Published in final edited form as:

Alcohol. 2017 August ; 62: 17–27. doi:10.1016/j.alcohol.2017.02.174.

A modified Timeline Followback assessment to capture alcohol exposure in pregnant women: Application in the Safe Passage Study

Kimberly Dukes, PhD^a, Tara Tripp, MA^a, Julie Petersen, MPH^a, Fay Robinson, MPH^a, Hein Odendaal, MD^b, Amy Elliott, PhD^c, Marian Willinger, PhD^d, Dale Hereld, MD, PhD^e, Cheryl Raffo, MPH^a, Hannah C. Kinney^{f,g}, Coen Groenewald, MD^b, Jyoti Angal, MPH^c, Rebecca Young, MPH^a, Larry Burd, PhD^h, and PASS Network

^aDM-STAT, Inc., One Salem Street, Suite 300, Maiden, MA 02148

^bStellenbosch University, Department of Obstetrics and Gynecology, Francie van Zijl Avenue, Tygerberg, South Africa, 7505

^cSanford Research, Center for Health Outcomes and Prevention Research, 2301 E. 60th Street North, Sioux Falls, SD 57104

^dNational Institute of Child Health and Human Development, 31 Center Drive, Building 31, Room 2A32, Bethesda, MD 20892-2425

^eNational Institute on Alcohol Abuse and Alcoholism, 5635 Fishers Lane, Rockville, MD 20852

^fBoston Children's Hospital, Department of Pathology, 300 Longwood Avenue, Boston, MA 02115

^gHarvard Medical School, 25 Shattuck Street, Boston, MA 02115

^hUniversity of North Dakota, Fetal Alcohol Syndrome Center, School of Medicine & Health Sciences, 501 North Columbia Road, Grand Forks, ND 58203-9037

Abstract

Prenatal alcohol exposure (PAE) has been linked to poor pregnancy outcomes, yet there is no recognized standard for PAE assessment, and the specific effects of quantity, frequency, and timing remain largely unknown. The Safe Passage Study was designed to investigate the role of PAE in a continuum of poor peri- and postnatal outcomes.

Address correspondence to: Kimberly Dukes, DM-STAT, Inc., One Salem Street, Maiden, MA 02148, USA, **Telephone:** + 1 781 395 4523, **Fax:** + 1 781 395 4968, Kim.Dukes@dmstat.com, or Kim.Dukes@me.com.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Disclaimer

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the Indian Health Service (IHS).

The objective of this manuscript is to describe the rationale for, and feasibility of, modifications to the traditional Timeline Followback (TLFB) for collecting PAE information in a large cohort of pregnant women. Participants from the Northern Plains region (in the United States) and Cape Town, South Africa, were followed prospectively using a modified 30-day TLFB interview, administered up to five times, to obtain detailed PAE information. Required modifications for our population included capturing information regarding sharing, type/brand, container size, and duration, in order to accurately record the amount of alcohol consumed. PAE status was defined for 99.9% of the 11,892 enrolled pregnancies at least once during pregnancy and for 92% across all trimesters. Of 53,823 drinks reported, 98% had all items necessary for standard drink computation. Sharing was reported for 74% of drinks in Cape Town, South Africa and for 10% in the Northern Plains. Compared to referent values from the traditional TLFB, 74% and 67% of drinks had different alcohol-by-volume and container size, respectively. Furthermore, a statistically significant difference was found between the number of containers reported and the number of standard drinks computed, using information from the modified TLFB. This is the first study of this size to wholly encompass all of these changes into a single measure in order to more accurately calculate daily consumption and assess patterns over time. The methods used to collect PAE information and create alcohol exposure measures likely increased the accuracy of standard drinks reported and could be generalized to other populations.

Keywords

Timeline followback (TLFB); prenatal alcohol exposure; self-report; standard drink; quantity-frequency methods

Introduction

Prevalence of Prenatal Alcohol Consumption and Risk to the Fetus

Alcohol use by pregnant women is a significant public health concern in the United States (US) and abroad, despite public-awareness campaigns and product labels warning of threats to fetal development (Chang, McNamara, Orav, & Wilkins-Haug, 2006). Prenatal alcohol exposure (PAE) has long been linked to neurodevelopmental and growth abnormalities and facial dysmorphism under the rubric of fetal alcohol spectrum disorders (Coriale et al., 2013), the most prevalent and preventable cause of intellectual disability in the US (0.5–9.1/1000) (Burd, Blair, & Dropps, 2012; Viljoen et al., 2005). The prevalence of self-reported PAE in the US between 2006 and 2010 was 8% (Centers for Disease Control and Prevention [CDC], 2012), although higher rates have been reported in American Indians in the Northern Plains (57%) (Iyasu et al., 2002), and in women of mixed ancestry in the Western Cape, South Africa (34%–51%) (May et al., 2000). However, research is limited regarding the impact of PAE early in gestation, specifically the impact to the fetus prior to pregnancy confirmation (Henderson, Gray, & Brocklehurst, 2007; Henderson, Kesmodel, & Gray, 2007; Kesmodel et al., 2012), as well as in the weeks leading up to delivery, when the fetus undergoes rapid growth and neurological development. The specific effects to the fetus of quantity, frequency, and timing (QFT) of PAE remain largely unknown, and conflicting information exists regarding the effects of low-to-moderate levels of exposure (Flak et al.,

2014; Henderson, Gray, et al., 2007; Lundsberg, Illuzzi, Belanger, Triche, & Bracken, 2015; Patra et al., 2011).

Methods to obtain PAE

Both biomarkers and self-reported assessment of alcohol consumption are used to determine PAE. *Biomarkers* such as fatty acid ethyl esters, ethyl glucuronide, and ethyl sulfate are objective, do not rely on participant veracity, and are typically obtained through maternal blood, meconium, or cord blood. Many validated *self-reported assessments* of PAE exist, and their appropriateness depends on the end goal of the research. There are brief assessments that screen for alcohol dependence (e.g., Tolerance Annoyance Cut-down Eye-opener, Cut-down Annoyed Guilty Eye-opener, Tolerance Worried Eye-opener Amnesia K[c]ut-down [Chang, 2001]) or that detect “risky” drinking behaviors (e.g., Alcohol Use Disorders Identification Test; Bohn, 1995; Saunders, 1993). A more lengthy assessment, the Timeline Followback (TLFB), developed by Sobell and Sobell (Sobell, Maisto, Sobell, & Cooper, 1979; Sobell & Sobell, 1979, 1992, 1995), is commonly used to capture the number of self-reported drinks consumed on each day during a reference period (e.g., 30 days), termed “exact recall” (Dawson, 2003). The TLFB is considered one of the most rigorous self-reported exposure assessments in research, valid for recall up to 360 days (Sobell & Sobell, 1992, 1995, 2004). The traditional TLFB includes reference materials defining standard container sizes and alcohol-by-volume (ABV) for four beverage categories (beer, wine, fortified wine, and hard liquor). Prior studies have administered the TLFB interview multiple times antenatally to characterize drinking (e.g., number of standard drinks consumed on average per day) at conception and during pregnancy (Bearer et al., 2003; Jacobson, Chiodo, Sokol, & Jacobson, 2002; Jacobson et al., 2008). A more extensive exact recall method, Form 90, captures additional information on type and size of drinks, but its complexity increases the likelihood of measurement error (Miller, 1996) and its length makes it non-ideal for many research settings.

Agreement between PAE collection methods

There are conflicting reports regarding concordance between biomarkers and self-report in PAE measurement; some studies indicate moderate to substantial agreement (Burd & Hofer, 2008; Himes et al., 2015; Joya et al., 2012; Lange, Shield, Koren, Rehm, & Popova, 2014; Littner, Cudd, O’Riordan, Cwik, & Bearer, 2008; Zelner et al., 2013), and others indicate no agreement (Derauf, Katz, & Easa, 2003). *Limitations of biomarkers* include: 1) lack of coverage throughout pregnancy because results are typically valid for short time windows; 2) specimen sensitivity to collection and storage conditions that may impede extraction of the biomarker result (e.g., necessity to freeze immediately); 3) prohibitive costs and need for specialized technicians and equipment; and 4) lack of generalizability based on willingness to participate (e.g., invasive techniques; Bakhireva & Savage, 2011; Bearer, Stoler, Cook, & Carpenter, 2004). *Limitations of self-report* include: 1) the majority of studies obtain PAE postpartum, not prospectively throughout pregnancy, potentially yielding inaccurate estimates due to long recall periods (Day, Wagener, & Taylor, 1985; Lange et al., 2014); 2) the collection of self-reported exposure during pregnancy may be biased due to concerns about confidentiality, social stigma (Sobell & Sobell, 2004), or fear the child may be taken away (Bhuvanewar, Chang, Epstein, & Stern, 2007; Lange et al., 2014); 3) the possibility of

inaccurate estimation of quantity consumed, as the participant's interpretation of a "standard" drink may differ from official guidelines (de Visser, 2015; Kerr & Stockwell, 2012); and 4) the complexity and length of assessments such as TLFB and Form 90 are not ideal for many research studies (Miller, 1996). Thus, there is no recognized standard for the assessment of PAE.

Timeline Followback Feasibility Study

Prior to the research described in this report, a feasibility study of 518 women was conducted in the target population, with one objective being to optimize the method with which alcohol exposure information would be ascertained. Non-published findings from the feasibility study indicated that women in our study population commonly reported sharing beverages and often used different container sizes than those referenced in the traditional TLFB. Further, there was a statistically significant difference found between the number of drinks reported in a typical week, solicited from a single question, and the number of standard drinks computed using the traditional TLFB with a 7-day reference period (difference = -1.24 drinks, p value = 0.0254).

Objective

The Safe Passage Study of the Prenatal Alcohol in Sudden Infant Death Syndrome (SIDS) and Stillbirth (PASS) Network was designed to investigate the role of PAE in a continuum of poor peri- and postnatal outcomes (Dukes et al., 2014). The interviewer-based TLFB was used to capture detailed information regarding QFT of PAE around the time of conception through 1 month post-delivery. The traditional TLFB required modifications for the Safe Passage Study population based on feasibility findings, as well as evidence from the literature showing that for self-report, that what constitutes a standard drink differs from official precepts (Devos-Comby & Lange, 2008). Study investigators modified the standard TLFB to capture information regarding sharing, type/brand of beverages consumed (to assign specific ABV values), and container size, for use in the calculation of standard drinks. Although the modifications were deemed necessary, it was unclear whether it was feasible to obtain this level of detail in a large cohort of pregnant women over several assessment periods. This report describes the modifications made to the standard TLFB used to obtain alcohol exposure data from pregnant women participating in the Safe Passage Study, and highlights our success in obtaining complete and detailed information.

Materials and Methods

Study Design

The Safe Passage Study enrolled 11,892 unique pregnancies from 10,888 women at high risk for maternal drinking during pregnancy from the Northern Plains region of the US and from Cape Town, South Africa. The maternal-fetal/infant dyad was followed through pregnancy and until 1 year post-delivery. Follow-up was completed on October 4, 2016. The research was overseen by the Network's Steering Committee, an external Advisory and Safety Monitoring Board, and by local institutional review boards and Tribal research councils (Angal, Peterson, Tobacco, & Elliott, 2016; Dukes et al., 2014). At the end of the recruitment visit, each participant was given educational materials on the potential effects of

smoking and drinking during pregnancy and was asked if they would like to be referred to local agencies that can help those who would like to reduce their consumption or abstain from using alcohol.

Alcohol Exposure Assessments

Self-reported alcohol exposure information was collected for the time period around conception, up to four times during pregnancy, and at 1 month post-delivery. Because biomarker analyses were not definitive and were cost prohibitive, the TLFB was chosen as the best method to elicit detailed self-reported alcohol exposure information, and because portions of the populations under study had lower literacy levels, interviewer administration was used. The traditional TLFB collects the number of self-reported standard drinks consumed on each day in a specified time period within four beverage categories (beer, wine, fortified wine, and hard liquor). Reference ABV values and visuals of container sizes are provided for each beverage category. Because women in this population shared beverages and utilized different container sizes than those referenced in the TLFB, as shown in the feasibility study, modifications for our population included collection of each specific beverage consumed, container size (volume), whether sharing was involved, and duration of drinking episode. Collection of these additional details was intended to more accurately assign ABV, reduce inaccuracies resulting from incorrect interpretation of a standard drink, and, in situations with sharing, reduce non-systematic participant estimation regarding the amount individually consumed. In addition, analysis was performed using meconium from 108 infants (72 from South Africa, 36 from Northern Plains), with moderate to substantial agreement between self-report at or after 19 weeks and meconium ethyl glucuronide 30 ng/g (Cohen's kappa = 0.57) (Himes et al., 2015).

Administration

Each TLFB interviewer received extensive training and completed a proficiency assessment prior to conducting the first interview. On-going trainings and quality assessments were conducted biannually throughout the data collection period (see Supporting Material: Appendix A). In accordance with the traditional TLFB approach, participants were first prompted to consider anchor dates, such as paydays, holidays, other special occasions, and regular events that involved drinking during the 30-day reference period (Sobell & Sobell, 2000). Once all anchor dates were obtained, drinking days were identified, and detailed information was recorded for each unique drinking day, defined to include continued drinking past midnight (Sobell & Sobell, 2004). A modified calendar worksheet and 2D visual prompts (see Supporting Material: Appendix B) aided participants in recall (Sobell & Sobell, 2004). Following the interview, information was transcribed from the calendar worksheet to the TLFB case report form.

Quantity

The traditional Sobell method queries an individual to report the number of standard drinks consumed per day. It has been shown that the amount constituting a standard drink differs from official precepts (Devos-Comby & Lange, 2008). In particular, "beverages whose container or serving sizes are not standard (e.g., 12-oz beer) may pose problems for drinkers when reporting level of alcohol consumption" (Dawson, 2003). The problem is further

exacerbated when the participant pours or shares a beverage from a large container, as the volume individually consumed, combined with specific ABV, is often greater than one standard drink. The modifications to the standard TLFB were implemented because it was so crucial in the Safe Passage Study to calculate as accurately as possible the total grams of alcohol consumed for each drinking day, in addition to determining the timing of exposure. Obtaining type/brand of alcohol was important because ABV values vary significantly within each category (e.g., wines 6–18%, beer 4–9%, spirits 16.5–95%). Not accounting for ABV and simply assuming the same ABV for all beverages within a category could result in inaccurate estimates of ethanol consumed, and therefore an under- or over-estimate of the number of standard drinks consumed. Customized lists of alcoholic beverages commonly consumed locally were developed (see Supporting Material: Appendix C) and reflected the fact that beverages consumed in South Africa were different from those in the Northern Plains. This methodology allowed for study of trends in consumption by beverage category and site (Sobell & Sobell, 2004), and has been shown to increase the accuracy of recall (Muggli, Cook, O’Leary, Forster, & Halliday, 2015). Beverage lists were broken into several categories and subcategories: beer, malt liquor, cooler/cider, shooter (mixed shot), cocktail (including packaged, premixed), spirit (including liqueurs and schnapps), and wine (including dessert/fortified), and included over 200 unique codes. If a beverage was not listed or the interviewer was uncertain how to code a beverage, open-text fields were available so entries could be assigned appropriate ABVs prior to data analysis. However, data were reviewed periodically and code lists were updated accordingly to minimize use of open-text fields. Each alcohol code was assigned an ABV value utilizing product labels, government publications, and store and brand websites.¹ Specifying container size, with the use of visual aids and tick marks to indicate fill line, avoided one container being erroneously reported as one standard drink regardless of actual container size and allowed for reports of small quantities (e.g., one sip was recorded as 20 mL). The sharing item was added due to the high prevalence of sharing among certain portions of the study population; however, the participant was prompted to report how much she individually consumed, if known. To accommodate situations of uncertainty, participants were allowed to provide a range of values for number of containers, number of people sharing, and duration of drinking episode. Collection of these values allowed for the use of minimum, maximum, or average values in analyses.

Frequency

Within the 30-day period, repeated drinking patterns (e.g., two 5-oz glasses of Merlot wine every Friday night, with no sharing) were collected only once and applied to each matching day indicated within the TLFB reference period. This approach minimized both interviewer and participant burden, reduced errors in recording, and allowed for examination of typical versus atypical patterns.

¹Percent alcohol by volume was derived from multiple sources (e.g., product label, Wegmans.com, Wikipedia.com, <http://pubs.niaaa.nih.gov/publications/Tips/tips.htm>, Beeradvocate.com, Ratebeer.com, Gooseisland.com, Beer100.com, Missionliquor.com, Drinksmixer.com, Inthespirit.co.uk, About.com) and one ounce is equivalent to 29.57 mL and a weight of 0.79 g/mL. oz., ounces; g, grams; mL, millilitres

Timing

The modified TLFB was administered at the Recruitment Interview (between 6 weeks gestation and delivery), again at up to three prenatal visits (20–24, 28–32, and 34+ weeks), dependent upon timing of enrollment, and at 1 month post-delivery. At the Recruitment Interview, exposure information was collected for the time around conception (15 days before and after last menstrual period [LMP]) and for 30 days prior to the participant's last reported drinking day. At subsequent contacts, if the participant reported consumption since her previous visit, the reference period consisted of the 30 days prior to the last drinking day.

Derived Alcohol Exposure Variables

The number of standard drinks for each beverage reported on a unique drinking day (Fig. 1) was calculated as follows: 1) standardized volumes to ounces ($1 \text{ mL} = 1/29.57 \text{ oz.}$), 2) calculated volume per person ($[\text{ounces per container} \times \text{number of containers}]/\text{number of people sharing}$), 3) calculated grams of ethanol consumed ($[\text{volume per person} \times \text{ABV} \times (0.79/100) \times (29.57)]$, where 0.79 is the specific gravity of ethanol), and 4) calculated number of standard drinks consumed using the US guideline, i.e., 14 g ethanol (National Institute on Alcohol Abuse and Alcoholism, 1998). If a range of values was given for number of containers or number sharing, the mean was used (Brick, 2006). The number of standard drinks for each beverage was summed to provide the total number of standard drinks for that day. Mean drinks per drinking day was calculated as the total number of standard drinks during a period (e.g., week, trimester, pregnancy), divided by the total number of drinking days in that period. Using gestational age (GA), number of standard drinks per day, number of drinking days, and number of days reported in a period, a comprehensive set of variables was created to describe the QFT of alcohol consumption that can be used to define drinking trajectories over the course of pregnancy (Fig. 2).

A conservative approach was employed when calculating quantity and timing of alcohol consumption. Specifically, if ABV could not be determined for a certain beverage, the lowest ABV within the category was assigned. When reference periods overlapped (e.g., last drink was less than 30 days after the previous visit), resulting in duplicate information, data from the shortest recall period were used. This removed the burden of checking for overlap from the interviewer. In the situation where a woman reported drinking, but did not provide quantity information, a value of 0.5 standard drinks was assigned (equivalent to one sip of a 40% ABV spirit) as a conservative approach to prevent exclusion from analyses involving quantity.

To summarize, information was collected at the drink level for each day of interest (up to five 30-day periods). The drink level data were used to calculate standard drinks for each drinking day, which corresponds to a calendar day and GA. Using this day level data, information was aggregated to time periods of interest, such as ever during pregnancy, week, month, and trimester, as well as any cutoff of interest (e.g., consumption prior to a certain test or assessment). For pregnancies with no drinking reported through the entire pregnancy, every day in the pregnancy was defined as zero standard drinks. Pregnancies enrolled in a later trimester or where drinking was reported at multiple time points do not have drinking information defined for every day in pregnancy.

Statistical Methods

To demonstrate the feasibility of using a modified TLFB to collect PAE information in pregnant women enrolled in the Safe Passage Study, data describing the completeness and the quality of the information collected is provided. The results are descriptive in nature and do not include information regarding the number of pregnancies or women exposed or QFT of exposure because it will be reported elsewhere.

Pregnancy level (n = 11,892, reflecting 10,088 participants)

Descriptive statistics, including means, standard deviations (sd), medians, and ranges for continuous variables and frequencies and percentages for nominal variables, are provided by race/ethnicity for selected maternal and infant characteristics. To illustrate the breadth of information collected, descriptive information regarding compliance with visits, TLFB completion rates, and whether QFT could be determined is shown by study visit. Furthermore, information regarding reports of sharing, length of recall (recall period = date of interview minus first day of reference period), inconsistencies in the data, and the determination of PAE status throughout pregnancy is provided. For participants with periods of overlap, we used Cohen's weighted kappa statistic to assess concordance between the numbers of drinking days reported in the overlapping periods: coded as 0, 1, 2, 3, or 4+ days.

Drink Level (n = 53,823)

For each beverage category in the modified TLFB, descriptive statistics are provided regarding the number of beverages reported and items required for standard drink calculation (including number missing). Information regarding the items added in the modified TLFB is presented by site for the four beverage categories listed in the traditional TLFB (i.e., beer, wine, fortified wine, and hard liquor/spirits). The proportion of drinks reported with sharing and the proportion with ABV and container sizes differing from TLFB referent values are provided. Reported container sizes are compared descriptively to a wider range of commonly available standard volumes. Information regarding how often participants made use of various options in the data collection process, such as open-text fields and ranges, is also provided.

Validation Sample (n = 4,309 drinks, n = 1,631 pregnancies)

We did not directly ask women to complete both the traditional and the modified TLFB for two reasons: 1) to avoid increased participant burden and 2) the results from the feasibility study strongly suggested the need for modifications. However, a validation sample was developed using reported drinks that 1) did not involve sharing, 2) fell into a "typical" range of standard container sizes (Table 4), and 3) were from the beer, wine, or spirits category. This restricted sample allowed for comparison of the number of containers reported (i.e., number of standard drinks in the traditional TLFB) with the number of standard drinks calculated using the additional information (ABV and container size) from the modified TLFB. The number of containers reported was compared to the number of standard drinks calculated using a paired *t* test. In addition, using pregnancies from which the drink-level sample was obtained, pregnancy-level analyses, not accounting for re-enrollments, were

performed to determine whether classification as a binge drinker was statistically different between the traditional and modified TLFB methods using Cohen's kappa statistics and corresponding 95% confidence intervals.

All analyses were performed using SAS/STAT® version 9.3.² *p* values were considered significant if $\alpha < 0.05$, using a two-sided test.

Results

The sample consists of 11,892 pregnancies from 10,088 women in three diverse populations: mixed ancestry (58%) from South Africa, and American Indian (18%) and white (23%) from the Northern Plains (other/not specified [1%]). White women were older, more educated, and had fewer preterm deliveries (<37 weeks gestation) compared to American Indian and mixed ancestry women (Table 1). Mixed ancestry women enrolled later in pregnancy, compared to white and American Indian women. Reference the Safe Passage Study design paper for more information (Dukes et al., 2014).

Of 53,823 drinks reported, beer was the most common, representing over 50%, while cooler/cider, spirit, and wine each represented about 13% (Table 2). All of the items necessary for standard drink computation were completed for over 97% of drinks reported, regardless of beverage category. Missing information was most prevalent for spirits (2.6%), due primarily to missing number sharing and number of containers. Items most likely to be missing were: number of containers for beer, cocktails, cooler/cider, and malt liquor; and number sharing for spirits and wine.

Overall, 10% ($n = 5560$) of drinks reported made use of the open-text field for type/brand (data not shown). Open-text reports were re-coded to existing codes when possible, or assigned to another ABV, if determinable. As a result, 519 (9.3%) open-text drink reports were coded to the lowest ABV within the corresponding beverage category, and 183 (0.3%) drink reports indicating an unknown beverage type were subsequently assigned to the lowest overall ABV of 2.5%. Overall, 956 (1.8%) drink reports did not have sufficient quantity information provided and were coded to 0.5 standard drinks. Participants opted to provide a range, rather than an exact value, for number of containers and persons sharing in 17% and 9% of drinks, respectively. Of particular note, 47% of all drinks reported involved sharing (74% in South Africa and 10% in the Northern Plains).

Table 3 provides descriptive information regarding items added in the modified TLFB (sharing, ABV, and container size). Across the four categories referenced in the traditional TLFB, at least 66% of drinks reported in South Africa (excluding fortified wine, with few reports) involved sharing, while in the Northern Plains, 21% of spirits and 5% or fewer wine and beer reports involved sharing. Ninety-nine percent and 40% of spirits reported in the Northern Plains and in South Africa, respectively, had an ABV outside the reference range of 43–50%. The majority of wine reports (84% in Northern Plains and 78% in South Africa) had container sizes different from the reference values. In South Africa, almost all (99%)

²Copyright, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

beer reports had container sizes different from the reference. Fig. 3 shows the ABV of spirits reported; for both sites, the majority of drinks fall below the TLFB reference range of 43–50%, primarily due to consumption of liqueurs.

Table 4 compares reported container sizes to a wider range of common container sizes found in the US and South Africa. Excluding shooter, where there are few reports, wine had the largest percentage of ‘non-standard’ container sizes in the Northern Plains (51.9%), while cocktail had the largest percentage in South Africa (38.2%). Overall, between 6% and 43% of drinks reported, depending on beverage category, were not of sizes commonly available locally.

Ninety-three percent of all eligible visits were completed and the TLFB was successfully collected nearly 100% of the time for participants attending a visit (Table 5). The percentage of pregnancies with complete QF information for all drinks reported was 96.0%, 98.5%, 98.5%, 97.8%, and 98.9% at the recruitment, 20–24 week, 28–32 week, 34+ week, and 1-month postnatal contacts, respectively, while overall, 99% have QF available on any (i.e., some) drinks reported across all visits. Duration of drinking is known for at least 93.9% of pregnancies at each visit. QF was not provided for 1% of women who reported drinking.

All but four pregnancies (missing Recruitment Interview or TLFB) have PAE status defined for at least one trimester of pregnancy (data not shown). PAE status was known for all trimesters in 92% of pregnancies and for every week in 65%. In three hundred and sixty-one (3.7%) pregnancies the quantity of a sip was reported at least once and, of these, 30 (0.3%) reported only sips of (mostly communion) wine and could be classified as not drinking. The average post-recruitment recall period for the TLFB, when drinking was reported, was 44.3 ± 19.2 days. The percentage of pregnancies with some overlap in days reported at different visits was 9.8%, with an average of 23.1 ± 33.4 days of overlap. Of 1325 reporting periods (3% of 43,571) with at least one overlapping day, the weighted Cohen’s kappa comparing number of drinking days reported was 0.4267 (95% CI: 0.3803, 0.4732), indicating moderate agreement (data not shown). Furthermore, in 71% of discordant cases, the later report indicated less drinking than the report with shorter recall; most often, the later report indicated no drinking vs. some drinking reported earlier.

Validation Sample (4,309 Drinks, 1,631 Pregnancies)

In the Northern Plains, the number of standard drinks computed using the modified TLFB was statistically significantly higher (all p values <0.0001) than the number of containers reported for the beer (mean $\pm$ std deviation) (1.0 ± 1.8), spirit (4.4 ± 6.1), and wine (0.9 ± 0.9) categories (Table 6). At the pregnancy level, 32.2% were classified as binge drinkers (four or more drinks on an occasion), based upon data from the modified TLFB, vs. 23.3% based upon the traditional TLFB (data not shown). In South Africa, a smaller proportion of pregnancies were available for this analysis (7.5%) as compared to the Northern Plains (22.4%), due to the high proportion of sharing in South Africa. The number of standard drinks calculated was statistically significantly higher (all p values <0.0015) using the modified as compared to the traditional TLFB for the beer, spirits, and wine categories in South Africa; however, the magnitude of the differences were not as great as those reported in the Northern Plains (Table 6).

Discussion

Summary

While other studies have adapted alcohol exposure assessments to collect type/brand, container size, and sharing information (Dawson, 2003; Day et al., 1985; Kaskutas & Graves, 2001; Kaskutas & Kerr, 2008; Muggli et al., 2015), this is the first study of this size to wholly encompass all of these changes into a single measure in order to more accurately calculate daily consumption and assess patterns over time.

Modifications to the standard TLFB and associated aids (e.g., modified calendar worksheets, pictures of drinking containers), as well as on-going interviewer trainings and data monitoring checks, were required for our study to aid participant recall, ensure uniformity of collection, and limit missing information. Of primary concern was whether collecting this level of detail for each beverage consumed for each day in a 30-day recall period would be feasible in high-risk pregnant women in the Northern Plains, US and the Western Cape of South Africa, given the transience of the populations and the sensitivity of the research topic. An additional concern was that the study protocol required exposure information to be collected at up to four assessment periods during pregnancy and one assessment post pregnancy, whereas most studies of rare pregnancy outcomes, such as stillbirth and SIDS, typically collect PAE only once during the postpartum period (Bailey & Sokol, 2011; Henderson, Gray, et al., 2007; Iyasu et al., 2002).

We were able to successfully capture the additional information required for standard drink computation using the modified TLFB in 11,892 pregnancies from Safe Passage Study participants. Specifically, PAE status was defined for 99.9% of pregnancies at least once during pregnancy and was defined for all three trimesters in 92%, with complete QFT obtained for 98.2% (52,867/53,823) of all drinks reported.

Further, the modified TLFB likely provides a more accurate assessment of PAE as compared to the traditional TLFB, based on the results of our 2007 feasibility study, where we found that women tended to report consuming less when asked simply to report the number of standard drinks in a period vs. completing the traditional TLFB method, as well as our validation study where we showed statistically significant underreporting of standard drinks when comparing the traditional vs. the modified TLFB methods (e.g., 3.2 fewer spirit standard drinks, on average). The need for the modifications is further supported by the following results: 1) approximately 47% of all drinks reported included sharing (74% in South Africa and 10% in the Northern Plains); 2) compared to the referent values provided with the traditional TLFB, 74.4% and 66.8% of drinks reported had different ABV and container size, respectively; 3) between 6% and 43% of drink reports, depending on beverage category, differed from container sizes commonly utilized at the study locations; and 4) 17% and 9% of drinks reported included a range (instead of a single value) for the number of containers and persons sharing, respectively.

Our findings provide unique insight into how often women would be making an interpretation to convert individual consumption to standard drinks, which can result in both under- and over-reporting, and corroborate findings from other studies (Devos-Comby &

Lange, 2008) with respect to obtaining more precise estimates of standard drinks when exact ABV, container size, and sharing are incorporated. The most common container size for a glass of wine reported in the Northern Plains was 6 oz. (23.8%), while the TLFB referent size is 5 oz. (14.0%). Some restaurants also offer larger 9-oz. pours (2.1% reported), which may still be interpreted by a participant as one “drink” using the traditional TLFB approach. Comparing these container sizes and assuming 12% ABV, one 5-oz glass of wine is equivalent to one standard drink, while a 6-oz and 9-oz glass are equivalent to 1.2 and 1.8 standard drinks, respectively (Table 7). This difference in how container size with a fixed ABV equates to the number of standard drinks increases as the number of glasses consumed increases. Similarly, the potency of ethanol, or ABV, in a beverage greatly affects the number of standard drinks computed. This is most evident for spirits, where ABVs reported in our study ranged from 16.5% to 95%. Among the 7,025 spirits reported, 60% in the Northern Plains and only 1.1% in South Africa had an ABV that fell within the referent range of 43–50%; without capturing specific type/brand of alcohol, these reports would have represented over-estimates of consumption.

Considerations

Some factors considered during the planning and execution phase for the collection of PAE in the Safe Passage Study are briefly discussed below.

Under-reporting

Customized tools were developed to aid recall (e.g., modified calendar worksheets, customized 2D visual aids for container sizes, site-specific alcohol code lists; Muggli et al., 2015; Sobell & Sobell, 2004). Efforts were made to reduce underreporting due to social stigma or fear the child may be taken away from the participant. At study onset, a Certificate of Confidentiality was established to protect participants in select US sites. Further, study staff were often from the same community as the participant, and rapport was built over the course of pregnancy. We believe that underreporting was minimized based on women reporting sips of alcohol in our study, likely indicative of truthfulness and a strong sense of trust between the participants and study staff. A validation study (Himes et al., 2015) using a subset of Safe Passage Study women (n = 108, case-control design), indicated strong concordance between maternal report and meconium biomarkers.

Cocktails and Mixed Shots/Shooters

ABVs and volumes for cocktails and mixed shots/shooters vary widely, and drinks in this category are not always mixed using the same parts or ingredients, even when consumed in a bar or restaurant setting (Kerr, Patterson, Koenen, & Greenfield, 2008). To simplify the collection of standard drink information for research, it has typically been assumed that a cocktail contains a single shot (1.5 oz.) of spirits with a standard ABV of 40%. In our study, however, the interviewer prompted women to provide specific information regarding container size, contents, and how the drink was mixed. When known, only alcoholic contents were recorded; otherwise, the reported container size and the specific ABV for the mixed beverage were used in the computation of standard drinks, as described in the Methods section.

Limitations

While we believe that our study data are comprehensive and provide additional accuracy over the standard TLFB, there were limitations in this application of the modified method. First, as in the traditional TLFB, it was necessary to make assumptions to uniformly assign ABV for certain drinks, notably cocktails (6.4% of drinks reported), where the specific ingredients were not listed separately. However, given the level of detail reported, we believe our calculations were more accurate than would have been obtained using the traditional method. Second, it has been reported that the TLFB may not be well suited for situations where researchers are attempting to generalize exposure patterns across time for participants who have infrequent or inconsistent drinking (Dawson, 2003). These concerns were minimized by the implementation of multiple collection time points throughout pregnancy and postpartum to reflect exposure during each trimester. Lastly, it is important to note that the modified TLFB does require extensive resources (e.g., to become familiar with local beverages and practices). However, we felt the benefit of obtaining the additional information was necessary to address our research question and outweighed the associated costs.

Conclusion

In a cohort of 11,892 pregnancies in 10,088 women from the Safe Passage Study, over multiple assessment periods, we successfully captured complete and detailed PAE information, the success of which will be advantageous toward addressing the study's primary analytic goals. The additional information required for the modified TLFB included type/brand of alcohol, whether sharing occurred, container size, and duration of drinking, as well as the use of codes with specific ABV assignment. The modifications likely increased the accuracy of standard drink computation and reduced non-systematic misclassification of exposure. In addition, though not demonstrated explicitly in this manuscript, the addition of duration will allow researchers to assess measures of exposure not available using the traditional TLFB (e.g., blood alcohol concentrations and definitions of binge that account for duration). Given our success, we think the modified approach has applications in other settings where detailed QFT information is necessary.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The authors gratefully acknowledge the cooperation of the study participants, PASS investigators and members of the NICHD Advisory and Safety Monitoring Board: Elizabeth Thorn, PhD (Chair); The Reverend Phillip Cato, PhD; James W. Collins, Jr., MD, MPH; Terry Dwyer, MD, MPH; George Macones, MD; Philip A. May, PhD; Richard M. Pauli, MD, PhD; Raymond W. Redline, MD; and Michael Varner, MD. The authors gratefully acknowledge Sandra and Joseph Jacobson for sharing their expertise with the timeline followback method in the pilot project that preceded the Safe Passage Study. The PASS Research Network is supported by the National Institute on Alcohol Abuse and Alcoholism, Eunice Kennedy Shriver National Institute of Child Health and Human Development, and National Institute on Deafness and Other Communication Disorders through the Cooperative Agreement Mechanism (U01 HD055154, U01 HD045935, U01 HD055155, U01 HD045991, and U01 AA016501). The following institutions and researchers comprise the PASS Network (additional network members other than authors listed):

DCAC: *Data Management/Information Technology*: Travis Baker, BS

DBPC: *Assistant Director*: Robin L. Haynes, PhD; *Co-investigators*: David S. Paterson, PhD, Kevin G. Broadbelt, PhD, Kyriacos Markianos, PhD, Ingrid A. Holm, MD, Theonia Boyd, MD, Drucilla Roberts, MD, Richard G. Goldstein, MD, Hanno Stein, PhD; *Technicians*: Claire Maggiotto, BS, Catherine Hassett, BS, Kathryn Schissler, BS

CCS Northern Plains: *Co-investigators*: Donald Habbe, MD, H. Eugene Hoyme, MD, Bradley Randall, MD, Mary Ann Sens, MD, PhD, Peter Van Eerden, MD; *Project Management*: Elizabeth Berg, RN, Christa Friedrich, MS, Marge Jackson, BA, Luke Mack, MA, Liz Swenson, RN, Deb Tobacco, MA

CCS South Africa: *Co-investigator and Project Manager*: Coen Groenewald, MBChB, MMed, FCOG environmental, M Comm; *Project Management*: Erna Carstens, RN, Mandy Potter, RN, Lucy Brink, MSc, Carlie du Plessis, RN, Milly de Jager RN

PAC: *Project Management*: J. David Nugent, MA, Carmen Condon, BA; *Data Analysis*: Joseph R. Isler, PhD, Margaret C. Shair, BA, Tracy Thai, MA, Joel S. Yang, PhD

NIH: *Project Scientists*: Howard J. Hoffman, PhD (NIDCD), Chuan-Ming Li, MD, PhD (NIDCD); *Program Officers*: Bill Dunty, PhD (NIAAA), Tonse Raju, MD, DCH (NICHD), Gordon B. Hughes, MD (NIDCD)

Further, the following individuals made significant contributions to the research and warrant recognition:

DCAC: Idania Ramirez, MPH, Jamie Collins, PhD, Laura Spurchise, MPH, Derek Petersen, BS

DBPC: Richard A. Belliveau, BA, Kristin McMillan, BA, Megan Minter, MS PAC: Johnston T. Grier, BA, Emilia F. Vignola, BA, Joseph J. Violaris, BA

Glossary

Timeline Followback (TLFB) Interview (Alcohol)

The Alcohol TLFB Interview is a drinking assessment method that obtains estimates of the quantity of daily drinking and has been evaluated with clinical and nonclinical populations.

Western Cape, South Africa

A .province of South Africa, situated in the southwestern part of the country.

References

- Angal J, Petersen JM, Tobacco D, Elliott AJ. Ethics Review for a Multi-Site Project Involving Tribal Nations in the Northern Plains. *Journal of Empirical Research on Human Research Ethics*. 2016; 11:91–96. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2692889/>. DOI: 10.1177/1556264616631657 [PubMed: 26928897]
- Bailey BA, Sokol RJ. Prenatal alcohol exposure and miscarriage, stillbirth, preterm delivery, and sudden infant death syndrome. *Alcohol Research & Health*. 2011; 34:86–91. [PubMed: 23580045]
- Bakhireva LN, Savage DD. Focus on: biomarkers of fetal alcohol exposure and fetal alcohol effects. *Alcohol Research & Health*. 2011; 34:56–63. [PubMed: 23580042]
- Bearer CF, Jacobson JL, Jacobson SW, Barr D, Croxford J, Molteno CD, et al. Validation of a new biomarker of fetal exposure to alcohol. *The Journal of Pediatrics*. 2003; 143:463–469. DOI: 10.1067/S0022-3476(03)00442-6 [PubMed: 14571221]
- Bearer CF, Stoler JM, Cook JD, Carpenter SJ. Biomarkers of alcohol use in pregnancy. *Alcohol Research & Health*. 2004; 28:38–43.
- Bhuvaneswar CG, Chang G, Epstein LA, Stern TA. Alcohol use during pregnancy: prevalence and impact. *Primary Care Companion to the Journal of Clinical Psychiatry*. 2007; 9:455–460.
- Brick J. Standardization of alcohol calculations in research. *Alcoholism: Clinical and Experimental Research*. 2006; 30:1276–1287. DOI: 10.1111/j.1530-0277.2006.00155.x

- Burd L, Blair J, Dropps K. Prenatal alcohol exposure, blood alcohol concentrations and alcohol elimination rates for the mother, fetus and newborn. *Journal of Perinatology*. 2012; 32:652–659. DOI: 10.1038/jp.2012.57 [PubMed: 22595965]
- Burd L, Hofer R. Biomarkers for detection of prenatal alcohol exposure: a critical review of fatty acid ethyl esters in meconium. *Birth Defects Research. Part A, Clinical and Molecular Teratology*. 2008; 82:487–493. DOI: 10.1002/bdra.20464
- Centers for Disease Control and Prevention (CDC). Alcohol use and binge drinking among women of childbearing age—United States, 2006–2010. *MMWR. Morbidity and Mortality Weekly Report*. 2012; 61:534–538. [PubMed: 22810267]
- Chang G. Alcohol-screening instruments for pregnant women. *Alcohol Research & Health*. 2001; 25:204–209. [PubMed: 11810959]
- Chang G, McNamara TK, Orav EJ, Wilkins-Haug L. Alcohol use by pregnant women: partners, knowledge, and other predictors. *Journal of Studies on Alcohol*. 2006; 67:245–251. [PubMed: 16562406]
- Coriale G, Fiorentino D, Di Lauro F, Marchitelli R, Scalese B, Fiore M, et al. Fetal Alcohol Spectrum Disorder (FASD): neurobehavioral profile, indications for diagnosis and treatment. *Rivista di Psichiatria*. 2013; 48:359–369. DOI: 10.1708/1356.15062 [PubMed: 24326748]
- Dawson DA. Methodological issues in measuring alcohol use. *Alcohol Research & Health*. 2003; 27:18–29. [PubMed: 15301397]
- Day NL, Wagener DK, Taylor PM. Measurement of substance use during pregnancy: methodologic issues. *NIDA Research Monograph*. 1985; 59:36–47. [PubMed: 3929131]
- de Visser RO. Personalized feedback based on a drink-pouring exercise may improve knowledge of, and adherence to, government guidelines for alcohol consumption. *Alcoholism: Clinical and Experimental Research*. 2015; 39:317–323. DOI: 10.1111/acer.12623
- Derauf C, Katz AR, Easa D. Agreement between maternal self-reported ethanol intake and tobacco use during pregnancy and meconium assays for fatty acid ethyl esters and cotinine. *American Journal of Epidemiology*. 2003; 158:705–709. [PubMed: 14507607]
- Devos-Comby L, Lange JE. “My drink is larger than yours”? A literature review of self-defined drink sizes and standard drinks. *Current Drug Abuse Reviews*. 2008; 1:162–176. [PubMed: 19630715]
- Dukes KA, Burd L, Elliott AJ, Fifer WP, Folkerth RD, Hankins GD, et al. The safe passage study: design, methods, recruitment, and follow-up approach. *Paediatric and Perinatal Epidemiology*. 2014; 28:455–465. DOI: 10.1111/ppe.12136 [PubMed: 25131605]
- Flak AL, Su S, Bertrand J, Denny CH, Kesmodel US, Cogswell ME. The association of mild, moderate, and binge prenatal alcohol exposure and child neuropsychological outcomes: a meta-analysis. *Alcoholism: Clinical and Experimental Research*. 2014; 38:214–226. DOI: 10.1111/acer.12214
- Henderson J, Gray R, Brocklehurst P. Systematic review of effects of low-moderate prenatal alcohol exposure on pregnancy outcome. *BJOG*. 2007; 114:243–252. DOI: 10.1111/j.1471-0528.2006.01163.x [PubMed: 17233797]
- Henderson J, Kesmodel U, Gray R. Systematic review of the fetal effects of prenatal binge-drinking. *Journal of Epidemiology and Community Health*. 2007; 61:1069–1073. DOI: 10.1136/jech.2006.054213 [PubMed: 18000129]
- Himes SK, Dukes KA, Tripp T, Petersen JM, Raffo C, Burd L, et al. Clinical sensitivity and specificity of meconium fatty acid ethyl ester, ethyl glucuronide, and ethyl sulfate for detecting maternal drinking during pregnancy. *Clinical Chemistry*. 2015; 61:523–532. DOI: 10.1373/clinchem.2014.233718 [PubMed: 25595440]
- Iyasu S, Randall LL, Welty TK, Hsia J, Kinney HC, Mandell F, et al. Risk factors for sudden infant death syndrome among northern plains Indians. *JAMA*. 2002; 288:2717–2723. [PubMed: 12460095]
- Jacobson SW, Chiodo LM, Sokol RJ, Jacobson JL. Validity of maternal report of prenatal alcohol, cocaine, and smoking in relation to neurobehavioral outcome. *Pediatrics*. 2002; 109:815–825. [PubMed: 11986441]

- Jacobson SW, Stanton ME, Moltano CD, Burden MJ, Fuller DS, Hoyme HE, et al. Impaired eyeblink conditioning in children with fetal alcohol syndrome. *Alcoholism: Clinical and Experimental Research*. 2008; 32:365–372. DOI: 10.1111/j.1530-0277.2007.00585.x
- Joya X, Friguls B, Ortigosa S, Papaseit E, Martinez SE, Manich A, et al. Determination of maternal-fetal biomarkers of prenatal exposure to ethanol: a review. *Journal of Pharmaceutical and Biomedical Analysis*. 2012; 69:209–222. DOI: 10.1016/j.jpba.2012.01.006 [PubMed: 22300909]
- Kaskutas LA, Graves K. Pre-pregnancy drinking: how drink size affects risk assessment. *Addiction*. 2001; 96:1199–1209. DOI: 10.1080/09652140120060789 [PubMed: 11487425]
- Kaskutas LA, Kerr WC. Accuracy of photographs to capture respondent-defined drink size. *Journal of Studies on Alcohol and Drugs*. 2008; 69:605–610. [PubMed: 18612577]
- Kerr WC, Patterson D, Koenen MA, Greenfield TK. Alcohol content variation of bar and restaurant drinks in Northern California. *Alcoholism: Clinical and Experimental Research*. 2008; 32:1623–1629. DOI: 10.1111/j.1530-0277.2008.00741.x
- Kerr WC, Stockwell T. Understanding standard drinks and drinking guidelines. *Drug and Alcohol Review*. 2012; 31:200–205. DOI: 10.1111/J.1465-3362.2011.00374.x [PubMed: 22050262]
- Kesmodel US, Bertrand J, Stovring H, Skarpness B, Denny CH, Mortensen EL. The effect of different alcohol drinking patterns in early to mid pregnancy on the child's intelligence, attention, and executive function. *BJOG*. 2012; 119:1180–1190. DOI: 10.1111/j.1471-0528.2012.03393.x [PubMed: 22712700]
- Lange S, Shield K, Koren G, Rehm J, Popova S. A comparison of the prevalence of prenatal alcohol exposure obtained via maternal self-reports versus meconium testing: a systematic literature review and meta-analysis. *BMC Pregnancy Childbirth*. 2014; 14:127.doi: 10.1186/1471-2393-14-127 [PubMed: 24708684]
- Littner Y, Cudd TA, O'Riordan MA, Cwik A, Bearer CF. Elevated fatty acid ethyl esters in meconium of sheep fetuses exposed in utero to ethanol-a new animal model. *Pediatric Research*. 2008; 63:164–168. DOI: 10.1203/PDR.0b013e31815f651e [PubMed: 18091344]
- Lundsberg LS, Illuzzi JL, Belanger K, Triche EW, Bracken MB. Low-to-moderate prenatal alcohol consumption and the risk of selected birth outcomes: a prospective cohort study. *Annals of Epidemiology*. 2015; 25:46–54. e43. DOI: 10.1016/j.annepidem.2014.10.011 [PubMed: 25453352]
- May PA, Brooke L, Gossage JP, Croxford J, Adnams C, Jones KL, et al. Epidemiology of fetal alcohol syndrome in a South African community in the Western Cape Province. *American Journal of Public Health*. 2000; 90:1905–1912. [PubMed: 11111264]
- Miller, WR. Form 90: A structured assessment interview for drinking and related behaviors test manual. Rockville, MD: National Institutes of Health; 1996.
- Muggli E, Cook B, O'Leary C, Forster D, Halliday J. Increasing accurate self-report in surveys of pregnancy alcohol use. *Midwifery*. 2015; 31:e23–28. DOI: 10.1016/j.midw.2014.11.003 [PubMed: 25467595]
- National Institute on Alcohol Abuse and Alcoholism. What Is A Standard Drink?. Washington, DC: 1998. <https://www.niaaa.nih.gov/alcohol-health/overview-alcohol-consumption/what-standard-drink>
- Patra J, Bakker R, Irving H, Jaddoe VW, Malini S, Rehm J. Dose-response relationship between alcohol consumption before and during pregnancy and the risks of low birthweight, preterm birth and small for gestational age (SGA) - a systematic review and meta-analyses. *BJOG*. 2011; 118:1411–1421. DOI: 10.1111/j.1471-0528.2011.03050.x [PubMed: 21729235]
- Sobell LC, Maisto SA, Sobell MB, Cooper AM. Reliability of alcohol abusers' self-reports of drinking behavior. *Behaviour Research and Therapy*. 1979; 17:157–160. [PubMed: 426744]
- Sobell, LC., Sobell, MB. Alcohol Timeline Followback Instructional Training Video. Toronto: Canada Addiction Research Foundation; 1979.
- Sobell, LC., Sobell, MB. Timeline Follow-Back: A Technique for Assessing Self-Reported Alcohol Consumption. In: Litten, RZ., Allen, JP., editors. *Measuring Alcohol Consumption; Psychosocial and Biochemical Methods*. Vol. 17. Totowa, NJ: Humana Press; 1992. p. 41-72.
- Sobell, LC., Sobell, MB. Alcohol Timeline Followback Users' Manual. Toronto, Canada: Addiction Research Foundation; 1995.

- Sobell, LC., Sobell, MB. Alcohol Timeline Followback Recall Aids. C. f. P. S., Nova Southeastern University. 2000. www.nova.edu/gsc/forms/TLFBrecallaids.pdf
- Sobell, LC., Sobell, MB. Alcohol consumption measures. In: Allen, JP., Columbus, M., editors. Assessing Alcohol Problems: A Guide for Clinicians and Researchers. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism; 2004. p. 55-74.
- Viljoen DL, Gossage JP, Brooke L, Adnams CM, Jones KL, Robinson LK, et al. Fetal alcohol syndrome epidemiology in a South African community: a second study of a very high prevalence area. *Journal of Studies on Alcohol*. 2005; 66:593–604. [PubMed: 16331845]
- Zelner I, Kenna K, Brien JF, Booking A, Harding R, Walker D, et al. Meconium fatty acid ethyl esters as biomarkers of late gestational ethanol exposure and indicator of ethanol-induced multi-organ injury in fetal sheep. *PLoS One*. 2013; 8:e59168.doi: 10.1371/journal.pone.0059168 [PubMed: 23533604]

Highlights

- This is the first study, in a population of pregnant women, to modify the Timeline Followback (TLFB) to include type/brand, container size, and sharing information in order to more accurately calculate daily alcohol consumption and assess patterns overtime.
- The Safe Passage Study enrolled 11,892 unique pregnancies from 10,088 women and successfully administered the modified TLFB to determine prenatal alcohol exposure (PAE) for 99.9% of pregnancies at least once during pregnancy and for 92% across all trimesters.
- Our findings provide unique insight into the issue of over- and under-reporting in the conversion of individual consumption to standard drinks, corroborating findings from other studies.

Unique Drinking Day #: <u>01</u>		Size of Container	# of Containers	# Sharing	Ice or Frozen	
Type of Alcohol		specify volume	specify number OR range	(including participant)	NO	YES
Alcohol Code	Specify Type of Alcohol	oz OR ml				
____	_____	____	____	____	0	1
____	_____	____	____	____	0	1
____	_____	____	____	____	0	1
____	_____	____	____	____	0	1

Total duration of drinking (hours): ____ : ____ - ____ : ____ OR Start Time: ____ : ____ End Time: ____ : ____
 (specify number OR range) (military time) (military time)

OR Check if unable to compute duration of drinking due to black out or passing out. —▶ ☐

Fig. 1.

Excerpt from the Timeline Followback (TLFB) case report form used in the Safe Passage Study to collect drink type, size of container, number of containers, number sharing, ice or frozen, and duration for each unique drinking day in the 30-day reference period.

Measure	Quantity/Frequency	Timing
Drinking days	Number of drinking days and abstinent days (total and consecutive)	LMP, pregnancy, week, month, trimester
Standard drinks*	Average, maximum, peak BAC, various binge cutoffs (with and without duration)	LMP, pregnancy, day, week, month, trimester, weekends, special occasions

Fig. 2.

The array of self-reported alcohol consumption measures collected on the modified Timeline Followback (TLFB).

*Countries have differing definitions for what is considered a standard drink. While the US guideline (14 g) was used to define a standard drink in this report, the detail elicited from the modified TLFB allows for derivation based on other national standards. BAC: blood alcohol content; LMP: last menstrual period

Fig. 3.

A boxplot of spirit ABV (%) by site representing the minimum, first quartile, median, third quartile, and maximum. NHigh and NLow refer to the number of drink reports clipped from the visual plot where ABV >60% or <20%, respectively. ABV: Alcohol by Volume

Table 1

Maternal and Infant Characteristics by Race

	South Africa		Northern Plains		Total ^x
	Statistic	Mixed Ancestry n=6896	American Indian n=2128	White n=2755	
Maternal Characteristics					
Age (years)	n	6896	2128	2755	11892
	mean (sd)	24.8 (5.9)	24.8 (5.5)	28.3 (4.9)	25.6 (5.8)
	median	24.0	24.0	28.0	25.0
	(min – max)	(15.0–45.0)	(15.0–43.0)	(16.0–44.0)	(15.0–45.0)
High School Educated	n(%)	1683 (24.4%)	1231 (58.0%)	2646 (96.0%)	5652 (47.6%)
Gravidity ^z	n	6870	2030	2698	11708
	mean (sd)	2.3(1.3)	3.2 (2.0)	2.5(1.5)	2.5(1.5)
	median	2.0	3.0	2.0	2.0
	(min - max)	(1.0–10.0)	(1.0–12.0)	(1.0–14.0)	(1.0–14.0)
Parity ^y	n	6870	2030	2698	11708
	mean (sd)	1.1 (1.2)	1.8 (1.7)	1.1 (1.1)	1.2 (1.3)
	median	1.0	1.0	1.0	1.0
	(min - max)	(0.0–8.0)	(0.0–10.0)	(0.0–9.0)	(0.0–10.0)
Gestational Age at Enrollment (weeks)	n	6896	2128	2755	11892
	mean (sd)	20.1 (7.1)	16.3 (7.1)	16.0 (3.3)	18.5 (6.7)
	median	20.0	15.0	16.1	17.4
	(min – max)	(6.0 – 40.3)	(3.6–39.6)	(5.0–35.6)	(3.6 – 40.3)
Infant Characteristics					
Preterm Delivery (<37 weeks)	n(%)	1053 (15.2%)	296 (14.8%)	272 (10.0%)	1634 (13.9%)
Birth Weight (grams)	n	6806	1809	2680	11395
	mean (sd)	2964.6 (617.3)	3409.6 (649.5)	3385.4 (601.3)	3135.7 (655.0)
	median	3000.0	3447.0	3430.0	3170.0
	(min – max)	(50.0–5740.0)	(170.0–5925.0)	(43.0–5690.0)	(43.0–5925.0)

^zGravidity = Number of times a woman has been pregnant including index pregnancy.

^yParity = Number of >20 week births (viable and non-viable) excluding index pregnancy. Multiples count as one birth.

Author Manuscript
Includes women with Other and Missing race.
x

Author Manuscript

Author Manuscript

Author Manuscript

Table 2

Drink Level Timeline Followback (TLFB) Collection Information

Beverage category	Number reported ^z	Able to calculate number of standard drinks	Information missing for calculation of standard drinks ^y	Unknown type/brand (assigned lowest ABV)	Number with sharing
Beer	27232 (50.6%)	26784 (98.4%)	n Container size Number of containers Number sharing	NA	16141 (59.3%)
Cocktail	3436 (6.4%)	3397 (98.9%)	n Container size Number of containers Number sharing	175 (5.1%)	407 (11.9%)
Cooler/ Cider	6757 (12.6%)	6656 (98.5%)	n Container size Number of containers Number sharing	14 (0.2%)	2775 (41.1%)
Malt Liquor	2108 (3.9%)	2094 (99.3%)	n Container size Number of containers Number sharing	49 (2.3%)	553 (26.2%)
Shooter (Mixed Shot)	341 (0.6%)	340 (99.7%)	n Container size Number of containers Number sharing	110 (32.3%)	9 (2.6%)
Spirit	6990 (13.0%)	6807 (97.4%)	n Container size Number of containers Number sharing	171 (2.5%)	3239 (46.3%)
Wine	6776	6711	n Container size Number of containers Number sharing	NA	1893

Beverage category	Number reported ^z	Able to calculate number of standard drinks	Information missing for calculation of standard drinks ^y	Unknown type/brand (assigned lowest ABV)	Number with sharing
	(12.6%)	(99.0%)	Container size	10(15.4%)	(27.9%)
			Number of containers	26 (40.0%)	
			Number sharing	53 (81.5%)	

^zThere were 183 (0.3%) unknown drink reports.

^yThese drink reports will be assigned a value of 0.5 standard drinks.

Table 3

Items Added in the Modified Timeline Followback (TLFB) Compared to Traditional TLFB Reference Values by Site (NP: Northern Plains, SA: South Africa)

Categories referenced in TLFB	Drinks reported		Statistic	Reported drinks with sharing involved		ABV referenced in TLFB	Reported drinks with different ABV ^x		Container size referenced in TLFB	Reported drinks with different container size	
	NP	SA		NP	SA		NP	SA		NP	SA
Beer (n=27232)	9330	17902	n(%) mean (sd)	469 (5.0%) NA	15672(87.5%) NA	5%	6672 (71.5%) 4.3 (0.4)	14927(83.4%) 5.4 (0.3)	12 oz 340 ml	1643(17.6%) ^w	17656(98.6%) ^w
Wine (n=5523)	3920	2603	n(%) mean (sd)	127(3.2%) NA	1728(66.4%) NA	10–12%	2949 (75.2%) 12.6(1.0)	1208(46.4%) 11.2 (2.4)	5, 25, 40 oz 150,750, 1500 ml	3304 (84.3%) ^w	2027(77.9%) ^w
Fortified Wine ^z (n=253)	43	210	n(%) mean (sd)	3 (7.0%) NA	35(16.7%) NA	16–18%	0 (0.0%) NA	113(53.8%) 12.5(0.0)	3, 25 oz 100,750 ml	39(90.7%) ^w	170(81.0%) ^w
Spirit ^y (n=6990)	3115	3875	n(%) mean (sd)	658(21.1%) NA	2581 (66.6%) NA	43–50%	3080 (98.9%) 36.2 (6.8)	1548(39.9%) 27.1 (9.9)	1.5, 12, 26, 40 oz 50,340,750, 1000 ml	1590(51.0%) ^w	977 (25.2%) ^w

^z Fortified wine is captured as a sub-category of wine in the modified TLFB and includes dessert wines.

^y Equivalent to the hard liquor reference in the traditional TLFB.

^x Means and standard deviations are all reported in ounces.

^w See Table 4 for further details.

Table 4

Comparison to Common Container Sizes by Site (NP: Northern Plains, SA: South Africa)

Beverage category	Drinks reported		Statistic	Standard z container sizes		Drinks with non-standard z container size		
	NP	SA				NP	SA	Overall
Beer	9330	17902	n(%)	12, 16, 22, 40, 64 oz 330, 340, 440, 650, 660, 750 mL		713 (7.6%)	1025 (5.7%)	1738 (6.4%)
Cocktail	3085	351	n(%)	4, 6, 8, 12, 16 oz 100, 150, 200, 250 mL		976 (31.6%)	134 (38.2%)	1110 (32.3%)
Cooler/ Cider	317	6440	n(%)	12 oz 275, 300, 330, 340, 660, 750, 3000 mL		103 (32.5%)	463 (7.2%)	566 (8.4%)
Malt Liquor	2108	0	n(%)	8, 9, 12, 16, 22, 40 oz 330, 750 mL		899 (42.6%)	0 (0.0%)	899 (42.6%)
Shooter (Mixed Shot)	286	55	n(%)	1, 1.5, 2oz 25, 50 mL		22 (7.7%)	41 (74.5%)	63 (18.5%)
Spirit	3115	3875	n(%)	1, 1.5, 12, 16, 25, 26, 40, 59 oz 20, 50, 100, 150, 200, 340, 375, 750, 1000, 1750 mL		1089 (35.0%)	330 (8.5%)	1419 (20.3%)
Wine	3963	2813	n(%)	3, 5, 6, 9, 25, 40 oz 100, 150, 250, 330, 340, 375, 660, 750, 1000, 1500, 2000, 3000, 5000 mL		2057 (51.9%)	466 (16.6%)	2523 (37.2%)

^z Standard container sizes are equitable to common container sizes found in the study locations.

Table 5

Participant Level Timeline Followback (TLFB) Collection Information

Visit	Contact complete ^z	TLFB completed	Timing determined	Quantity/Frequency available		Duration available	
				Any	All	Any	All
Recruitment	11886/11892 (99.9%)	11886/11886 (100.0%)	99.7%	99.0%	96.0%	97.3%	94.0%
20–24 weeks	8444/9221 (91.6%)	8429/8444 (99.8%)	100%	99.3%	98.5%	96.6%	94.1%
28–32 weeks	3339/3531 (94.6%)	3338/3339 (99.9%)	100%	99.3%	98.5%	95.8%	93.9%
34+ weeks	10139/10713 (94.6%)	10119/10139 (99.8%)	100%	99.2%	97.8%	95.8%	94.8%
1 month	9494/11365 (83.5%)	9446/9494 (99.5%)	100%	99.2%	98.9%	96.4%	95.3%
All	43302/46722 (92.7%)	43218/43302 (99.8%)	99.8%	99.0%	96.8%	96.9%	94.3%

^z Depending on the time of enrollment, not all participants are eligible for all prenatal visits.

Table 6
Comparison of Standard Drinks as Calculated by Modified and Traditional Timeline Followback (TLFB)

	n	Statistic	Modified TLFB	Traditional TLFB	Difference (Modified-Traditional)	p value
Northern Plains						
Beer	961	mean (sd)	4.6 (4.3)	3.6 (2.9)	1.0 (1.8)	<0.0001
		(min - max)	(0.5–48.1)	(0.5–24.0)	(–5.0–24.1)	
Spirit	582	mean (sd)	7.2 (7.6)	2.8 (1.8)	4.4(6.1)	<0.0001
		(min - max)	(0.5–39.6)	(1.0–12.0)	(–2.3–34.6)	
Wine	1992	mean (sd)	2.4 (1.6)	1.5 (0.9)	0.9 (0.9)	<0.0001
		(min - max)	(0.4–30.0)	(0.3–15.0)	(–0.8–15.0)	
South Africa						
Beer	109	mean (sd)	3.9 (3.0)	3.5 (2.6)	0.4 (0.7)	<0.0001
		(min - max)	(0.9–15.5)	(1.0–12.0)	(–0.6–5.5)	
Spirit	342	mean (sd)	4.2 (6.2)	2.9 (2.3)	1.3 (4.6)	<0.0001
		(min - max)	(0.5–81.9)	(1.0–22.5)	(–4.2–59.4)	
Wine	307	mean (sd)	2.8 (3.3)	2.6 (2.5)	0.3 (1.4)	0.0015
		(min - max)	(0.6–37.4)	(1.0–26.5)	(–2.2–13.3)	

Table 7

Standard Drinks Computed from Various Wine Pours

Reference ABV 12%		
Container Size	Number of containers	Standard drinks computed
5 oz	1	1
	2	2
	4	4
6 oz	1	1.2
	2	2.4
	4	4.8
9 oz	1	1.8
	2	3.6
	4	7.2