

ASSESSMENT AND DETECTION

Comparing the Effectiveness of TWEAK and T-ACE in Determining Problem Drinkers in Pregnancy

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Abstract — **Aim:** The TWEAK and T-ACE screening tools are validated methods of identifying problem drinking in a pregnant population. The objective of this study was to compare the effectiveness of the TWEAK and T-ACE screening tools in identifying problem drinking using traditional cut-points (CP). **Methods:** Study participants consisted of women calling the Motherisk Alcohol Helpline for information regarding their alcohol use in pregnancy. In this cohort, concerns surrounding underreporting are not likely as women self-report their alcohol consumption. Participant's self-identification, confirmed by her amount of alcohol use, determined whether she was a problem drinker or not. The TWEAK and T-ACE tools were administered on both groups and subsequent analysis was done to determine if one tool was more effective in predicting problem drinking. **Results:** The study consisted of 75 problem and 100 non-problem drinkers. Using traditional CP, the TWEAK and T-ACE tools both performed similarly at identifying potential at-risk women (positive predictive value = 0.54), with very high sensitivity rates (100–99% and 100–93%, respectively) but poor specificity rates (36–43% and 19–34%, respectively). Upon comparison, there was no statistical difference in the effectiveness for one test performing better than next using either CP of 2 ($P = 0.66$) or CP of 3 ($P = 0.38$). **Conclusion:** Despite the lack of difference in performance, improved specificity associated with TWEAK suggests that it may be better suited to screen at-risk populations seeking advice from a helpline.

INTRODUCTION

Alcohol use during pregnancy has been identified as an issue critical to the health of mothers and babies from all socio-economic groups. Maternal drinking during pregnancy can adversely affect the foetus with effects ranging from mild cognitive impairment and impaired mental functioning to foetal alcohol syndrome, characterized by growth deficiency, central nervous system disorders and a pattern of distinct facial features (Lemoine *et al.*, 1968; Jones and Smith, 1973). The current US advice for women who are planning a pregnancy or pregnant is to completely abstain from drinking alcohol (USDHHS, 2005). However, ~14 to 22% of women have reported drinking some alcohol during pregnancy (Stratton *et al.*, 1996; Public Health Agency of Canada, 2007). This perinatal alcohol use underscores the reason that foetal alcohol spectrum disorder, a condition that is 100% preventable, remains the number one cause of mental retardation in the world today.

Health care providers play an important role influencing the health behaviours of the pregnant women in their care. Pregnant women often describe their health care providers as the best source of information and generally follow their advice (Handmaker and Wilbourne, 2001). Since no defined safe threshold of alcohol during pregnancy exists, and all women have the potential of drinking some alcohol, health care providers are advised to routinely screen all women of childbearing age to identify alcohol use in pregnancy (American College of Obstetricians and Gynecologists (ACOG), 2008; Sarkar *et al.*, 2009). Among women who drink alcohol in pregnancy, the most prevalent population fails to meet the Diagnostic and Statistical Manual of Mental Disorders, 4th Ed.(DSM IV) criteria for alcohol dependency (American Psychiatric Association (APA), 1994); instead, many of these women lead high-functioning lifestyle, are employed, educated and seek medical care upon recognizing their pregnancy (Ebrahim *et al.*, 1998). Yet they continue their alcohol consumption at levels that put

both themselves and their unborn foetus at risk. Since this prevalent population may not present with the same stereotypical symptoms seen in alcoholic patients, many women with risky drinking habits who are seen by primary care physicians often remain unrecognized and untreated. Addiction experts estimate that up to 90% of people who abuse drugs or ethanol are able to maintain their normal lifestyle (Morse *et al.*, 1997). In order to effectively identify women of childbearing age who are at risk of continuing their alcohol consumption in pregnancy, alcohol screening tools have been developed (Floyd *et al.*, 2007; Chang, 2001).

These tools are quick, inexpensive, non-invasive questionnaires and currently the best available method for detecting prenatal alcohol use (Floyd *et al.*, 2006; American College of Obstetricians and Gynecologists, 2004). With new evidence suggesting even low to moderate level of alcohol consumption may have negative long-term implications for children exposed prenatally (Sayal *et al.*, 2007; D'Onofrio *et al.*, 2007), identification of non-abusive but still risky alcohol consumption in pregnant women becomes critical. The TWEAK and T-ACE questionnaires are considered to be most effective screening tools in pregnancy as they were developed and validated for identifying alcohol use in obstetric women (Chang, 2001). Easy to administer and score, both instruments were initially adapted from CAGE and Michigan Alcohol Screening Test (MAST) tool to specifically identify at-risk drinking in pregnancy (Russell *et al.*, 1994; Sokol *et al.*, 1989). The TWEAK tool has been validated using cut-points (CP) of either two or three, depending on the population on which it is administered. While a CP score of two has been shown to be most effective in the population T-ACE was validated in. Both tools are superior than older instruments such as CAGE or MAST, as they place decreased emphasis on issues of guilt related to drinking (Russell *et al.*, 1996; Bradley *et al.*, 1998).

Given that screening questionnaires do not perform well across all populations and that health care practitioners often

The TWEAK Tool

TWEAK	QUESTIONS	Points
Tolerance	How many drinks does it take to feel the first effect? (3 or more = 2 points)	
Worry	Have close friends worried or complained about your drinking in the past year? (Yes = 2 points)	
Eye-opener	Do you sometimes take a drink in the morning when you first get up? (Yes = 1 point)	
Amnesia	Has a friend or family member ever told you about things you said or did while you were drinking that you could not remember? (Yes = 1 point)	
Cut Down	Do you sometimes feel the need to cut down on your drinking? (Yes = 1 point)	

Russell M. New assessment tools for risk drinking during pregnancy: T-ACE, TWEAK and Others. *Alcohol Health and Research World* (1994) 18 (1): 55-61

Fig. 1. The TWEAK tool.

rely on appearance to identify women at risk of using alcohol in pregnancy, more research is necessary to determine the effectiveness of screening tools among various population subgroups, due to the inherent differences that exist. Validation research on both tools was conducted in primarily minority women, from low SES, with a history of dependence and/or abuse to alcohol (Russell *et al.*, 1994; O'Connor and Whaley, 2003). As this may not represent the majority of potential at-risk pregnant women for whom clinicians routinely care for and generally fail to screen (Morse *et al.*, 1997), it is important to determine their effectiveness in such a population. The women who call the Motherisk Alcohol and Substance Use Helpline for information are representative of this target population who are educated, employed and come from various socio-economic strata (Lavi *et al.*, 2005). To our knowledge, these two screening tools have not been compared head to head in this type of pregnant population. The primary objective of our study was to ascertain the effectiveness of the TWEAK and T-ACE at identifying at-risk drinkers in this diverse population who call this helpline of their own volition. Secondly, utilizing standard cut-off points that have been validated for screening, a comparison was done to determine if one test performed better than another.

MATERIALS AND METHODS

Setting and subjects

The Motherisk Alcohol and Substance Use Helpline (+11-877-FAS-INFO) is a specialized component of the Motherisk Program, a Teratogen Information Service based at The Hospital for Sick Children in Toronto, Ontario, Canada. This national service provides evidence-based information and counselling regarding risks related to alcohol and other recreational drug use during pregnancy and lactation to health care professionals, as well as pregnant women whom they refer.

Pregnant women calling the Motherisk Helpline to report any alcohol consumption during pregnancy and at least 2 months prior were invited to participate in our study. As part

of the inclusion criteria, women had to provide all relevant information as required on the standardized intake form and complete both TWEAK and T-ACE screening questionnaires. Study enrollment began in December of 2006 and continued until November of 2007. Out of 202 eligible participants, a total of 175 women (87%) were included in the study, upon providing informed consent. This cohort provides the opportunity to conduct research with minimal concerns for underreporting as it accesses women who willingly called to self-report exposures, out of a desire to define their risk of adverse outcomes and make well-informed decisions about their pregnancy. This constitutes an optimal opportunity to test the qualities of widely used tools, such as the TWEAK and T-ACE. Subsequently, each patient was screened with both the TWEAK and the T-ACE questionnaire.

Study instruments and definitions

The TWEAK and T-ACE tools. TWEAK is a five-item scale developed originally to screen for risk drinking during pregnancy. It is an acronym for the questions below: T-Tolerance: 'How many drinks does it take to feel the first effect?' W-Worried: 'Have close friends or relatives Worried or Complained about your drinking in the past year?' E-Eye-openers: 'Do you sometimes take a drink in the morning when you first get up?' A-Amnesia (blackouts): 'Has a friend or family member ever told you about things you said or did while you were drinking that you could not remember?' K (C)-Cut down: 'Do you sometimes feel the need to Cut down on your drinking?' On the tolerance question, two points are given if a woman reports that she requires at least three or more drinks to feel the effect of alcohol. A positive response to the worry question yields two points, and positive responses to the last three questions yield 1 point each. On a seven-point scale, a woman who scores a total of two or more points is likely to be an at-risk drinker (Fig. 1).

T-ACE (Tolerance, Annoyed, Cut down, Eye-Opener) is a four-item screening tool that excludes the W-Worried and A-Amnesia questions, and instead adds a question A-annoyance: 'Have people ever annoyed you by criticizing

The TACE Tool

T-ACE	QUESTIONS	Points
Tolerance	How many drinks does it take to feel the first effect? _____	(3 or more = 2 points)
Annoyed	Have people ever annoyed you by criticizing you about your drinking?	(Yes = 1 point)
Cut down	Do you sometimes feel the need to cut down on your drinking?	(Yes = 1 point)
Eye-opener	Do you sometimes take a drink in the morning when you first get up?	(Yes = 1 point)

Sokol RJ, Martier SS, Ager JW (1989) The T-ACE questions: Practical prenatal detection of risk drinking. *American Journal of Obstetrics and Gynecology* 160(4): 863-870

Fig. 2. The T-ACE tool.

you about your drinking?' Similar to the TWEAK, a response of 'three or more drinks' on the tolerance question scores two points. A positive response to the subsequent three questions scores one point each. A total score of two or more out of five indicates risk of a drinking problem and referral for further assessment (Fig. 2).

Cut point (CP). CP refers to the score used to define a positive screen: for this study, we used a CP of three or more for the TWEAK tool, and two or more on the T-ACE.

Risk or problem drinking. 'Risk or problem drinking' is commonly used to describe non-dependent drinking which is not sufficiently severe to meet the criteria for alcohol abuse disorder, but can still result in adverse consequences for the drinker (Stratton *et al.*, 1996). As part of the standard intake, women described their daily use of alcohol in pregnancy, recalling all episodes to the best of their ability. In the context of this study, the standard criteria for risk drinking during pregnancy were defined as an average consumption of more than one standard drink (13 g ethanol) per day or occasions where ≥ 5 drinks were consumed (Hankin and Sokol, 1995). Women were also asked 'Would you consider yourself a problem drinker because you find it difficult to stop drinking alcohol?' A positive response to this denoted a problem drinker. This self-identification, further confirmed by her reported alcohol consumption meeting the risk criteria, was the gold standard against which the TWEAK and T-ACE were compared.

Study procedures

All study patients were recruited during the initial call to the Motherisk Alcohol and Substance Use Helpline. For the purpose of this study, only two specialized helpline counsellors who routinely conduct interviews and document information using the standardized intake form were used in order to reduce variability of data collection and improve consistency.

During the interview process, details pertaining to patient's medical, psychiatric and pregnancy history, including all exposures to alcohol and other recreational substances in current pregnancy, were documented. At this time, the counsellor also administered both screening questionnaires on the same patient as part of the initial intake process. Patients were given

directions for answering survey items as per published survey directions (Cohen and Vinson, 1995). In addition, the counsellor utilized cognitive interviewing techniques to improve reporting by leading patients through each day of the recall period, cueing personally memorable events to aid recall (Friedenreich, 1994). Scores were analysed using the statistical software — SPSS (version 11.0). Chi-square analysis was used to determine differences in categorical variable between women who were identified as problem drinkers using the TWEAK and T-ACE tools compared to those who were not (non-problem drinkers). Student *t*-test and/or Mann–Whitney *U*-test was used to compare continuous data such as sensitivity and specificity rates between the TWEAK and T-ACE tools. The study was approved by the Hospital for Sick Children's Research Ethics Board.

RESULTS

Of 175 women enrolled in the study, 75 met criteria for problem drinking. Demographics are summarized in Table 1 and show no differences between the groups in regard to maternal age ($P = 0.094$) and ethnicity ($P = 0.421$) between problem drinkers and others. While most women were from a Caucasian background in both groups, smaller clusters of women from Aboriginal, African-Canadians, Hispanic, South and East Asian origins were also part of this Motherisk cohort. In addressing highest education level completed and employment status, problem drinkers were similarly educated ($P = 0.084$) and no less employed than non-problem drinkers ($P = 0.141$). However, there were a significantly higher number of women categorized as problem drinkers who identified themselves as single or divorced ($P = 0.044$).

At various CP of TWEAK and T-ACE, individual scores were tabulated for each screening questionnaire and summarized in two by two contingency tables. As an example, Table 2A shows the proportion of problem drinkers and non-problem drinkers who screened positively on the TWEAK and T-ACE tool using a CP score of two or more.

At a CP of two or more, TWEAK test accurately identified all problem drinkers, as did T-ACE (i.e. 100% sensitivity (Table 3)). However, both TWEAK and T-ACE had a false pos-

Table 1. Maternal characteristics

Maternal demographics	Non-problem drinkers (n = 100)	Problem drinkers (n = 75)	Overall P-value
Maternal ethnicity			
Caucasian	57.1%	55.4%	0.421
Other	42.9%	44.6%	
Maternal education			
Grade school	18.7%	21.7%	0.064
High school	46.7%	50.8%	
College/university	34.6%	27.5%	
Maternal employment			
Employed	73.1%	68.6%	0.141
Unemployed	26.9%	31.4%	
Marital status			
Married/common law	43.3%	34.8%	0.044 ^a
Single/divorced	56.7%	65.2%	
Maternal age (years)			
Mean \pm SD	29.1 \pm 5.8	27.5 \pm 6.3	0.094

SD: standard deviation.

^aStatistical significance (P -value < 0.05).

itive rate of 64 and 81%, respectively, i.e. specificity was poor, as represented by their true negatives values (TWEAK = 36 and T-ACE = 19 women) (Table 2A). The TWEAK test had a positive predictive value (PPV) of 0.54 with a probability of positively identifying 54% of the risk drinkers, while T-ACE identified 48% of risk drinkers accurately. Statistical analysis indicated no significant differences ($P = 0.66$) between the rates of sensitivity or specificity between the TWEAK and T-ACE tests at a CP of two or more.

Table 2B shows the ability of TWEAK and T-ACE to effectively identify pregnant women at risk of continuing their alcohol use in pregnancy using a CP of three or more as a positive screen. At this slightly higher CP, the TWEAK test is still able to capture almost all risk drinkers with almost perfect sensitivity of 99% and slightly improved specificity. Similarly, T-ACE test was more effective at screening out an additional 15 non-problem drinkers, thereby improving its specificity rate (true negative = 34%). Unfortunately, this test was less sensitive at CP of three or more and missed identifying five problem drinkers (sensitivity = 93%) (Table 3).

At CP of three or more, the PPV of TWEAK remained unchanged at 0.54, while the PPV for T-ACE test improved to 0.51. However, there was still no difference in the sensitivity and specificity rate between the two tools at a CP of three or more ($P = 0.38$).

An increasing trend for specificity rates was seen as the CP used for a positive screen increased with both screening tests (Table 3). It appears that sensitivity rates for both TWEAK and T-ACE start at 100% at a CP of two or more, perfectly capturing all women with a potential for risk drinking behaviour. However, as the CP score to screen positive increases by one point, sensitivity decreases.

Table 2A. Identifying risk drinkers with TWEAK and T-ACE: CP of 2

Cut-point Threshold = 2+	TWEAK	TWEAK	T-ACE	T-ACE
	Positive	Negative	Positive	Negative
Non-problem drinkers	64 FP	36 TN	81 FP	19 TN
Problem drinkers	75 TP	0 FN	75 TP	0 FN

FP: false positive; TN: true negative; TP: true positive; FN: false negative.

Table 2B. Identifying risk drinkers with TWEAK and T-ACE: CP of 3

Cut-point Threshold = 3+	TWEAK	TWEAK	T-ACE	T-ACE N
	Positive	Negative	Positive	egative
Non-problem drinkers	63 FP	37 TN	66 FP	34 TN
Problem drinkers	74 TP	1 FN	70 TP	5 FN

FP: false positive; TN: true negative; TP: true positive; FN: false negative.

DISCUSSION

The methodological strength of this study is based on the fact that in this cohort, women made the initial contact of their own volition and provided a full account of their exposure. This completeness of data provision is unique in research involving high-risk pregnant women. In the past, women with problem drinking were found to be predominantly college-educated, employed and of high socio-economic status (Ebrahim *et al.*, 1998). The demographics of our study cohort are representative of this population and further confirm previous research that describes women most likely at risk for prenatal alcohol use.

Both TWEAK and T-ACE have been used to screen for periconception risk drinking in general household population, outpatient samples, hospital inpatients, etc. (Chan *et al.*, 1993, 1998; Russell *et al.*, 1994). This is the first study comparing the effectiveness of TWEAK and T-ACE among women who voluntarily admitted to drinking alcohol at risk levels. As a result, any inherent concerns associated with underreporting are minimal in this cohort. Moreover, to our knowledge, these two tests have not been compared in a population where women may be motivated enough to contact a health service, but still be at risk for continued alcohol use in pregnancy.

Previous data suggest that although TWEAK performed similar to T-ACE in detecting a range of drinking patterns, it performed better than T-ACE in predicting risk drinking at CP of two or more (Chang *et al.*, 1999). This was supported by our findings, with TWEAK having a trend toward better positive value compared to T-ACE. Unfortunately, at a CP of two or more, with a large number of false positives (Table 2A), a positive screen of both TWEAK and T-ACE is in itself not very accurate at identifying only risk drinkers. However the zero false negatives indicate both tests are useful in identifying all risk drinkers. In this population, T-ACE performed better at a CP of three or more (3+) (as opposed to CP of 2+) and accurately identified up to 51% of risk drinkers, without compromising sensitivity and specificity.

The TWEAK appeared to perform adequately at CP of both 2+ and 3+, identifying ~54% of prenatal risk drinkers accurately. However, upon examination of sensitivity and specificity rates, our results suggest that TWEAK using a CP of three or more performs better, without compromising sensitivity. To most effectively screen risk drinking, achieving both high sensitivity and specificity rates is ideal. However, in

Table 3. TWEAK and T-ACE: summary of sensitivity, specificity and PPV

Cut-points	TWEAK			T-ACE		
	PPV	Sensitivity	Specificity	PPV	Sensitivity	Specificity
2 or more	0.54	100	36	0.48	100	19
3 or more	0.54	99	43	0.51	93	34

PPV: positive predictive value.

a clinical setting where time is limited and consequences of an omission may be high, a test capable of capturing all potential women at risk for consuming alcohol in pregnancy may be preferable to a more specific one, particularly as specificity can improve with subsequent inquiries or tests. In the context of this study, one possible explanation for low specificity rates may be a function of women reporting their most recent alcohol consumption during pregnancy, when they may have already begun to reduce their alcohol use.

Upon comparing TWEAK and T-ACE for effectiveness in screening for problem drinking, the lack of statistical difference appears to suggest that one test is not much better than the other. A possible confounder for this may be due to the number of women in the study cohort. To address this limitation, results of this cohort were extrapolated 4-fold, and subsequently analysis still failed to detect any statistical difference between the two groups. The ability to generalize the findings also needs to be addressed. Although the nature of our study cohort adds to the strength of this study, due to their voluntary self-report of alcohol use by the participants, it is important to recognize that this forthcoming attitude may not be representative of all pregnant women, particularly at a first prenatal visit. To address this potential limitation, questions regarding alcohol could be incorporated into standard intake forms routinely used to document patient information during regular physician visit.

Pregnancy provides an ideal opportunity to educate women and their partners about the adverse effects of alcohol and the benefits of stopping its use at any time during pregnancy or postpartum. In order for the health care team to screen alcohol using women effectively, members of the team should also be educated about how to screen, the proper screening tool to use for the population in question and how to assist the woman who admits use.

CONCLUSION

Using recommended thresholds, the TWEAK and T-ACE tests are not ideal when used alone to identify problem drinking in a population of high-functioning pregnant women motivated enough to seek advice from a helpline. Both T-ACE and TWEAK tools appear to perform best at a CP of three. Despite the lack of statistical difference between the two tools with respect to test performance, improved specificity associated with TWEAK at CP of three suggests it might be better suited to identify risk drinkers more accurately in populations seeking advice from a helpline, without compromising sensitivity.

Conflict of interest statement. No conflict of interest to be declared.

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