test the BrAC Estimator software, a program designed to produce individualized estimates of BrAC from TAC data by fitting mathematical models to a specific person wearing a specific TAS device.
- In this single-subject design with breath analyzer peak BrAC scores ranging from 0.013 to 0.057, the software created consistent models for the 2 TAS devices, despite differences in raw TAC data, and was able to compensate for the attenuation of peak BrAC and latency of the time of peak BrAC that are typically observed in TAC data.
- This software program represents an important initial step for making it possible for non-mathematician researchers and clinicians to obtain estimates of BrAC from TAC data in naturalistic drinking environments.

Marques P.R. and McKnight A.S. Field and Laboratory Alcohol Detection With 2 Types Of Transdermal Devices. Alcohol Clin Exp Res. 2009 Apr;33(4):703-11.

- The National Highway Traffic Safety Administration (NHTSA) conducted research to evaluate the accuracy and precision of two types of electrochemical transdermal alcohol detection devices, one of which was SCRAM. They contracted with the Pacific Institute for Research and Evaluation (PIRE) to conduct this multi-year study beginning in 2004.
- SCRAM was worn by 22 paid research subjects for a combined total of 96 weeks.
- SCRAM detected 88% of drinking episodes with BACs of 0.080, or higher and 57% of all drinking events of 0.020 or higher.
- They concluded that the circumvention system “performed well” and it “seems unlikely that circumvention by obstruction can constitute a real threat to the integrity of this system while drinking.”
- They noted that SCRAM reads all alcohol it is exposed to, regardless of source, but stated that there were “no false positives of any note” with SCRAM, as there were no incidents where these events generated a TAC curve that would have been mistaken for a drinking event.
- The researchers also said that two wearers indicated that the device “helped goad them toward sobriety in a way that other motivators were unable to do.”
- Overall, the researchers noted, “there is no doubt that the transdermal concept is valid as long as expectations of quantitative parity with BAC are moderated”
- It is important to understand that the researchers examined first generation SCRAM devices, which were prone to moisture accumulation issues that have since been corrected. This issue caused SCRAM to read lower over time during the research period.
- Also, in the section on “Rule-Based Sensitivity Analysis,” the researchers report a false positive of 12.34% using a 0.020 TAC cut-off (p 36). It is critical to understand that this false positive rate is based on a theoretical algorithm the researchers developed as part of a “virtual experiment,” and is not the false positive rate seen in the actual field and laboratory testing, which was 0. In fact, the researchers plainly state, “Because we found no false positives of any note, the key question ... concerns the false negative rate” (p 23).
 - The researchers state that, “the concept of false positives has two different meanings with transdermal detection: 1) ... those [with TAC curves] that look like drinking events..., and 2)

- ... those that can cause a transdermal response [i.e. any discrete TAC reading, regardless of the curve that it forms.]”
- For their theoretical algorithm they use the second definition, and describe how it is different than the AMS alert criteria (pp 33-37).
 - They explicitly state that this calculated rate of false positives does not represent the actual false positive rate, as it counts every elevated TAC reading that does not occur when somebody is actually drinking as a false positive.
 - This includes elevated TAC readings that continue after the person stopped consuming alcohol, as well as elevated TAC readings that do not create a confirmable TAC curve per the AMS alert criteria.
 - For example, if a person’s TAC curve continued beyond their BrAC curve (which is expected) and they had 10 elevated TAC readings after their BrAC returned to zero, they counted this as 10 false positives. If a person had an individual “spike” for a TAC reading, which would never be confirmed as drinking and in fact would not even generate an alert, they counted it as a false positive.
 - The entire purpose of this section of the report was to determine if the concept of alert analysis and confirmation criteria could be eliminated, and simply have the computer report drinking every time it saw a TAC reading above 0.020.

Mathias, C. W., Hill-Kapturczak, N., Karns-Wright, T. E., Mullen, J., Roache, J. D., Fell, J. C., & Dougherty, D. M. (2018). Translating transdermal alcohol monitoring procedures for contingency management among adults recently arrested for DWI. *Addictive behaviors*, 83, 56-63.

<https://doi.org/10.1016/j.addbeh.2018.01.033>

- This article describes the quality improvement process aimed at adapting TAC-informed CM aimed at minimizing alcohol use and maximizing treatment completion
- Participants completed a screening, brief intervention, and referral to treatment; those with high risk alcohol histories were enrolled in an 8-week CM procedure to avoid TAC readings.
- Across four PDSA cycles, the retention for the full 8-weeks of treatment was increased.
- The proportion of weeks with alcohol use was not decreased across cycles, the peak TAC values observed during drinking weeks were significantly lower in Cycles 1 and 4 than 3.

Mathias CW, Hill-Kapturczak N, Karns-Wright TE, Mullen J, Roache, JD, Fell JC, Dougherty DM. (2018) Translating transdermal alcohol monitoring procedures for contingency management among adults with DWI. *Addictive Behaviors* 83:56-63.

- Recent developments in alcohol monitoring devices have made it more feasible to use contingency management (CM) procedures to reduce alcohol use.
- A growing body of literature is demonstrating the effectiveness of CM to reduce alcohol use among community recruited adults wearing transdermal alcohol concentration (TAC) monitoring devices.
- This article describes the quality improvement process aimed at adapting TAC-informed CM aimed at minimizing alcohol use and maximizing treatment completion. This extends literature to a high-risk population; adults arrested and awaiting trial (pretrial) for criminal charge of driving while intoxicated (DWI).

- CM may be developed as a tool for pretrial supervision to be used to increase bond compliance of those arrested for DWI and for others as a method to identify the need for additional judicial services.

Midgette, G., Kilmer, B., Nicosia, N. et al. A Natural Experiment to Test the Effect of Sanction Certainty and Celerity on Substance-Impaired Driving: North Dakota's 24/7 Sobriety Program. *J Quant Criminol* (2020). <https://doi.org/10.1007/s10940-020-09458-6>.

- This research evaluates the deterrent effect of the North Dakota 24/7 Sobriety Program that increases the certainty and celerity of sanction for arrestees ordered to abstain from alcohol and other drugs on substance-impaired driving arrests.
- Participants were monitored for alcohol in North Dakota for just over 1.1 million days between 2008 and 2015.
- Over 95% of breathalyzer tests were taken and passed; and, among violations, missed tests were four times as common as positive tests.
- Over half of participants never tested positive via breathalyzer (53.5%) and two-thirds of CAM participants (67.4%) completed the program without a confirmed violation.
- Monitoring via CAM was more common in North Dakota than South Dakota (62% of monitoring days vs 30%).
- The 24/7 Sobriety Program is associated with a 9% reduction in substance-impaired driving arrests at the county level after accounting for the impact of oil exploration in the Bakken region, law enforcement intensity, alcohol availability, whether the state's large universities were in session, and socio-demographic characteristics.
- The results suggest frequent monitoring combined with increased sanction celerity deters substance use-involved crime.

Mun EY, Li X, Businelle MS, Hébert ET, Tan Z, Barnett NP, Walters ST. Ecological Momentary Assessment of Alcohol Consumption and Its Concordance with Transdermal Alcohol Detection and Timeline Follow-Back Self-report Among Adults Experiencing Homelessness. *Alcohol Clin Exp Res*. 2021 Apr;45(4):864-876. doi: 10.1111/acer.14571. Epub 2021 Mar 3. PMID: 33583057; PMCID: PMC8252787.

- Studies of alcohol use presume valid assessment measures. To evaluate this presumption, we examined the concordance of alcohol use as measured by ecological momentary assessment (EMA) self-reports, transdermal alcohol concentration readings via SCRAM, and retrospective self-reports via the Timeline Follow-Back (TLFB) among adults experiencing homelessness.
- Forty-nine adults who reported alcohol misuse were recruited from a homeless shelter, and alcohol use was assessed: (i) 5 times or more per day by EMA, (ii) every 30 minutes by a SCRAM device, and (iii) by TLFB for the past month at the end of the study period.
- For alcohol use intensity, EMA and SCRAM resulted in statistically significant correlations. The concordance of TLFB with either EMA or SCRAM was weak, especially at the day level.
- The results show that EMA is a valid approach to quantifying alcohol use, especially given its relatively low cost, low participant burden, and ease of use.

Neville, F. G., Williams, D. J., Goodall, C. A., Murer, J. S., & Donnelly, P. D. (2013). An experimental trial exploring the impact of continuous transdermal alcohol monitoring upon alcohol consumption in a cohort of male students. *PLoS One*, 8(6), e67386. <https://doi.org/10.1371/journal.pone.0067386>

- Researchers at the University of St. Andrews School of Medicine examined the impact of SCRAM monitoring upon alcohol consumption in male students.
- 60 male university students were randomly allocated into three experimental conditions. Two of those conditions included wearing a SCRAM bracelet. Alcohol consumption was measured through alcohol timeline follow-back, and using data collected from SCRAM.
- Participants self-reported 96 incidents of alcohol consumption, and 71 (74%) of these were confirmed as drinking events on SCRAM. Unconfirmed self-report alcohol consumption events were typically incidents in which participants drank a relatively small quantity of alcohol over an extended period, or consumed while eating food.
- Alcohol consumption during the 14-day trial decreased significantly for both participants who were only asked not to drink and those who were asked not to drink and who wore SCRAM. But significantly fewer participants who wore SCRAM drank alcohol.
- Possible reasons for this difference identified from the focus groups and diaries included the anklet acting as a reminder of commitment to the study (and the agreement to sobriety), participants feeling under surveillance, and the use of the anklet as a tool to resist social pressure to consume alcohol.
- The study demonstrated ways in which the technology may be supportive in facilitating sobriety. Results from the study have been used to design a research project using continuous transdermal alcohol monitors with ex-offenders who recognize a link between their alcohol consumption and offending behavior.

N. Nicosia, B. Kilmer, & P. Heaton. Can a criminal justice intervention improve public health? Assessing the effect of 24/7 Sobriety program on alcohol-related mortality. *The Lancet Psychiatry*.

- This research estimated the association between the South Dakota 24/7 Sobriety Program and county-level mortality between January 2005 and June 2011, during which time 16,932 people (about 3% of the adult population) participated in the program.
- The analysis indicated that the 24/7 Program was associated with a 4.2% reduction in all-cause adult mortality, with the largest associations among women and individuals older than 40 years.
- The 24/7 Sobriety Program might have public health benefits that could extend beyond individuals directly enrolled in the program.
- This negative association between the 24/7 Sobriety Program and mortality rates represents a substantial advance in the understanding of how criminal justice interventions could help shape public health policy.

Rash C.J., Petry N.M., Alessi S.M. & Barnett N.P., Monitoring Alcohol Use in Heavy Drinking Soup Kitchen Attendees, *Alcohol* (2018), <https://doi.org/10.1016/j.alcohol.2018.10.001>.

- Rates of heavy alcohol use in soup kitchen attendees range from 30% to 38%, but these data are based entirely on self-reported drinking. Little is known about the intensity or frequency of drinking in this population.
- We assessed alcohol use transdermally every 30 minutes over a 3-week period among heavy drinkers who attended local soup kitchens. In addition to transdermal alcohol monitoring, participants were randomly assigned to daily breath alcohol monitoring with or without reinforcement for alcohol-negative breath samples (BrAC).
- Nineteen participants completed the 21-day monitoring period in full; three persons removed the anklet 3-16 days early due to hospitalization, impending hospitalization, or incarceration.

- When using BrAC, transdermal, and self-report data, the percentage of non-drinking days was 93%, 58%, and 57% and the longest duration of consecutive non-drinking days averaged 10.3, 7.2, and 5.7 days, respectively.
- These data suggest that transdermal monitors are well tolerated and documented substantial heavy drinking in this population. Soup kitchens users are in need of alcohol interventions, and soup kitchens may represent a novel opportunistic setting for intervention delivery for an important and growing health disparities population.

Richards VL, Liu Y, Orr J, Leeman RF, Barnett NP, Bryant K, Cook RL, Wang Y. Sociodemographic and clinical factors associated with transdermal alcohol concentration from the SCRAM biosensor among persons living with and without HIV. Alcohol Clin Exp Res. 2021 Sep;45(9):1804-1811. doi: 10.1111/acer.14665. Epub 2021 Aug 2. PMID: 34342009; PMCID: PMC8526382.

- Transdermal alcohol biosensors can objectively monitor alcohol use by measuring transdermal alcohol concentration (TAC). However, it is unclear how sociodemographic and clinical factors that influence alcohol metabolism are associated with TAC.
- The aim of this study was to examine how sociodemographic factors (sex, age, race/ethnicity) and clinical factors (body mass index, liver enzymes: alanine aminotransferase [ALT] and aspartate transaminase [AST]), alcohol use disorder, and HIV status) were associated with TAC while controlling for level of alcohol use.
- Researchers analyzed data from a prospective study involving contingency management for alcohol cessation among persons living with and without human immunodeficiency virus (HIV) that used the SCRAM biosensor.
- HIV status was not independently associated with TAC. Future studies should consider the sex and liver function of the participant when using alcohol biosensors to measure alcohol use.

Roache, J. D., Karns, T. E., Hill-Kapturczak, N., Mullen, J., Liang, Y., Lamb, R. J., & Dougherty, D. M. (2015). Using transdermal alcohol monitoring to detect low-level drinking. *Alcoholism: Clinical and Experimental Research*, 39(7), 1120-1127. <https://doi.org/10.1111/acer.12750>

- Several studies have objectively quantified drinking through the use of SCRAM CAM.
- Criteria that AMS uses to detect drinking are known to be conservative and only reliably detect heavy drinking equivalent to 5 or more standard drinks.
- The group has developed Research Rules used to process TAC data in a manner that will detect low-level and moderate drinking even though it is below the AMS criteria for detection.
- We observed 606 occurrences of positive TAC events over a total of 867 days and processed the TAC data to retain 345 as possible drinking events even though AMS criteria confirmed drinking for only 163 of these events. The kinds of TAC events removed or retained by our Rules are illustrated as are cases of low and moderate drinking days that were detected by our rules but not by the conservative AMS criteria. AMS Confirmed TAC events have a high specificity (99.8%) to detect primarily heavy drinking, but have a poor sensitivity to detect lower level drinking and a poor specificity as an indicator of alcohol abstinence. In contrast, our Research Rules detected 100% of TAC events detected by AMS but also detected 31% of the lower-level drinking events not detected by AMS with 91% specificity.
- Reliance upon the AMS criteria for alcohol detection affords a high specificity for detection of heavy drinking but is a poor indicator of abstinence rates. In contrast use of our Research Rules

provides more sensitive means to quantify either any drinking or low-moderate levels of drinking while still maintaining good specificity.

Roache J.D., Karns T.E., Hill-Kapturczak N., Mullen J., Liang Y., Lamb R.J. and Dougherty D.M. Using Transdermal Alcohol Monitoring to Detect Low-Level Drinking. *Alcohol Clin. Exp. Res.* 2015 Jul;39(7):1120-7.

- This research sought to characterize the sensitivity of SCRAM to detect low-level drinking defined as the consumption of 1 to 3 beers.
- Results were analyzed from 32 male and 29 female research volunteers wearing SCRAM under controlled conditions.
- Nearly 40% of participants drinking 1 beer did not have a positive TAC reading. However, positive TAC readings were observed in more than 95 and in 100% of participants drinking 2 and 3 or more beers, respectively.
- Use of AMS standard criteria for confirming drinking events reliably detected the consumption of 5 beers, but 45.9% of all occasions of drinking 1-3 beers were unconfirmed using this criteria.
- 8 drinking events had absorption or elimination rates that exceeded AMS' confirmation criteria at the time of the research, with the highest absorption being 0.077 TAC/hour and the highest elimination being 0.055 TAC/hour.
- They concluded that lower limit of detection less than 0.020 TAC must be used to reliably detect low-level drinking of 1 to 3 standard drinks, and because of this, lack of confirmed SCRAM events may not indicate complete abstinence. They also recognized that a lower level of detection could potentially impact false positives in the real world.
- The researchers noted that AMS established conservative criteria to avoid false-positive detections when using SCRAM monitoring for court-adjudicated offenders, and that other researchers (reference Barnett) modified the criteria to make detection of alcohol drinking less conservative.

Russell, M. A., Turrisi, R. J., & Smyth, J. M. (2022). Transdermal sensor features correlate with ecological momentary assessment drinking reports and predict alcohol-related consequences in young adults' natural settings. *Alcoholism: Clinical and Experimental Research*, 46, 100– 113. <https://doi.org/10.1111/acer.14739>

- Wearable transdermal alcohol concentration (TAC) sensors passively monitor alcohol concentration in natural settings and measurement of multiple features from drinking episodes, including peak intoxication level, speed of intoxication and elimination, and duration.
- A total of 222 young adults aged 21-29 who regularly drink heavily participated in a 5-day study that included the ecological momentary assessment (EMA) of alcohol consumption (daily morning reports and participant-initiated episodic EMA sequences) and the wearing SCRAM CAM anklets.
- Day- and person-level associations of TAC features with drink counts (morning and episodic EMA) and alcohol-related consequences were tested using multilevel modeling.
- TAC features were strongly associated with morning drink reports but only moderately associated with episodic EMA drink counts at both day and person levels.
- These results support the utility of TAC sensors in studies of alcohol misuse among young adults in natural settings and outline the specific TAC features that contribute to the day-level prediction of alcohol-related consequences.

Sakai, J. T., Mikulich-Gilbertson, S. K., Long, R. J., & Crowley, T. J. (2006). Validity of transdermal alcohol monitoring: fixed and self-regulated dosing. *Alcoholism: Clinical and experimental research*, 30(1), 26-33. <https://doi.org/10.1111/j.1530-0277.2006.00004.x>

- The researchers conducted a laboratory study involving 24 subjects on the SCRAM device.
- SCRAM consistently detected consumption of approximately two standard drinks. There were no false negatives.
- 80 samples were collected from no-dose subjects. Each time SCRAM reported a TAC of 0.000. There were no false positives.
- TAC curves were right-shifted relative to BrAC curves, and TAC peaks were lower than BrAC peaks.
- SCRAM reliably differentiated between low dose and high dose drinkers
- Twenty others wore the bracelet in the community for 8 days, kept a drinking log and provided a BrAC sample each day. All individuals who reported drinking during the week had positive TAC readings. The only subject who reported no drinking for the entire week had 0.000 TAC readings 98% of the time, a maximum TAC reading of 0.001, and nothing that resembled a TAC curve.
- They also concluded that the bracelet was “adequately comfortable for most users.”
- The study was primarily funded by NIDA, NIMH and NIH, but AMS also contributed to the costs of the study. However, “by contract, the researchers were free to publish any results without prior approval by company representatives,” and the Colorado Multiple Institutional Review Board and the General Clinical Research Center’s Scientific Advisory Committee approved the research protocol.

Shaw, D., McCluskey, K., Linden, W. & Goodall, C. (2012). Reducing the harmful effects of alcohol misuse: the ethics of sobriety testing in criminal justice. *Journal of Medical Ethics*, 38(11), 669-671.

- The study examined the impact of continuous transdermal alcohol monitoring upon alcohol consumption in male students at a Scottish university.
- This was the first time the SCRAM technology had been systematically analyzed outside of the United States.
- The findings from this study have informed the design of a research project exploring the use of continuous transdermal alcohol monitors to assist ex-offenders reduce recidivism.

Sirlanci M, Rosen IG, Wall TL, Luczak SE. *Applying a novel population-based model approach to estimating breath alcohol concentration (BrAC) from transdermal alcohol concentration (TAC) biosensor data*. *Alcohol*. 2019 Dec;81:117-129. doi: 10.1016/j.alcohol.2018.09.005. Epub 2018 Sep 20. PMID: 30244026; PMCID: PMC6426692.

- Researchers report on a novel mathematical framework to improve the ability to model eBrAC from TAC data that uses aggregate population data instead of individualized calibration data to determine model parameter values via a random diffusion equation.
- Based on the theoretical mathematical approach, researchers test the efficacy of this method using datasets of contemporaneous BrAC/TAC measurements obtained by (1) a single subject during multiple drinking episodes and (2) multiple subjects during single drinking episodes.

- Results indicate the population-based model is promising, with better fit within a single participant when stratifying episodes.
- This study provides initial proof-of-concept for constructing, fitting, and using a population-based model to obtain estimates and error bands for BrAC from TAC.

van Egmond K, Wright CJC, Livingston M, Kuntsche E. A parallel test of the SCRAM-CAM transdermal monitors ensuring reliability. *Drug Alcohol Rev.* 2021 Nov;40(7):1122-1130. doi: 10.1111/dar.13353. Epub 2021 Jul 7. PMID: 34235793.

- This study aims to provide further evidence of the reliability of the SCRAM-CAM testing two monitors in parallel.
- Participants received four standard drinks while wearing SCRAM-CAMs simultaneously on their left and right ankles. The SCRAM-CAMs sampled TAC every 30 minutes and participants were monitored for at least 2–3 hours after their BrAC levels reached zero. Weight and height measures were taken to calculate body mass index (BMI).
- There was a positive correlation between the TAC measurements from the left and right SCRAM-CAM, a cross-correlation model revealed that this correlation was not significantly different for sex or BMI.
- Cross-correlation models show a significant effect of BMI on the relationship between left and right peak TAC values, which may be due to outlier effects. No further effects were significant for on both peak and AUC values.
- Results show that TAC measured by SCRAM-CAMs worn on the left and right showed a good correlation, with correlations between AUC and peak TAC values considered to be fair.

Vanlaar W., Robertson R. and Simpson H. Monitoring Alcohol Use through Transdermal Alcohol Testing. *J. Offender Monitoring.* 2007; 19(2):26-28.

- The researchers concluded that after more than 70 years of research and 22 peer-reviewed studies into the science underpinning this new technology, it has been clearly established that ingested alcohol can be validly measured in perspiration through the process of transdermal alcohol testing, i.e., testing of alcohol that is excreted through the skin.
- Research studies over the past 10 years have demonstrated that transdermal alcohol readings or results are correlated to blood alcohol concentrations. There is a recognized and measurable delay in the absorption and elimination of alcohol, so simultaneous breath or blood and transdermal alcohol readings should not be expected to produce similar results at a specific point in time.
- Transdermal alcohol testing is a valid way of determining whether an individual has consumed a small, moderate, or large amount of alcohol, and is designed to be a screening device to determine alcohol use. This testing method is not designed to produce a specific blood alcohol concentration (BAC) reading.

Villalba K, Cook C, Dévieux JG, et al. Facilitators and barriers to a contingency management alcohol intervention involving a transdermal alcohol sensor. *Heliyon.* 2020;6(3):e03612. Published 2020 Mar 26. doi:10.1016/j.heliyon.2020.e03612

- The aims for the study were to (1) explore barriers and facilitators to participating in a contingency management (CM) intervention using SCRAM CAM as the potential alcohol measure for the Intervention; (2) explore levels of appropriate compensation for using the

SCRAM CAM and for study assessments as part of a CM intervention study; and (3) attitudes and beliefs on lifestyle changes as a consequence of wearing SCRAM CAM among HIV-positive and HIV-negative heavy drinkers in Florida.

- Six themes were identified as barriers and facilitators for participation in a CM intervention using SCRAM CAM to measure alcohol use: (1) health assessment, (2) monetary incentives including payment structure and levels of compensation, (3) stigma associated with wearing SCRAM CAM, (4) aesthetics and other related concerns with wearing SCRAM CAM, (5) motivation to stop drinking, and (6) social support.
- Stigma was a major barrier for wearing SCRAM CAM; however, if participants were motivated to change their behavior then the monetary incentives became a facilitator to wearing the sensor.

Wang Y., Fridberg D.J., Leeman R.F., Cook R.L. & Porges E.C., Wrist-Worn Alcohol Biosensors: Strengths, Limitations, and Future Directions, Alcohol (2018), doi: <https://doi.org/10.1016/j.alcohol.2018.08.013>.

- Recently developed wrist-worn alcohol biosensors are small, inexpensive, and may be acceptable for daily use. However, these devices are at the prototype phase and have just begun to be tested for research applications.
- In this paper, we describe our experiences with two prototypes of these new wrist-worn alcohol biosensors and their associated smartphone applications in both a controlled laboratory setting and the real-world environment.
- Preliminary experiences with these devices highlight their advantages including comfort, high participant acceptability, and good compliance.
- However, there are various limitations that should be addressed prior to future research applications of these biosensors, including large interpersonal variations in transdermal alcohol readings, lack of immediately applicable data analysis/interpretation software, and poor battery life after a few months.

Yu, J, Fairbairn, CE, Gurrieri, L, Caumiant, EP. Validating transdermal alcohol biosensors: a meta-analysis of associations between blood/breath-based measures and transdermal alcohol sensor output. *Addiction*. 2022; 1– 11. <https://doi.org/10.1111/add.15953>

- Prior studies have yielded highly variable correlations and lag times between transdermal alcohol concentration (TAC) and blood/breath alcohol concentration (BAC).
- The current review aimed to synthesize transdermal validation studies, aggregating results from more than three decades of research to characterize the validity of transdermal sensors for assessing alcohol consumption.
- Databases were searched for studies listed prior to March 1, 2022 that examined associations between transdermal alcohol sensor output and blood and breath-based alcohol measures, resulting in 31 primarily laboratory-derived participant samples.
- Analyses revealed that the average correlation between TAC and BAC was large in magnitude and TAC lagged behind BAC by an average of 95.90 minutes.
- Lag times for ankle-worn devices were approximately double those for arm/hand/wrist-worn devices, and TAC–BAC correlations also tended to be stronger for arm/hand/wrist-worn sensors.
- This meta-analysis indicates that transdermal alcohol sensors perform strongly in assessing blood/breath alcohol concentration under controlled conditions, with particular promise for the newer generation of wrist-worn devices.