Building a case for a standardised antenatal alcohol screening programme in the UK.

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Declaration

I declare that no outputs submitted for this degree have been submitted for a research degree of any other institution. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

This study was given a favourable opinion by the Tyne and Wear South Research Ethics Committee (Ref: 15/NE/0216) dated 4th September 2015.

I declare that the Word Count of this Commentary is 11,027 words

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Abstract

Background

A paucity of antenatal alcohol consumption prevalence rates in the UK and limited guidance around the implementation of antenatal screening practices led to the inception of my research within the field. In particular, the need to raise awareness of the risks of Prenatal Alcohol Exposure (PAE) and FASD with UK health professionals and the wider public. As a midwife researcher I identified that addressing this gap in knowledge was urgently required to evaluate and improve antenatal alcohol practices and services.

Introduction

My published papers follow a logical and sustained sequence of investigations to address this deficit, and consequently make an independent and original contribution to knowledge and understanding. Adopting an inductive approach, I initially examined the utility of self-report in relation to blood biomarkers to improve existing screening methods. Expanding the scope of my research to examine patient and healthcare professional's expectations, knowledge and experience in relation to alcohol in pregnancy and the condition of Fetal Alcohol Spectrum Disorder (FASD). Finally, I consolidated this work by evaluating existing practices and services across the North-east and North Cumbria to inform future policy and make service recommendations.

Aim

The aim of my PhD was to investigate the feasibility and clinical effectiveness of antenatal alcohol screening for pregnant women, their partners and clinicians; and to evaluate a regional antenatal alcohol service provision in maternity practice.

Design and Methodology

I have taken a pragmatic approach and utilised a variety of methods to fully address my research objectives. A systematic review was undertaken comparing the diagnostic accuracy of blood biomarker analysis to maternal self-report in the detection of antenatal alcohol consumption. Retrospective anonymous surveillance using clinical audit methodology and blood biomarker analysis was employed to obtain epidemiological prevalence data regarding antenatal alcohol use. Surveys were used to understand patient understanding and attitudes to antenatal alcohol screening and healthcare professionals' knowledge and experience of alcohol and FASD in practice. An evaluation of current alcohol prevention, screening and treatment service provision in maternity care practices and services in the North East and North Cumbria using content analysis was undertaken to inform strategic planning for the Local Maternity System.

Results

The six publications present a logical and inductive progression of enquiry, culminating in the presentation of a body of evidence which validates antenatal alcohol screening as feasible, acceptable and a recognised public health priority which should be integral to routine clinical practice. However, the effectiveness of the screening methods varied, and more research is required into blood biomarker analysis in pregnancy. Training and education requirements were also identified in

healthcare professionals and the public. In response, the prioritisation of antenatal alcohol screening and the standardisation of best practices are recognised needs in UK maternity services. As a measure of success, I have received national and local recognition of my research which is now informing and changing clinical practice.

Discussion

My main knowledge contributions are:

- Production of empirical evidence that antenatal alcohol screening can effectively identify women at risk, thereby facilitating intervention to improve both maternal and infant health outcomes

- The demonstrated feasibility and acceptability of establishing routine antenatal alcohol screening also has the potential to determine reliable UK alcohol in pregnancy prevalence rates to inform future healthcare strategies.

- Self-report is the cheapest and most accessible method of screening, but blood biomarkers may also be beneficial and cost-effective in the long-term.

- FASD and alcohol in pregnancy training is urgently required for UK healthcare professionals.

- Alcohol reduction in pregnancy should be made an urgent public health priority in UK maternity services to improve health outcomes across the life-course.

- Standardised UK patient pathways involving alcohol screening and management practices are required, and the sharing of best practices will facilitate referrals and support regardless of location.

- The implementation of these recommendations requires appropriate leadership, commissioning and training strategies.

Conclusions

My research has helped raised awareness and improved current practices relating to alcohol in pregnancy in the UK. The findings include original regional prevalence rates and have identified potential antenatal alcohol screening and management strategies. My evidence-based recommendations are already informing national Public Health England recommendations, NICE consultations, multidisciplinary training and service improvement initiatives. This new evidence has demonstrated the need for further inquiry into the challenging and complex issues surrounding alcohol harm reduction in pregnancy.

Acknowledgements

I would like to thank my brilliant co-authors from whom I have learned so much. They have motivated and supported me in all aspects of my research which has culminated in this PhD submission. I would also like to express my sincere gratitude to all participants in the studies, without whom I could never have completed this work.

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Finally, I would like to dedicate this work to all the families who face the daily challenges of living with FASD. I have total respect and admiration for you all. I would like to acknowledge the heroic work of four very special women, all mothers of FASD children whom I have the privilege to call colleagues and friends. Karen Slater, the late Pip Williams, Kathleen Mitchell and Anne Russell all valiantly share their poignant personal stories and experiences of addiction, in a tireless campaign to raise FASD awareness and prevent future alcohol exposed pregnancies. Your unwavering bravery and resilience are truly inspiring and have provided the impetus and meaning to my journey. Thank you.

Glossary of Terms

ADHD	Attention Deficit Hyperactivity Disorder
ALT	Alanine Aminotransferase
ARBD	Alcohol Related Birth Defects
APPG	All Party Parliamentary Group
ARND	Alcohol Related Neurodevelopmental Disorders
AST	Aspartate Aminotransferase
AUDIT	Alcohol Use Disorder Identification Test
Audit-C	Alcohol Use Disorders Identification Test-Concise
BMI	Body Mass Index
CAGE	Alcohol use questionnaire with four items: Cut down, Annoyed, Guilt, Eye-opener
CDT	Carbohydrate-Deficient Transferrin
CNS	Central Nervous System
CI	Confidence Interval
CMO	Chief Medical Officer
CNS	Central Nervous System
CRN	Clinical Research Network
DH	Department of Health
DSM-5	Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition)
EtG	Ethyl Glucuronide
EU	European Union
FAEE	Fatty Acid Ethyl Ester
FASD	Fetal Alcohol Spectrum Disorders
FAS	Fetal Alcohol Syndrome
FAST	Fast Alcohol Screening Test
GGT	Gamma-Glutamyl Transferase
GP	General Practitioner
IRAS	Integrated Research Application System
LMS	Local Maternity System
MCV	Mean Corpuscular Volume
ND-PAE	Neuro-behavioural Disorder associated with Prenatal Alcohol Exposure
NEQAS	National External Quality Assessment Service
NHCT	Northumbria Healthcare Foundation NHS Trust
NHS	National Health Service
NIAAA	National Institute on Alcohol Abuse and Alcoholism
NICE	National Institute for Health and Care Excellence
NIHR	National Institute of Health Research
NPEU	National Perinatal Epidemiology Unit
NO-FAS	National Organisation for Fetal Alcohol Syndrome
NTHFT	North Tees and Hartlepool NHS Foundation Trust
ONS	Office for National Statistics
PAE	Prenatal Alcohol Exposure
PEth	Phosphatidyl ethanol
PFAS	Partial Fetal Alcohol Syndrome

PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QUADAS-2	Quality Assessment of Diagnostic Accuracy Studies
RCOG	Royal College of Obstetricians and Gynaecologists
RfPB	Research for Public Benefit
SPSS	Statistical Package for the Social Sciences
T-ACE	Alcohol use questionnaire with four items: Tolerance, Annoyance, Cut down, Eye opener
TLFB	Timeline Follow-Back procedure
TWEAK	Alcohol use questionnaire with five items: Tolerance, Worried, Eye-opener, Amnesia and K/Cut down
UK	United Kingdom
USA	United States of America
WBAA	Whole Blood Associated Acetaldehyde
WHO	World Health Organisation

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1. Chapter One – Introduction

This chapter sets the scene for my PhD by providing an overview of the epistemological and philosophical position of my work; what originally initiated the research and what has maintained the momentum to complete it. The research presented in this PhD by doctoral works is based on six sequential studies that make a coherent and significant contribution to knowledge, validating the importance and feasibility of antenatal alcohol screening to improve maternal and infant outcomes in the United Kingdom (UK). The impact of this research culminated in a regional evaluation of antenatal alcohol service provision with the recommendations implemented to change clinical practice and service provision. The research was undertaken part-time from 2014 to 2020 whilst the author worked for Northumbria Healthcare Foundation NHS Trust (NHCT), as a full-time Senior Research Nurse and Midwife.

1.1. Philosophical and epistemological position of my published papers

My special interest in Fetal Alcohol Spectrum Disorder (FASD) began in 2012 when I attended a FASD training session and met a mother speaking candidly about the daily challenges she experienced parenting her daughter who had extensive neurodevelopmental disabilities caused entirely by Prenatal Alcohol Exposure (PAE). Until this point, I had not realised the enormity of problems that can arise as a result of PAE and FASD. This issue was not addressed or even acknowledged by most UK health care professionals. Social services, education and the judicial system were inevitably burdened with the challenges of FASD, although understandably unaware because these complex individuals remained undiagnosed and therefore invisible. Furthermore, without robust evidence, policy makers in Public Health and Government had no inducement to act; and without prevalence data, research was not being commissioned (Department of Health, 2015).

To place the magnitude of FASD in context, the NHS spent £30 million in 2013 to screen and diagnose for Down's syndrome, which affects approximately 0.1% of pregnancies, yet there was no allocated budget for alcohol screening in pregnancy which was estimated to impact upon 1-5% of pregnancies (Taylor, 2013; Morleo *et al.*, 2011). This incurable but avoidable disability was not on the UK health prevention agenda and antenatal alcohol screening in pregnancy was not routine practice, so children were rarely diagnosed with FASD preventing access to essential services and interventions. Having listened to the expressed need for change from families living with FASD, the extent of this public health inequality motivated my subsequent research (FASD Network UK, 2019; NOFAS-UK, 2018).

My professional discipline as a midwife researcher draws upon qualitative paradigms as the woman-centred approach is fundamental, aligning to the subjective interactive perspective of the individual whereby reality is constructed in the interpretivist paradigm. Feminism frames the midwifery profession and by adopting feminist approaches we can fully appreciate and explore the intricate relationship between women, alcohol and FASD which has traditionally incurred judgement and hostility from the media, highlighting the unjust gender inequalities that still persist today (Corrigan *et al.*, 2017; Scambler, 2018). Paradoxically, the positivist paradigm is also intrinsic to midwifery practice, as the medically led, obstetric and gynaecological domains of knowledge also underpin midwifery. Evidence derived from quantitative results; measurable and generalisable, predominantly influence practice and legislation. As a midwife, working in clinical trials, I was adept and experienced in both paradigms.

In response to these complex dynamics, which reflect the epistemological art or science debate of midwifery, I adopted a pragmatic paradigm of inquiry, guided by the knowledge gaps and emerging research questions (Power, 2015). From my professional position, the logical course was to examine the upstream prevention of FASD and explore the related alcohol agenda from the viewpoint of women

and pregnancy. Therefore, my early research focus was to generate quantifiable prevalence data regarding alcohol exposed pregnancies to facilitate and implement targeted solutions. My subsequent research developed organically as my knowledge of the area deepened and my networks and area of influence in the subject field expanded. Combined, my research has contributed to regional, national, and international developments within the field of antenatal alcohol screening and management. It has also informed national policy in the UK and made a positive contribution to clinical practice, maternity services and initiating new research internationally.

Chapter 2: Framework of understanding for FASD

2.1 Background to FASD

FASD is noted as the leading known cause of preventable non-genetic learning disability in the Western world (Poole *et al.*, 2016; Stratton, Howe and Battaglia, 1996). This astonishing statistic and the ability to avert the harm resonated with my personal sense of injustice and galvanised my preliminary investigations. FASD is an umbrella term relating to a broad spectrum of intellectual and developmental deficits in individuals, resulting from PAE. Alcohol is fetotoxic and teratogenic (i.e. a substance which interferes with the normal development of the embryo or fetus) and freely crosses the placenta (Mukherjee *et al.*, 2005). In the absence of a developed blood filtration system, the fetus is unprotected from alcohol circulating in the blood stream and damage to any organ in the body can result (British Medical Association, 2016). Hepper (2012) conducted research using ultrasound monitoring of fetal behaviour and observed that when mothers consumed just one unit of alcohol, fetal activity ceased for up to two hours (Hepper, Dornan and Lynch, 2012). Hepper (2012) also concluded that the liquor in the uterus acts as a reservoir for alcohol that is recirculated through the fetus many times before eventually returning to the mother to be metabolised and excreted (Hepper *et al.*, 2012).

FASD is associated with a range of physical and intellectual disabilities including small stature, organ damage, hearing and vision impairments (May *et al.*, 2013a). However, only 10% of children with FASD present with the distinctive facial dysmorphia, including a small head, small eyes, thin upper lip and a smooth philtrum. The lack of distinctive physical features make diagnosis more difficult and it is often referred to as a ‘hidden’ disability (Walker, Edwards and Herrington, 2016). Damage to the brain for all children with FASD can result in developmental disabilities including general learning difficulties, language, social or motor skills impairment, poor memory, attention deficits, inhibited

consequential thinking and reduced planning ability (Streissguth and Kanter, 1997; Andrews *et al.*, 2018). This illustrates how FASD is an enduring and significant public health concern.

2.2 Risk factors of FASD

FASD is linked to heavy alcohol intake during pregnancy, but not all babies exposed to high levels of alcohol are affected (Ceccanti *et al.*, 2014). Binge drinking, defined as exceeding six units in one day, has been identified as the greatest risk to the fetus, but the safety of low to moderate levels of PAE have yet to be evidenced (Maier and West, 2001). The severity of alcohol harm to a fetus primarily depends on three risk factors: the quantity of alcohol a pregnant woman drinks on each occasion; the frequency of drinking episodes and the gestation of her pregnancy (May and Gossage, 2011; May *et al.*, 2013a)**.**

Specific maternal characteristics also influence how children can be affected by PAE (May and Gossage, 2011). Mothers who are poorly nourished; have had multiple pregnancies and births; are lower-than-average weight, height, and body mass index (BMI); who smoke or engage in polydrug use; are older and who come from a family of heavy drinkers, are more likely to be adversely affected (May and Gossage, 2011; Ceccanti *et al.*, 2014). Environmental factors also predispose children affected by PAE if their mothers experience adverse-living conditions and high levels of stress (May *et al.*, 2013b). Examples include social isolation, living in communities with limited antenatal care or in circumstances where excessive drinking is common and accepted (May and Gossage, 2011). These complex social, economic and health related factors relating to PAE are commonly encountered by the midwife delivering antenatal care but due to low levels of awareness, this issue was not routinely addressed in practice.

2.3 Living with FASD

Individuals with FASD face daily challenges that may include understanding and following directions; focusing their attention; controlling emotions and impulses; communicating, socialising, and performing daily life skills such as, feeding, bathing, counting money, telling the time, and personal safety awareness. FASD-related brain damage also inhibits the processing of routine life situations and can cause children and adults to make bad decisions, repeat the same mistakes, trust the wrong people and impedes their understanding and prediction of consequences to their actions (Catterick and Curran, 2014; Flak *et al.*, 2014; Public Health England, 2016b; Streissguth and Kanter, 1997). Consequently, children who suffer from FASD can be difficult to manage, are more likely to be taken into the care system and come into contact with the criminal justice system (Streissguth and Kanter, 1997; NOFAS-UK; NIAAA, 2015). Furthermore, people with FASD are more likely to suffer from mental health disorders including Attention Deficit Hyperactivity Disorder (ADHD); depression and anxiety; problems with hyperactivity, conduct and impulse control; and poignantly an increased incidence of alcohol and substance misuse disorders. These factors place a huge emotional, physical and fiscal burden on their families, the health service, social care, education and the judiciary system (Stade *et al.*, 2009; Catterick and Curran, 2014). Consequently, research to reduce this impact and ensure early intervention is key.

2.4 Prevalence rates of FASD

Internationally, the prevalence rate of FASD is commonly represented as 1% (NIAAA, 2015). Previously the prevalence of FASD within the UK was estimated to be 1-2%, a conservative estimate due to incomplete datasets; limited data intelligence systems and low practitioner awareness and specialist expertise (Morleo *et al.*, 2011; Harwin, 2010; Blackburn, Carpenter and Egerton, 2009; Mukherjee, Hollins and Curfs, 2012). However, recent data suggests that FASD prevalence rates in

the UK ranges from 6% to 17% (McQuire *et al.*, 2019). Given the disparity in figures and lack of current epidemiological data, contemporary research in this field was paramount.

2.5 FASD Economic impact

The human costs of pain, suffering and stress associated with the numerous disabilities of individuals and families living with FASD are difficult to quantify. The financial burden of FASD has not yet been officially measured in the UK, but a Canadian cost analysis which included the health, educational and social care needs of children with FASD in 2013 calculated an astounding $1.8 billion total per year (Popova *et al.*, 2016). Children born with FASD are referred to internationally as one million dollar babies due to the life-time costs posed by the condition (Thanh and Jonsson, 2009). At a conservative 1% prevalence, of the 679,106 live births in England and Wales in 2017, 67911 of these children would have FASD (ONS, 2018b). In the UK, even a modest 1% prevalence rate would cost almost £68 billion for children born in 2017 alone. If UK FASD prevalence rates are nearer 17%, this bill could be multiplied seventeen times. This colossal expense can be argued to justify the cost effectiveness of preventative antenatal alcohol screening and interventions. In addition, Public Health England (2016) estimated the cost of alcohol consumption to the NHS alone to be in excess of £3.5 million pounds per year, contributing to an overall annual cost to society of £21 billion (Public Health England, 2016b). Therefore, by generating empirical data on antenatal alcohol prevalence rates I set out to inform the debate and influence future policy.

This chapter has provided a framework of understanding regarding the symptoms and impact of FASD, implications for midwifery care and the rationale for my subsequent body of work.

Chapter 3: Women and alcohol

3.1 Culture

As a reflexive practitioner, I recognise that my research has been shaped by a variety of social and feminist paradigms which influence the likelihood of FASD and cause complexity and confusion for women and their partners. Therefore, it was imperative my research explored why alcohol harms should be addressed at society level rather than burdening individuals with blame. This is an important concept because stigma associated with women, alcohol and FASD can be a significant barrier to care access and provision (Corrigan *et al.*, 2017).

Alcohol pervades all social classes in the UK and interestingly, hazardous levels of alcohol consumption are more common in the highest income households (22%) compared to the lowest (13%) (Department of Health, 2016). Women from managerial and professional socio-economic groups drink more on average than female routine and manual workers or women who were unemployed (Office for National Statistics, 2018). One explanation for this is that women may have more opportunity for corporate drinking than previous generations due to changes in attitude and behaviour regarding alcohol, combined with a culture of drinking to excess in some workplace settings (Romo, Dinsmore and Davis, 2015).

One study reported that women who were more educated, were more likely to frequently drink alcohol and admit to their drinking problem (Borgonovi and Huerta, 2010). Although we are progressing to an international consensus recommending total abstinence in pregnancy; societal influences and personal experience remain powerful influences (Schölin, 2016). Alcohol is an embedded element of UK culture, with 87% of men and 80% of women reporting alcohol consumption in the preceding year

(Department of Health, 2016). Alcohol is comparatively cheaper than ever before, more readily available and socially acceptable; and therefore is not generally perceived to be harmful (Public Health England, 2016b). An appreciation of cultural context is an important step to understanding why women drink in pregnancy and informed the exploration of potential management strategies.

3.2 Alcohol harms and trends

Alcohol consumption is associated with co-morbidities including injury, cardiovascular disease and many cancers (Department of Health, 2016). Alcohol misuse can also originate from and trigger mental health problems (Alcohol Concern and Alcohol Research UK, 2018). Sadly, alcohol-specific deaths among women reached the highest on record in 2017 at 8.0 deaths per 100,000 females (ONS, 2018a). High alcohol consumption trends in women of childbearing age increases women's risk of having a child affected by PAE (Mukherjee, Hollins and Turk, 2006). To illustrate this, the Office for National Statistics (ONS) found that 'binge drinking' or 'heavy episodic drinking' which equates to six or more units per session, remains highest in the age groups 16-24 year olds (42%) and 25-44 year olds (35.6%) (ONS, 2017). In the early 1990's the media coined the somewhat derogatory term 'ladette' to reflect this UK-wide phenomenon of young women who "behave in a boisterously assertive or crude manner and engage in heavy drinking sessions" (Oxford Dictionary, 2018). The significant public health risk posed by alcohol supported my research exploring the feasibility of alcohol screening in the pregnant population.

3.3 Alcohol in pregnancy prevalence rates

Although most women avoid alcohol during pregnancy, 25–50% of European women continue to drink alcohol and some to high levels (Gray and Henderson, 2006). This may be partially attributed to the fact that approximately half of UK pregnancies are unplanned, and many women unwittingly consume alcohol before pregnancy confirmation (Morleo *et al.*, 2011). This necessitates research examining the impact of counselling women who realise that they were drinking around the time of conception and early pregnancy. The UK Infant Feeding Survey (2010) identified that 40% of mothers consumed alcohol in pregnancy (McAndrew *et al.*, 2012). This survey was not distributed by doctors or midwives and therefore women may be more comfortable giving a truthful, anonymous responses thus increasing reliability. This was corroborated with a 41.3% prevalence rate in 2018, placing the UK in the global top four highest consumers of alcohol during pregnancy (Popova *et al.*, 2018). These studies substantiated the urgent need to determine accurate UK prevalence data and to establish a national, routine antenatal alcohol screening strategy. This palpable gap in knowledge and clinical practice guided my research aims and objectives.

3.4 Official guidelines

Although pregnant women in England should receive information about the risks of alcohol harm from their midwives at the booking appointment at 8-12 weeks, for reasons unknown, this assumed approach appears to have limited impact on their drinking behaviour. Evidence shows that approximately two fifths of women drink alcohol when pregnant (McAndrew *et al.*, 2012; McQuire *et al.*, 2019). The disparity presented between best practice and women's drinking behaviours warranted further investigation.

The ostensible dissonance between the evidence of PAE associated harms and the perpetuated high drinking behaviours in pregnancy may be somewhat explained by the unclear and sometimes contradictory messages that women receive from health professionals (Schölin, 2019). A range of contradictory guidelines and advice from various professional bodies were in the public domain in 2014. These discrepancies and the clear lack of evidence contributed to inconsistent clinical interventions and underpinned my research which aimed to inform, improve and standardise best practice. For example, the National Institute for Clinical Excellence (NICE) (2008) based their recommendations on the Royal College of Obstetricians and Gynaecologists (RCOG) guidelines (2008, updated 2015), which stated that women could drink 1-2 units of alcohol 1-2 times per week following the first trimester of pregnancy (NICE, 2008a; RCOG, 2018). This information was based primarily on evidence linking alcohol in early pregnancy with the increased incidence of miscarriage, premature birth and low birth weight (NICE, 2008a; Nykjaer *et al.*, 2014). Advice which conflicted with international evidence-informed guidelines, including the British Medical Association (BMA) (2007), who clearly stated that abstinence is the only safe policy for women who are pregnant or planning a pregnancy (British Medical Association, 2007; Parliament, 2012; Scottish Government Consultation, 2012).

It was also notable that England lagged behind the public health messages of a number of developed countries including France, Germany, Canada and Australia who explicitly recommended alcohol abstinence throughout pregnancy to prevent the risk of FASD (British Medical Association, 2007). Indeed as far back as 1981 United States of America (USA) recommended complete abstinence in pregnancy due to the expanding body of evidence highlighting the risks of harm from PAE and lack of information regarding any ‘safe’ amounts of alcohol consumption in pregnancy (Warren, Hewitt and Thomas, 2011; NIAAA, 2015). Conversely, NICE (2008) acknowledged that although there was

general agreement that women should not drink excessively during pregnancy, the level of drinking harmful to a pregnant woman and her baby remained unclear, concluding insufficient evidence to recommend total abstinence (NICE, 2008b).

The Chief Medical Officer (CMO) guidelines were eventually updated in January 2016, in response to the unavoidable growing evidence supporting a more 'precautionary' approach (Department of Health, 2016). In August 2016, the NICE Antenatal Care Guidelines followed suit and referred women to the CMO guidelines which now advised abstinence from alcohol in pregnancy or when planning a pregnancy, to minimise the risks of harm (Department of Health, 2016). However, evidence suggests that these new guidelines were not adequately promoted to professionals or the public, resulting in continued lack of awareness and poor compliance, again reinforcing the importance of my research objectives (Schölin, 2019). Specifically, professional perspective data were warranted to explore local and national attitudes and identify gaps in practice.

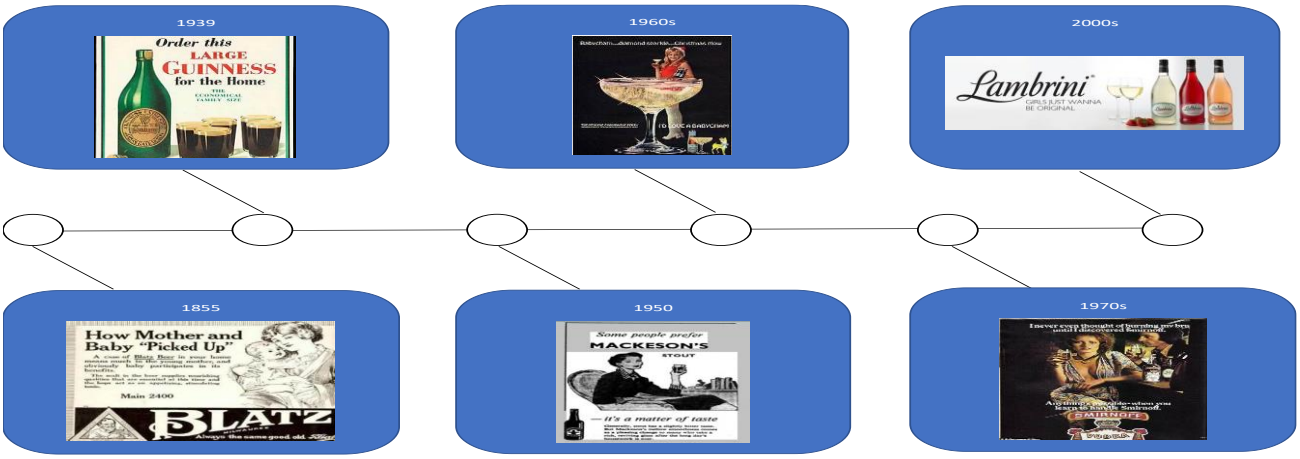
3.5 Units of alcohol

Women in the UK are known to have a generally poor understanding of alcohol units, as demonstrated through their consumption levels and higher exposure risk to alcohol (May and Gossage, 2011). This is corroborated by research which recognised that individuals tend to underestimate the alcohol content of different types of drinks when asked to accurately demonstrate a unit measure (Mukherjee *et al.*, 2013). This may partially explain the evidence that alcohol consumption is consistently and significantly under reported, a concern I wanted to explore further (Kaner, 2007; Wilson, 2012).

3.6 The alcohol industry and the power of advertising

The role of the alcohol industry has been instrumental in perpetuating the female drinking culture by actively targeting women through advertising to maximise sales and profits. The changing roles of women in society since the mid-nineteenth century can be seen reflected in alcohol advertising (Figure1). The gender stereotypes range from the nurturing mother and dutiful housewife; to submissive sex object, liberated career woman flirting with feminism, to fun loving party girls and 'ladettes' who could rival any of their male counterparts in the drinking stakes (Hastings, 2016; Atkinson *et al.*, 2019; Institute of Alcohol Studies, 2020a).

Figure 1. Timeline of alcohol advertising



In recent decades, the alcohol industry has been quick to capitalise on the increasing prosperity of women because of improved gender equality in the workplace, developing marketing strategies intended to entice more women to spend their earnings on alcoholic beverages (European Centre for Monitoring Alcohol Marketing, 2008). The Institute of Alcohol Studies has estimated that the UK alcohol industry was worth £46 billion in 2014, equating to 3.7% of total consumer expenditure

(Institute of Alcohol Studies, 2020b). The alcohol industry marketing allocation for 2010 was assessed at £600m-£800m (All Party Parliamentary Group, 2015). In stark contrast, the Public Health England budget to assist adults and children affected by alcohol in 2018 was a mere £10.5 million (Public Health England, 2018). Empirical antenatal alcohol screening prevalence data can substantiate the need to address this issue as a public health emergency, preventing future disease, reducing disability and lowering mortality rates.

This chapter has highlighted the complex relationship between women and alcohol. I have explored the perspectives of feminism and gender in socio-economic, political and cultural contexts. The contentious problem of women drinking in pregnancy can unjustly vilify mothers, but by contextualising the alcohol agenda within a post-modernist social and feminist framework we can begin to objectively explore and constructively address the issues raised. Recognition of the wider philosophical and epistemological paradigms and how they have influenced my subsequent research is also key to setting the scene behind my work and its iterative development.

Chapter 4: Gaps in knowledge

This chapter will provide an overview of antenatal alcohol screening practice, national governance and FASD service provision prior to my research, identifying the gaps in knowledge and service provision.

4.1 Antenatal alcohol screening

Antenatal screening is recommended by the WHO (2014) to facilitate the early identification and management of harmful drinking among pregnant women (WHO, 2014). Yet, alcohol drinking during pregnancy data are not routinely documented or audited. The limited evidence available was based on self-report and often unreliable because of poor estimation, poor recollection, the patient-clinician relationship, expected social norms and fear of perceived judgement (Walker *et al.*, 2005; Lange *et al.*, 2014). As a result, maternal alcohol consumption levels are often significantly under-estimated. I have witnessed this in practice when delivering a pilot study of brief interventions for 'risky drinking' in pregnancy. A definitive evaluation was not feasible due to a lack of case identification via self-reported screening (Wilson, 2012). It concerned me greatly that the lack of documented, standardised and effective antenatal screening suggested that many women were not receiving the support they required, resulting in avoidable and continued exposure to alcohol harms.

4.2 National governance and metrics

The non-existence of national antenatal alcohol guidelines, recommended patient pathways and best practice standards, are testimony to the low priority afforded to alcohol use in pregnancy. Furthermore, alcohol data were either not obtained or not published by the national maternity governance organisations in the UK, including the Maternity Services Data Set, National Perinatal Epidemiology

Unit and the Perinatal Institute for maternal and child health. Finally, a dearth of published antenatal alcohol service evaluations or relevant audits in the UK invited investigation.

4.3 FASD Service provision

The Prescribed Specialised Services Advisory Group (2015) had considered a proposal for NHS England to commission a specialist FASD service but declined due to lack of incidence and prevalence data (Department of Health, 2015). They stated that without these data, they could not predict the potential number of FASD referrals per year. A paucity of PAE prevalence data undoubtedly contributed to this impasse.

4.4 Problem statement

The lack of PAE prevalence data and the need for an accurate and acceptable antenatal alcohol screening tool motivated and shaped my research. The unavailability of standardised maternity provision and the absence of any official governance and metrics, compelled me to examine these neglected areas. The collective knowledge omissions and service provision oversights initiated the genesis of my research endeavours. This thesis will set out how my coherent body of knowledge fills these gaps by contributing crucial new evidence supporting the progression to an antenatal alcohol screening programme that is fit for purpose in the UK. A body of work designed to effectively prevent harm and improve the health outcomes of mothers and their babies.

Chapter 5: Research aims and Methods

The overarching aim was to explore the feasibility and clinical effectiveness of antenatal alcohol screening to clinicians, pregnant women and their partners. This culminated in a regional evaluation of antenatal alcohol service provision in maternity practice.

5.1 Specific aims of the included papers

Paper I.

The aim of study 1 was to evaluate the results of all relevant literature comparing the efficacy of combined blood biomarker analysis with maternal self-report, in the detection of alcohol exposure. This was to inform future research enquiry.

Paper II.

The aim of study II was to measure the prevalence of alcohol consumption in a North-East England NHS Trust, taken from a random sample of pregnant women in the first trimester, using blood biomarkers compared to self-report, and to ascertain the efficacy of both methods. This study also aimed to obtain empirical evidence to evaluate if routine antenatal alcohol screening was required.

Paper III

Study III aimed to reproduce the blood biomarker analysis in a random sample of pregnant women in the first trimester, in a second similar socio-economic NHS locality. This was to increase sample size, compare prevalence rates and review the validity and generalisability of the result. The second aim was to corroborate the benefit of blood biomarker screening.

Paper IV

The aim of study IV was to evaluate risk awareness of drinking alcohol during pregnancy in pregnant women and their partners. The study also aimed to explore the acceptability of various alcohol screening methods to women and partners with the intention of informing future practice.

Paper V

Study V aimed to investigate health care professionals FASD knowledge and their attitudes to various methods of alcohol screening in pregnancy. This new evidence could then be used to address the knowledge gaps, guide future training strategy and inform practice recommendations.

Paper VI

Finally, study VI aimed to review current alcohol prevention, screening and treatment service provision in nine maternity Trusts across the North-East and North Cumbria (NENC). The aim was also to identify best practices and gaps in service to inform future recommendations for the Local Maternity System Transformational plan and implementation of the Better Births report across the region (National Maternity Review, 2016).

5.2 Design, methods and participants

This is a compilation thesis, comprising of six studies using a variety of data collection and analysis methodology. Fundamentally, the methodology selected was dictated by the research question (Grove, 2013). Each study was designed to obtain the appropriate breadth and depth of data required to meet the research aims. To ensure the integrity and quality of evidence, the appropriate governance measures were adopted in each study. An overview of the studies included in the thesis is presented in Table 1.

Table 1. Design, methods, and participants of studies I-VI

Study design	Study sample	Data collection	Analysis
I. systematic review.	779 records identified and 8 studies included.	Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.	QUADAS II Quality appraisal tool.
II. Blood analysis survey and audit method using cross-sectional retrospective data.	600 antenatal women at booking and 2993 antenatal women at booking.	600 booking blood samples. 2993 medical notes.	Bloods tested for Carbohydrate Deficient Transferrin (CDT) and Gamma glutamyl transferase (GGT). Statistical analysis using SPSS statistical software package.
III. Blood analysis survey method using cross-sectional retrospective data.	600 antenatal women at booking.	600 booking blood samples.	Bloods tested for Carbohydrate Deficient Transferrin (CDT) and Gamma glutamyl transferase (GGT). Statistical analysis using SPSS statistical software package.
IV. Survey method using prospective cross-sectional sample.	212 responses from antenatal clinics. 171 pregnant women and 41 partners.	Anonymous paper questionnaire.	Statistical analysis using SPSS statistical software package. Thematic analysis (Braun and Clark, 2006).
V. Survey method using prospective cross-sectional sample.	250 responses 78 Midwives 60 Health Visitors 55 Obstetricians 31 Paediatricians 26 GP's	Online survey	Statistical analysis using SPSS statistical software package.
VI. Service evaluation.	Nine NHS Trusts	Face to face survey	Content analysis (Neuendorf, 2017).

Study I. An initial literature review had highlighted the absence of a systematic review in this field and the need for a more methodical approach to critically appraise existing antenatal alcohol screening research was identified. A systematic review was conducted to compare the efficacy of blood analysis and maternal self-report in detecting at-risk women during pregnancy. This review investigated diagnostic accuracy. Study inclusion criteria considered whether: 1) the study was of pregnant women; 2) the study compared self-reported alcohol consumption with analysis of biomarkers for alcohol in blood samples; 3) the study was of a sample taken from a community, hospital or clinic-based population; and 4) the study publication had a title and abstract in English available in the databases searched. Study exclusion criteria applied if a case-control design was employed or recruitment was restricted to participants who were known alcohol/drug abusers. The precise aim was to detect studies that screened for low or moderate alcohol consumption to identify women who may need help or support. The search timeframe included all publications until the 31st of August 2015. This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher *et al.,* 2009) . The study was registered with the online database PROSPERO (CRD42015028051). The QUADAS II tool was used to evaluate the risk of bias and applicability of all studies included in the analysis (Whiting *et al.,* 2011). The full methodology and quality appraisal can be found in Howlett et al (2017) (Howlett *et al.,* 2017a).

Study II. Building upon the findings from the systematic review, Study II was a prevalence study of pregnant women, using cross-sectional retrospective data from 2014 to 2015, comparing the prevalence of alcohol consumption in the first trimester of pregnancy using self-report and blood biomarker analysis. Northumbria Healthcare NHS Foundation Trust (NHCT) is one of the largest in England, covering a population of approximately 500,000. The area has a varied population ranging from an affluent and rural population to former areas of coal mining and heavy industry which have

left a legacy of high levels of social deprivation and the poorest outcomes for alcohol related disease in England (ONS, 2016). A sample of 600 blood samples were taken from a booking population of 2986 in 2014, equating to 20% of the population, ensuring a representative and reliable sample. An aliquot (0.5 mL serum/plasma) was tested of each anonymised blood sample for Carbohydrate Deficient Transferrin (CDT) and Gamma glutamyl transferase (GGT). CDT is a validated marker of binge drinking and sustained alcohol consumption in the general population, normalising 2–3 weeks from the start of abstinence. In the UK, CDT testing is commissioned by the government to assess alcohol abstinence in medics, pilots and banned motor vehicle drivers (Wolff *et al.*, 2010).

GGT is a liver enzyme which is elevated for eight weeks after the last exposure to alcohol. GGT is a cost-effective and highly sensitive marker for alcohol use in the general population, but is also increased in diabetes and obesity, with drug use and in cholestasis (Hock *et al.*, 2005; Stoler *et al.*, 1998). The full cohort of 2993 booking appointments in 2015 were audited from the medical notes. The 2014 medical notes audit had to be abandoned as only 334 alcohol histories were recorded. The full methodology can be found in Howlett et al (2018), (Howlett *et al.*, 2018).

Study III. This was a prevalence study to identify first trimester alcohol intake in pregnancy, using cross-sectional retrospective data from 2015. Replicating the methods of Study II, six-hundred random blood samples taken at the antenatal booking appointment were anonymously analysed for the presence of CDT and GGT using a North Tees and Hartlepool NHS Foundation Trust (NTHFT) cohort (Howlett *et al.*, 2020). NTHFT has a similar post-industrial, socio-economic profile of social deprivation and poor alcohol related disease outcomes (ONS, 2016). This study built a greater confidence in my earlier results by doubling the total sample size to one thousand two hundred. The blood biomarker analysis (Papers II & III) was assured by the National External Quality Assessment Service (NEQAS) assurance scheme (UKNEQAS, 2021).

Study IV. This was a prospective survey of women and their partner's attending antenatal clinics at NHCT during a 30-day period in 2015 (Howlett *et al.*, 2017b). The women were the focus of this study as screening can only be beneficial if women feel comfortable with the methods used. I also included partner's responses because it is documented that they are a significant influence upon women's attitudes and behaviours (National Maternity Review, 2016). The survey questionnaire was designed and reviewed by an expert Multidisciplinary team panel and a PPI representative. The questionnaire was piloted in an antenatal clinic on a single day and as it was not modified further, the pilot data were included in the results. The survey document was universal for pregnant women and their partners and took 3–5 minutes to complete. Participants were asked to specify their role as a pregnant woman or partner, but anonymity was protected to encourage open and honest responses. The following questions were asked:

1. What level of alcohol do you think is safe in pregnancy? (Nothing/1–2 units per week/1–2 units once or twice a week/more than 3 units per occasion).

2a. In this pregnancy, which statement applies the most? (Stop drinking pre-pregnancy? /stop at the time your pregnancy was confirmed or suspected? /stop drinking after seeing midwife/still drinking/prefer not to say).

2b. If you stopped drinking during pregnancy, how many weeks pregnant were you when you stopped drinking? (State number of weeks).

3. Would you be happy to have your routine booking bloods tested for alcohol levels in a future pregnancy? (Yes/no).

4. Would you be happy to have your baby's first dirty nappy (meconium) tested? (Yes/no).

Subjects were asked to expand on answers to questions 3 and 4 using free text. They were also asked for any general additional comments in free text.

Quantitative data were analysed using SPSS for Windows version 21 owing to its renowned precision and validity (IBM, 2021). Data were summarised using standard descriptive statistics (e.g., frequency, mean, median). Thematic analysis followed the six steps of Braun and Clark (2006) (Braun and Clark, 2006) to ensure familiarisation with the free-text comments, every comment was read and re-read, then reviewed by another researcher to ensure accuracy and reliability. While reading over the comments, initial codes were produced through distinguishing features of the data. All relevant data were gathered through note writing. Once codes were developed, they were organised into potential themes. The relevant quotations were reviewed, and the final themes specified.

Paper V. A cross-sectional national online survey conducted between October 2015 and July 2016 to ascertain healthcare professionals' (Midwives, Health Visitors, Obstetricians, Paediatricians and General Practitioners) perceived knowledge, attitudes and clinical practices concerning alcohol in pregnancy and FASD. Health care professionals are central to screening for alcohol use early in pregnancy, detecting alcohol exposed pregnancies and identifying women who require specialist support. Only a fraction of children with FASD are diagnosed in the UK, and this study aimed to investigate if a lack of awareness by NHS health professionals may be a contributing factor. Health Professionals were sent a web-link to the survey via email using a pragmatic cascade method of distribution which maximised the number of potential respondents but prevented the calculation of the numbers approached and the corresponding response rate.

The study aims and data management processes were summarised in the introduction and all participants remained anonymous. The survey was piloted by representatives from each respondent group before general circulation to ensure clarity, validity and reliability (Ng, 2006). After feedback, some questions were adapted appropriately. No data were included from the pilot phase in the results,

to avoid compromising accuracy and consistency. Twenty four questions relating to perceived knowledge, attitudes, and clinical practices relating to alcohol in pregnancy and FASD were asked (Howlett *et al.*, 2019). Data analysis was validated by the software package SPSS which is designed to provide accurate and validated results (IBM, 2021). Data were evaluated using standard summary statistics (e.g., mean, median, and frequency) and descriptive statistics facilitated the attainment of in-depth information from respondents. Only valid responses are included, invalid reactions referred to unanswered questions or blank fields. Three answers were given which did not appear to respond to corresponding questions, deeming them invalid. Three researchers checked the data and unanimously agreed the answers invalid. All responses were verified by the co-authors to mitigate bias.

Paper VI. A cross-sectional study approach was adopted to undertake a service evaluation using the principles of survey methodology. This study was initiated when the North-East Local Maternity System (LMS) board assigned one of the seven priorities to improve maternal and infant health, to reducing alcohol consumption in pregnancy. This is derived from NHS England's 'Better Births' strategy which aims to ensure that women receive safer, individualised care and greater informed choice and control to facilitate better outcomes (National Maternity Review, 2016). My growing reputation as an expert in this speciality was facilitated by my previous research portfolio, my original contributions to the field and expensive engagement in knowledge transfer strategies nationally and internationally. Therefore, I was commissioned to design a service evaluation survey to increase understanding of existing antenatal alcohol services and clinical practices across the nine maternity Trusts in the North-East and North Cumbria region, over a 2-month period in 2018.

The key Stakeholders included heads of midwifery, local authority 0–19 Teams, Trust alcohol liaison nurses/midwives and Public Health representatives for alcohol and substance misuse. I developed the

survey in collaboration with local key experts in the field from Balance, the North East England Regional Alcohol Office, Durham Public Health and a fetal medicine consultant. The survey used closed and open-ended questions to quantify variables and capture exploratory findings, thus maximising the breadth and depth of findings. The survey included elements from a previous service provision data collection tool which had targeted leadership, commissioning, metrics, patient pathways and staff training. Data were systematically collected using the survey method face to face or in one instance via a telephone conference call. The detailed survey questions are documented in the publication (Howlett, 2020).

Content analysis was the research method used to systematically interpret and code written text, converting qualitative information into quantitative data (Neuendorf, 2017). The volume of text was compressed into content classifications in accordance with coding protocols (Stemler, 2001). Each survey response was captured in a word document, then read and checked to ensure familiarity with the data. All locality data documents were then anonymised and numbered. Each document was transferred to an excel spread sheet, assigned a column and topics were duly established. Consequently, themes and sub-themes were produced and quantified, and the commonalities and differences noted. The data were then re-examined for accuracy. Basic categorisation, or coding was employed to organise data with similarities, thus mapping and interpreting the data (Braun and Clark, 2006; Neale, 2016).

5.3 Methodology

This chapter will describe in more detail the methodology employed in my research. It will briefly evaluate epidemiology and prevalence studies, surveys and clinical audit. Finally, consideration will be given to ethics and the patient involvement.

5.3.1. Epidemiology and Prevalence studies

My studies can be categorised as non-experimental research, because they included observational and descriptive elements (Grove, 2013). Papers II and III can be described as epidemiological studies as they examined the patterns of health-related phenomena in a defined population. Epidemiological studies are essential to public health, and inform policy decisions and evidence-based practice by identifying risk factors for disease and targets for preventive healthcare (Bell, 2010).

The prevalence studies utilised cross-sectional designs to obtain data from the pregnant population at risk of alcohol consumption. A snapshot of the population at risk, determines the extent to which the condition of interest is present (Bowling, 2009). The formula for Prevalence rate is,

$$\frac{\text{Number of cases with the condition or disease at a given point in time}}{\text{Number in the population at risk of being a case}} = K$$

K is the number of people for whom the rate was established (e.g., per 100 population). Data were obtained from the sample. The denominator is the size of the sample and the numerator is the number of cases with the condition, at a given time as identified in the study. The quality of descriptive studies such as this, are more dependent on having a representative sample and high quality measuring instruments than design (Byrne, 1998).

5.3.2 Methodological Considerations

Methodological problems can arise with potential for issues with reliability or validity e.g. the acquiescence response (saying yes to please the inquirer), evaluation anxiety, interviewer bias, mood of participant at the time, recall bias, etc., could arise in Papers II and IV (Babbie, 2013). Monk et al (2014) report that real-time reporting of drinking suggests higher levels of consumption than self-reports based on recall (Monk, Heim and Price, 2014). This is attributed to recalled levels of consumption often involving a significant amount of guesswork and research on alcohol consumption has historically been over-reliant on retrospective self-reporting (Morleo *et al.*, 2011). The self-reported alcohol consumption in general population surveys appears to dramatically underestimate consumption. Ely et al (2009) attribute this to under-reporting and the low response rates in general population drinking surveys (Ely *et al.*, 2009). They adopted the common assumption that under-reporting affects heavier drinkers more than light drinkers because they are more likely to have poorer recall or because they are more likely to deliberately under-report their drinking from shame or guilt. Therefore, self-reported consumption may bias estimates of actual consumption levels, compromising the validity of the results if not acknowledged. Blaikie (1993) concurs that non-respondents may differ from respondents in some critical way, and this could skew the results (Blaikie, 1993).

In response to these methodological concerns, I carefully considered the issues around self-reported data in relation to self-disclosure. I reviewed the current literature and incorporated the relevant findings and recommendations. Muggli et al (2015) conducted a study which aimed to identify the determinants which would enable women to provide accurate data in surveys of alcohol use in pregnancy (Muggli *et al.*, 2015). They used focus groups in a public hospital in Australia with a total of 26 pregnant women and new mothers. Participants reviewed a set of alcohol survey questions

followed by a guided discussion. The findings showed that women's emotional responses were generally positive, but they acknowledged the potential for anxiety and fear of judgement. Confidentiality and survey method, including a preference for methods other than face-to face, were also significant influences. Therefore, the questions rooted in clear context may reduce anxiety around questions about alcohol use in pregnancy (Muggli *et al.*, 2015). They advocated methods using shorter recall periods, a list of drinks choices, measures of special occasion drinking and minimising complex and subjective language increase accurate self-report (Muggli *et al.*, 2015). A setting perceived as confidential and anonymous may reduce the inclination to provide socially acceptable answers. The evidence is based on a study with a small sample size and may have cultural limitations which compromise reliability, but the conclusions do accord with other similar studies (Morleo *et al.*, 2011; May and Gossage, 2011; Payne *et al.*, 2005; Payne *et al.*, 2014). This insight informed the scope of my research, influenced my survey methodology and led to further exploration of alcohol biomarkers. Finally, one significant advantage of survey was the effectiveness yet relative inexpense of production and administration (De Vaus, 2002).

5.3.3 Clinical Audit

Elements of clinical audit methodology were utilised in Papers II & VI because routine clinical data were easily accessible and very relevant to my research. The data I retrieved had never been utilised for clinical or research purposes before. Clinical audit involves a clinical performance assessment, resulting in refinement of clinical practice and the measurement of performance against agreed standards, forming a cyclical process of improving the quality of clinical care (NICE, 2002). Clinical audit is a comparatively simple and economical process providing objective relevant data.

5.3.4 Patient confidentiality

From the antenatal booking notes, the patient hospital numbers and month of booking only were utilised to facilitate the research in Papers II & III, but confidentiality and data protection were meticulously adhered to. All data were managed according to standard NHS guidelines and ethical approval requirements.

5.3.5 Ethical Issues

The Integrated Research Application System (IRAS), a single online system for applying for permissions and approvals for health and social care research in the UK, was employed to coordinate all NHS research governance regulations. This study was given a favourable opinion by the Tyne and Wear South Research Ethics Committee (Ref: 15/NE/0216). NHCT and Northumbria University ethical and Caldicott protocols were adhered to throughout this study (NHS R&D Forum, 2014). The respondent's right to confidentiality was respected and all legal requirements on data protection observed. The patients and clinicians were fully informed about the aims of the survey prior to participation. The surveys were designed to maintain anonymity and confidentiality and no personal identifiable details were requested or obtained. Implied consent was acquired by the respondents voluntarily returning the completed questionnaires in accordance with the Declaration of Helsinki principles (World Medical Association, 2013).

5.3.6 Patient and Public Involvement (PPI)

PPI has been integral to this research from inception to dissemination, demonstrating that the issue is important and relevant to the recipients of this research, i.e., women and FASD communities. The need for prevalence data about alcohol in pregnancy and FASD rates in the UK has been advocated by members of the FASD Network, represented by Maria Catterick, who advised in research planning meetings from Studies II-IV (Catterick, 2019). Likewise, birth mothers of children with FASD internationally have maintained a keen interest in this work and have kindly advised on the research content and survey questions of Studies II-IV, ensuring the integrity and validity of my research (Williams, 2019; Mitchell, 2019; NOFAS-UK, 2019).

This chapter has showcased my expertise in applying a broad range of methodological and research approaches including epidemiology and prevalence studies, surveys and clinical audit. These have been used to inductively build a comprehensive picture of a relatively unknown area. Specifically, establishing prevalence data, examining effective alcohol screening tools and exploring the attitudes of both maternity service users and the health care providers. Staying true to my original aims, a key area has been the authentic involvement of those most affected by FASD, empowering them to shape a service that is truly fit for purpose.

Chapter 6: Results and Implications

In this chapter, my six publications demonstrate my original contribution to knowledge as required in the award of a PhD (Phillips and Pugh, 2010). These publications illustrate how I have undertaken empirical work that had never been done before. I identified that a lack of FASD services could be traced back along the life-course to an absence of alcohol awareness and services in antenatal care, which if effectively addressed could prevent future harms of alcohol exposure. To evidence the extent of PAE I obtained regional antenatal alcohol prevalence rates for the first time. I investigated potential antenatal alcohol screening tools for the routine implementation into health services, from both service user and provider perspectives. Finally, I evaluated a regional antenatal alcohol service and from this gained novel data, synthesised new recommendations for service provision and clinical practice. I have incorporated a multidisciplinary approach to instigate systematic change to improve health outcomes for women and their children. In short, I am the first midwife in the UK to investigate the issue of alcohol in pregnancy from these perspectives and consequently I have contributed valuable new knowledge which is already informing national healthcare provision.

Paper I: How strong is the evidence for using blood biomarkers alone to screen for alcohol consumption during pregnancy? A systematic review.

The systematic review process increased my knowledge and understanding of current methods as I critically appraised the efficacy of self-report in relation to blood biomarkers. GGT was investigated in five studies, (Magnusson, Goransson and Heilig, 2005; Stoler *et al.*, 1998; Savage *et al.*, 2002; Larsson *et al.*, 1983; Halperin *et al.*, 1984) mean corpuscular volume (MCV) and phosphatidylethanol (PEth) in three studies (Kwak *et al.*, 2014; Magnusson, Goransson and Heilig, 2005; Savage *et al.*,

2002) and CDT, aspartate aminotransferase (AST), alanine aminotransferase (ALT) and whole blood associated acetaldehyde assay (WBAA) were each investigated in two studies (Comasco *et al.*, 2012; Magnusson, Goransson and Heilig, 2005; Stoler *et al.*, 1998; Savage *et al.*, 2002; Larsson *et al.*, 1983). Although the methodological quality of all eight eligible studies was good, none of the biomarkers had both high sensitivity and specificity when compared to self-report. Evidence suggested that a combination of biomarkers, or combining biomarkers with self-report, increases accuracy. In conclusion, the blood biomarkers examined were of limited use in screening for low and moderate alcohol consumption in pregnancy when compared to self-report. Given the literature, many of the UK population of pregnant women would fall into this category of drinkers (Mukherjee *et al.*, 2005; Mamluk *et al.*, 2017; ONS, 2017). Therefore, certain biomarkers with higher detection rates of mild to moderate drinkers, such and CDT and PEth, may complement self-report and help improve the accuracy of diagnosis. In summary, I established that blood biomarkers and self-report both have strengths and limitations but the two combined may be a novel and robust antenatal alcohol screening approach that is feasible in practice. The impact of this could have significant implications for maternity services and the prevention of alcohol related harms including FASD. The findings from this systematic review have shaped the research questions of my subsequent publications by helping to clearly identify the potential of combining self-report with blood biomarkers in antenatal alcohol screening.

Paper II: Assessing prevalence of alcohol consumption in early pregnancy: Self-report compared to blood biomarker analysis

The percentage of women who reported consuming alcohol two months before pregnancy was 74.1% and yet only 0.8% admitted consuming any alcohol in the first trimester. CDT analysis revealed a

prevalence rate of 1.4% and GGT a prevalence rate of 3.5%. A statistically significant seasonal variation was noted, with months like December (Christmas) yielding higher values in both CDT & GGT. Further research in larger sub-samples would be useful to establish national antenatal alcohol prevalence data. If substantiated, this finding could inform national public health strategies, and maternity service provision. Although those with elevated CDT generally had high levels of GGT, only one person was positive for both CDT and GGT. Results from CDT analysis and self-report may underestimate prevalence in different ways. GGT appeared to lack specificity, but it may have value in supporting findings from CDT analysis. Blood biomarkers found a slightly higher level of alcohol consumption than was reported by the women, but the blood biomarkers used were sensitive to high level drinkers only.

Further studies using additional blood biomarkers, such as Ethyl glucuronide (EtG) may be useful to detect recent lower-level alcohol consumption. I provided the first UK-based study to compare self-reported alcohol consumption in the first trimester of pregnancy with data obtained from blood biomarker analysis, which contributes to the international body of evidence. This served to highlight the significance of the alcohol agenda in pregnancy in the UK and the need for routine screening in pregnancy. Furthermore, I identified that research combining blood biomarkers and self-report, may be beneficial in detecting an accurate alcohol drinking history in pregnancy. The wider impact being that these prevalence rates have been used by Public Health to inform new national antenatal alcohol guidelines.

Paper III: Assessing the prevalence of alcohol consumption in early pregnancy using blood biomarker analysis: A consistent pattern across North-East England?

The NTHFT data revealed a CDT prevalence rate of 1.7% and a GGT prevalence rate of 4.2%. However, no overlapping cases were identified, and no significant correlation was demonstrated between levels for CDT or GGT (Spearman r = 0.06). These results support my earlier work and establish a more robust evidence base. Prevalence rates according to CDT and GGT analysis were comparable in both areas, suggesting similar patterns of sustained alcohol consumption in pregnancy across the region. Combining these data with those for (NHFT) gives a total prevalence estimate of 1.6% (95% CI: 0.8–2.3) for the region. This is a significant step towards establishing a national picture.

Paper IV: A survey of attitudes, beliefs and practice regarding alcohol use and screening in pregnancy: an opportunity for support and education?

One-hundred and seventy-one pregnant women and 41 partners participated. Of the pregnant women, 153 (89.5%) felt women should abstain from alcohol consumption, although only 70 (40.9%) reported not drinking in pregnancy. Of 96 women who reported drinking in pregnancy and reported when they stopped, all but six (6.3%) stopped drinking when they found out they were pregnant. Of women and partners who recorded an answer, 177 (87.2%) said they would consent to blood biomarker analysis. Confusion over safe levels of alcohol and using screening as an opportunity for education and support emerged as key themes from free-text responses. I determined that most parents want to be informed about any risks of harm to their baby including alcohol and most women were very positive about receiving extra screening interventions to identify alcohol consumption and actively requested more information about alcohol in pregnancy.

Nonetheless, I acknowledge that the acceptability of screening for alcohol in pregnancy in the small number of women who continue to drink is unclear due to the complex factors previously discussed. My work has already led to the effective implementation of antenatal alcohol screening by including service user's perspectives which now reassures midwives and other professionals that women are receptive to questions pertaining to their drinking habits. This new evidence can support health care professionals, who may feel uncomfortable asking women about alcohol consumption. I have incorporated my findings into staff training packages, including the validated PH training collaboration which has been rolled out locally, regionally and nationally.

Paper V: A survey of health care professionals' knowledge and experience of Fetal Alcohol Spectrum Disorder (FASD) and alcohol use in pregnancy.

There were 250 responses to the surveys (78 midwives, 60 health visitors, 55 obstetricians, 31 paediatricians and 26 general practitioners). Of 51 midwives who had referred someone for alcohol use in pregnancy, 36 (70.6%) had referred to an alcohol specialist nurse and 42 (82.4%) to an obstetrician, 16 (31.4%) to addiction services and 18 (35.3%) to a social worker or child protection officer. Of 32 health visitors who had referred for alcohol use in pregnancy, 28 (87.5%) had referred to an alcohol specialist nurse, 4 (12.5%) to an obstetrician, 11 (34.4%) to addiction services, and 12 (37.5%) to a social worker.

Only 5 of 25 (20%) GPs would refer for any alcohol consumption in pregnancy, 8 (32%) if consumption was greater than 14 units per week, and 5 (20%) if greater than 21 units per week: whilst 8 (32%) specified they would refer if the patient was visibly drunk at consultation. In total, 18 (58.1%) paediatricians had diagnosed a patient with Fetal Alcohol Syndrome (FAS) or FASD and 11 (36.7%)

worried about stigmatisation initiated by diagnosis. The highest levels of FASD training were undertaken by 17 (54.8%) paediatricians, compared to only 17 (21.3%) midwives. This was mirrored in perceived knowledge levels; overall, only 49 (19.8%) respondents knew the estimated UK prevalence of FASD for example. These findings support my professional observations that UK clinicians urgently require training in alcohol screening in pregnancy and FASD generally to improve awareness, recognition and appropriate management of both issues.

Paper VI: An antenatal alcohol service evaluation for the North East of England and North Cumbria.

This service evaluation effectively reviewed the current maternity alcohol service provision, established the main themes to be addressed and guided the development of evidence-based recommendations. The traditionally overlooked issue of alcohol in pregnancy was afforded low priory throughout contemporary specialist maternity commissioning, guidelines and services. Inconsistencies were identified throughout regional clinical practices and service provision. For example, a variety of alcohol screening tools were employed with diverse thresholds for referral. A lack of standardised guidelines and patient pathways were partially attributed to varied local commissioning agreements. Limited professional knowledge and awareness was reflected in the fragmented access to training and was further compromised by the lack of UK specific FASD and alcohol consumption in pregnancy prevalence data.

To address these deficits, research and health promotion programs were recommended to increase awareness, educate and prevent future alcohol harms. Innovative best practices identified in the region included multi-agency collaborations, alcohol and FASD champions, local FASD awareness

promotions; and Public Health led, protected-time mandatory training for all maternity staff. These initiatives facilitated delivery of high quality, effective and efficient patient-focused services. Data collection and documentation was sporadic and inconsistent, and governance was not common practice. Audit and monitoring were recommended for measuring and raising standards of care, driving the quality agenda and informing future planning of service provision. A standardised antenatal alcohol screening tool and an approved threshold of referral were also advocated. Standardised patient pathways involving effective alcohol screening and appropriate management processes incorporating best practice, were advised to facilitate referrals to easy-access, seamless alcohol services for pregnant women regardless of postcode. Implementation of these recommendations would necessitate appropriate leadership, commissioning and training strategies in order to successfully achieve the LMS objective of reducing alcohol in pregnancy. Despite my experience as Principal Investigator and study coordinator on earlier research, this paper is my first piece as sole author, illustrating how my journey into clinical research has developed and flourished.

Chapter 7: Discussion and Evaluation

This chapter will detail the impact of my research. It will consider my contribution to the field of knowledge and the consequential implications for practice. As these findings are relevant to many clinical areas, I have compiled them into maternity services, primary care, secondary care and public health. The identified training needs will also be highlighted and finally, recommendations for future research will be recognised.

7.1 Contribution to the field of study

These articles represent an original and independent contribution to scholarship and have advanced my chosen field of study in several ways. I have presented and disseminated these findings which have added extensively to the current body of knowledge around UK antenatal alcohol screening in clinical practice. Significantly, I have examined the larger perspective of alcohol service provision in maternity care for the first time in North-East England and North Cumbria and synthesised evidence-based recommendations for clinical practice. My research findings have been disseminated at international conferences specialising in FASD, alcohol and substance abuse issues. (Appendix 1)

7.2 Impact of my research

When I embarked upon this research, I had not anticipated the opportunities that this work would have upon my professional and personal life. It is a particularly niche area and within a short period of time I was regarded a national expert on the area of PAE and FASD, specifically because I was a midwife rather than a pure academic conducting this research. I have learned that being a clinical academic in

this field has created a demand that offers a world of possibilities. Reflecting upon this developmental journey, I was surprised at how much I have achieved already but also realise how much still remains to be done. I have been very lucky that the close knit FASD community has been very supportive and motivating. My networking skills and resourcefulness have enabled me to maximise my prospects, fulfil my obligations and further this worthy cause. This coherent body of research has direct implications for antenatal alcohol service provision and the clinical practice for all healthcare professionals caring for pregnant women and their children.

Antenatal screening for alcohol is vital to identify those women who require appropriate support and advice, and the process is deemed acceptable to women and their partners. The implementation of a screening programme also raises awareness whilst providing the opportunity to educate women and their families about the risks of alcohol harm. Pregnancy affords women the perfect opportunity and motivation to evaluate their health and lifestyle and make positive changes to benefit their entire life course. Health care professionals require the training and skills to deliver best practice. Importantly, effective antenatal alcohol screening also facilitates the identification of children at risk of FASD and expedites appropriate service referrals. My recommendations span many aspects of health provision and encompass maternity services, primary care, secondary care, public health and staff training. I have used the Research Impact Framework to demonstrate the four categories that assisted me to systematically identify a range of specific and verifiable impacts of my work. (Kuruvilla *et al.*, 2006) (Appendix 2)

7.3 Recommended further research

- Additional research on biomarkers such as EtG and PEth merit further investigation to ensure the most effective biomarkers are selected for alcohol screening to support self-report. Future studies could include consented blood analysis which would permit the identification of medical, demographic and lifestyle risk factors regarding alcohol consumption. Whilst acknowledging the risk of bias acquired through the procedure of consent, comparing anonymous and consented sampling may allow measurement of these biases.
- Research examining the women's viewpoint around their feelings and reactions to their realisation that they were drinking periconceptionally and the impact this has on their emotional and psychological wellbeing during and post-pregnancy would be a very interesting progression of my work. The role of the midwife and other healthcare professionals in this is also worthy of further exploration.
- Pilot-testing a screening programme and interviewing women to evaluate the effectiveness and acceptability would further inform the introduction of a national antenatal alcohol screening programme.
- Meconium testing is known to be a very reliable method to inform retrospective alcohol consumption behaviours in the 2nd and 3rd trimester of pregnancy (Pichini *et al.,* 2012; Lange *et al.,* 2014). A meconium testing study in South West Scotland found that over 15% of pregnant women were drinking substantial amounts of alcohol and only 1% declined to participate (Abernethy *et al.*, 2018). Research using an English cohort would bolster this work and benefit early FASD diagnosis and intervention. Furthermore, these data could help prevent future alcohol exposed pregnancies in the same women.

- During my international networking, birth mothers of children with FASD have expressed a general deficit of evidence from their perspective. Some women have specifically requested research into their personal challenges of coping with addiction whilst raising a child with FASD throughout the life course. As previously verified, resourcing FASD research remains challenging. In the absence of a dedicated funding stream, progress is slow and problematic. FASD remains largely unacknowledged in the UK compared to similar neuro-behavioural congenital problems such as autistic spectrum disorder. A change in awareness around fetal alcohol harm and a more joined-up working and information exchange when developing care pathways is required. I am hopeful that the commissioners and providers can work collaboratively to make a positive difference to the lives of the children and young people living daily with fetal alcohol related harm. I continue to advocate for Alcohol and FASD research with organisations including Public Health England, NICE and Parliament.

Chapter 8: My personal Journey

In this chapter, I will reflect upon the professional and personal impact of my research experience and give an account of the successes, challenges and limitations I have encountered, also contemplating how they have contributed to my knowledge, skills and competencies as a clinical academic researcher.

8.1 Professional Context

My professional background, experience and knowledge had huge benefits to understanding women who access maternity care. Working in the NHS, in antenatal services and as a midwife meant I was an accepted part of the team which helped to establish clinical and research networks of support. This 'insider' role had both advantages and disadvantages; access to patient sensitive data within a professional code of conduct is contrasted to the risk of role conflict and the need to prioritise other important duties and obligations. As an experienced clinical trials nurse and midwife, I have many research skills, contacts and project management expertise to efficiently and effectively run my studies to time and target. The support I received from my R&D department for example was invaluable when navigating the ethics and research governance processes.

My research continues to be aligned to the Nursing and Midwifery Council (NMC) standard 'Prioritise People', a value applicable throughout my professional scope of practice which includes direct care, leadership, education and research (NMC, 2018).

From a strategic perspective, my work also resonates with the NHS long term plan. Salient points include 'doing things differently', which advocates professional collaboration and partnership working to provide a cohesive service, meeting the needs of local communities through primary care networks

and integrated care systems. PAE and FASD falls precisely into the preventing illness and tackling health inequalities objective which aims to tackle some of the most significant causes of ill health, including alcohol (NHSEngland, 2019). Ensuring the 'Best start in life for all', which include the objectives to reduce stillbirth and premature births, can benefit directly from a reduction in PAE (Public Health England, 2016a). Finally, my work directly impacted upon the implementation of the 'Better Births' recommendations by informing the local LMS priority to reduce alcohol in pregnancy (National Maternity Review, 2016).

Leading this research and changing clinical practice has involved developing my quality improvement expertise and applying my compassionate and inclusive leadership skills (National Improvement and Leadership Development Board, 2016). In undertaking the process of applying the new knowledge acquired to improve the health outcomes of mothers and their children, my work could be described as translational research (Haby *et al.*, 2016).

8.2 Challenges

Initially as part of my professional development I had negotiated a modest amount of protected study time to conduct this research and disseminate the findings. Unfortunately, the department experienced a restructure and this support was no longer available. Working full time without allocated study time was demanding but not insurmountable. I have employed my seasoned skills of time management, prioritisation and tenacity to complete this project.

The lack of funding from day one has been challenging. The timelines dictated by conventional funding organisations were protracted and prohibitive. The issues of PAE and FASD were not prioritised on

the health agenda, and in many ways this research is still regarded as avant-garde. Inevitably, funds were only allocated to predetermined health needs to meet obligations ensuring the accountability of the finite resources available. Epidemiological prevalence studies are particularly difficult to finance because organisations such as the NIHR have narrow remits which usually only fund interventional research which can be translated directly into practice, again to demonstrate financial accountability.

An interesting reflection of note was the lack of midwifery journals interested in publishing my work. The only professionally aligned publication was in the Journal of Research in Nursing, and most of the other journals were European or American based. This mirrors my observations of the significance attributed to PAE and FASD within the midwifery profession and across the UK generally.

I am defined by Myres-Briggs as an Introverted, Intuitive, Feeling and Judging (INFJ) personality, known as the 'Advocate' (Myres Briggs, 2017). This assessment was accurate, beneficial and increased my general self-awareness on a personal and professional level. As an introverted personality type, I found public speaking at conferences intimidating. However, with repeated exposure, desensitisation and positive feedback, I now feel more comfortable in the role as my confidence has increased to the point where I now actually enjoy the chance to increase awareness in my quest to prevent future harm.

8.3 Limitations

I was generously awarded capacity building funding from my Trust R&D department which allowed me a small budget to finance the blood analysis using CDT and GGT. However, this was not my original proposal. I had originally intended to conduct the blood analysis as a region-wide study, using

the additional blood biomarker EtG. EtG is a sensitive test which can detect low levels of alcohol consumed up to three days previously (Kilburn *et al.*, 2015). It can identify the more common, low level and occasional drinkers who may be unaware of the risks of alcohol exposure to their baby but is considerably more expensive to analyse. EtG results would have added even greater value to my findings and possibly given more accurate prevalence rate data to better inform practice. Therefore, I adopted a pragmatic and flexible approach, downscaling my research to meet financial constraints. Nonetheless, the original plan is merely postponed to a later study. The data I have collected thus far will strengthen future funding bids and evidences the need for further research in this area.

In summary, I have thrived personally and professionally under the stimulating environs of this PhD. I have a clearer understanding of professional practice issues, clinical and research governance and current NIHR and NHS imperatives. I have established significant networks through my personal research. I also collaborate with key regional and national stakeholders such as the NIHR CRN, NHS partner organisations and universities, contributing to a collaborative strategic vision for research and innovation in practice.

When I first embarked on these research assignments, I anticipated challenges and hoped to gain new knowledge, skill sets and expertise in research and the specialism of PAE and FASD. My expectations have been exceeded and yet I am acutely aware of how much I still need to learn. Moreover, I had not anticipated the diverse, exciting and rewarding experiences that were also part of this rich and complex voyage of self-discovery. On reflection, I believe that PhD by publication was the appropriate route for me to obtain a doctorate qualification as I was keen to publish the evidence to expedite change in this sphere of clinical practice and service provision. Like funding applications and ethical approval, awaiting publication from journals has been prolonged and at times frustrating. I have learned that

many processes of governance and publication are out of the researcher's control and therefore patience, acceptance and resilience are essential qualities. Feedback from reviewers has generally been insightful, constructive and undeniably improved the quality of my writing and my competency as an independent researcher.

8.4 Conclusions

This submission for PhD by publication has demonstrated a body of work providing evidence of an independent and original contribution to the knowledge and understanding around FASD prevention in the form of antenatal alcohol screening. This experience has allowed me the opportunity to undertake innovative research and develop professionally as both nurse and midwife researcher. I have developed my knowledge skills and expertise to the extent where I now receive invitations to provide specialist consultancy opportunities across a range of services nationally. My studies are already informing health policy, further research and clinical practice in the UK and are internationally relevant. Pursuing this body of work has allowed me to network internationally at conferences with inspirational international experts in the field. Due to the complex and far-reaching implications of FASD and alcohol in society, I now have an entire future career of research opportunities to pursue and the burgeoning research skills and strategies required to achieve them. My progress is eloquently articulated by Sir Winston Churchill, '*This is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning*.'

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9. Published papers

Paper I. Howlett H, Abernethy S, Brown NW, Rankin J & Gray WK. (2017) How strong is the evidence for using blood biomarkers alone to screen for alcohol consumption during pregnancy? A systematic review. European Journal of Obstetrics & Gynaecology and Reproductive Biology 213, pp. 45–52.

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Full length article

How strong is the evidence for using blood biomarkers alone to screen for alcohol consumption during pregnancy? A systematic review

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ABSTRACT

Accurate and early identification of women at risk from alcohol consumption during pregnancy allows education and support programmes to be targeted at those most in need. We aimed to conduct a systematic review to compare the efficacy of blood analysis and maternal self-report in detecting at risk women during pregnancy. This review investigated diagnostic accuracy. We searched four databases (Medline, Embase, Psychinfo and CINAHL) for relevant articles and conducted hand searches of recent issues of key journals in the field. No restriction was placed on inclusion in terms of publication date or language. Studies were deemed eligible if they were original research and included a direct comparison of the results of blood biomarker analysis and self-reported alcohol use for the detection of alcohol consumption in pregnant women. Quality appraisal of included studies was conducted using the QUADAS II tool. Eight studies met the inclusion criteria. Gamma-glutamyltransferase (GGT) was investigated in five studies, mean corpuscular volume (MCV) and phosphatidylethanol (PEth) in three studies and carbohydrate deficient transferrin (CDT), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and whole blood associated acetaldehyde assay (WBAA) were each investigated in two studies. Although all of the studies were rated of good methodological quality, none of the biomarkers had both high sensitivity and specificity when compared to self-report. There was some evidence that a combination of biomarkers, or combining biomarkers with self-report, increases accuracy. In summary, the blood biomarkers examined were of limited use in screening for low and moderate alcohol consumption in pregnancy when compared to self-report. However, certain biomarkers, such and CDT and PEth may complement self-report and help improve the accuracy of diagnosis.

Introduction

Fetal Alcohol Spectrum Disorder (FASD) is a range of disorders present at birth resulting from alcohol exposure in pregnancy [1,2]. Alcohol is teratogenic (i.e. a substance which can interfere with the normal development of the embryo or fetus) and, as such, for women who consume alcohol in pregnancy there is an increased risk that their baby may present with FASD [3]. FASD is a leading, preventable cause of developmental delay in high-income countries [4]. FASD children usually present with damage to the brain and central nervous system which cause lifelong intellectual and developmental disabilities. This can have a number of negative impacts on the person with FASD, including attention deficits, poor social skills, hyperactivity, reduced coordination and slower cognitive processing speeds, with deficits in receptive language and verbal working memory [5]. Executive functioning difficulties are demonstrated with poor organisational and planning skills, and the inability to learn from consequences [6,7]. Physical disabilities of FASD can affect any organ or system in the body and symptoms may include cardiac, renal, ocular and auditory defects [6]. Babies born in the severest 10% of FASD can be diagnosed with Fetal Alcohol Syndrome (FAS), which, in addition to the impacts listed above, is associated with facial dysmorphologies, smaller birth weight and a range of mental health disorders in later life [1,2]. Consequently, FASD constitutes a significant public health issue, impacting on health and social care resources, as well as the education and justice systems [5,7].

Reports of the prevalence of FASD vary widely depending on the setting. Prevalence figures from 11.1 to 33.5 per 1000 have been reported in the United States [6,8]. The highest reported prevalence of FASD is 63.9–207.5 per 1000, from a South Africa study [9,10].

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Variations in prevalence rates are likely to be attributable to differences in maternal drinking behaviour, degrees of public awareness, differences in the diagnostic criteria, assessment techniques used, methods of surveillance, and varying sample/population demographics [7]. However, generally the most significant challenge in obtaining reliable data on prevalence is the need for a maternal history of alcohol use in pregnancy to allow diagnosis.

Screening for alcohol use in pregnancy

In the UK, and many other countries, screening, based on self-report, followed by in-depth interview of those who screen positive, is widely used as a means of identifying those at risk and is seen by many as a 'gold standard' [5]. Self-report avoids many, although not all, of the ethical problems associated with more invasive screening methods. However, self-report can be unreliable and may be biased by social desirability responses dependant on the patient-clinician interaction and perceived stigma around alcohol use in pregnancy [11,12]. For some women the situation is complicated by confusion regarding what is a 'safe' amount of alcohol to consume in pregnancy and difficulty in judging how much alcohol they have consumed [3,13–16].

Nevertheless, given the potential profound impact of the physical and psychological problems which are caused by FASD, it is essential that women drinking alcohol in pregnancy are identified and offered support as early in pregnancy as possible [17]. The use of simple screening questionnaires is inexpensive, non-invasive, relatively quick to administer and requires no specialist equipment [18,19]. Tools such as TWEAK, CAGE, T-ACE, AUDIT and AUDIT-C are widely used in clinical practice, and their relative merits have been reviewed [20,21]. AUDIT-C, T-ACE and TWEAK are cited as the most valid tools for identifying drinking in BMA guidance and in a systematic review by Burns et al., and are recommended by the UK Department of Health [19,20]. In the United States, the National Institute of Alcohol Abuse and Alcoholism (NIAA) also advocate simple screening questionnaires, such as the T-ACE, as worthwhile preventive measures [22]. Despite the limitations of self-report, in the absence of a valid alternative, it remains the most suitable method for identifying women who drink alcohol in pregnancy.

Biomarkers for alcohol use in pregnancy

Over the last 10–15 years, there has been a growing interest in the identification of novel biomarkers for alcohol consumption in pregnancy in samples of maternal blood, urine and hair and post-partum meconium [14]. Such biomarkers offer the prospect of an objective and quantitative method for identifying women who consume alcohol in pregnancy. Analysis of meconium samples has been of particular interest, given the possibility that it can provide information regarding alcohol use across a substantial portion of the ante-natal period [23]. Although meconium testing may be useful as an aid to the diagnosis of FASD, a simple, inexpensive and accurate method is needed that can detect alcohol exposure in the early stages of pregnancy. This would allow women who may be drinking, or are at risk of drinking, during pregnancy to be offered early help and support, and thus prevent further harm to the fetus. Biomarkers in blood may offer a useful compromise between the identification of exposure over the long-term offered by meconium, hair and nail analysis, but which involve complicated and expensive analytical techniques, and the much shorter half-life of biomarkers from urine analysis. Unlike other tissue sample types, alcohol biomarkers in blood samples taken during the first

Table 1
Summary information for biomarkers used.

Name	Description	Period after alcohol consumption during which a positive result may be recorded	Strengths	Weaknesses
Gamma-Glutamyltransferase (GGT), Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT)	Liver enzymes	Elevated 1–3 weeks after last exposure	Able to measure relatively recent changes in alcohol consumption patterns and may be a good marker for drinking in early pregnancy and before the pregnancy was confirmed. [21].	Not increased by binge drinking. May be elevated by other forms of liver damage, including non-alcoholic fatty liver disease. Sensitivity and specificity are thought to be low, limiting clinical utility. [21]
Mean Corpuscular Volume (MCV)	Average red blood cell volume	Elevated after 1–3 months of heavy alcohol consumption	Greater specificity than GGT, AST and ALT. [21,14].	MCV is naturally elevated in mid- to late stage pregnancy, limiting specificity. Elevated MCV levels are only produced after sustained and regular excessive drinking. [14] Therefore, MCV has limited value as a single marker. [21].
Carbohydrate Deficient Transferrin (CDT)	CDT is synthesised and secreted in the liver and acts as a carrier for iron in the blood.	Elevated 1–3 weeks after sustained exposure	Thought to have higher specificity, but lower sensitivity than GGT or MCV. Able to detect binge drinking and sustained exposure. Commercial assays for clinical use available. [21,39].	Will not detect low/moderate drinkers. Total transferrin increases naturally during pregnancy, so CDT is taken as a percentage of total transferrin, the validity of this approach requires further investigation. [21] Historical studies may be affected by methodology and lack of suitable common standard material. [39]
Whole Blood Associated Acetaldehyde Assay (WBAA)	Acetaldehyde is the main product of oxidative ethanol metabolism.	Can be detected one month after alcohol consumption	Acetaldehyde-protein adducts (APAs) have a longer half-life than free acetaldehyde and remain high in blood for approximately a month after alcohol intake. Thought to have high sensitivity and specificity. [28]	Potential to produce false-positives due to the formation of acetaldehyde in blood after sample collection. [28]
Phosphatidylethanol (PEth)	A group of ethanol-derived phospholipids, formed in the presence of ethanol	Can be 2–3 weeks after sustained alcohol consumption	Sensitive indicator of heavy alcohol use. May be a good marker for drinking in early pregnancy and before the pregnancy was confirmed. [40,41]	Will not detect low/moderate drinkers. There is no suitable calibration material to standardise assays between different methods. PEth may be unstable unless frozen. [40,41].

trimester can be used to identify alcohol exposure during the early weeks of pregnancy, allowing timely intervention.

Aims

The aim of this systematic review was to compare rates of alcohol consumption reported by pregnant women and that seen on analysis of blood biomarkers. We aimed to evaluate the current utility of biomarkers as a screening method to detect alcohol use during the early stages of pregnancy.

Methods

This is a review of the literature and does not require ethical approval. It conforms to the provisions of the Declaration of Helsinki in 1995 (as revised in Tokyo 2004). This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [24]. The study was registered with the online database PROSPERO (CRD42015028051).

Inclusion/exclusion criteria

Studies were considered for inclusion if: 1) the study was of pregnant women; 2) the study compared self-reported alcohol consumption with analysis of biomarkers for alcohol in blood samples; 3) the study was of a sample taken from a community, hospital or clinic based population; and 4) the study publication had a title and abstract in English available in the databases searched. Studies were excluded if they followed a case-control design or recruited only subjects who were known alcohol/drug abusers. Our specific aim was to identify studies that screened for low or moderate alcohol consumption to identify women who may

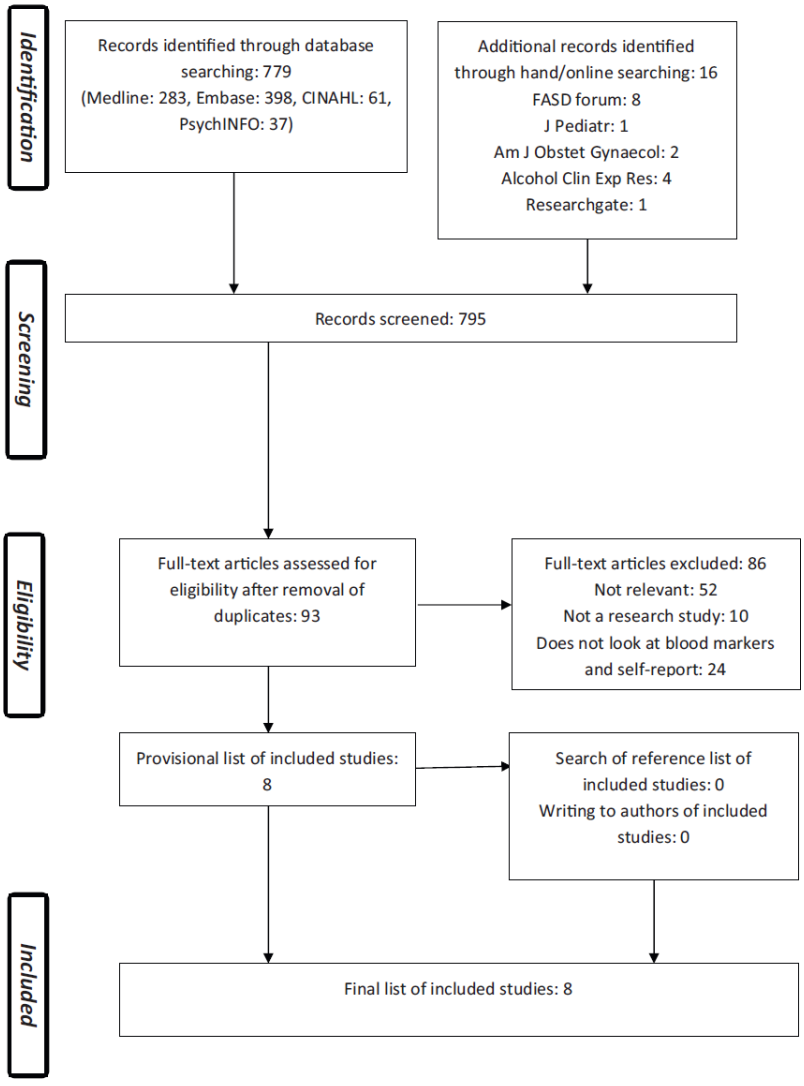

Fig. 1. Flow chart of study identification procedure.

Table 2
Summary of study characteristics and key findings from included studies.

Author, year	Setting	Population	Design	Gestational age	Blood test and cut off used	Questionnaire and cut off used	Self-report and blood sample at the same time?	Summary of results	Birth outcomes
Kwak, [26,27]	South Korea	355 referrals of singleton women over a 12 month period, no history of psychiatric or cognitive problems, 305 consented (85.9%)	Prospective, hospital based	First trimester	PEth in whole blood (1.2 nmol/L)	Study specific questionnaire, categories based on US Institute on Alcohol, Abuse and Alcoholism definitions	Blood test within 4 weeks	AUROC 0.69 for abstainers vs any alcohol consumption during pregnancy, sensitivity 40.7%, specificity 95.4%. AUROC 0.99 differentiating heaving drinks from light, moderate and non-drinkers	Reported on 284 subjects. Greater proportion of spontaneous abortions in moderate/heavy drinkers compared to light/none drinkers, but no significant difference (risk ratio 3.2, 95% CI 0.9 to 11.1)
Comasco, [30]	Sweden	2481 women over a 19 month period, 2264 consented (91.3%); 1869 followed up at 32 weeks gestation. CDT analysis in 198, PEth in 77 (randomly sampled)	Prospective, hospital based	Second trimester (week 16–18)	CDT (1.7%) PEth (0.1 μmol/L)	AUDIT (≥9), AUDIT-C (≥1)	Yes for AUDIT, week 32 for AUDIT-C	10.7% reported abstinence before pregnancy, compared to 87.7% during pregnancy. Binge drinking before pregnancy associated with drinking during pregnancy. No positive CDT or PEth results. Younger women drank more before pregnancy, but older women more during pregnancy. Higher pre-pregnancy AUDIT score, older age, nicotine use and previous legal abortion predicted alcohol use in pregnancy.	3 (0.13%) spontaneous abortions and 1 peri-natal death, 0.9 had birth weight <2.5 kg. Birth weight of girls was significantly higher in those who drank in pregnancy than abstainers.
Magnusson, [28]	Sweden	306 women randomly selected from 1106 referrals over a 12 month period, 303 consented (99.0%)	Prospective, clinic based	Median 12 weeks, range 8 to 24 weeks	MCV (96 f/L), GGT (0.8 μkat/L), AST (0.6 μkat/L)), ALT (0.6 μkat/L)), CDT (1.5%)	TLFB (6 standard drinks during ≥2 weeks or 5 standard units per episode on ≥2 occasions), AUDIT (6 or higher)	Yes	15% of women had risky drinking behaviour during pregnancy AUDIT appears to be more informative than biomarkers, but both had low sensitivity, pre-pregnancy drinking predicts drinking in pregnancy.	Not reported
Stoler, [29]	United States	695 women approached over a 3 year period, multiple gestations and known exposure to teratogen excluded, 529 consented (76.1%)	Prospective, hospital based	At prenatal check, 20% in first trimester, 80% in second or third trimester	WBAA, GGT, CDT (3% not including trisialoisoform), MCV	TWEAK, TLFB	Yes, self-report pre-pregnancy also used.	All four markers together were more predictive of outcomes than self-report using the infants' physical features as the gold standard. Clear dose response relationship between at least one positive marker and self-report	67/407 (16.5%) of infants showed signs associated with maternal alcohol consumption. Two or more biomarkers was a good predictor of infant outcomes.
Savage, [31]	United States	11 women approached, excluded if <18 years or not	Prospective, clinic based	First trimester	WBAA, GGT, MCV (no cut-offs reported)	TLFB	Yes	All biomarkers normal or not detected, 5 drank alcohol during pregnancy, all 5 reduced intake	Not reported

Table 2 (*Continued*)

Author, year	Setting	Population	Design	Gestational age	Blood test and cut off used	Questionnaire and cut off used	Self-report and blood sample at the same time?	Summary of results	Birth outcomes
		first trimester, 10 consented (90.9%)						initially, but 3 returned to pre-pregnancy drinking by month 4	
Larsson, [32]	Sweden	702 women enrolled, 669 women had samples taken for analysis. No data on non-consent	Prospective, clinic based	At first clinic visit, median 10–11 weeks, 92% in first trimester	GGT AST ALT (no cut-offs specified)	Structured interview	Yes	13% admitted drinking excessively during pregnancy At 95% specificity, sensitivity was only 25%	Birth weight lowest and spontaneous abortion highest in women with high alcohol intake and birth weight highest and spontaneous abortion lowest in women with lowest alcohol intake
Halperin, [33]	Switzerland	630 women enrolled, 308 newborns assessed	Prospective, setting not stated	Second trimester (14–20 weeks)	GGT (22 U/L)	Structured interview	Yes	GGT elevated in 8.4%, but screening suggested 1% of women with risky drinking GGT correlated with birth weight, but sensitivity was weak	Those with high GGT had reduced intra-uterine growth

need help or support. The effects of heavy alcohol consumption on the fetus are well known and women who are alcohol dependent or heavy alcohol users will probably already be known to health services without the need for additional screening. The Substance Abuse and Mental Health Services Administration (SAMHSA) defines heavy drinking as drinking 5 or more drinks on the same occasion on each of 5 or more days in the past 30 days.

Definition of self-report included use of screening tools, in-depth interview and techniques such as time line follow back (TLFB). A substance or test was considered to be a blood biomarker when analysed from a blood sample taken by venipuncture and there was research evidence suggesting it may be a useful marker for alcohol consumption in humans. Table 1 summarises the properties of commonly used alcohol biomarkers in blood.

Information sources and database searching

To identify relevant studies, a database search was conducted in Medline (1946 to present), Embase (1980 to present) CINAHL (1981 to present) and PsycINFO (1806 to present). A cut-off date of 31st of August 2015 was used. A librarian (SA), who was a member of the study team, conducted the database searches.

In addition, all references of included studies and previous systematic reviews related to alcohol use in pregnancy were screened (HH and WKG) and studies not identified by database searching were reviewed. Citation searching of the included studies identified further articles which were screened for relevance (SA). Finally, the titles of articles in key journals and research databases over the 12 months prior to the date cut-off (31st August 2015) were hand searched for relevant articles. A flow diagram detailing studies identified at all stages of the search is shown in Fig. 1.

Study screening

All titles and abstracts of studies identified during database and reference list searches were screened by a senior research midwife (HH) and a research associate/statistician (WKG).

Data extraction

Data relating to population characteristics (e.g. setting, demographics), study design and key findings were independently extracted by two researchers (HH and WKG).

Methodological quality assessment

The Quality Assessment of Diagnostic Accuracy Studies, QUADAS-II tool, was used to assess methodological quality [25] independently by two researchers (HH and WKG).

Data synthesis

A narrative synthesis of included studies is presented. A meta-analysis was not possible due to the small number of included studies.

Results

Design, setting, recruitment strategies and participants

Eight studies met our inclusion criteria, although two studies were of the same population [26,27]. Settings and designs are summarised in Table 2. All studies were prospective and all seven that reported the setting were hospital or clinic based. Three were from Sweden, two from the United States and South Korea and one from Switzerland (see Table 2). The proportion of women approached who agreed to blood sampling was generally high, varying between 76.1% and 99.0% in the six studies (15–21) that reported recruitment rates.

Summary of study findings

Measures of alcohol consumption by self-report

Study findings are summarised in Table 2. A range of biomarkers were studied and most studies investigated more than one marker. Gamma-glutamyltransferase (GGT) was investigated in five studies, mean corpuscular volume (MCV) and phosphatidylethanol (PEth) in three studies and carbohydrate deficient transferrin (CDT), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and whole blood associated acetaldehyde assay (WBAA) were investigated in two studies each. There was a much smaller spread of self-report tools used, with TLFB utilised in three studies and structured interview in two. AUDIT/AUDIT-C was employed in two studies and TWEAK in one study (see Table 2). The two studies of Kwak et al. [26,27] used a study specific questionnaire.

In the study by Magnusson et al. [28], there was poor agreement between the AUDIT and TLFB, with AUDIT only identifying 13 of 24 (sensitivity 54.2%) cases identified by TLFB, but identified a further nine women who drank alcohol not identified by TLFB. Although Stoler et al. [29] used both the TWEAK and TLFB to identify women who consumed alcohol; they did not compare the two methods.

Comparison of alcohol blood biomarkers with self-report

PEth and CDT appear to be of use in identifying heavy drinking, but their accuracy in identifying low/moderate levels of drinking was poor [26,27,29,30]. In the study by Comasco et al. [30], no positive PEth or CDT results were recorded and only 24 women in the study by Stoler et al. [29] were positive for CDT, compared to 98 by self-report. Only 12 of the 98 self-positives reported by Stoler et al. [29] were positive for MCV and only five positives compared to 24 positives by TLFB reported by Magnusson et al. [28]; there were no MCV positives in the study by Savage et al. [28,29,31]. Magnusson et al. [28] reported 10 positives for AST and eight for ALT compared to the 24 positives identified by TLFB and Larsson et al. [32] reported that at 95% specificity, sensitivity for AST was 15% and for ALT was 19% compared to structured interview. Savage et al. [31] reported no positives for WBAA analysis in their sample of 10 women, whilst Stoler et al. [29] identified 120 positives for WBAA, compared to 98 positives from self-report. Finally for GGT, Stoler et al. [29] reported 13 positives (98 by self-report), Savage et al. [31] no positives (five by self-report), Magnusson et al. [28] two positives (24 by self-report) and Larsson et al. [32] 66 positives from 89 moderate to heavy drinkers, giving a specificity of 95% but a sensitivity of only 26%. Halperin et al. [33] recorded 24 positives by GGT, although only three of these reported alcohol consumption during structured interview.

Quality appraisal

The included studies reviewed were judged to be generally of good methodological quality using the QUADAS-II tool (see Table 3). Methods of patient selection were not detailed for the study by Savage et al. [31], Larsson et al. [32] and Halperin et al. [33] included all women attending antenatal clinics in a given time frame. However, details provided were scant. Halperin et al. [33] did not document any evidence of ethical approval or patient consent and Larsson et al. [32] detailed ethical approval but not consent procedures. The risk of bias was deemed high in terms of the flow and timing of assessments for the studies of Kwak et al. [26,27] and unclear for Comasco et al. [30]. Kwak et al. [26] reported a delay of up to four weeks between self-report and blood sampling. In the study by Comasco et al. [30] not all enrolled patients were included in blood analysis and the method of patient selection was not clarified. All other studies were deemed low risk for bias and applicability on all items.

Although none of the studies specifically mention blinding, blood sampling was conducted at the same time or after self-report, meaning that self-report was effectively blinded. Furthermore, although it was often unclear whether blood sample results were interpreted without knowledge of the result of self-report, the objective nature of blood sample analysis meant that we considered the risk of bias to be low.

Although the healthcare system was generally well described in the three studies from Sweden, the nature of the clinics used and how they were funded in the US, Swiss and South Korean studies was not specified. This may have resulted in some bias with regard to the generalisation of the findings to other sites, but we did not consider this to be an important bias in terms of our study aims and objectives.

Comment

The risks to the fetus of consuming large amounts of alcohol in pregnancy are relatively well understood, yet the potential risks of low to moderate drinking in pregnancy are far from clear [3,34,35]. An important first step in identifying the risks and potential effects of low to moderate alcohol consumption on birth outcomes, is an accurate history of maternal alcohol use. Our study suggests that, currently, there is little evidence that blood biomarkers offer a more objective assessment of alcohol consumption in pregnancy than self-report. However, there was some evidence that a

Table 3
Quality appraisal using the QUADAS-2 tool.

	Patient selection		Index test(s)		Reference standard		Flow and timing
	Risk of bias	Applicability	Risk of bias	Applicability	Risk of bias	Applicability	Risk of bias
Kwak, [22,23]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	High risk
Comasco, [26]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Unclear
Magnusson, [24]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Stoler, [25]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Savage, [27]	Unclear	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Larsson, [28]	Unclear	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Halperin, [29]	Unclear	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk

combination of biomarkers, or combining biomarkers with self-report, increases accuracy.

Bakhireva and Savage [21] have described the ideal biomarker to detect alcohol use in pregnancy as one that has high sensitivity and specificity and a capacity to detect low to moderate levels of alcohol consumption over a long period of time since the last exposure. Samples should be easily obtainable using minimally invasive techniques, sample preparation should be nominal and the analytical technique should be inexpensive, quick and at the point of care. Although previous research into alcohol biomarkers in pregnant women is rather limited, none of the currently known biomarkers can be said to meet all these criteria.

Use of blood biomarkers is attractive in that blood sampling, although invasive, is accepted and seen as a standard medical procedure in many societies and many of the criteria laid out above are met. Blood samples are generally more straightforward and less expensive to analyse than many other tissue types (e.g. hair, fingernail and meconium). Blood sampling also has the potential to detect alcohol consumption early in pregnancy allowing support to be given to those women at risk. However, normal changes in blood biochemistry across the pregnancy cycle, and high between-subject variation in the nature of these changes, presents a substantial challenge for analysts. Furthermore, the requirement to accurately detect low to moderate levels of these biomarkers is a further complication with many of the cut-offs set around the lower level of quantification [26]. An important issue with newer biomarkers, such as PEth, is the lack of suitable reference standard preparations, which will introduce wide variation in results between different laboratories.

Blood biomarkers may be helpful in detecting heavy drinking behaviour in known alcohol abusers, yet many such women will already be known to health and social services and so already have access to support services. However, our findings suggest that blood biomarkers are of limited use in detecting low and moderate levels of alcohol consumption in the general population of pregnant women [36,37]. Although no single biomarker appears to be useful, the studies by Magnusson et al. [28] and Stoler et al. [29] suggest that a combination of several biomarkers or of self-report and biomarkers may offer greater accuracy. However, further work will be needed if such screening is to be useful in a clinical setting. A more refined approach than the simple additive method used by Stoler et al. [29] may be required. Specific biomarkers and screening tools should be selected to complement each other, covering exposure in the short- and long-term.

We have taken self-report to represent a gold standard for identifying alcohol use in pregnancy. We recognise that self-report has many flaws when attempting to identify women who drink in pregnancy. The challenges of personal recall regarding amounts and frequency of alcohol consumption, combined with the stigma and fear of repercussions can inhibit self-disclosure [4,14,38]. In this regard, we also acknowledge that those women who refused consent to take part in the respective studies may well contain a higher proportion of those who drink in pregnancy than those who did consent, and that, as such, all of the studies included are likely to have an inherent bias. One way of assessing the level of this bias would be to conduct an initial anonymous analysis of routine blood samples from clinic attendances that would not require patient consent followed by a study seeking consent from a different cohort, but within the same setting. Further research into the attitudes of pregnant women, their partners and clinicians to self-report and biomarker screening may help identify other sources of bias. The relationship between health care professionals, alcohol and how this influences clinical practice is also worthy of additional investigation.

Limitations

As with all systematic reviews, it is possible that we have not identified all published studies which met our inclusion criteria. Nevertheless, we searched the reference lists, undertook citation searching of the included studies, hand searched recent journals in the area and reviewed forums and databases for FASD special interest groups. Publication bias, with studies with negative findings less likely to be published, may also have influenced our findings.

Gestational age at the point of the blood tests and self-reports varied within studies that we reviewed. The sensitivity and specificity of some blood biomarkers used in this review may alter throughout the course of pregnancy due to the normal physiological changes that occur, such as the increased circulating maternal blood volume. Therefore, some biomarkers may be more reliable earlier in pregnancy.

Conclusions

Although self-report may have many flaws as a method of detecting women who consume alcohol in pregnancy, no single blood biomarker can be recommended as a replacement for self-report based on current evidence. There appears to be some evidence that a combination of biomarkers, or biomarkers used to complement self-report, may have some clinical value. Simply adding up the number of positive biomarkers from a battery may be too crude a method for routine clinical use. Further investigation of the validity and reliability of a specific biomarker at a given duration of gestation or duration from last consumption, to give an overall picture is needed. Likewise, understanding the profile of women who would and would not consent to alcohol biomarker analysis and whether knowing that biological samples could be used to investigate alcohol consumption would increase the accuracy of self-reporting would be particularly interesting. Further qualitative research into women's and clinicians' attitudes towards, and the acceptability of, ante-natal alcohol screening would also be valuable. However, screening for alcohol use in pregnancy, using either biomarkers or self-report, will only be useful if it is accompanied by patient education and support at an early stage in the pregnancy. The ultimate benefit of any screening programme may be that screening presents an opportunity for discussion on this often sensitive topic.

Author contributions

H.H. and W.K.G. conceived and, with J.R., designed the study. S. A. conducted the database searches. H.H., W.K.G. and N.B. undertook study screening, extraction, synthesis and interpretation. H.H. and W.K.G. drafted the paper and all authors commented on the paper and gave final approval for submission.

Disclaimer

The authors report no conflicts of interest

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Assessing prevalence of alcohol consumption in early pregnancy: Self-report compared to blood biomarker analysis

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ABSTRACT

Providing appropriate antenatal and postnatal care for women who drink alcohol in pregnancy is only possible if those at risk can be identified. We aimed to compare the prevalence of alcohol consumption in the first trimester of pregnancy using self-report and blood biomarker analysis. Six-hundred routine blood samples from 2014, taken at the antenatal booking appointment, in the first trimester of pregnancy, were anonymously analysed for the presence of Carbohydrate Deficient Transferrin (CDT), a validated marker of chronic alcohol exposure (normalising 2–3 weeks from abstinence) and Gamma-glutamyltransferase (GGT), a liver enzyme elevated for up to 8 weeks after alcohol exposure. In a separate sample of women, from 2015, data taken during the antenatal visit, documenting women's self-reported alcohol consumption, were collected. The percentage of women who reported alcohol intake in the first trimester was 0.8%. This compared to 74.1% of women who reported consuming alcohol before pregnancy. CDT analysis revealed a prevalence rate of 1.4% and GGT a prevalence rate of 3.5% in the first trimester of pregnancy. Although those with elevated CDT generally had high levels of GGT, only one person was positive for CDT and GGT. Results from CDT analysis and self-report may underestimate prevalence for different reasons. GGT appeared to lack specificity, but it may have value in supporting findings from CDT analysis. Further studies using additional blood biomarkers, or a combination of blood biomarkers and self-report, may be beneficial in accurately detecting alcohol drinking history in pregnancy.

1. Introduction

Alcohol is the most widely used toxicant and teratogen worldwide (Smith et al., 2016; World Health Organization, 2014). Throughout Europe and Western societies, alcohol is socially acceptable, readily available and therefore not generally perceived as harmful. Binge drinking, defined as four or more standard drinks on a single occasion in America or in the UK, exceeding six units in one day is common and acceptable, with young women of childbearing age sometimes drinking as much as men (Department of Health, 2016). As an estimated 50% of pregnancies in the UK are unplanned, even informed and compliant women may have unwittingly consumed alcohol in pregnancy (British Medical Association Board of Science, 2007).

Alcohol is both teratogenic and fetotoxic and passes freely across the placenta to the unborn baby at levels at least equal to that of the mother (Hepper et al., 2012). Alcohol is known to have a direct effect on neural development including proliferation, migration, synaptogenesis, and cell death (Smith et al., 2016). It is widely acknowledged that prenatal alcohol exposure can have a negative impact on growth before and after birth, miscarriage, stillbirth and preterm birth (Comasco et al., 2012; Department of Health, 2016).

Although alcohol is teratogenic, the timing, dose and frequency of exposure are known to significantly influence outcomes (British Medical Association Board of Science, 2016). The effects of alcohol consumption on the fetus appear to be confounded by other factors such as diet, smoking, poly-drug use and genetics. Epigenetics may determine some of the harmful effects of prenatal alcohol exposure and contribute to the deficits and abnormalities concomitant to Fetal Alcohol Spectrum Disorder (FASD) (Kobor and Weinberg, 2011). Hereditary and lifestyle factors are known to affect fetal outcomes in response to exposure to alcohol, particularly with moderate drinking (Flak et al., 2014; Kilburn et al., 2015; Nykjaer et al., 2014; Skogerbo et al., 2013). Nevertheless, some reports suggest a link between low/moderate alcohol consumption or binge drinking and poor pregnancy outcomes (Flak et al., 2014; Lewis et al., 2012).

Children with FASD present with damage to the brain and central

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nervous system causing intellectual and developmental disabilities (British Medical Association Board of Science, 2016). Prevailing FASD traits can include attention deficits, poor social skills, hyperactivity, impaired coordination, abnormal muscle tone, slower cognitive processes, alongside difficulties with verbal working memory and receptive language (Savage et al., 2002). Secondary disabilities include educational exclusion, substance abuse, mental illness and even premature mortality and morbidities (Mukherjee et al., 2012). These consequences incur huge costs to health, education, social care and justice sectors (Popova et al., 2017a). The prevalence of FASD globally is thought to be around 1–3%, although reliable data are limited and estimates vary widely depending on the setting (Mukherjee et al., 2012). One recent study using active-case ascertainment found the weighted (to be representative of the background population) FASD prevalence rates of four US communities ranged from 3 to 10% (May et al., 2018). Only after diagnosis can individuals with FASD, and their families, be offered the support needed to help improve outcomes. Although diagnosis guidelines vary, for individuals without the fetal alcohol syndrome (FAS) dysmorphic features, diagnosis of FASD is generally only possible with a maternal alcohol consumption history. In the United Kingdom (UK), this is primarily based on self-report, with more detailed questioning of those who screen positive. This method is commonly regarded as the 'gold standard' (British Medical Association Board of Science, 2007).

Popova et al. (2017a) estimated the prevalence of alcohol use during pregnancy globally via random effects meta-analysis and fractional response modelling. The five countries with the highest rates were Russia (36.5%), the UK (41.3%), Denmark (45.8%), Belarus (46.6%) and Ireland (60.4%). Tsang and Elliott (2017) note that alcohol use data from high risk populations such as indigenous women, adolescents, women with low socioeconomic demographics, women diagnosed with HIV or alcohol use disorders were excluded from analysis as they were not deemed generalisable to their national population. However, the exclusion of these populations from research studies may mean that many prevalence estimates are conservative. Another study by Popova et al. (2017b) illustrated a higher than average prevalence of alcohol use during pregnancy among the Aboriginal populations of Canada and the United States at approximately 36.5% and 42.9% respectively, compared to the general population levels of 10% and 15%.

Although there are no reliable estimates of the prevalence of FASD in the UK, given the data on alcohol use in pregnancy, it is likely to be towards the upper end of the global range (Popova et al., 2017a). Nonetheless, obtaining accurate and reliable data on alcohol use in pregnancy is complicated. Social stigma associated with drinking alcohol, poor recall and difficulty in estimating the alcohol content of some drinks or the volume consumed is thought to result in significant under-reporting (Lange et al., 2014). Self-report can also be influenced by the patient-clinician interaction and the desire of the patient to provide social acceptable responses (Ford et al., 2009; Jones et al., 2011). The situation is compounded by mixed messages to pregnant women in the UK regarding safe levels of alcohol consumption. Although internationally (including the UK Department of Health), guidelines appear to be hardening towards recommendations of total abstinence throughout pregnancy (Department of Health, 2016), informal information sources (such as friends and family and personal experience of a previous pregnancy when alcohol was consumed without adverse effect) can contradict this guidance and influence behaviour (Raymond et al., 2009). All of these factors are likely to contribute to under-diagnosis of FASD, resulting in many mothers and children not getting the support they need.

In an attempt to overcome the potential shortcomings of self-report, objective biomarkers for alcohol consumption have been sought. Analysis techniques using samples of maternal blood, urine, hair and fingernails have been developed (Lange et al., 2014). Of these, blood sampling may be the most promising, given that sampling blood is acceptable to most cultures, sample preparation is relatively straight forward and there are many alcohol metabolites and markers for alcohol consumption which remain within the blood for an extended period (Bakhireva and Savage, 2011). It is important to recognise that the use of biological samples for screening raises wider ethical issues related to consent, stigmatisation, individual rights and the rights of the unborn child (Mizejewski, 2010; Zizzo et al., 2013).

Nonetheless, despite the widespread use of self-report and growing evidence of the technical feasibility of biomarker analysis, there are limited previous data regarding the validity of blood biomarkers to record alcohol consumption in pregnant populations (Bakhireva and Savage, 2011; Howlett et al., 2017; Magnusson et al., 2005; Savage et al., 2002).

We aimed to compare the prevalence of alcohol consumption from self-report with that identified through blood biomarker analysis within a random sample of all women attending routine antenatal clinics during the first trimester of pregnancy in the Northumbria Healthcare National Health Service (NHS) Trust. We hypothesised that the prevalence of alcohol consumption in early pregnancy would be significantly higher from blood biomarker analysis than from self-report. In secondary analysis, we sought to detail the variation in blood biomarker data throughout the year.

2. Methods

2.1. Ethical issues

This study was given a favourable opinion by the Tyne and Wear South Research Ethics Committee (Ref: 15/NE/0216). Individual patient consent was not required. Data on self-reported alcohol consumption were extracted from collated clinical data and patient medical notes. Existing routine clinical blood samples were analysed anonymously, with only the month the blood sample was taken recorded. Blood samples were taken from a different year (and so a different sample of women) to the self-reported data to avoid the possibility of identification of individual blood samples as belonging to a specific individual. Anonymous blood sampling had the advantage of ensuring the blood samples were representative, since we could analyse samples from all patients, without the potential biasing effect of requiring consent.

2.2. Study design

This was a prevalence study of pregnant women, using cross-sectional retrospective data from 2014 to 2015, which compared two methods designed to identify first trimester alcohol intake in pregnancy.

2.3. Participants and setting

Northumbria Healthcare NHS Foundation Trust is one of the largest acute healthcare Trusts in England, covering a population of around 500,000 people living in North Tyneside and Northumberland in North East England. Although much of Northumberland is rural, the South East of the region was formerly an area of intensive coal mining and heavy industry. North Tyneside is largely urban and forms the Eastern border of the city of Newcastle-upon-Tyne. The North East of England has some of the poorest outcomes for alcohol related disease in England, and some of the highest levels of social deprivation (Office for National Statistics, 2016). Rates of drinking over the recommended limits are higher than the average for England (25.7%) at 30.3% and the region also has the highest percentage of binge drinkers at 22.9% (England average 16.5%) (Public Health England, 2017).

2.4. Data collection

In the UK, pregnant women are advised to inform their general

practitioner of their pregnancy and see a midwife within the first trimester. The midwife visit (commonly referred to as the booking visit) usually occurs in the 8th to 12th week of pregnancy and information is taken on demographics, general health, lifestyle (including diet, smoking and use of drugs and alcohol) and a blood sample drawn (take up 95%). Since this service is free at the point of delivery, compliance rates are extremely high. The data collected from this booking visit were used in our study across two years, 2014 and 2015.

2.4.1. Blood biomarker analysis

We randomly selected 600 antenatal blood samples taken at booking, from 2986 recorded bookings during 2014. Fifty samples were taken for each of the 12 months. Routine blood testing is offered at the antenatal booking appointment and around 95% of pregnant women attend. Samples are taken by trained nurses or midwives by venipuncture. The sample used by the laboratory to screen for virological infection is separated to remove the serum. Once routine analysis is complete, the remainder of this serum is frozen (at −40 °C in a monitored freezer) and stored for two years (to allow further screening should the clinical need arise). We tested an aliquot (0.5 mL serum/plasma) of each anonymised blood sample for Carbohydrate Deficient Transferrin (CDT) and Gamma glutamyltransferase (GGT). CDT is a validated marker of binge drinking and sustained alcohol consumption in the general population which normalises 2–3 weeks from the start of abstinence. Shipton et al. utilised CDT as a marker to identify chronic alcohol consumption in second trimester pregnant women as it is regarded to have relatively high sensitivity and specificity in pregnancy (Shipton et al., 2013). In the UK, CDT testing is also employed by the government to assess alcohol abstinence in banned motor vehicle drivers (Wolff et al., 2010). GGT is a liver enzyme which is elevated for eight weeks after the last exposure to alcohol. GGT is a highly sensitive marker for alcohol use in the general population, but is also increased in diabetes and obesity, with drug use and in cholestasis (Hock et al., 2005; Stoler et al., 1998). As such, its specificity is thought to be much lower than CDT. However, the specificity of GGT can be improved if used in combination with CDT and this is why these two biomarkers were chosen (Hock et al., 2005).

Each aliquot was labelled with the month the sample was taken and given a unique study number; the link between the sample and any patient identifiable information was lost at this point. Analysis was undertaken by HB Innovations (Medical School, University of Newcastle, UK), who measured the disialo CDT isoform using capillary electrophoresis. Transferrin is the iron transport protein in the blood and it can have up to eight carbohydrate chains attached to it. Typically there are three to five chains attached. Nonetheless, alcohol interferes with the attachment mechanism in the cell during protein synthesis. If there are high levels of alcohol in the blood, the transferrin has fewer carbohydrate chains attached to it. The International Federation for Clinical Chemistry (IFCC) has agreed on the disialo (2 carbohydrate chains) as the universal reference standard molecule and we report our results as the percentage of disialo CDT to total transferrin (Weykamp et al., 2013). GGT was undertaken in the Clinical Chemistry department using a specific enzymatic assay. Both laboratories participate in the UK NEQAS external quality assurance scheme.

Samples were analysed during early 2016. The samples were stored at −35 °C in a temperature monitored freezer and had not been previously thawed. CDT has been shown to be stable for at least 2 years at −20 °C, 7 days at 4 °C and 30 h at room temperature and over ten freeze thaw cycles (Arndt, 2001; Helander and Nordin, 2008; Martensson et al., 1998; Weykamp et al., 2013). GGT has been shown to be stable for at least a year at −20 °C, 7 days at 4 °C and 10 freeze thaw cycles (Clark et al., 2003; Cuhadar et al., 2013).

A positive result for probable chronic alcohol use in pregnancy was recorded if the CDT level was ≥1.60%, with an additional cut off of ≥1.87% used for very probable chronic alcohol use in pregnancy (Arndt, 2001). An increase in CDT will be detected with alcohol intake in excess of 6–10 UK units per day. One unit of alcohol is measured as 10 mls (or 8 gms) of pure alcohol in the UK. Thus, a positive result would be recorded for exposure of 48–80 gms per day (or 3.4 to 5.7 'standard' US drinks at 14 gms per standard drink). A positive GGT result was recorded if the level was ≥45 U/L, which is the upper end of the normal range.

2.4.2. Self-reported alcohol consumption

From data collected in 2015 we collated and analysed data on alcohol consumption for 2993 booking appointments. This was the same appointment at which the blood samples (analysed for CDT and GGT) were taken, but from a different year and so a different sample of women (see **ethical issues**, above). All women who attend the booking appointment are asked by their midwife: *'How many units of alcohol did you drink per week before pregnancy?'* and: *'How many units of alcohol do you currently drink per week?'* These two questions are taken from the AUDIT C questionnaire. The full AUDIT C is only completed in full if women report drinking in pregnancy to the screening question (Bush et al., 1998).

Data are recorded in the medical notes and entered electronically; and summary reports produced by the Trust's Information Services Department. All reports of drinking in pregnancy were checked (HH & AR) against the original paper copy for accuracy.

2.5. Statistical analyses and sample size calculation

Statistical analysis was supported by the statistical software package SPSS (version 21 for windows, IBM Corp, Armonk, USA). Data were summaries using standard descriptive statistics depending on the level of the data. Confidence Intervals (CIs) were calculated for prevalence data based on the assumptions of the binomial distribution using standard formulae. A lack of overlap in confidence intervals is indicative of a significant difference between groups. The Kruskal-Wallis test was used to compare the variation in biomarker levels between months and Spearman's correlation coefficient was employed to assess association between biomarker levels. GGT levels are quoted to one decimal place and CDT levels to two decimal places, reflecting the different methods of quantification.

2.5.1. Sample size

The primary aim of the study was to identify if there was a significant difference in the prevalence of alcohol consumption between self-report and CDT analysis. Significance was assessed based on the 95% CI for the difference in prevalence between the two samples. Provided the lower bound of the 95% CI was above zero, a significant difference was assumed. Based on the finding of Shipton et al. (2013), we estimated the prevalence of a positive CDT result to be 3% and, based on our own data from previous years, of a positive self-report to be 1%. Assuming we had records of self-report for at least 2000 women, a sample of 600 (approximately 20% of all bookings) blood samples was deemed sufficient to meet these requirements.

3. Results

3.1. Self-reported alcohol consumption

Data were available for 2993 antenatal bookings. The mean age at booking was 29.3 years (standard deviation 5.689). Of women with booking data available 2219 (74.1%, 95% CI 72.6 to 75.7) reported consuming alcohol two months before pregnancy. Reported units of alcohol consumed pre-pregnancy are detailed in Fig. 1. In contrast, only 17 women (0.57%, 95% CI 0.30 to 0.84) reported drinking alcohol at their booking appointment. Of the 17, 10 (58.8%) reported consuming 1–3 units per week, four (23.5%) reported consuming 4–6 units per week, and the remaining three consumed > 9 units per week. Only two (one > 9 units per week, one 4–6 units per week) of the 17

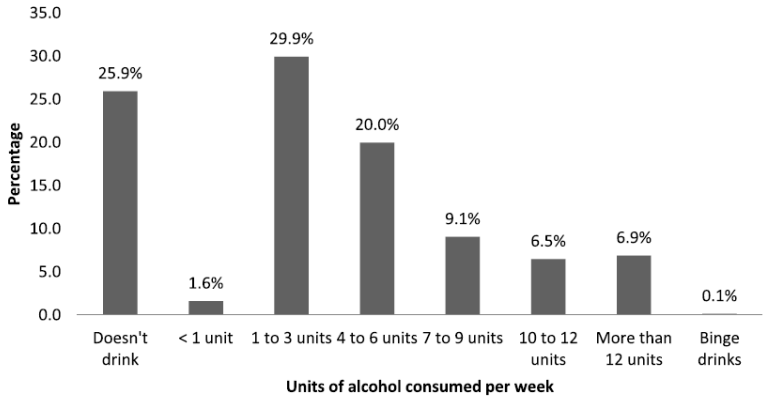

Fig. 1. Self-reported alcohol consumption pre-pregnancy.

(11.8%) women were referred to a substance misuse clinic.

3.2. Alcohol consumption based on CDT analysis

Of the 600 samples tested, 11 (1.8%) had a transferrin genetic variant that can lead to high blood CDT concentrations in the absence of previous alcohol consumption and therefore these samples were excluded from data analysis. In addition, one sample (0.2%) appeared to have some level of interference, either due to a transferrin genetic variant or a monoclonal gammopathy. Of the remaining 588 samples, five (0.9%) had values signifying probable chronic alcohol use and a further three (0.5%) of the samples had levels indicating very probable chronic alcohol use (1.4% positive samples in total, 95% CI 0.42 to 2.30). The median CDT value was 1.04 (IQR 0.89 to 1.19). Three of the positive samples were from January and three from March, one from December and one from July. Box-plots summarising the data for each month are shown in Fig. 2. There was a significant difference between the CDT values by month (X^2 (11) = 78.076, $p < 0.001$). The months with the highest mean ranks were (in order) March, January and August and the month with the lowest mean rank was November, followed by September and July.

3.3. Alcohol consumption based on GGT analysis

Of the 600 samples tested, a valid result was recorded for 599. Twenty-one (3.5%, 95% CI 2.0 to 5.0) samples had GGT values above the threshold. The median GGT value was 14.2 (IQR 11.2 to 20.0). Of the positive samples, four were for June, three from January, October and December, two from March, April and November and one from May and September. Box-plots summarising the data for each month are shown in Fig. 3. There was a significant difference between the GGT values by month (X^2 (11) = 22.049, $p = 0.024$). The months with the highest mean ranks were (in order) December, May and March and the month with the lowest mean ranks were August, February and September.

3.4. Comparison of prevalence based on self-report, CDT and GGT

Based on overlapping confidence intervals, there was no significant difference between level of alcohol consumption from self-report and CDT analysis or between CDT and GGT analysis. Still, the difference between self-report and GGT analysis was significant. As shown in Table 1, of 587 samples with a valid result for both GGT and CDT analysis, only one subject was positive for both CDT and GGT suggesting low levels of correlation between results for the two biomarkers (Spearman's $r = 0.044$, $p = 0.288$). Nonetheless, of the eight subjects with a positive CDT result, all but one (87.5%) had a GGT value above the median. The median GGT value in the eight CDT positive samples was 20.3, compared to 14.2 for the CDT negative samples, this difference was significant ($U = 1276.0$, $z = 2.178$, $p = 0.029$). In contrast, of the 21 subjects with a positive GGT result, only 10 (47.6%) had a value above the median. The median CDT value in the 21 GGT positive samples was 1.04, the same as in the GGT negative samples, this difference was not significant ($U = 5222.0$, $z = 0.601$, $p = 0.548$).

4. Discussion

This is the first UK-based study to compare self-reported alcohol consumption in the first trimester of pregnancy with data obtained from blood biomarker analysis. Our results are based on routine screening practice in the UK NHS and are of a representative sample of all women using our ante-natal services. Given that very few pregnant women in the UK do not use these services, our data are likely to be representative of our catchment. Such data could only be obtained through anonymised blood analysis, without the requirement for direct consent. As such we believe our data to be unique in representing alcohol use in pregnant women. Only two separate Swedish studies had previously compared self-report to blood biomarker analysis in the first trimester. Magnusson et al. (2005) identified 15% of women had risky drinking behaviour during pregnancy and concluded that AUDIT self-report screening appeared to be more informative than a range of biomarkers, but both had low sensitivity. Significantly, pre-pregnancy drinking habits were found to be predictive of drinking patterns in pregnancy. Conversely, Larsson et al. (1983) reported 13% of women in a structured interview reported drinking excessively during pregnancy, compared to the GGT biomarker which identified 26% of excessive consumers.

Although the prevalence estimate based on self report was lower than for CDT and GGT analysis, the estimates for CDT and self-report were not significantly different based on the overlap in confidence intervals. Further research on larger groups would be needed to conclude that relying on self report leads to under-reporting. However, the upper limit of the 95% CI for percentage of women who reported drinking alcohol in pregnancy was below the lower end of estimates of the prevalence of FASD of around 1–3% (May et al., 2014, 2015), suggesting some degree of under-reporting. The reported prevalence was higher for GGT analysis and although this may be due to levels of GGT remaining elevated in the blood for longer after the last exposure than for CDT, it seems likely that false positive results due to the presence of co-morbidities, such as obesity and diabetes have a role to play (Hock et al., 2005; Stoler et al., 1998). This may also account for the relatively large number of extremely high (outlying) values seen for GGT levels.

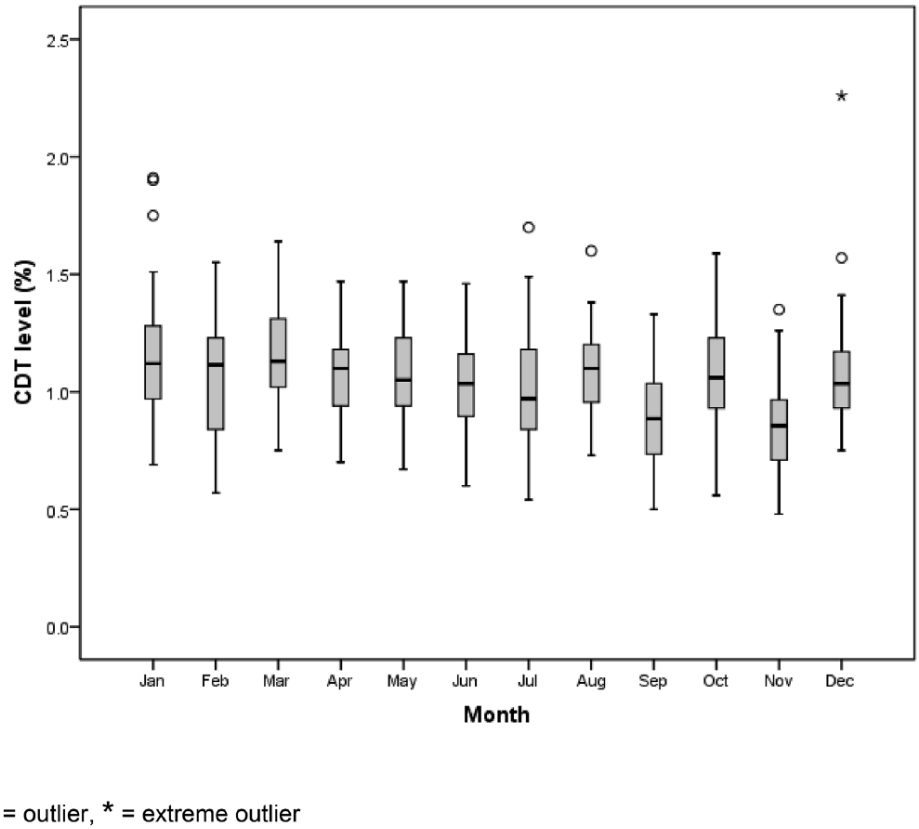

Fig. 2. Box plots of CDT values per month.

As our analysis was of de-identified blood samples, we are unable to adjust for these confounding effects. Used in isolation, GGT analysis cannot be recommended as a method for detecting women who drink alcohol in pregnancy, and the lack of correlation between CDT and GGT levels is striking, with only one subject being positive for both biomarkers.

The lack of agreement between biomarker analysis methods has been noted by other authors (Magnusson et al., 2005; Stoler et al., 1998). Stoler et al. (1998) and Magnusson et al. (2005) identified generally poor levels of agreement between self-report and biomarker analysis and individual biomarkers in consented samples. The reasons for these apparent discrepancies are likely to be complex. CDT analysis and self-report may be subject to bias towards under-reporting of the true prevalence for different reasons. Issues surrounding self-report as a method of identifying women who drink alcohol in pregnancy are well documented and include stigma, recall bias, social pressures and patient-clinician interaction (British Medical Association Board of Science, 2007). Yet, it is the recommended method for screening in pregnancy (National Institute for Health and Care Excellence, 2008). The importance of alcohol screening is also emphasised by the World Health Organization (World Health Organization, 2014). Nevertheless, screening is only beneficial if it is supported by a clear pathway of referral for support and counselling. Our data in relation to subsequent referral rates to substance misuse clinics suggests that this is an area for improvement. Blood biomarker analysis offers the possibility of a more objective assessment. For the most commonly recognised blood biomarkers (e.g. CDT, GGT, phosphatidylethanol, aspartate aminotransferase and alanine aminotransferase), the threshold for a positive test is only reached with sustained drinking over a period of 2–3 weeks (Comasco et al., 2012; Kwak et al., 2014; Stoler et al., 1998; Yang et al., 2015). As such, it only offers a cross-sectional picture and may omit moderate drinkers or not reflect behaviour over the long-term. A systematic review of international studies comparing self-report to blood biomarkers concluded that further investigation of the validity and reliability of a specific biomarker at a given duration of gestation or duration from last consumption, to give an overall picture is needed (Howlett et al., 2017).

To an extent, our study builds on the work of Shipton et al. (2013) who used CDT analysis to investigate the prevalence of alcohol consumption in pregnant women in Glasgow, Scotland, although their sample were in the second trimester of pregnancy. Their prevalence estimate was higher than ours (5%), however their 150 samples were selected from the most deprived parts of the city, using a Monday clinic to capture the higher weekend alcohol consumption patterns. As such, findings from the two studies are difficult to compare.

Identifying women who drink alcohol at very high levels is clearly important, but blood biomarker analysis is unlikely to identify those drinking at more moderate levels. These women may also be at risk from poor outcomes for themselves and their children. Identifying an appropriate threshold, which takes account of inter- and intra-subject variations in the measure of the biomarker, but which is able to detect moderate alcohol consumption is technically challenging. All existing methods of alcohol detection in pregnancy, including meconium and maternal hair and nail analysis, suffer from similar limitations and

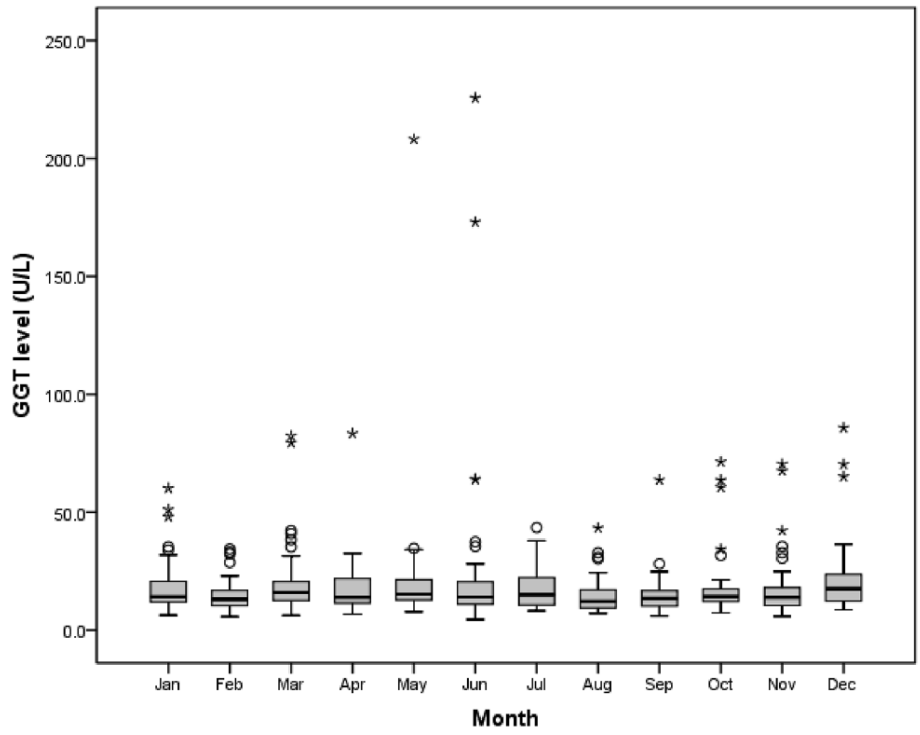

Fig. 3. Box plots of GGT values per month.

Table 1
Cross tabulation of CDT and GGT data.

		GGT result		Total
		Negative	Positive	
CDT result	Negative	560	19	579
	Positive	7	1	8
	Total	567	20	587

these may prove difficult to resolve (Bakhireva and Savage, 2011; Joya et al., 2012). As suggested by Stoler et al. (1998), it may be that a combination of self-report and analysis of a number of biomarkers, which takes into account binge drinking as well as sustained daily drinking, is a more efficient way to identify those at risk.

Both CDT and GGT levels varied significantly by month, with both methods recording some of the highest values in January–March (six of eight positive CDT samples were taken in this period). This may be due to social drinking in December (Christmas), although further research on larger sub-samples is needed. If seasonal patterns of drinking were clearly identified in such work then this may help to guide interventional strategies.

5. Limitations

Since our data came from two different samples, we are unable to comment on whether the methods identified the same women. The decision to use separate samples was taken to avoid the possibility of identifying any of the women whose samples were used for the anonymous blood analysis. The use of anonymised samples also precluded analysis of a number of potentially confounding variables, since we only had ethical approval to identify the month the sample was taken. We used a relatively crude method for assessing self-reported alcohol consumption, but this reflected current clinical practice and avoided the need to seek consent, thus ensuring our findings were representative of our service. Consequently, we feel that our study presents a valuable baseline situation against which the findings of a future study could be compared. We also recognise that our findings may not be generalisable to other populations, even within the UK. The North East region has notably poorer alcohol related health outcomes than much of England and this may have impacted on our findings.

6. Conclusions

The prevalence of drinking estimated from CDT analysis and self-report were not significantly different, but evidence suggests that both approaches may represent an underestimate for diverse reasons. GGT appeared to lack specificity and, at best, it may have a role to play in supporting findings from CDT analysis. Prevention is key and a clear and consistent public health message is required to emphasise that there is no safe amount, time or type of alcohol to drink during pregnancy or when trying to conceive.

Further studies using alternative blood biomarkers, or a combination of blood biomarkers and self-report, may prove beneficial in

accurately detecting drinking history in pregnancy. Future work should consider the use of blood analysis with consent, which would allow the identification of demographic, medical and societal risk factors for alcohol use and allow us to investigate patterns of drinking across all three trimesters of pregnancy. Although some degree of bias in those who choose to consent is likely, the use of anonymous and consented sampling may allow such biases to be quantified. As such, the data presented here, from a large sample of women in early pregnancy, is an important addition to what is known about alcohol use in pregnancy.

Conflicts of interest

There were no conflicts of interest.

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Funder's role

The sponsor of this study had no role in the study design, in collecting the data, in data analysis or interpretation, in writing this manuscript or in the decision to submit to this journal for publication.

Author contributions

HH, NB, SM, EMS, JR and WKG conceived and designed the study. HH, LN, AR and NB, were involved in data acquisition. WKG, HH and NB, contributed to data analysis. WKG, HH and NB wrote the first draft and all authors commented on the paper and gave final approval for submission.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.ejmg.2018.05.009.

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Short Report

Assessing the prevalence of alcohol consumption in early pregnancy using blood biomarker analysis: a consistent pattern across north-east England?

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ABSTRACT

Background We previously investigated the prevalence of alcohol consumption in early pregnancy in Northumbria Healthcare NHS Foundation Trust, a locality of north-east England. The prevalence was 1.4% based on blood sample biomarker analysis using carbohydrate deficient transferrin (CDT) and 3.5% for gamma-glutamyltransferase (GGT).

Aims To supplement this research by investigating the prevalence of alcohol use using identical methods in a different locality of the same region.

Methods Six-hundred random blood samples taken at the antenatal booking appointment were anonymously analysed for the presence of CDT, a validated marker of chronic alcohol exposure (normalizing 2–3 weeks from abstinence) and GGT, a liver enzyme elevated for up to 8 weeks after alcohol exposure.

Results The North Tees and Hartlepool NHS Foundation Trust data revealed a CDT prevalence rate of 1.7% (95% CI: 0.7–2.9) and GGT prevalence rate of 4.2% (95% CI: 2.6–5.9). However, these measures are not sensitive to low levels of alcohol; and no overlapping cases were identified or a significant correlation demonstrated between CDT or GGT.

Discussion These data support our earlier work. Prevalence rates according to CDT and GGT analysis were similar in both areas, suggesting similar patterns of sustained alcohol use in pregnancy across the region.

Keywords alcohol, blood biomarkers, foetal alcohol spectrum disorder, pregnancy, prevalence, self-report

Introduction

Alcohol is both teratogenic and fetotoxic and passes freely across the placenta to the unborn baby.[1] Prenatal alcohol exposure (PAE) increases the risk of miscarriage, stillbirth, preterm birth and Foetal Alcohol Spectrum Disorder (FASD).[2,3] Children with FASD suffer damage to the brain and central nervous system causing intellectual and developmental disabilities.[4] Children with Foetal Alcohol Syndrome (FAS) also present with the classic facial dysmorphia and are therefore slightly easier to diagnose, but FAS only represent ~10% of all children who fall under the umbrella term FASD.[5]

The timing, dose and frequency of PAE are known to affect outcomes.[4] Other factors such as diet, smoking, poly-drug use and genetics can further influence the impact upon

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the foetus, particularly with moderate drinking.[6–9] The links between low to moderate alcohol consumption, binge drinking and poor pregnancy outcomes are still contentious but cannot be disregarded.[6,10] This is the rationale behind the amendment of UK Government guidelines in 2016, which advised that pregnant women or those planning conception should avoid alcohol completely to eliminate the associated risks of harm.[2]

The prevention of harm from alcohol for the mother and baby should be a UK priority in the antenatal period, given the potential scale of the problem. This would accord with NHS England's 'Better Births' strategy which aims to improve the outcomes of maternity services in England by ensuring that women receive greater informed choice and control, thus facilitating safer, individualized care to meet the needs of every mother and baby.[11] The Safer Maternity Care action plan specifically targets a reduction in preterm births, stillbirths, neonatal and maternal deaths, and serious brain injuries, all of which can be associated with alcohol.[12]

It is therefore imperative that we identify women who drink alcohol in pregnancy so that we can provide the appropriate care in a supportive and non-judgemental environment. Also, diagnosis of FASD children without facial dysmorphia is only possible if a history of alcohol consumption in pregnancy is documented in the medical records. Therefore, identifying each case of PAE is fundamental.[13]

Blood sampling is an objective biomarker for alcohol consumption which may overcome some of the limitations of self-report.[14] Despite the widespread use of self-report and growing evidence of the technical feasibility of biomarker analysis, there are limited previous data regarding the validity of blood biomarkers to record alcohol consumption in pregnant populations.[15–18]

Within the Northumbria Healthcare NHS Foundation Trust (NHFT) area of north-east England we previously reported prevalence rates of alcohol consumption in early pregnancy to be around 1.4% based on analysis of blood samples for the biomarker carbohydrate deficient transferrin (CDT) and 3.5% for the biomarker gamma-glutamyltransferase (GGT).[19] This was the first report of the prevalence of alcohol consumption using biomarker analysis within a representative population of first trimester, pregnant women in the UK.

This short report details our next study which we anticipated would corroborate these findings. We conducted a similar trial in the North Tees and Hartlepool NHS Foundation Trust (NTHFT) area, in the south of the region. We aimed to obtain the prevalence of alcohol consumption identified through blood biomarker analysis from a random sample of all women attending routine antenatal clinics during the first trimester of pregnancy across a twelve month period.

Methods

Ethical issues

This study was given a favourable opinion by the Tyne and Wear South Research Ethics Committee (Ref: 15/NE/0216). Individual patient consent was not required. Existing routine stored clinical blood samples were analysed anonymously, with only the month the blood sample was taken recorded. Each aliquot was labelled with a unique study number and the month the sample was taken; at this point the link between the sample and any patient identifiable information was lost. Anonymous blood sampling had the advantage of ensuring the blood samples were representative, since we could analyse samples from all patients, without the potential biasing effect of requiring consent.

Study design

This was a prevalence study of pregnant women, using cross-sectional retrospective data from 2015, to identify first trimester alcohol intake in pregnancy.

Participants and setting

NTHFT covers a population of around 400 000 people living in East Durham, Hartlepool, Stockton on Tees and surrounding areas. The region was formerly an area of intensive coal mining and heavy industry. The socio-demographics are very similar for Northumbria where there are also areas of more rural and affluent communities. The north-east of England has some of the poorest outcomes for alcohol related disease in England, and some of the highest levels of social deprivation.[20] Stockton on Tees is ranked amongst the top 10% of England's local authorities experiencing the highest impact-cost of alcohol per head of population.[21] Rates of drinking over the recommended limits in the north-east are higher than the average for England (25.7%) at 30.3% and the region also has the highest percentage of binge drinkers at 22.9% (England average 16.5%) (Fig. 1).[21]

Blood biomarker analysis

We randomly selected 600 antenatal blood samples taken from the 3752 recorded bookings during 2015. A total of 50 samples were taken for each of the 12 months. We tested an aliquot (0.5 ml serum/plasma) of each anonymised blood sample for CDT and GGT. Shipton *et al.*[22] studied CDT as a biomarker to identify chronic alcohol consumption in second trimester pregnant women because it is considered

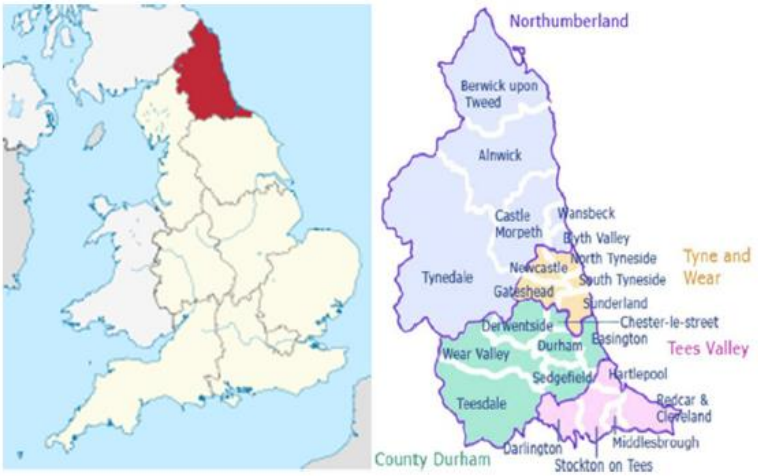

Fig. 1 Map of North-East England.

to have a high sensitivity and specificity in pregnancy. CDT is also elevated for up to 3 weeks after sustained alcohol exposure and therefore may be a reliable indicator for detecting alcohol consumption in early pregnancy and before the pregnancy was confirmed.[18] GGT is a sensitive biomarker for alcohol consumption in the general population as levels remain elevated for up to 8 weeks after last exposure. Consequently, it may be a good marker for alcohol consumption in early pregnancy and the period before the pregnancy was confirmed.[23,24] Analysis was conducted by HB Innovations (Medical School, University of Newcastle, UK). They measured the disialo CDT isoform using capillary electrophoresis. The International Federation for Clinical Chemistry (IFCC) agreed on the disialo (2 carbohydrate chains) as the universal reference standard molecule and our results were reported as the percentage of disialo CDT to total transferrin.[25] The Clinical Chemistry department analysed the GGT using a specific enzymatic assay. Both laboratories conform to the UK NEQAS external quality assurance scheme. The samples were stored at −35°C, in a monitored freezer. Further details on methods are available in the original article.[19]

A positive result for probable chronic alcohol use in pregnancy was recorded if the CDT level was ≥ 1.60%, with an additional cut off of ≥ 1.87% used for very probable chronic alcohol use in pregnancy.[26] A positive GGT result was recorded if the level was ≥ 45 U/L, which is the upper end of the normal range. The International Federation for Clinical Chemistry (IFCC) agreed the standardized measures which have been adopted in this study in accordance with best practice.

Sample size

The sample size of 600 blood samples was derived from an assumption of prevalence of around 1.5%, based on our previous work, and a requirement to have confidence intervals no wider than 1%.[19]

Results

Alcohol consumption based on CDT analysis

Eight samples had insufficient content available for analysis. Of the remaining 592 samples tested, 0.8% ($n = 5$) appeared to have a transferrin genetic variant, which precluded further analysis. Another 4.1% ($n = 24$) appeared to have some level of interference or could not be quantified. Of the remaining 563 samples, 0.2% ($n = 1$) had elevated CDT above the cut off of 1.6% and may be chronic alcohol users, whilst 1.6% ($n = 9$) had very high CDT above 1.87 and are very likely to be chronic alcohol users. This provides an overall prevalence of 1.8% (95% confidence interval (CI): 0.7–2.9).

Combining these data with those for (NHFT) gives an overall prevalence estimate of 1.6% (95% CI: 0.8–2.3) for the region as a whole.

Alcohol consumption based on GGT analysis

One sample was damaged leaving 591 available for GGT analysis. Two had insufficient blood to analyse, leaving 589 with quantifiable results. Of these, 25 (4.2%, 95% CI: 2.6–5.9) tested over the < 45 U/L reference range for adult

females. Combining these data with those for (NHFT) gives an overall prevalence estimate of 3.9% (95% CI: 2.8–5.0).

Comparison of prevalence based on CDT and GGT

A total of 563 samples had data for both CDT and GGT, with none of the cases identified overlapping and no significant correlation identified between levels for CDT or GGT (Spearman $r = 0.06$) (Fig. 2).

Discussion

Main findings of this study

The NTHFT alcohol consumption prevalence rate for CDT was 1.7% and GGT was 4.2%. No significant correlation or overlap of cases was identified between the levels for CDT or GGT. The reason for this disparity can be explained by their different biochemical properties. GGT is increased by comorbidities such as liver damage, obesity, cholestasis and drug use; and can remain elevated for up to 8 weeks post alcohol exposure. CDT analysis in antenatal alcohol screening may be most effective in detecting women who drink consistently high levels of alcohol and can detect alcohol up to 3 weeks post last exposure. A heavy binge drinking episode for example might elevate the GGT levels but may not be enough to increase the CDT results. Also, the window of detection is shorter in CDT than GGT so it is logical that more positive results would occur with GGT as demonstrated in these results.

The measurement of CDT has been bedevilled by marked differences between the assays; therefore, historical results may have introduced misclassification of alcohol consumption in some studies. More recently the assays for CDT have been standardised and a cut off of 1.70% has been set to distinguish those with heavy consumption.[27] This study therefore used the agreed consensus cut off for CDT. A lack of agreement between the various markers of alcohol use has been reported[28,29] and others have highlighted the poor performance of gamma GT as a marker for alcohol use.[30] There are issues with CDT as a universal marker due to different forms of CDT present in certain populations and disease states, and its poor performance at detection of binge drinking. Therefore we chose to measure GGT due to its widespread availability and CDT as a readily accessible, more specific marker as neither was perfect. In time we hope to develop a method for phosphatidyl ethanol (PEth) but there are methodological and sample stability issues to be overcome.

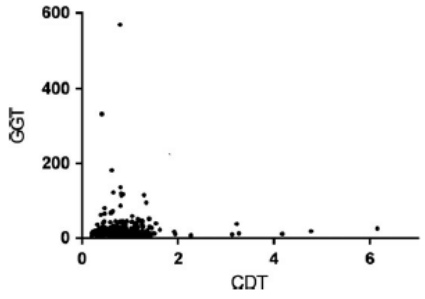

Fig. 2 Scatterplot of blood level of CDT and GGT.

Although GGT appeared to lack specificity, it may have a role to play in supporting the results of CDT analysis.[19,31] Although neither biomarker is ideal in isolation, these results do make a useful contribution to our current body of evidence. Given the potential clinical benefits of biomarkers in the antenatal period, further research is warranted.

From a feasibility perspective, GGT is a relatively cheap test, but CDT a little more expensive. However, the cost benefits of early identification of women in need of support and preventing further harm to the foetus would be justified when considering the health economics of one child with FASD being coined as a $1 million baby from a seminal Canadian study.[32] A comprehensive UK cost benefit analysis would be useful in deciding the utility of routine blood biomarkers for alcohol screening in pregnancy.

What is already known on this topic

Screening for alcohol use in early pregnancy can facilitate the identification of women who require appropriate care provision. This can limit the risk of further harm to the foetus and prevent a myriad of avoidable FASD traits.[33] The potential benefits of screening would be the subsequent financial savings for health, education, social care and justice sectors in later years.[34]

Self-report is regarded as the reference standard in routine practice despite that it can under-estimate drinking levels due to factors such as stigma, recall bias, social pressures and patient–clinician interaction.[35] Our data suggest that blood biomarker screening in isolation may not be the panacea to allowing those in need to access care during pregnancy or in early life, but it may help support other initiatives. The use of additional blood biomarkers such as PEth is another sensitive indicator of heavy alcohol consumption to consider in future studies.[7] Ethyl glucuronide (EtG) is a sensitive test which can be used to detect low levels of alcohol consumed up to three days previously. EtG may help to identify the more common, low level and occasional drinkers who may be unaware of the risks of alcohol exposure to their baby.[7] Further research into a combination

of blood biomarkers and self-report may be beneficial in detecting a more detailed drinking history, taking into account binge drinking as well as sustained daily drinking.[24]

Prospective studies should consider consented blood analysis, which would enable the identification of medical, demographic and lifestyle risk factors for alcohol consumption. This would facilitate the examination of alcohol habits spanning all three trimesters of pregnancy. Despite the element of bias incurred through the process of consent, comparing anonymous and consented sampling may allow these biases to be quantified.

There is an ethical debate around women's attitudes towards consent for blood biomarker screening. Yet, women in the UK are already routinely screened throughout pregnancy for many sensitive issues such as their HIV status and exposure to domestic violence.[36] The recent introduction of routine CO monitors to detect smoking in pregnancy has been readily accepted by women and staff alike, so we would expect the inclusion of routine alcohol biomarker screening to be adopted accordingly. This is supported by a recent survey of women and their partners, of whom 87.2% would agree to consent for blood biomarker analysis.[37] Furthermore, FASD birth mothers are openly requesting a more proactive antenatal alcohol screening approach in the UK because they feel that had these services been in place, their children may have been spared the devastating harms of PAE.[38]

Ultimately, prevention should be the primary objective.[36] The establishment of robust alcohol screening practices in pregnancy are only beneficial if sustained by bespoke pathways of referral and support.

What this study adds

The overall number of positives for CDT and GGT were similar across both areas to the north and south of the region, which suggests that the two sample populations are comparable, allowing the data to be combined for an overall analysis that is likely to be representative of the north-east region of England. However, the generalisibility of these findings to the entire population of England may be limited due to the higher than average levels of alcohol consumption and socioeconomic deprivation in the north-east. Additionally, the north-east of England has the least ethnically diverse population in the country, with 93.6% classed at White British.[20,39] This factor may also contribute to the regional drinking culture.

This research is based upon a pilot study conducted by Shipton *et al.*[22] who examined the prevalence of alcohol consumption in second trimester pregnant women using CDT analysis. While their prevalence evaluation was greater than ours at 5%, their 150 samples were taken from the most deprived areas of Glasgow, Scotland, using a Monday clinic to obtain the higher weekend alcohol consumption levels. As the sampling method is very different for the Shipton *et al.* study, it is difficult to directly compare the results.

Limitations

The reported prevalence rates in both samples are likely to be conservative as both CDT and GGT only detect chronic heavy drinkers. To detect an increase in CDT and GGT levels, women need to drink 6–10 UK units per day.[23,26] One unit of alcohol is measured as 10 ml (or 8 g) of pure alcohol in the UK. Thus, a positive result would only be recorded for exposure of 48–80 g per day (or 3.4–5.7 'standard' US drinks at 14 g per standard drink).

Unfortunately there is not yet a national or international gold standard regarding biomarkers to detect alcohol in pregnancy and so we cannot compare these findings to an official benchmark which may help us to detect any flaws or false positives for example. However, this work has provided new evidence in the field and could feasibly contribute towards this objective.

Identifying women who drink heavily in pregnancy is imperative, but CDT and GGT analysis is unlikely to identify those drinking at low to moderate levels. Nonetheless, these women may also be at risk of poor outcomes for themselves and their children. There is an argument that some heavy drinkers may already be known to maternity services, particularly the complex cases, so blood biomarker analysis may not be very helpful for the few it would identify. The evidence from our original study would not support this theory as only two women from the entire cohort were referred to a specialist clinic for alcohol support. The majority of women, $n = 67$ were referred for other substances, perhaps suggesting that alcohol is not deemed a priority by professionals or the women themselves. Nevertheless, an estimated 41.3% of women in the UK consume alcohol during pregnancy and the predicted prevalence rates of FASD nationally are 6–17%;[40,41] higher than the prevalence of chronic, heavy alcohol consumption reported here with CDT and GGT.[41] This added to national statistics reporting that 79% of women drink alcohol, with the highest rate of binge drinkers being of childbearing age; our prevalence rates are not implausible.[42] It is important to remember that only a fraction of women who drink alcohol in pregnancy and the subsequent children born with FASD are ever identified in routine practice.[43] This means that the vast majority of pregnant women and FASD children remain unsupported.[4]

What is clear from the literature is that the alcohol agenda and the issue of FASD are both significant public health concerns in the UK. We all have a duty to raise awareness of these issues with the general public and to train our NHS healthcare professionals to prevent, screen and manage PAE and FASD effectively.

Conclusions

For the first time, our study provides data for the prevalence of chronic, heavy alcohol consumption in the first trimester of pregnancy, across the north-east region of England. As these measures are not sensitive to low levels of consumption, further research and data are required to allow healthcare providers to develop appropriate screening and support services for this vulnerable patient group.

Conflicts of Interest

There were no conflicts of interest.

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Authors' contributions

HH, NB, SM, JR and WKG conceived and designed the study. HH, LN and NB were involved in data acquisition. WKG, HH and NB contributed to data analysis. HH, WKG and NB wrote the first draft and all authors commented on the article and gave final approval for submission.

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Funder's role

The sponsor of this study had no role in the study design, in collecting the data, in data analysis or interpretation, in writing this article or in the decision to submit to this journal for publication.

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A survey of attitudes, beliefs and practice regarding alcohol use and screening in pregnancy: an opportunity for support and education?

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Abstract
Providing antenatal and postnatal support for women who drink alcohol in pregnancy is only possible if those at risk can be identified. However, screening will only be helpful if women feel

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comfortable with the method used. We conducted a survey of pregnant women and their partners to investigate self-reported beliefs and practice regarding drinking during pregnancy and the acceptability of screening. Pregnant women and their partners attending antenatal clinics in North-East England were asked to complete a short survey regarding their alcohol consumption in pregnancy, their beliefs about safe levels of alcohol in pregnancy and whether they would be happy to have their blood or their baby's meconium analysed for alcohol biomarkers. The data were summarised using descriptive statistics and thematic analysis. A total of 171 pregnant women and 41 partners participated. Of the pregnant women, 153 (89.5%) felt women should abstain from alcohol consumption, although only 70 (40.9%) reported not drinking in pregnancy. Of 96 women who reported drinking in pregnancy and reported when they stopped, all but six (6.3%) stopped drinking when they found out they were pregnant. Of women and partners who recorded an answer, 177 (87.2%) said they would consent to blood biomarker analysis. Confusion over what level of alcohol is safe and using screening as an opportunity for education and support emerged as key themes from free-text responses. Most women viewed screening for alcohol in pregnancy positively, although its acceptability in the small number of women who continue to drink is unclear.

Keywords
alcohol, alcohol screening, fetal alcohol spectrum disorder, pregnancy

Introduction

Drinking alcohol during pregnancy can have a profound effect on the fetus and can result in life-long impairments and disabilities, usually referred to under the umbrella term fetal alcohol spectrum disorder (FASD) (British Medical Association Board of Science, 2016). In the UK, Department of Health guidance emphasises that there is no safe level of alcohol consumption in pregnancy (Department of Health, 2016). However, the UK is estimated to have one of the highest rates of alcohol use in pregnancy in the world, at 41.3% (Popova et al., 2017). Unfortunately, the proportions of women who consume alcohol prior to confirmation of pregnancy are not differentiated from those who knowingly drink in pregnancy.

Screening for alcohol use early in pregnancy may help identify those who need support to stop or reduce their alcohol consumption (Mukherjee et al., 2005). In addition, screening throughout pregnancy and of the neonate may allow infants affected by maternal alcohol consumption to be identified. However, screening raises ethical and legal issues related to consent, individual rights and freedoms, the rights of the unborn child and stigmatisation (Mizejewski, 2010; Zizzo et al., 2013). For some women and their partners, the situation is complicated further by confusion regarding what is a 'safe' amount of alcohol to consume in pregnancy (Anderson et al., 2014; Bearer et al., 2004; Mukherjee et al., 2005; Stade et al., 2009; Van der Wulp et al., 2013). Although official guidance appears to be hardening towards recommendations of total abstinence in many countries (Department of Health, 2016), societal influences and personal experience remain powerful influences (Raymond et al., 2009). The National Institute for Heath and Care Excellence (NICE) provides national guidance and advice to improve health and social care for England and Wales. NICE advocates the importance of screening as part of antenatal care, stipulating that

women should be given information about all aspects of life that may affect their health or the health of their baby, including alcohol (NICE, 2008). The World Health Organization (WHO) emphasise that their primary priority is screening to prevent, reduce and cease the use of alcohol during pregnancy and in the postpartum period in order to optimise the health and wellbeing of women and their children (WHO, 2014).

In the UK and many other countries, screening, based on self-report, followed by in-depth interviews of those who screen positive, is widely used as a means of identifying those at risk and is recommended by the WHO and the British Medical Association as the preferred method of screening (British Medical Association Board of Science, 2007; WHO, 2014). Self-report avoids many, although not all, of the ethical problems associated with more invasive screening methods. However, self-report can be unreliable and may be biased by social desirability responses dependent on the patient–clinician interaction (Ford et al., 2009; Jones et al., 2011). The use of biomarkers for alcohol consumption (e.g. blood, urine or hair analysis in the mother or blood or meconium testing in the neonate) has been investigated (Bakhireva et al., 2014; Burd and Hofer, 2008; Shipton et al., 2013). Although raising more ethical issues, biomarkers have the potential to offer a more objective method of screening, but a consensus on the accuracy and clinical utility of biomarker analysis has yet to emerge (Lange et al., 2014; Shipton et al., 2013).

There have been numerous studies looking at levels of alcohol exposure in pregnant women, using both biomarkers and self-report (Larsson et al., 1983; Magnusson et al., 2005; Savage et al., 2002). Nevertheless, despite the widespread use of self-report and growing evidence of the technical feasibility of biomarker analysis, there are very limited data regarding the acceptability of screening (Anderson et al., 2014; Mizejewski, 2010; Shipton et al., 2013; Zizzo et al., 2013). Our study had two aims: (a) to investigate beliefs and practice regarding alcohol consumption in pregnancy and (b) to investigate whether biomarker screening for alcohol use in pregnancy was acceptable to women and their partners attending antenatal clinics in north-east England.

Methods

This was a prospective survey of women attending antenatal clinics.

Survey questionnaire

The survey questionnaire items were decided upon by an expert panel of gynaecologists, obstetricians, paediatrics and midwives employed by our organisation. A representative of the FASD network, an organisation set up to represent and provide assistance for parents with FASD children, assisted in the development and review of the survey questionnaire to help make it more accessible to our target group. The questionnaire was piloted in an antenatal clinic on a single day and was not modified further based on the pilot. The pilot data are included in the results. In designing the study we were concerned that women and their partners would be unwilling to complete the survey if they felt information could be linked back to their medical records, and therefore no personally identifiable information was collected. Although having a combined pregnant woman and partner survey was considered, with separate sections for each group to complete, we felt that the possibility of some partners inadvertently completing the pregnant woman's section and vice versa was too great. For this reason we used the same survey for both groups. Thus, data for the

women–partners dyads were unlinked. The survey document consisted of three sheets of paper (including the cover information sheet) and took 3–5 minutes to complete. The full documentation is included in Appendix 1. Patients and their partners were asked whether they were attending the clinic as a pregnant woman or a partner and covered the following questions:

1. What level of alcohol do you think is safe in pregnancy? (Nothing/1–2 units per week/1–2 units once or twice a week/more than 3 units per occasion).
2a. In this pregnancy, which statement applies the most? (Stop drinking pre-pregnancy?/stop at the time your pregnancy was confirmed or suspected?/stop drinking after seeing midwife/still drinking/prefer not to say).
2b. If you stopped drinking during pregnancy, how many weeks pregnant were you when you stopped drinking? (State number of weeks).
3. Would you be happy to have your routine booking bloods tested for alcohol levels in a future pregnancy? (Yes/no).
4. Would you be happy to have your baby's first dirty nappy (meconium) tested? (Yes/no).

Subjects were asked to expand on answers to questions 3 and 4 using free text. They were also asked for any general additional comments in free text.

Setting and timeframe

Questionnaires were handed out by medical students (KL and CD) to all women and their partners attending antenatal clinics, pregnancy assessments units, maternity wards, scanning clinics and substance misuse clinics in North Tyneside General Hospital and Wansbeck General Hospital during a 30-day period in 2015. The local policy for all antenatal women to be asked about their alcohol consumption at the time of booking could result in this cohort of women being better informed about the risks of alcohol in pregnancy compared to other localities and may consequently influence their responses. It is important to reference that enquiring about alcohol consumption at booking is considered best practice but that there are no published national audits comparing National Health Service (NHS) organisations.

The substance misuse antenatal clinic occurred one half-day per fortnight and was included to provide a valid cross-section of the patient population. Responses were not collected separately for the substance misuse clinic. This was a conscious decision to avoid any suggestion that responses were not anonymous, given the smaller number of women attending these clinics and the sensitivity of the topic.

All women attending the clinics during the study period were deemed eligible for inclusion in the study and no one was excluded (i.e. not given a questionnaire). The researchers were mindful of contaminating responses, and this was one of the main reasons the questionnaires were handed out by medical students, who would not be known to participants in a clinical capacity. Participants were invited to complete the questionnaire with a brief, general explanation from the students and with guidance from the information sheet. Any factual questions relating to the research topic were only answered after questionnaires had been returned.

In 2015 there were 5967 bookings within the NHS organisation, 92% of whom described their ethnicity as White British. All women attending these clinics were invited

to participate to ensure that a representative sample of women's data was collected. Both hospitals are located in north-east England, an area with the highest alcohol-related mortality rate for women in England in 2014 (15.1 per 100,000 compared to an average for England of 9.1 per 100,000) (Office for National Statistics, 2016). Although local data are not available at a national level, the UK is estimated to have one of the highest rates of alcohol consumption in pregnancy in the world (Popova et al., 2017). This is attributed to a culture of risky alcohol consumption habits including binge and frequent drinking, combined with a high rate of unplanned pregnancies. The north east of England reflects these trends.

Once the surveys had been handed out, participants were free to complete them in their own time, and were asked to hand them back to either a member of the research team or a member of clinical staff either at that clinic or at a subsequent attendance. Participants were not monitored or watched while completing the survey and no pressure was placed on individuals to complete it.

A total of 306 surveys were handed out and 212 were collected, 171 from pregnant women and 41 from partners.

Statistical analysis

Quantitative data were analysed using SPSS for Windows version 21 (IBM Corp., Armonk, NY, USA). Data were summarised using standard descriptive statistics (e.g. frequency, mean, median). Thematic analysis with the six steps set out by Braun and Clark (2006) permitting identification of themes, to ensure familiarisation each free-text comment, was read and re-read. While reading over the comments, initial codes were generated through identifying interesting features of the data. All relevant data were gathered through the use of writing notes. Once codes were established they were collated into potential themes. The relevant quotations were reviewed and the final themes were defined.

Results

Beliefs and practice relating to alcohol in pregnancy

The first two themes in the questionnaire relate to women and their partners' views around alcohol in pregnancy, and subsequently how these opinions affect their behaviours.

In answer to question 1, 189 (89.2%) participants (153 women, 36 partners) thought that no alcohol should be consumed while pregnant. A further 20 (9.4%) (16 women, four partners) thought that 1–2 units per week was a safe amount to drink, and three (1.4%) people (two women, one partner) thought that more than 3 units on an occasion was safe.

Out of the 171 pregnant women, 70 (40.9%) reported that they stopped drinking before they became pregnant and 90 (52.6%) stopped drinking when they found out they were pregnant. An additional five women continued to drink after they found out they were pregnant, but stopped when they saw their midwife for the first time (first trimester); five women did not document when or whether or not they stopped drinking or preferred not to say; and one woman reported still drinking during pregnancy.

Of the 170 women who had stopped drinking alcohol, 39 (22.9%) did not document how many weeks pregnant they were when they stopped drinking and one did not know. For the 130 women who did document how many weeks they were when they stopped drinking

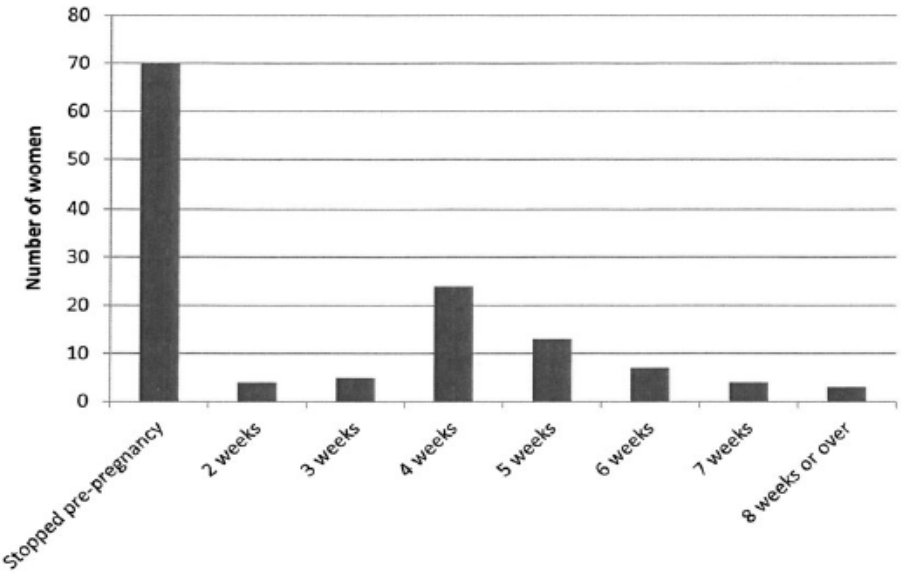

Figure 1. Gestational age when women reported to have stopped drinking alcohol in pregnancy ($n = 130$).

(including the 70 who stopped pre-pregnancy), the data are summarised in Figure 1. The peak period for cessation of alcohol consumption was weeks 4 to 6, which corresponds with the time of pregnancy confirmation for many women.

Of the 171 women we surveyed, 101 (64.3%) reported drinking alcohol during pregnancy. Furthermore, of the 153 women who said no level of alcohol is safe to drink in pregnancy, 84 (54.9%) drank alcohol until pregnancy was confirmed or until their booking visit with the midwife. Of the 16 women who said 1–2 units per week was a safe amount, three stopped pre-pregnancy, 10 stopped at confirmation of pregnancy and three preferred not to say or did not document. Finally, of the two women who said more than 3 units per week was safe, one was drinking at the time of the survey and one stopped drinking after meeting the midwife for the first time.

Attitudes towards screening for alcohol levels in blood and meconium

Of the 203 participants who completed questions 3 and 4, 177 (87.2%) said that they would be happy for their or their partner's blood to be tested for alcohol in a future pregnancy. A total of 168 (82.8%) individuals said they would be happy to have their baby's meconium tested for alcohol consumption; 10 were happy to have their or their partner's blood tested, but not their baby's meconium; and 1 person said no to having their blood tested, but yes to their baby's meconium. Altogether, 25 people said no to both forms of testing. There was no relationship between declining both forms of testing and self-reported drinking during pregnancy (χ^2 (1) = 0.039, $P = 0.844$).

Findings from thematic analysis of free text responses

Free text responses were received from 8 partners (19.5%) and 71 pregnant women (41.5%). Three themes were identified: (a) Social constructions of alcohol consumption during pregnancy; (b) Attitudes towards screening for alcohol; and (c) Educational and informative aspects facilitating informed choice. The most pertinent extracts have been taken from these responses and are referenced in the following. They were taken from a number of respondents.

Social constructions of alcohol consumption during pregnancy

Women who reported abstinence during pregnancy were often very clear in their views, for example 'drinking during pregnancy is wrong', recognised alcohol as harmful to their baby and saw their baby's health as paramount: 'putting baby at risk' and 'baby's safety should come first'.

However, there was evidence of confusion regarding safe levels of alcohol in pregnancy: 'drinking is safe in later pregnancy' and '1–2 drinks on a special occasion isn't bad'. Women hold misconceptions of what is acceptable to consume while pregnant. Some women are unsure of the risk and dangers of alcohol to the baby, and although some women understand and recognise the effects, others may not necessarily view alcohol consumption as having health implications for their baby: 'Pregnant women should not drink at all, it is a drug and can harm the baby. These tests will make sure the baby is healthy' and 'drinking is safe in later pregnancy'.

Screening for alcohol during pregnancy: reassuring 'good mum behaviour' versus invasiveness

The majority of women had positive responses towards screening for alcohol to ensure their baby is healthy. The statements illustrate that women want the best for their babies; however, they feel more support is needed to ensure safety within their pregnancy: 'routine screening may help identify the people [who drink] and protect the fetus'.

Screening was also felt to offer reassurance, feelings of safety and reduced risk to the baby, and to allow women to make informed choices due to an increased understanding of the effects of alcohol misuse during pregnancy: 'Would be useful for women to know levels and dangers. (Need to) highlight how alcohol affects the baby.'

Those who were happy to take a test did so to 'prove I don't drink alcohol in pregnancy' and having 'nothing to hide'. Interestingly, a partner referred to trust as a reason to take a test: 'To check if my partner has been lying about drinking in pregnancy.' One woman stated a test would be 'too invasive', and another mentioned the 'fear of needles'.

Education and information are essential and facilitate informed choice

Women expressed their need for education and support: 'I'd prefer for the guidelines regarding alcohol and pregnancy to be much clearer in the UK, it is currently too vague.'

Women suggested that the use of screening for alcohol use during pregnancy could help identify those at risk and enable appropriate support to be given by the healthcare provider: 'Routine screening may help identify the people and protect the fetus. May also provide opportunity for advice/useful information for future pregnancies.'

One woman recognised the social stigma towards alcohol consumption and advised of the benefits of screening for alcohol enabling women to receive appropriate support:

> It would help the women that need the support and it would be helpful to have care/support for babies with alcohol in their system, alcohol during pregnancy is demonised and many women feel like they cannot speak out or get the support they need. Maybe the NHS could look into getting better support.

Women themselves have highlighted the need for more education: 'to be warned of the risks – reading and listening to what has been found, alcohol more dangerous than class "A" substances, everyone should be tested and warned of the dangers'.

Furthermore, the statements provided by women suggest the informative aspects of screening for alcohol may lead to decreases in alcohol consumption: 'I would hope the test would scare others to stop drinking alcohol' and 'I think it would make mothers think twice about drinking if they were being monitored.'

One woman acknowledged that educational and informative discussions during the patient–healthcare provider relationship had increased her awareness of the effects of alcohol in pregnancy: 'Had a conversation with midwife which made the impact of alcohol on fetus real.'

Discussion

Practice regarding alcohol use in pregnancy

The majority of women in our survey reported drinking in pregnancy, although the vast majority stopped once they found out they were pregnant. These relatively high rates of drinking are in line with estimates of alcohol use in pregnancy in the UK from a recent review (Popova et al., 2017). High rates of alcohol use in pregnancy have also been reported in Ireland, Australia and New Zealand and have also been strongly linked to smoking (O'Keeffe et al., 2015). This suggests that possibly in the future alcohol screening could be incorporated into antenatal smoking cessation initiatives, which have been culturally accepted into clinical practice by staff and patients alike.

Confusion over safe level of alcohol consumption in pregnancy

Our data suggest that there is some confusion regarding safe levels of alcohol consumption in pregnancy and a disconnection between knowledge and practice. The views of partners towards drinking in pregnancy were similar to those of pregnant women with regard to the proportion who believed that there was no safe level of alcohol consumption in pregnancy. The anonymous nature of data collection means we are unable to investigate any correlation between the views of women and their partners. More than half of women who believed that there was no safe level of alcohol consumption in pregnancy reported drinking during the first trimester. Whether this is simply a consequence of confusion over what is a safe level of alcohol to drink in pregnancy or a manifestation of a more complex balancing of professional advice with wider societal influences is not clear, but it is an area worthy of further investigation.

The UK Department of Health has recently updated its guidance and states that there is no safe level of alcohol consumption in pregnancy (Department of Health, 2016). The Royal College of Obstetricians and Gynaecologists guidance from 2015 may be updated to reflect

this, but currently suggests that low levels of alcohol consumption in the latter stages of pregnancy are not known to confer any increased risk (Royal College of Obstetricians and Gynaecologists, 2015). Changes in guidance, while needed and welcome, combined with the wide variety and range of information sources available (online and print media, family and friends, general practitioners) may cause some confusion as to what level of alcohol consumption is safe. This view is broadly supported by recent research on the subject. The 2010 Infant Feeding Survey describes how antenatal women reported receiving advice varying from abstinence to limiting the amount of alcohol they drank to general information about the health effects of drinking (McAndrew et al., 2012). Many women received information from more than one source, resulting in mixed messages. Interestingly, 54% of women gave up drinking in pregnancy when given information about stopping compared with 31% who stopped only when advised to limit the amount of alcohol they drank.

A study using semi-structured telephone interviews of 19 pregnant women in Australia found confusion over safe levels of alcohol after the introduction of guidelines promoting abstinence (Anderson et al., 2014). Women expressed a wish for clear, concise advice from health professionals. A much larger ($n = 1103$) Australian study of women aged 18–45 years found that over one-third of women were unaware of the possible effects of alcohol on the fetus, although 80% thought that women should not drink alcohol while pregnant (Peadon et al., 2010). Likewise, a study of 439 pregnant women in Denmark in 1998 found that 76% thought some alcohol consumption during pregnancy was acceptable, although most recognised binge drinking as unacceptable (Kesmodel and Schioler Kesmodel, 2002). Interestingly, attitudes towards drinking in pregnancy were not linked to knowledge on the subject, which supports our findings. This was also noted by researchers in an Australian study conducted in 2006, and suggests attitudes are shaped not only by knowledge but also by social influences (e.g. friends and family) and experience (e.g. previous healthy birth) (Peadon et al., 2010). A UK study reported qualitative thematic analysis of interviews with 20 pregnant women regarding alcohol use in pregnancy. Key themes were confusion over safe levels of alcohol consumption in pregnancy, a lack of detail in the advice given, as well as conflict between health professionals' advice and women's own experience of a previous pregnancy and the reported experience of friends and relatives. This supports the view that societal influences and experience shape women's attitudes as much as advice given by healthcare professionals (Raymond et al., 2009). Another factor that is likely to add to the confusion is the difficulty for many people in estimating how many units of alcohol are contained in a measure of a particular beverage (Mukherjee et al., 2005, Mukherjee et al., 2013).

Attitudes toward biomarker screening for alcohol use in pregnancy

Our study suggests that biomarker screening is broadly supported by pregnant women and their partners. Crucially, many women expressed the view that screening may facilitate a greater level of information and support for pregnant women. This finding resonates with findings published by the WHO in that screened pregnant women valued the opportunity for greater personal contact and support, and for the development of coping strategies (WHO, 2014). Accurate data on alcohol consumption at an individual level is needed if FASD is to be identified and appropriate care and support provided. However, discussing alcohol consumption in pregnancy can be difficult for clinicians and it is often perceived as a sensitive topic (Payne et al., 2014). Furthermore, the validity of simple screening questionnaires in providing an accurate record of maternal alcohol consumption is

unclear. An alternative approach is to use biomarkers, but the validity and usefulness of these tests is as yet unclear and some tests can be time-consuming and expensive (Bearer et al., 2004; Mizejewski, 2010; Van der Wulp et al., 2013; Zizzo et al., 2013).

Although our results suggest that blood or meconium alcohol screening is acceptable to the vast majority of women and partners in our sample, its acceptability in those at highest risk from alcohol exposure is unclear. In the UK, the British Medical Association recommends that routine screening for alcohol use should be an integral part of the current antenatal screening tests provided to pregnant women (British Medical Association Board of Science, 2007). Furthermore, they maintain that the screening process itself would also raise awareness of the dangers of maternal alcohol consumption, and consequently lead to a reduction in drinking during pregnancy.

Limitations

Our study has a number of limitations. Given the anonymous nature of data collection we did not collect sociodemographic data on participants. This was a conscious decision which we felt would improve completion rates and avoid any suggestion that the information collected could be linked to patients' records. For the same reason, and to avoid over-complicating the questionnaire, we did not attempt to link responses for pregnant woman–partner dyads. Self-reporting of alcohol consumption is widely considered to underestimate actual alcohol consumption (Mukherjee et al., 2013). We are also unable to comment on the drinking habits, beliefs and attitudes of those who were unwilling to complete the questionnaire. Due to stigma associated with alcohol use in pregnancy, it is possible that this group would contain proportionately more women who had drunk alcohol during pregnancy (Zizzo et al., 2013). Those women in our sample who were attending substance misuse clinics were more likely to be at high risk of alcohol consumption. However, we accept that even in this subgroup it is possible that, due to stigma, those who continued to consume alcohol may have been less likely to complete the survey. Qualitative data examining the attitudes, beliefs and practices of women attending antenatal substance misuse clinics would be of particular interest in improving our understanding of how this group can best be supported during their pregnancy. Nonetheless, almost two-thirds of women who completed the questionnaire reported drinking during pregnancy, and around 4% reported drinking after finding out they were pregnant, suggesting that our sample, if not entirely representative of all pregnant women, contains a wide range of views and experiences. We also recognise that, as for all studies of self-report, claims to have stopped drinking may not reflect total abstinence, but rather that levels of drinking have reduced considerably from pre-pregnancy.

Our findings may also be influenced by the fact that there is a local policy for all antenatal women to be asked about their alcohol consumption at the time of booking. This may mean our cohort is relatively well informed with regard to the risks of alcohol consumption in pregnancy. However, to our knowledge, there are no reports comparing alcohol screening practices across the UK. Second, women with high-risk pregnancies (e.g. multiple births, the presence of diabetes) attend proportionally more antenatal clinics than other women and so are likely to be overrepresented in our cohort. This group of women may have a better understanding of antenatal risk factors and be more cautious in their approach to alcohol consumption. Finally, the ethnic mix of our background population is predominantly White British. This factor may affect the reproducibility of this study in areas with more diverse ethnicity and could limit generalisability.

Strengths

This study gives us an insight into the attitudes of a convenience sample of women and their partners. Participants were recruited from a variety of clinics, giving a good indication of general attitudes to alcohol and pregnancy. The decision to include partners was deemed important because they are known to have a strong influence over women's behaviours in pregnancy. However, we are unable to comment on any association between the views of individual women and partners. Further investigation of the role of partners in shaping women's attitudes and practice is required. There is evidence that women who are supported by their partners have better pregnancy outcomes for themselves and their babies (National Maternity Review, 2016). Given evidence of strong societal influences on shaping beliefs and attitudes regarding alcohol use in pregnancy, educating partners as well as pregnant women is likely to be key to influencing practice.

Conclusions

There is an identified need for clear concise guidance on alcohol use in pregnancy to reduce confusion on the issue and to counteract societal influences. Nearly 90% of women and partners surveyed believed that no alcohol should be consumed during pregnancy. While this finding is positive and suggests that doctors and midwives are succeeding in educating women about the risks of drinking in pregnancy, many women consumed alcohol until their pregnancy was confirmed, and views on safe levels of alcohol in pregnancy varied. Health professionals delivering maternity care are perfectly placed to fulfil a crucial role in the primary prevention of FASD. Screening for prenatal alcohol use should be prioritised, as decreasing or eliminating the use of alcohol during pregnancy could reduce the severity of the effects on the fetus. In addition, appropriate screening strategies for alcohol use in all women of childbearing age should be considered in primary care. This could include preconception health promotion, contraceptive counselling, and referral to substance misuse programmes for those women identified to have an alcohol use disorder. Despite ethical concerns, blood and meconium biomarker screening was generally viewed positively, and was seen as an opportunity for education and support rather than a threat to individual freedoms. Future work should focus on canvassing the views of women deemed to be at high risk of alcohol exposure in pregnancy such as those who smoke (O'Keeffe et al., 2015). Adapting existing initiatives to reduce tobacco use or avoid certain foods in pregnancy may be an effective and resource-efficient way of initiating a discussion on this sensitive topic.

Key points for policy, practice and/or research

- Screening for prenatal alcohol use should be a priority and is seen as an opportunity for education and support.
- Alcohol screening strategies for all women of childbearing age should be considered in primary care.
- Future work should focus on the views of women deemed at high risk of alcohol exposure in pregnancy, such as those who smoke.
- Antenatal smoking cessation resources may be transferable to alcohol management initiatives.

Author contribution

HH, SM and JR conceived and designed the study. HH, SM, KL and CD were involved in data acquisition and LD, WKG, HH, SM, KL and CD contributed to data analysis. WKG, HH and LD wrote the paper and all authors commented on the paper and gave final approval for submission.

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Declaration of conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Ethics

The study received a favourable ethical opinion from the Tyne and Wear South National Research Ethics Committee (Ref: 15/NE/0216). The survey data presented here were provided on a voluntary basis and were collected anonymously. The front page of the survey sheet contained information about the study aims and objectives and how the data would be used. The contact details of the lead midwife (HH) were also given in case people required more information prior to completing the form. Given the voluntary nature of data collection, written consent was not obtained from those who completed the survey.

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Kate Langley is studying Medicine at Newcastle University.

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Appendix 1. A patient survey about drinking alcohol in pregnancy

Information about the research

This is a patient survey about drinking alcohol in pregnancy.

It is part of a larger study looking at the prevalence of alcohol consumption in pregnancy and the acceptability of screening to clinicians, pregnant women and their partners.

We would like to invite you to take part in our research study. Joining the study is entirely up to you; before you decide we would like you to understand why the research is being done and what it would involve for you. Helen Howlett or any of the team will answer any questions you may have. We would like you to complete a short questionnaire which should take about 5 minutes. Please feel free to talk to others about the study if you wish. Do ask us if anything is unclear.

We would like to learn more about women and their partners' views about alcohol in pregnancy and the acceptability of routine alcohol screening tools. This is important and will benefit the future care of women and their babies.

We are inviting all antenatal patients attending clinics in Northumbria Healthcare NHS Foundation Trust. We intend to collect 200 responses in a 2-month period to inform us of patient views.

All research in the NHS is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by Tyne and Wear South Research Ethics Committee.

Your decision to take part in the research is entirely voluntary, and you can change your mind at any stage.

We intend to publish and disseminate these findings and they are also part of a professional doctorate award. All participants can be assured that individual participants will not be identifiable from any report or publication placed in the public domain because all responses are anonymous.

This study is funded and sponsored by Northumbria Healthcare NHS Foundation Trust.

If you have any questions then please ask Helen Howlett, Senior Research Midwife on 01670 564149.

Many thanks for your help with this important work.

We would welcome your views about drinking alcohol in pregnancy

Please circle the answer that applies

(1) What level of alcohol do you think is safe in pregnancy?

(a) Nothing
(b) 1–2 units per week
(c) 1–2 units once or twice a week
(d) More than 3 units per occasion

(2) In this pregnancy, which statement applies the most?

(a) I stopped drinking pre-pregnancy?
(b) I stopped at the time my pregnancy was confirmed or suspected?

If so how many weeks were you?

(c) I stopped drinking after seeing my midwife?
(d) I am still drinking
(e) I prefer not to say

In the future we would like to determine the levels of alcohol consumption during pregnancy. We know that a lot of women are drinking when they get pregnant and some throughout pregnancy. We can test for alcohol consumption in the first 12 weeks by a blood test and for alcohol after 12 weeks by checking the baby's first dirty nappy (meconium). None of these tests are currently done in pregnancy so we are asking mothers and fathers to give their opinion.

We would like to know if in a future pregnancy you would find this acceptable.

(3) Would you be happy to have your routine booking bloods tested for alcohol levels in a future pregnancy?

Yes
No
If yes why?

_____
_____

If no why?

_____
_____

(4) Would you be happy to have your baby's first dirty nappy (meconium) tested?

Yes
No

If 'yes' why?

_____

_____

If 'no' why?

_____

_____

(5) Are you:

Currently pregnant
The partner of someone who is currently pregnant

Additional comments

Thank you for your responses

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A Survey of Health Care Professionals' Knowledge and Experience of Foetal Alcohol Spectrum Disorder and Alcohol Use in Pregnancy

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ABSTRACT

BACKGROUND: Foetal alcohol spectrum disorders (FASDs) are one of the most common preventable forms of developmental disability and congenital abnormalities globally, particularly in countries where alcohol is considered socially acceptable. Screening for alcohol use early in pregnancy can facilitate the detection of alcohol-exposed pregnancies and identify women who require further assessment. However, only a small percentage of children with FASD are identified in the United Kingdom. This may be partly attributed to a lack of awareness of the condition by National Health Service (NHS) health professionals.

METHODS: We developed an online survey to determine health care professionals' (midwives, health visitors, obstetricians, paediatricians, and general practitioners) perceived knowledge, attitudes, and clinical practices relating to alcohol in pregnancy and FASD.

RESULTS: There were a total of 250 responses to the surveys (78 midwives, 60 health visitors, 55 obstetricians, 31 paediatricians, and 26 general practitioners). About 58.1% of paediatricians had diagnosed a patient with foetal alcohol syndrome (FAS) or FASD and 36.7% worried about stigmatisation with diagnosis. Paediatricians reported the highest levels of FASD training (54.8%), with much lower levels in midwives (21.3%). This was reflected in perceived knowledge levels; overall, only 19.8% of respondents knew the estimated UK prevalence of FASD for example.

CONCLUSIONS: We identified a need for training in alcohol screening in pregnancy and FASD to improve awareness and recognition by UK professionals. This could improve patient care from the antenatal period and throughout childhood.

KEYWORDS: alcohol, pregnancy, foetal alcohol spectrum disorder, alcohol screening

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Introduction

Alcohol exposure is one of the leading risk factors for population health worldwide, and as a known toxin and teratogen, it has a direct impact on maternal and child health.[1] There is a body of evidence demonstrating that prenatal alcohol exposure (PAE) can profoundly affect the foetus and result in a myriad of lifelong physical and cognitive disabilities, known internationally as foetal alcohol spectrum disorders (FASDs).[2] Foetal alcohol spectrum disorder is an umbrella term that encompasses several medical diagnoses, from the complete presentation of foetal alcohol syndrome (FAS), to a range of conditions – including partial foetal alcohol syndrome (pFAS), alcohol-related birth defects (ARBDs), alcohol-related neurodevelopmental disorders (ARNDs), and neurobehavioral disorder associated with prenatal alcohol exposure (ND-PAE). These diagnostic terms demonstrate various features of FASD and facilitate appropriate interventions in the patient pathway. For clarity, the term FASD will be used in this article. In the United Kingdom, FASD has recently become increasingly prominent within the public health agenda, as awareness of the condition slowly improves.[3] The Chief Medical Officers for the United Kingdom recommend that pregnant women, or those planning to become pregnant, avoid drinking any alcohol at all to keep risks to a minimum.[4] Screening for alcohol use early in pregnancy will facilitate the identification of those in need of support to discontinue or reduce their alcohol consumption.[5] Furthermore, screening of the mother during pregnancy, and later of the neonate, may enable infants exposed to alcohol to be identified and diagnosed.[6] In the United Kingdom, women of child-bearing age are some of the highest consumers of alcohol.[7] Popova et al[8] recently estimated that 41.3% of women in the United Kingdom consume alcohol during pregnancy, corroborating findings by the UK Infant Feeding Survey, where two in five mothers admitted drinking alcohol during

pregnancy.[9] This compares to a global estimated average of 10%, but Western societies which traditionally have a stronger alcohol culture were understandably found to have higher prevalence rates including the United States, estimated at 20% to 30%.[8] The UK National Institute for Heath and Care Excellence (NICE)[10] specifies the importance of screening as part of antenatal care, recommending that women should be given information about all issues including alcohol that may affect their health or the health of their baby. To optimise the health and well-being of women and their children, the World Health Organization (WHO) state that screening is a priority to prevent, reduce, and stop the use of alcohol during pregnancy and the postpartum period.[1]

After the child is born, the early diagnosis of FASD facilitates opportunities for early intervention and management for the affected child and reduces rates of secondary disabilities, such as mental health problems and exclusion from school.[11] It also helps reduce the risk of future PAE pregnancies.

As the first point of contact, physicians and other health care professionals are in a position to fulfil a crucial role in the prevention and identification of FASD. Appropriate screening for prenatal alcohol use should be prioritised in clinical practice, as eliminating or decreasing alcohol consumption at any point in pregnancy will reduce the risk of harm to the foetus.[12] The effectiveness of brief interventions are well documented, and even the process of screening has been shown to raise awareness and may reduce alcohol consumption in pregnancy.[2] It is, therefore, important to consider the knowledge and attitudes of health care professionals regarding alcohol because a lack of understanding of the issues will limit opportunities for FASD prevention, diagnosis, and early intervention.[13] Several international studies involving doctors and midwives have demonstrated confusion around the appropriate advice to give to pregnant women on the use of alcohol in pregnancy and the effects of alcohol on the foetus. Payne et al[14] surveyed 166 midwives across Western Australia and reported that 93.2% said that they ask about alcohol consumption in accordance with the national guidelines which advocate that not drinking is the safest option in pregnancy. In addition, 64.2% stated that they informed women of the effects of PAE, 47.5% did not always use the recommended Alcohol Use Disorders Identification Test (AUDIT; a simple screening tool developed by WHO to pick up the early signs of hazardous and harmful drinking and identify mild dependence), and 70.4% admitted to not providing brief interventions. Diekman et al[15] surveyed 600 US obstetrician-gynaecologists and found that although 97% reported asking patients about alcohol consumption, only 20% would advise abstinence as the safest option in pregnancy, 13% were unsure about harmful levels, and 4% believed that eight or more drinks per week would not increase the risk of adverse outcomes. Some studies have identified the provision of vague advice regarding drinking alcohol in pregnancy, recommending 'cutting down' rather than 'giving up' alcohol.[12,16,17] It has been suggested that conflicting official British national health and professional organisations and even international advice has confused the issue for health care professionals and women alike.[18] For example, the lack of conclusive evidence regarding the safety of low levels of PAE has contributed to the varying guidelines and advice on alcohol consumption during pregnancy.

Thousands of families are currently seeking an FASD diagnosis for their children and have voiced their concerns over the lack of services available.[19] The FASD Network United Kingdom has requested this research to raise awareness with health care professionals to help address this important issue.[20]

The level of FASD knowledge among professionals is a documented factor that influences the rates of diagnosis.[21,22] The literature reports that paediatricians under-report FASD and even misdiagnose the condition as other medical conditions such as attention deficit hyperactivity disorder, due to stigma as well as diagnostic uncertainty.[17]

Evidence suggests that biomarkers may have clinical value in detecting alcohol consumption in pregnancy, to highlight women in need of support and later to facilitate diagnosis for children affected with FASD.[23] Consequently, we were interested in finding the views of health care professionals around obtaining blood or meconium samples to supplement self-report, given the complex ethical nature of the issue.

The aim of this study was to explore the current perceived knowledge, practices, and attitudes of the key health professionals in the United Kingdom regarding alcohol consumption in pregnancy and FASD in childhood. For the purpose of this study, we adopted the Oxford Dictionary definition of Knowledge 'Facts, information and skills acquired through experience or education; the theoretical or practical understanding of a subject'.

It was intended that these findings would help address an apparent gap in knowledge when the UK prevalence rate for alcohol consumption in pregnancy is the fourth highest in the world, and yet most children with FASD-related disabilities remain undiagnosed and therefore, unsupported. We intend to use the results from this study to highlight the training needs of each professional group to provide evidence based recommendations to improve clinical practice.

Ethics

The study received a favourable ethical opinion from the Tyne & Wear South National Research Ethics Committee (Ref: 15/NE/0216). The survey data presented here were provided on a voluntary basis and were collected anonymously using an online survey.

Methods

This was a cross-sectional online survey conducted between October 2015 and July 2016.

Key professional groups were sent a web-link to the survey via email. We used a pragmatic cascade method of distribution to maximise the number of potential respondents, making the exact figures approached unknown. An introductory summary contained information about the study aims and how the data would be used. The contact details of the lead midwife (H.H.) were also given in case respondents required more information before completing the form. Given the nature of data collection, written consent was not obtained from those who completed the survey. Names and addresses, or any other personal identifiable data, were not collected.

Participants

We targeted key health professionals involved in screening for alcohol and FASD during antenatal, postnatal, and paediatric care. Surveys were sent to midwives, obstetricians, general practitioners (GPs), health visitors, and paediatricians. In the United Kingdom, the role of the midwife is to provide care and support to women during pregnancy, throughout labour, and the early postnatal period. The midwife enables women to make informed choices about their care and is usually the first and main contact. Whereas, health visitors are nurses or midwives who have completed extra training to work with families to give pre-school-age children the best possible start in life by promoting healthy lifestyles and preventing illness. Contact with the family usually begins antenatally with an introductory visit at around 32 week's gestation. An email cascade approach was used for distribution using colleagues and contacts at local, regional, and national levels. These included the local National Health Service (NHS) Trust distribution network and research and professional organisations such as the National Institute for Health Research Local Clinical Research Network and the Institute for Health Visiting. We asked recipients to forward the survey links to other colleagues to maximise the number of respondents.

Survey questionnaire

The online survey was piloted by representatives from each professional group before general circulation and took under 10 minutes to complete. After feedback, some questions were adapted to aid clarification and ensure that the profession-specific part of the surveys were appropriate. No data from the pilot phase were included in the final results because we did not want to compromise the accuracy and consistency of the results. Health care professionals were asked general questions around alcohol in pregnancy and FASD in the first part of the questionnaire, and the later questions were adapted to the specific role of each profession. For example, obstetricians and midwives were asked about alcohol during pregnancy and referring mothers while paediatricians and health visitors focussed more on the presentation of the children with FASD and retrospective PAE issues. We wanted to gain a greater insight into perceived knowledge and confidence levels in all professions and learn about a general range of issues around alcohol and FASD screening, referral practices, and finally, diagnostic experience. The intention was then to identify the gaps in perceived knowledge to inform future training provision. Feedback regarding professional practice in the United Kingdom is of particular interest, as the current documented lack of service provision poses many challenges to NHS staff.[19] We were guided by the questions asked by the existing international body of knowledge so that we could augment existing data and compare this to our UK sample of respondents. The questions were multiple-choice type with additional free text to complete where appropriate. The questions can be categorised into three broad areas of clinical practice, knowledge, and attitudes, which we acknowledge can overlap. The questions are listed in Table 1.

Data analysis

Data analysis was supported by the software package SPSS (version 23, IBM Corp, Armonk, NY, USA). Data were summarised using standard summary statistics (eg mean, median, and frequency) depending on the type of data collected. We employed descriptive statistics to gain in-depth information from our respondents. Only valid responses are included. In this study, invalid answers referred to unanswered questions, or the field was left blank. For three questions, an answer was given which did not appear to answer the question. In these cases, the answer was deemed invalid. Three researchers reviewed the data and came to a consensus regarding valid answers. All responses were also verified by the co-authors to reduce bias.

Results

There were a total of 250 responses to the surveys: 78 midwives, 60 health visitors, 55 obstetricians, 31 paediatricians, and 26 GPs responded during the data collection period (10 months).

Clinical practice-related results

Alcohol screening practices in pregnancy. Rates of reported screening for alcohol use were generally high (midwives 68/75 [90.7%], health visitors 51/55 [92.7%], obstetricians 41/55 [74.5%], although rates were lower in GPs 14/26 [53.8%]). However, there was little consistency in the choice of alcohol screening tools. The most common approach used by 113 respondents was simply detailed questioning with no specific tool. Five clinicians used AUDIT. Alcohol Use Disorders Identification Test – C, a shortened version of the AUDIT tool, was used by 32 professionals. A total of 18 staff utilised a local NHS Trust-specific assessment. Four respondents used TACE (a measurement tool of four questions: **t**olerance, **a**nnoyance, **c**ut down and **e**ye opener), and two utilised CAGE (four questions: cut down, annoyance, guilt and eye opener).

Table 1. Survey questions.

Clinical practice-related questions 1. Do you routinely screen for alcohol consumption in your general consultations? Yes/No
2. Do you ask about alcohol consumption at antenatal visits? Yes/No
3. Which assessment tool do you use? Self-reporting Audit C AUDIT TACE TWEAK Don't ask Other (please specify)
4. What levels of alcohol consumption would cause you to refer? Any alcohol if still drinking >4 units/week >6 units/week >14 units/week >21 units/week AUDIT C > 4 AUDIT C > 5 AUDIT C > 6 If drunk at appointment Other (please specify)
5. Who would you refer to? Never referred Alcohol specialist nurse/midwife Obstetric consultant Addictions service Social worker/child protection Non-government organisations, eg Alcoholics Anonymous Community psychiatric nurse (CPN)/Mental Health Team Liver/Alcohol medical consultant Other (please specify)
6. Do you currently screen for foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD)? Yes/No
7. If a child in your care was suspected of having foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD), who would you refer to? Paediatrician Speech therapist Geneticist Psychologist Neurodevelopmental paediatrician Social worker Children and adolescents mental health service (CAMHS) Non-government organisation eg FASD Network UK, NOFAS UK Never referred Other (please specify)
Knowledge-related questions
8. How many children are thought to be affected by foetal alcohol syndrome (FAS) in the UK? 1: 100 1: 500 1: 1000 1: 2000 I don't know
9. How many children are thought to be affected by foetal alcohol spectrum disorder (FASD) in the UK? 1: 100 1: 500 1: 1000 1: 2000 I don't know
10. How confident do you feel in your knowledge about the prevalence and presentation of foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD)? Not confident Fairly confident Very confident

Table 1. (Continued)

11. Have you received training on asking about alcohol consumption in pregnancy? Yes/No
12. Would you feel comfortable discussing maternal alcohol consumption during pregnancy if a child in your care demonstrated some foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD) traits? Yes/No
13. Have you ever received training in foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD)? Yes/No
14. Do you feel able to recognise signs, symptoms and behaviours associated with foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD) in infants and children? Yes/No
15. How confident do you feel in diagnosing foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD)? Not confident Fairly confident Very confident
16. Have you ever suspected foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD) but did not refer? Yes/No
17. Have you ever been convinced of a diagnosis but did not record? Yes/No
18. Do you feel worried about stigmatisation with diagnosis? Yes/No
19. How many foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD) children have you knowingly encountered in your career? 1-5 6-10 11-20 21-40 41 +
20. Would you be interested in further training on foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD)? Yes/No
Attitude-related questions 21. To help identify children at risk of foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD), do you think pregnant women should be routinely screened for alcohol consumption using a blood test during their routine booking bloods? Yes/No
22. Would you feel comfortable asking permission from pregnant women to screen for alcohol levels with the routine antenatal booking bloods? Yes/No
23. To help identify children at risk of foetal alcohol syndrome (FAS)/foetal alcohol spectrum disorder (FASD), do you think we should routinely screen pregnant women for alcohol consumption by testing the first meconium nappy? Yes/No
24. Would you feel comfortable asking permission from mothers to check for alcohol levels in the first meconium nappy? Yes/No

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test; TACE, tolerance, annoyance, cut down and eye opener; CAGE, cut down, annoyance, guilt and eye opener.

Referral for alcohol use in pregnancy. Reported levels of drinking at which midwives would refer varied considerably: 32/75 (43.2%) specified they would refer for any reported alcohol consumption, 10 (13.5%) stated they would refer if drinking more than 14 units of alcohol per week and 8 (10.8%) if more than 21 units per week. A further 11 (14.9%) indicated they would only refer if the patient was visibly drunk at an appointment. Responses from health visitors were similar: 26/53 (49.1%) indicated they would refer if any drinking was reported, 6 (11.3%) if greater than 14 units per week and 4 (7.5%) is greater than 21 units per week, 3 (5.7%) said they would only refer if the patient was visibly drunk when seen.

Of 51 midwives who answered that they had referred someone for alcohol use in pregnancy, 36 (70.6%) had referred to an alcohol specialist nurse and 42 (82.4%) to an obstetrician, 16 (31.4%) to addiction services and 18 (35.3%) to a social worker or child protection officer. Of 32 health visitors who had referred someone for alcohol use in pregnancy, 28 (87.5%) had referred to an alcohol specialist nurse, 4 (12.5%) to an obstetrician, 11 (34.4%) to addiction services, and 12 (37.5%) to a social worker.

Only 5/25 GPs responded that they would refer for any alcohol consumption in pregnancy, 8 if consumption was

greater than 14 units per week, and 5 if greater than 21 units per week: 8 specified they would refer if the patient was visibly drunk when seen.

Referral for FASD. The numbers of known children with FASD were very low, with five or fewer was the most common response even among paediatricians. Of the 31 paediatricians in the study, 18 (58.1%) had diagnosed a patient with FASD. However, 11/30 (36.7%) said they worried about stigmatisation with diagnosis and, of these, 2 said they had been convinced of a diagnosis but did not refer to more specialist services.

51/55 (92.7%) health visitors said they would refer an infant with FASD to a paediatrician or neurodevelopmental paediatrician, and 36 (65.5%) would refer to the GP and 12 (21.8%) to a social worker. All 24 GPs respondents said they would refer to a paediatrician or neurodevelopmental paediatrician, and 3 said they would refer to a social worker.

Knowledge-related results

Training in screening for alcohol use in pregnancy and identifying FASD in infants. Rates of previous training in FAS and FASD (Figure 1) were generally low, with midwives and GPs having the lowest rates of previous training and health visitors the highest rates. This was corroborated with a high level of requests for further training across the specialities, ranging from 98% of health visitors to two-thirds of GPs. Online training packages were requested by some respondents because they can be easily accessed at a time and place to suit.

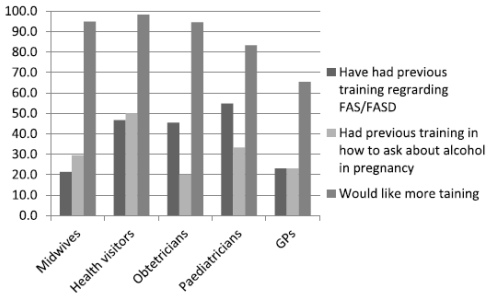

Figure 1. Previous training and need for further training.

Perceived knowledge of FASD. The lack of training was reflected in low levels of knowledge about the prevalence of FAS and FASD in the general population. Overall, only 22.1% of respondents knew the estimated prevalence of FAS and only 19.8% the estimated prevalence of FASD (Figure 2).

Discussing FASD with parents. Health visitors, paediatricians, and GPs were asked how comfortable they would feel discussing FASD with a parent; 38/60 (63.3%) of health visitors, 24/30 (80.0%) paediatricians, and 23/25 (92.0%) GPs said they would feel comfortable.

Signs, symptoms, and diagnosis. A total of 17 from 74 (23.0%) midwives said they would feel confident (1 very confident and 16 fairly confident) in identifying the signs and symptoms of FASD, whereas 11/55 (20.0%) health visitors and only 1 (3.8%) GP said they would feel confident (all fairly confident). Confidence was higher in paediatricians (64.5%, 15 fairly confident and 5 very confident) and obstetricians (34.5%, 18 fairly confident and 1 very confident).

A total of 18 (58.1%) paediatricians had previously diagnosed FASD, although only 3 (9.7%) claimed to be very confident and 14 (45.2%) fairly confident about diagnosing FASD. In contrast, only one (3.8%) GP disclosed they had ever diagnosed FASD before, two (7.7%) said they would be fairly confident about diagnosing; none stated they would be very confident.

Attitude-related results

Attitudes to blood and meconium screening. As blood and meconium screening has the potential to detect alcohol consumption in pregnancy and supplement self-report, professionals opinions were sought on the feasibility of both in practice.

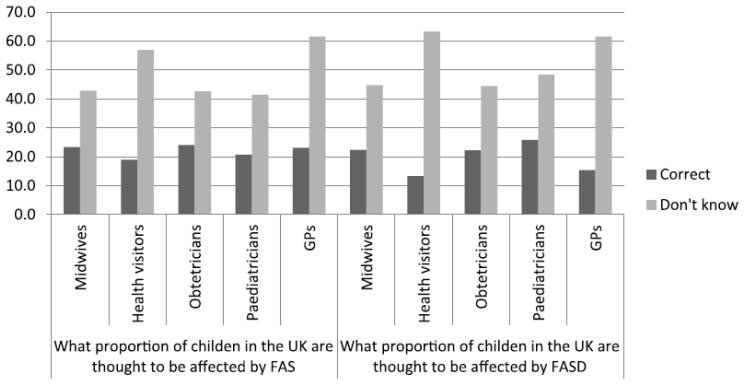

Figure 2. Knowledge of the prevalence of FAS and FASD.

General practitioners (64.0% and 70.8%, respectively) and health visitors (74.6% and 63.8%, respectively) were much stronger advocates than midwives (56.4% and 41.6%, respectively), obstetricians (45.5% and 43.6%, respectively), or paediatricians (40.0% and 35.7%, respectively).

Discussion

The results of this study gives us a greater understanding of the perceived knowledge, attitudes, and clinical practices of the key health care professionals delivering care throughout the patient journey from the antenatal period and throughout childhood. This included the identification and referral of women who drink alcohol in pregnancy and the identification and diagnosis of children with FASD. Furthermore, the results of our survey support findings from other settings, suggesting that these issues are not unique to the UK health system.[14] Indeed, many of the underlying reasons for this lack of consistency (eg lack of confidence in discussing a sensitive issue, rights of the individual, and lack of a clear 'gold standard' to screen for alcohol use) are common globally.[17]

Clinical practices

Awareness and practices around alcohol screening were generally very encouraging. Most professions indicated that they proactively ask about alcohol consumption, and very few from each professional group had never referred a mother for alcohol or a child with FASD. A diverse range of alcohol screening tools were used, and the levels of alcohol consumption which triggered a referral varied considerably. This trend was observed across all professional groups. Further research into developing a standardised alcohol referral protocol specifically for pregnant women may support health professionals to provide a more consistent service.

An important indicator of the success, or otherwise, of current clinical practice is the reported experiences of the women themselves. The Infant Feeding Survey 2010[9] asked women about the information they received in pregnancy regarding alcohol. Of the women who drank before pregnancy, 71% received information about drinking during pregnancy, and 62% said they had been given general information about the effects of drinking alcohol on the baby. Only 36% stated they had been given information on how to cut down or limit the amount they drank during pregnancy, while just 29% said they had been given information on stopping drinking alcohol completely. When analysing the figures for those who received information about drinking, the most common source was a midwife (81%); 14% stated a health visitor, and 13% cited a doctor. In an Australian study, Crawford-Williams et al,[24] highlighted the barriers identified by health professionals in discussing alcohol with women. They include the concepts that many professionals have a perception that most women do not drink in pregnancy; that women know not to drink; that alcohol is not a priority in a time-limited antenatal visit; and that discussing alcohol might cause anxiety, frighten, or anger the woman.[24] These perceptions can be classified into determinants such as self-efficacy, risk perception, and personal identity. The identification of specific barriers by the health professional increases self-awareness and is an important part of understanding what needs to be changed. Therefore, self-reflection and awareness of differing and potentially conflicting beliefs should be included in future training.

Referral pathways for patients with FASD varied widely, as there are no current NHS-coordinated FASD services established in the United Kingdom to date.[2] The lack of diagnostic clinics, interventions, and care pathways were reported as barriers to referrals by GPs, paediatricians, and health visitors in particular. Until very recently, only one official diagnostic clinic in the United Kingdom was available and most FASD management resources are derived from Canadian or Australian practices.[25] A lack of patient access to diagnostic services is well documented and will inevitably inhibit best practices of early intervention.[17,26,27] To maintain the momentum of the informed and proactive health professionals, there is a clear need for the United Kingdom to launch standardised, high-quality FASD services.

Knowledge. FASD training was a substantial need identified across all the professional groups surveyed. In particular, screening for FASD, alcohol use, and the onward referral processes were acknowledged as learning requirements. These findings corroborate empirical evidence and previous research which concluded that if FASD-related disorders (including secondary co-morbidities) are to be effectively prevented, identified, and treated, improvements to referral systems, professional education, and screening are essential for pregnant women and children with PAE.[14,21] General practitioner responses especially reflected a desire for additional training. The relatively low levels of current FASD training in the United Kingdom are reflected in the low level of knowledge pertaining to FAS and FASD prevalence. In addition, the signs, symptoms, and diagnosis confidence levels were similarly low, with the exception of paediatricians. This identified knowledge gap may compromise the provision of care for mothers and children throughout the patient journey. Interestingly, health visitors, paediatricians, and GPs demonstrated relatively high levels of confidence in discussing FASD with patients. This is an interesting finding for a group of professionals who otherwise report a lack of training in FASD and a limited knowledge base. This may be explained by the interpretation of the question in terms of professional competency rather than from an FASD-specific perspective.

Identified gaps in FASD knowledge and awareness would support a link to the considerable under-diagnosis in the United Kingdom.[21,22] Popova et al[28] estimated an FASD prevalence rate of 5% based on an FAS prevalence rate in excess of 50 per 10 000 of the general population. The latest figures from a large cohort prevalence study found that up to 17% of children screened positive for FASD but had not received a formal diagnosis.[29]

1.	Comprehensive alcohol screening training across the key professions, including a focus on the issue of stigma.
2.	A standardised antenatal alcohol screening tool
3.	A national protocol for alcohol referrals including Brief Interventions
4.	Universally accessible alcohol services across the UK with specialist pathways for pregnant women.
5.	A nationwide evidence-based professional training in FASD, screening and referrals which should also be included in the pre-registration curriculum.

Figure 3. Recommendations for practice.

In the United States, Gahagan et al[27] surveyed 879 paediatricians and found that 62% could identify children with FASD, 50% would diagnose a child who presented with FASD but only 34% would manage and coordinate treatment. Similarly, Nevin et al[26] surveyed 75 family physicians in Toronto and found that 8% had diagnosed a child with FAS and 17.9% had had suspicions but had not diagnosed. Confidence levels in FAS diagnosis were found to be low with 49% feeling that they had little confidence. Furthermore, only 60.8% reported advising pregnant women on alcohol consumption.

A little over half of the paediatricians had actually diagnosed FASD and over a third expressed concerns around stigmatisation of diagnosis. This suggests that the issue of stigma needs to be explored further in training packages to facilitate the diagnosis and management of children and adults with FASD. Stigma around alcohol use in pregnancy is an international issue. In Australia, Elliott et al[30] surveyed 132 paediatricians; 76.5% reported suspecting but not diagnosing FAS, 12.1% had been convinced but not diagnosed. The authors also report that of the same paediatricians, 79.6% agreed that early diagnosis may be beneficial, but 69.6% believed that diagnosis may be stigmatising, and furthermore, 36.4% presumed that parents might resist referral for assessment and intervention. Mukherjee et al[13] also attributed the reluctance to diagnose FASD to professional lack of knowledge and stigma. Stigma is a serious concern for health professions. Corrigan et al[31] confirmed that mothers of children with FASD are significantly stigmatised for their past behaviour and often experience public discrimination. To address this, Corrigan et al[31] recommend contact-based strategies in preference to educational strategies when implementing stigma reduction interventions.

Attitudes

Interestingly, professionals did not necessarily agree to routine blood or meconium screening even though they may facilitate the detection of foetal alcohol exposure. This may arise from an ethical and legal perspective as patient consent was not specified in the question. General practitioners and health visitors were the strongest supporters of screening initiatives. One possible explanation may be that children's advocacy is a key role of the health visitor, but this is also true of the paediatricians who were more circumspect. To contextualise this matter, the NHS currently recommends offering routine antenatal screening of hepatitis B, HIV, and syphilis in every pregnancy.[10] These tests arguably share similar issues of stigma and sensitivity as alcohol in pregnancy, but through training and a changing culture of practice, all have now become an accepted screening routine by women and health care professionals alike. Similarly, biomarker screening may benefit both the mother and child, and could be undertaken in a supportive manner which could direct valuable resources to those most in need.

Recommendations for practice. This study has identified a noteworthy gap in knowledge around risks of PAE and the management of children with FASD across the professions (Figure 3). This deficit will undoubtedly influence clinical practice and may partly explain the United Kingdom's estimated high alcohol prevalence rates in pregnancy. It has also recognised clear FASD-related training needs which corroborate the conclusions of Mukherjee et al.[13] While, acknowledging that some literature may not necessarily correlate increasing knowledge with behaviour change, we feel that education is the key facilitator available in this instance.[32] Training will increase knowledge and understanding, thus providing a rationale and catalyst for health care professionals to change attitudes to prevention, diagnosis, and early intervention. To support these initiatives and behaviour changes, the United Kingdom urgently requires clear, consistent, and mandated FASD referral pathways, guidelines, early interventions, and support services for children and their families. This strategy should also include education around the risks of harm from alcohol in pregnancy. Screening for alcohol should be routine in all primary-care settings, with an emphasis on preconception health advice and contraceptive counselling. Referrals to established alcohol or substance misuse services for women identified to have an alcohol use disorder should also become the norm so that women receive the specialist support required. These initiatives could help to prevent further cases of FASD, and would minimise co-morbidities and maximise the potential of individuals with FASD. A high-profile public health promotion to alert both health professionals and the general public to the risks of foetal alcohol exposure is overdue. Future research should seek to better understand FASD prevalence and characteristics of at-risk groups so that effective services and interventions can

be developed. A cost-benefit analysis of the impact of awareness raising, training, screening, and referral on downstream costs to health and social care budgets should also be conducted to support the engagement of stakeholders at Government level. A Canadian study has referred to children with FASD as $1 million babies, but the prevention and management costs are likely to be a fraction of this.[33]

Strengths and limitations

We had originally planned to send our surveys to each relevant professional body for distribution across the United Kingdom. However, this approach was denied by all but the Institute of Health Visitors. We, therefore, asked local professional networks such as the North East and North Cumbria Clinical Research Network to circulate the questionnaires among all eligible health professionals locally and nationally. We requested all recipients to forward our survey link to other appropriate colleagues. This pragmatic approach increased the potential number of health professionals who received a questionnaire, but unfortunately left no clear audit trail. Consequently, we do not know the total number of health professionals who were invited to participate in the survey to calculate the response rate. Ideally in future studies, we would have profession-specific questionnaires distributed from the corresponding professional governing bodies for maximum distribution.

Some health visitors responded to the paediatrician's questionnaire, but we were able to identify them from the first question which asked about their speciality area. The data were then reassigned to the health visitor statistics. We are unable to comment on the generalisibility of our responders. Our results may be influenced by the inherent response bias of any survey questionnaire. The professionals who have an interest in alcohol consumption in pregnancy and FASD may have been more likely to participate. This could have led to an overestimation of knowledge, attitudes, and practices in this sample. Social desirability bias may also confound self-reported opinions and practices. This may influence responses to sensitive questions around as assessment and management, but the anonymity of this research should mitigate this bias. This exploratory study gives insight into the perceived knowledge, attitudes, and practices of five strategic NHS professions in relation to alcohol in pregnancy and FASD throughout childhood.

The generic limitations of questionnaires could also be applied to this study and include factors such as the truthfulness of responses, individual's agendas, a lack of conscientious response and differences in understanding and interpretation. We also recognise that our findings are based on self-report and not a formal assessment of knowledge but still provide a useful insight.

Finally, due to the scope of this study, we were unable to examine individual's detailed personal beliefs and perceptions, as many aspects of clinical practice that we asked about such as screening tools and referrals are guided by local protocols and resources. However, this topic would be worthy of future investigation and could include more qualitative methodologies such as interviews and focus groups.

Conclusions

This study highlights a need for training and education regarding the risks of alcohol in pregnancy and FASD in children for health professionals in the United Kingdom. The health care infrastructure around FASD across the life course in the United Kingdom lags behind many Western countries such as USA, Canada, and Australia. However, we can learn from their experience and share the best practices already established on an international scale. If we are to prevent or minimise the risk of harm from PAE and make a significant difference to the outcomes of individuals with FASD, we need to work collaboratively to expedite the establishment of world class FASD services throughout the United Kingdom.

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Author Contributions

H.H., S.M., E.-M.S. and J.R. conceived and designed the study. H.H. and W.K.G. were involved in data acquisition and H.H. and W.K.G. contributed to data analysis. H.H. wrote the paper and all authors commented on the paper and gave final approval for submission.

Ethics

The study received a favourable ethical opinion from the Tyne & Wear South National Research Ethics Committee (Ref: 15/NE/0216). The survey data presented here were provided on a voluntary basis and were collected anonymously using an online survey.

Funder's Role

The sponsor of this study had no role in the study design, in collecting the data, in data analysis or interpretation, in writing this manuscript, or in the decision to submit to this journal for publication.

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An antenatal alcohol service evaluation of the north-east of England and north Cumbria

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ABSTRACT

Background NHS England's 'Better Births' strategy aims to improve maternal and infant health outcomes. A strategic priority identified in the north-east local maternity system is to reduce alcohol consumption in pregnancy due to the documented diverse risks of harm to mother and baby, including foetal alcohol spectrum disorder.

Aims To evaluate current alcohol prevention, screening and treatment service provision in maternity care across the region, and inform future recommendations.

Methods A service evaluation survey was developed to systematically consult strategic stakeholders across all nine maternity trusts in the region over a 2-month period in 2018. Content analysis was employed to identify fundamental themes and inform recommendations for practice.

Results High variation was reported throughout regional clinical practices, service provision and staff training. For example, a number of alcohol screening tools were identified, each with diverse thresholds for referral; reported data collection and documentation practices were multifarious, incomparable and unquantifiable; audit was rare and guidelines were primarily influenced by local commissioning agreements.

Discussion Standardized patient pathways involving alcohol screening and management practices are required, and sharing best practices will facilitate referrals and support regardless of location. The implementation of these recommendations requires appropriate leadership, commissioning and training strategies.

Keywords alcohol, foetal alcohol spectrum disorder, pregnancy, screening, women's health

Introduction

Alcohol is the most popular drug of choice globally and constitutes a major public health concern in the UK. In 2017, 80% of the UK population consumed alcohol, with a specified rate of 77% for women.[1] Alcohol-specific deaths amongst women in 2017 were the highest on record at 8.0 deaths per 100 000 females.[2] Alcohol consumption at any level is associated with many co-morbidities including injury, cancers, cardiovascular and liver disease.[3, 4] Alcohol misuse can also originate from and result in mental health problems including anxiety and depression.[5, 6] Women's attitudes to alcohol have changed over recent decades as alcohol is more readily available, socially acceptable, highly promoted through advertising and therefore not generally perceived as harmful.[7–9] Binge drinking, defined as exceeding six units in one day, is most common in younger women of childbearing age, and some women now drink as much as men.

An estimated 41% of women in the UK consume alcohol during pregnancy; the fourth highest in the world.[10] Only 55% of pregnancies are planned and many women inadvertently consume alcohol before pregnancy confirmation.[11–13] In 2016, all four UK Chief Medical Officers (CMO)s updated alcohol recommendations to accord with international standards and advised that the safest approach for women who are pregnant, or trying to conceive, is not to drink any alcohol.[3] NICE updated their advice accordingly in December 2018.[14] The previous guideline for England had instructed pregnant women to drink no more than 1–2 UK units once or twice a week and not to get drunk or binge drink.[15] A legacy of mixed

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messages around the risks of alcohol in pregnancy still persists as this new guideline slowly embeds into clinical practice and public awareness.[16]

Alcohol is teratogenic and passes freely across the placenta to the unborn baby, whose immature liver cannot metabolize ethanol.[17] Prenatal alcohol exposure (PAE) has long been associated with miscarriage, premature birth, stillbirth and low birth weight.[18] However, PAE can also cause a range of physical and neurodevelopmental problems, which are encompassed by the umbrella term foetal alcohol spectrum disorder (FASD).[19] PAE can affect language and memory, inhibit processing and understanding, cause attention deficits and generate emotional, behavioural and learning difficulties.[18] PAE-related brain damage can be extensive and is influenced by timing, frequency and quantity of alcohol exposure.[20] Emerging evidence suggests that even low levels of PAE can compromise foetal growth and increase the probability of preterm delivery, therefore cautionary abstention advice eliminates these risks.[21] The facial dysmorphia of foetal alcohol syndrome (FAS), the most severe end of the FASD spectrum, is generally recognized but only presents in ~10% of FASD cases.[19, 22] FASD is the most common cause of non-genetic learning disability in the UK but is regarded as a 'hidden' disability as most children cannot be easily diagnosed from their physical presentation alone.[12, 17, 19] A recent large scale, longitudinal cohort study identified 6–17% of children screened positive for symptoms of FASD.[23] Secondary co-morbidities are common and include substance abuse, sexual inappropriateness, exclusion from school, unemployment, homelessness and involvement with the criminal justice system.[17, 24] In the UK, data are not yet available to calculate the economic impact on the health, education, social care services and the criminal justice systems; but the Canadian cost of FASD totalled ~$1.8 billion in 2013.[25]

Reducing alcohol consumption across the life-course and particularly in pregnancy aligns with several UK Government and PH initiatives including 'Health Matters: Giving every child the best start in life',[26] family nurse partnership,[27] making every contact count (MECC)[28] and better births.[29] NHS England's 'better births' strategy aims to ensure that women receive greater informed choice and control, thus facilitating safer, individualized care and ensuring better maternal and infant outcomes. The local maternity system (LMS) boards are tasked with implementing better births,[29] and the north-east LMS has identified alcohol reduction in pregnancy, as one of the seven prevention priorities to maximize mental and physical health during pregnancy and the postnatal period; and an opportunity to improve health and wellbeing and reduce health inequalities at a time when women are receptive to change and maternity staff can make every contact count.[30] This objective is shared with the UK All Party Parliamentary Group (APPG) FASD agenda to develop policy to improve awareness, prevention, diagnosis and support.[31]

Aims

To conduct a service evaluation to explore current alcohol prevention, screening and treatment provision in maternity care across the north-east of England and north Cumbria in 2018. To assess the level of service across the region; identify any gaps and highlight best practices. For the purposes of this study, best practices are defined as those considered effective and innovative, and utilize the scaling of resources for optimal patient outcomes. An evidence-based approach is the ideal but due to the vanguard nature of this specialist area, some practices are yet to be researched, so clinical expertise and patient values govern implementation.[32] Finally, to develop strategic recommendations to inform local decision making, and thereby meet the LMS primary objective of reducing alcohol in pregnancy.

Methods

A cross-sectional study approach was adopted to undertake a service evaluation using the principles of survey methodology.[33] The survey was developed in collaboration with local key experts in the field from balance (the North East England Regional Alcohol Office, funded by local authorities with the remit to encourage people to reduce their consumption and reduce the impact that alcohol is having on the region through education, sharing best practice and calling on Government for change)[34] Durham Public Health, a foetal medicine consultant and a specialist FASD research midwife. The survey used closed and open-ended questions to quantify variables and also capture exploratory, open ended questions, thus maximizing the depth and breadth of data collected.

The survey was developed with the intention to gain greater understanding of current alcohol services and clinical practices in pregnancy. As PH and the LMS commissioned this work, a previous custom-made smoking data collection tool was adapted, which had successfully obtained similar data in a region-wide maternity service evaluation. Consequently, the survey questions mapped the relevant aspects of service provision such as leadership, commissioning, metrics, patient pathways and staff training; as specified in Table 1.

Table 1 All nine hospital trusts delivering maternity services across the north-east of England and north Cumbria were asked the following questions in a structured interview. A summary of the results are recorded below and have been categorized under general headings

Networks, leadership and coordination		
Are there local multi agency alcohol partnership meetings? Do these meeting include issues around alcohol and pregnancy?	Specific meetings with alcohol strategy groups	Three trusts
	Substance misuse meetings which include alcohol	Three trusts
	No specific multi agency alcohol partnership meetings but alcohol was linked into other multidisciplinary team collaborations	Two trusts
If so, is the group well attended by key decision makers and appropriate representatives from maternity services?	Alcohol and substance misuse groups well attended by the key stake holders	All nine areas
	Trusts providing a maternity representative	Five trusts
Has the group developed any objectives linked to alcohol use during pregnancy?	Alcohol use in pregnancy objectives set	Three trusts
	Alcohol use in pregnancy objectives in draft	One trust
	FASD action plan devised	One trust
If so, how do these objectives influence: • Commissioning of local services • Service delivery	Annual FASD awareness day	Two trusts
	FASD included in the drug and alcohol agenda	One trust
	Alcohol screening training for maternity staff	Three trusts
	Training delivered in schools	One locality
	Alcohol in pregnancy in the MEC initiative	One locality
	Substance misuse providers and local GP's offering alcohol screening and ABIs, advice and guidance around alcohol use during pregnancy	One locality
	0–19 service including alcohol screening and ABIs, advice and guidance around alcohol use during pregnancy	One locality
	Health visitor early help plan	One locality
Are there processes in place to monitor progress against the objectives?	Task and finish group objectives reviewed using quarterly data quality monitoring	One locality
	Trust data collected, monitored and audited	One trust
	Audit of maternity notes	One trust
	The alcohol units at booking submitted to maternity services data set and NHS digital	One trust
	Six monthly or quarterly reviews	Three trusts

(Continued)

Table 1 Continued

Are issues linked to alcohol and pregnancy addressed in the local:	Added health checks to incorporate alcohol in pregnancy	One locality
• Health and wellbeing strategy	Pre-birth pathway for multiple pregnancy women with substance and alcohol misuse whose children are removed into care	One trust
• CCG strategic/business plans		
• Joint Strategic Needs Assessment (JSNA)	Health matters: giving every child the best start in life Government initiative utilized to link alcohol and pregnancy	Two trusts
• Children's plan	Children's plan utilized	One trust
	JSNA	One locality
	The vulnerability agenda	One locality
	Drug and alcohol agenda	One locality
	The troubled families programmes	One locality
	The regional network	One locality
	The MECC initiative	One locality
	Better births agenda	One locality
	The 0–19 service	One locality
	The better health at work agenda	One locality
	The healthy school award	One locality
	The healthy child programme health and wellbeing strategy	One locality
Is there a local champion for issues linked to alcohol and pregnancy in the trust or maternity unit?	Substance misuse midwives (including alcohol)	Five trusts
	Public health midwives	Three trusts
	Individual midwives managing alcohol and substance misuse cases in their general caseload	Two trusts
	Hospital inpatient liaison team for alcohol intervention for 24/7 cover	One trust
	Absence of a local champion or specialist midwife	One trust
Is there a dedicated midwife for alcohol? If so, which organization funds this post?	A dedicated midwife for alcohol	No trusts
Does your organization have an obstetrician with an interest in substance/alcohol misuse?	Obstetrician with an interest in substance/alcohol misuse	Seven trusts
	Obstetrician with an interest in mental health and accepted substance misuse patients	One trust
	Obstetrician with a maternal medicine clinic and accepted substance misuse patients	One trust
Evidence-based planning and commissioning		
Is there a clear understanding of the impact of alcohol use in pregnancy in the local area/within the trust, e.g. have you ever carried out a needs assessment, or tried to baseline this?	Conducting baseline assessment prevalence work with Sheffield university	One locality
	Audit of screening and training impact conducted	One locality
	Feedback from yearly training given to maternity staff has demonstrated a clear understanding of the issues of alcohol use in pregnancy	One trust

(Continued)

Table 1 Continued

Perceived good understanding by maternity leads but not been formally assessed	Three trusts	
Perceived poor understanding by leads	Four trusts	
Perceived basic level of understanding by leads but still requiring training	One trust	
Do you have any kind of specialist local service provision for women drinking alcohol during pregnancy?	Specialist local service provision for women drinking alcohol during pregnancy	One trust
	Generic substance and alcohol misuse service	Eight trusts
	Women having a self-referral option only to services within their local area. This is a confidential service and no information is fed back to midwives even if they request it	One locality
	Specific vulnerable women's service but not solely pregnancy focused	One trust
	Obstetric consultant providing a specialist alcohol service in pregnancy	One trust
Metrics and data collection		
How do you assess whether a woman is using alcohol during pregnancy? e.g. do you use a recognized screening tool such as AUDIT C?	Alcohol use disorders identification test for consumption AUDIT C	Four trusts
	AUDIT	One trust
	Bespoke antenatal screening tool	One trust
	General antenatal alcohol screening questions	Four trusts
How do you assess whether a woman should be referred to appropriate support? e.g. do you identify a particular threshold via AUDIT C?	Any alcohol consumption is a concern in pregnancy and referred	One trust
	Audit C score of one or more for referral	One trust
	Audit C score of five or more as the threshold for referral	Three trusts
	Midwife's clinical judgement	Four trusts
What data do you collect around alcohol use during pregnancy? Timing, amount and frequency? Do you ask about pre-pregnancy drinking habits, e.g. 2 months prior to conception?	Audit C questions	Five trusts
	Impact on lifestyle	One trust
	Timing, frequency and amount	Six trusts
	Partners drinking habits	Two trusts
	Previous support with drinking	One trust
	Pre-pregnancy drinking habits	Seven trusts
When would you collect data around alcohol use during pregnancy? e.g. booking visit?	Booking visit	All nine trusts
	All contacts when high risk	Two trusts
	16-week appointment	Two trusts
	All contacts	Three trusts
What kind of system do you have for collecting data (e.g. paper based, electronic)?	Both electronic and paper	Seven trusts
	Electronic only	One trust
	Paper only	One trust

(Continued)

Table 1 Continued

What do you do with the data once you have collected it? e.g. do you collect it centrally to get any population wide record of alcohol use during pregnancy?	Report to National Maternal and Perinatal Institute	Three trusts
	Annual trust statistics	Three trusts
	Stored on database but not analyzed for alcohol purposes	Three trusts
	Monitor data collection and referrals onto other services	Two trusts
	Dashboard and trust performance report	One trust
Is mother's alcohol consumption recorded in baby notes?	Recorded in all cases	Four trusts
	Only recorded in high risk cases	Five trusts
Is the maternity alcohol documentation audited?	Yes	Five trusts
	No	Four trusts
Pathways		
If a woman is identified with an alcohol-related need, how would you deal with this? Would you use a stepped approach (e.g. leaflet, ABI and referral into service) depending on the level of need?	Alcohol information given	All nine trusts
	ABI	Five trusts
	Referral to a specialist service or clinic	All nine trusts
Does your organization have a clinic dedicated to the care of women with alcohol or substance misuse?	High risk clinic	Seven trusts
	No specialist clinic	Two trusts
Are the local alcohol services well understood and are pathways into the service clear?	Complex pathways but understood by staff and service users	Three trusts
	Clear pathway understood by staff and service users	Six trusts
How quickly could you refer a pregnant woman into an appropriate service?	Immediate access	Eight trusts
	Service level agreement of access within 2 weeks	One trust
Are local alcohol services flexible and in locations to make them easily accessible to meet individual need?	Yes	Seven trusts
	Includes outreach facilities	Three trusts
	Unknown	Two trusts
Are alternative means of support provided, e.g. peer support, text services?	Generic alcohol support ambassador scheme	Three trusts
	Generic texting service	One trust
	Local trust maternity website or app	Three trusts
	Baby buddy app	Three trusts
	Antenatal peer support	Two trusts
Is information regarding PAE shared with SCBU, HV, GP and paediatrician?	Routinely shared this information	Three trusts
	Only share information if concerns were raised	Six trusts
Are the risks of alcohol in pregnancy discussed in	Preconception clinics	One trust
1. Preconception clinics?	ONLY diabetic and epileptic women	Two trusts
2. Gynae appointments?	Gynae appointments	One trust
3. Sexual health clinics?	Sexual health clinics	Three trusts
	Pharmacy FASD promotion initiative	One locality

(Continued)

Table 1 Continued

Workforce and training		
How do you ensure that all midwives have received appropriate training around:	Annual maternity staff training in alcohol screening, referrals and FASD	Two trusts
	Two yearly training in alcohol screening, referrals and FASD	One trust
• Screening for alcohol use during pregnancy	Training in alcohol screening, referrals and FASD as required	Four trusts
• Referring into appropriate services	Three yearly training in alcohol screening, referrals and FASD	One trust
• Foetal Alcohol Spectrum Disorder	No training provided in alcohol screening, referrals or FASD ABIs training	One trust
	ABIs training	Five trusts
Are any systems in place to ensure that all midwives (maternity care workforce) and support workers can regularly update their knowledge and skills around alcohol?	Face to face in house training	Six trusts
	Generic alcohol awareness eLearning	One trust
	Access to literature and resources	Four trusts
	Extra training provided when required	Three trusts
Who delivers alcohol training for midwives (and wider maternity staff group)?	Public health trainer only	Three trusts
	Specialist midwife only	Five trusts
	A combination of specialist midwife and a public health specialist trainer	One trust
Have you developed a tailored training package around alcohol? If so, what is this based upon (e.g. CMO guidelines/latest evidence base)?	An alcohol training package based on International FASD recommendations	Five trusts
	No bespoke alcohol-training package developed	Four trusts
How flexible is training to fit around the demands, pressures and operations of maternity services?	Training at community midwives meetings	Two trusts
	Training at hospital hubs	One trust
	In house training and on the wards	Four trusts
	As part of statutory and mandatory annual training	One trust
	Mailshots, literature updates and resources	Three trusts
	FASD awareness day is highlighted every year	One trust

(Continued)

Table 1 Continued

Are midwives trained to disseminate the latest CMO guidelines around alcohol use during pregnancy (i.e. no alcohol is the best and safest option)? Are there any resources to support this and share with women (e.g. leaflets)?	CMO advice from 2016	Three trusts
	FASD network recommendations and leaflets	Six trusts
	Balance–local north-east alcohol office	Two trusts
	NHS choices	Five trusts
	Change for life programme resources	One trust
	Trust maternity website	Two localities
	Baby Buddy app	Two trusts
	Bounty app	One trust
	Bespoke evidence-based materials	Two trusts
	Local pregnancy book which is given to all pregnant women	One trust
	Facebook and Twitter	One trust
	Council newsletter	One locality
	Drug and alcohol in pregnancy leaflet	One trust
	'My little one' app developed with local resources referenced	One trust
Trust alcohol or substance misuse policy	A substance misuse policy which included alcohol	Four trusts
	A substance misuse policy which did not reference alcohol	Three trusts
	Did not have a policy for alcohol or substance misuse available at the time of service evaluation	Two trusts

Participants

The selected survey sample consisted of an established PH network of leaders in maternity and alcohol services; including heads of midwifery (HOM), members of local authority commissioned 0–19 team (who provide public health interventions for children and families from birth to age 19), trust alcohol liaison nurses/midwives and PH representatives for alcohol and substance misuse. An introductory email was circulated by PH Durham to all relevant parties explaining the purpose of the service evaluation and inviting stakeholders to participate. Three to four participants from each locality volunteered and all included HOMs and representatives from PH. Meetings to conduct the service evaluation survey were subsequently arranged across all nine maternity trusts in the North East and North Cumbria (NENC) over a 2-month period in 2018. Data were collected systematically using the survey conducted face to face or in one instance via a telephone conference call. The questions are reproduced in the first column of Table 1. Results were shared with each Trust and permissions granted prior to publishing and disseminating these findings.

Data analysis

The data were analyzed using the principles of content analysis because it is recommended for investigating trends and patterns.[35, 36] Content analysis afforded a reliable and systematic data reduction technique in which the volume of text was condensed into content categories in accordance with coding protocols.[36] Each hand-written survey response data document was typed up in word, then read and re-read to ensure intimate knowledge of the data. Every locality data document was then anonymized and allocated a number. Each data document was transferred to an excel spread sheet, allocated a column and then all topics were identified, From these, themes and sub-themes were elicited, then quantified, with close attention paid to commonalities and differences. The data were then re-checked for accuracy. Basic categorization, or coding was utilized which organized data with similar meaning, patterns, concepts, associations or explanations, consequently mapping and interpreting the data.[37] Every category of response to each question is listed in the middle column in Table 1.

Ethics

As a service evaluation, ethical approval was not required. No patient contact was made. Permissions were sought and sanctioned from each trust, in collaboration with PH Durham who commissioned this project.

Results

The questions and results after content analysis completion are presented in Table 1. The original, unabridged data are available on request.

Themes

Each theme has been addressed in turn with the corresponding recommendations detailed in Table 2.

A. Networks, leadership and coordination

Local multi agency alcohol partnership meetings varied in configuration, with one-third specifically addressing the alcohol agenda and one-third included alcohol in the substance misuse agenda. Alcohol and substance misuse meetings tended to be generally well attended by strategic stake holders but only five of the nine trusts provided a maternity representative. Three trusts had set objectives and one trust reported objectives in draft. One trust had a FASD action plan.

Five trusts had substance misuse midwives, which included alcohol, three trusts had PH midwives, and none had a dedicated midwife for alcohol. Seven trusts had an obstetrician with an interest in substance/alcohol misuse, one had an obstetrician with an interest in mental health and accepted substance misuse patients; and one had an obstetrician with a maternal medicine clinic and accepted substance misuse patients.

Recommendations: Table 2 A. Networks, leadership and coordination.

B. Evidence-based planning and commissioning

To better understand the local impact, one PH organization was undertaking some alcohol in pregnancy baseline assessment work in collaboration with Institute of Alcohol Studies at Sheffield University.

Only generic local substance misuse support services were available to women in every locality but one, which was pregnancy specific.

Recommendations: Table 2 B. Evidence-based planning and commissioning.

C. Metrics and data collection

Several alcohol screening tools and mixed thresholds for referrals across the region were identified. Various alcohol-related data in pregnancy was collected, such as preconception alcohol habits, partners drinking habits, previous alcohol issues, etc. Midwives reported generally asking the amount, frequency and timing of alcohol consumption but it was not always documented. All localities described enquiring about alcohol at booking visit but many only asked high risk women throughout later maternity contacts.

Documentation was a combination of paper and electronic.

Antenatal alcohol documentation was rarely audited, so it was difficult to accurately assess existing practices. Mother's alcohol history tended to only be documented in the baby hospital notes in high risk cases and not routinely audited across the region.

Recommendations: Table 2 C Metrics and data collection.

D. Patient pathways

Local substance misuse and alcohol guidelines varied significantly and were absent in two trusts. None were solely alcohol specific. Several required updating to take into account the CMO guidelines of 2016.[3] Patient pathways of intervention varied according to local organization protocols and respective commissioning agreements.

Most trusts reported high-risk, substance misuse or vulnerable women clinics to support pregnant women who drink alcohol. However in one trust, community midwives manage these women within their routine caseload and are trained in alcohol brief interventions (ABIs).

Extra resources offered to women varied across the region, ranging from general maternity booklets and websites, the Baby buddy App, the Pregnancy book, NHS Choices leaflets, Balance adapted resources, Royal College of Obstetrics and Gynaecology materials and the Bounty app. Resources by Drink Aware, an alcohol funded organization, were widely available. However, new evidence has cautioned that they do not always clearly communicate the risks with alcohol use during pregnancy.[38]

Recommendations: Table 2 D. Patient pathways.

E. Workforce and training

Training in alcohol and FASD was inconsistent with only two trusts providing annual updates for staff. ABIs were taught in five localities. Protected alcohol training time was rare but deemed essential to benefiting practice and patient outcomes. Training was delivered by a substance misuse midwife or the PH lead, predominantly face to face, but generic alcohol-related eLearning resources were available and considered effective.

Guidelines and resources accessed from a multitude of international sources including the CMO, National Institute on Alcohol Abuse and Alcoholism, NOFAS-UK, NHS Choices, Drugs Alcohol Recovery Services (DISC) Drug and Alcohol Recovery Services and FASD Network.

Recommendations: Table 2 E. Workforce and training.

Table 2 Recommendations

A	Recommendations for networks, leadership and coordination
1.	Maternity health professionals to engage with local multi agency alcohol partnership groups to raise the issue of reducing alcohol in pregnancy, and to set and measure meaningful objectives to provide a seamless service that meets the needs of pregnant women and their families. To utilize existing initiatives which address alcohol in pregnancy to facilitate a greater awareness and facilitate prevention.
2.	To form a regional expert health professional working group specializing in reducing alcohol in pregnancy to raise the profile of the risks of alcohol in pregnancy; to facilitate specialist education in the field and promote the sharing of best practices.
3.	To establishing at least one Champion or Public Health Midwife in each trust to support this, and engage senior managers as gatekeepers for the initiative.
B	Evidence-based planning and commissioning
1.	To increase our knowledge base on this issue, more research is required around the issues of alcohol screening, the harms of alcohol in pregnancy, prevalence rates, education, staff training, FASD diagnosis, FASD prevalence rates, interventions and support. Research should also focus around pregnant women using alcohol reduction services.
2.	To commission specialist support for women in pregnancy from local alcohol and substance misuse providers. Services need to be immediately accessible, and all providers should operate under shared clinical governance and protocols in accordance with the LMS objective to reduce alcohol in pregnancy.
C	Metrics and data collection
1.	To develop and standardize alcohol screening practices, services and patient pathways across the region to facilitate referrals and support regardless of location.
2.	An antenatal specific screening tool should be considered to maximize the detection of women consuming alcohol in pregnancy, which incorporates all evidence-based significant information. A universally agreed referral threshold is also required to ensure that every woman receives equitable support across the region. In accordance with MECC 2019, alcohol should be discussed at every consultation.
3.	Any maternal disclosure of alcohol consumption in pregnancy must be documented in the antenatal notes. Documented evidence is generally a requirement of diagnosis for children without the classic FAS facial dysmorphia.
4.	A combined role of smoking cessation/alcohol/public health advisor in maternity clinics may be cost effective.
5.	A single format of accurate data collection is required across the NHS. We need to unify and utilize existing datasets such as the maternity dashboard and trust performance reports to provide invaluable health informatics that can be reliably compared and monitored within each trust and across the region. Consistent and clear data should be collected and documented in designated maternal and neonatal medial notes to facilitate this.
6.	An annual audit of local maternity notes would ensure compliance and measure data across the region. Data to be published in National Maternal and Perinatal Institute reports to collect national alcohol consumption prevalence and referral rates. This will provide national data intelligence to inform the planning of FASD service provision and identify training needs in maternity and paediatric staff. Audit could be part of the role of the maternity alcohol champion or specialist midwife.
7.	Alcohol in pregnancy data should be incorporated into NHS quality targets such as the Care Quality Commission and Maternity Data Set to ensure that the issue is regarded as a priority nationally.
D	Patient pathways
1.	Every trust in the region should have an alcohol or substance misuse guideline.
2.	Specialist services need to be flexible, immediately accessible and conveniently located to meet the needs of women in urban and rural locations. A clear communication arrangement is required, so that women receive a seamless service and maternity staffs are kept informed of each individual woman's engagement with the service to monitor her progress and provide the relevant additional support. Specific maternity alcohol support would be the gold standard.
3.	To utilize resources already available such as the red baby book as this follows the infant throughout childhood. It would provide an effective tool to share information with the health visitor, GP, school nurse, teacher or social worker if required. A special PAE question tick box in the book could be added and completed in the antenatal period as a simple way to document and facilitate diagnosis. Any PAE could also be documented in a regional perinatal data management system such as BadgerNet UK, the NHS newborn and infant physical examination screening management and reporting tool (NIPE SMART system) and all baby notes and electronic records should routinely be shared with the multidisciplinary team.
4.	To routinely share public health and NHS approved resources with women, many of which are free and have electronic access.
5.	Prevention of FASD and raising awareness of PAE should be included in all relevant primary care services and gynaecology clinics.

(Continued)

Table 2 Continued

E	Workforce and training
1.	Standardized, mandatory alcohol, ABIs and FASD training for maternity staff across the region should be delivered annually in protected time and preferably face to face or eLearning if this is not possible. Consistent information and practices should be shared and regularly updated with the latest evidence and guidelines. Feedback has suggested from this service evaluation that training should address some potentially challenging issues including health professional's attitudes towards alcohol; and how to support women who have already consumed alcohol in pregnancy.
2.	Training is required for all professionals working with children and substance misuse services to raise awareness of the link between PAE and the risk of FASD.
3.	The risks of alcohol across the life course and particularly in pregnancy; and FASD should be core curriculum for all pre-registration health professionals, teachers and social workers.

Discussion

Main finding of this study

This service evaluation successfully assessed the current maternity service provision regarding alcohol reduction in pregnancy and has highlighted the fundamental themes to be addressed in clinical practice. The main areas in need of improvement include a lack of consensus regarding guidelines; patient pathways and service provision. A limited knowledge base and awareness is compounded by a paucity of both contemporary alcohol consumption in pregnancy prevalence data, and the prevalence of PAE harm. This is evidenced in the historically low profile of alcohol within specialist maternity commissioning, guidelines and services. Therefore, research and health promotion initiatives are required to raise awareness, educate and prevent future harm.[4, 7, 29, 39] Innovative and commendable best practices identified in the region included multiagency collaborations, alcohol and FASD champions; PH protected annual training for all maternity staff and promoting local FASD awareness initiatives. Finally, audit and monitoring is imperative for measuring and raising standards of care, driving the quality agenda and informing future planning of service provision.

What is already known on this topic?

The alcohol agenda is a new priority in UK maternity services, the level of current provision is unknown and elementary commissioning recommendations are not yet established.

Maternity staffs already manage many important competing issues that optimize patient outcomes. This includes smoking, which has followed a very similar trajectory of culture change that we can anticipate alcohol to replicate over the coming years. Like tobacco 30 years ago, alcohol is a legal, socially acceptable drug, which can stigmatize women who drink antenatally because of its associations with poor pregnancy outcomes.[40] Consequently, there are lessons to be learned from smoking prevention initiatives such as 'BabyClear', which successfully achieved individual behaviour change in pregnant women by engaging leaders, reorganizing and standardizing healthcare systems to implement best practice guidelines.[41]

Systemic health promotion to prevent future alcohol-related harm is critical.[42, 43] Documented practice change strategies echo the findings of this study and advocate the importance of leadership, ownership and engagement, the implementation of clinical practice guidelines and patient pathways, audit and performance monitoring, training and the provision of appropriate educational materials.[43] Evidence highlights the need to urgently raise the profile of PAE and FASD through national PH campaigns in the UK, given the current general low levels of awareness and high prevalence of PAE.[22, 23] Educating children in schools could prevent PAE harms in future pregnancies.[45] In response to the documented hazardous drinking habits nationally, campaigns addressing the general alcohol agenda are already underway and include education and advertising programmes, minimum unit price initiatives, regulating the alcohol industry regarding advertising and labelling will all alert the public to the risks to health and the unborn.[34, 44]

As demonstrated in some localities, adopting local PAE and FASD awareness initiatives include pharmacy campaigns, collaborations with on and off sales outlets and regularly reviewing their impact. FASD day on 9 September every year is another opportunity to raise awareness and engagement.

What this study adds

This is the first-region wide, service evaluation studying alcohol service provision in maternity care. The challenges regarding current alcohol-related antenatal care in NENC were documented. Some originate from lack of understanding

around the risks of alcohol across society combined with the previously low priority of the alcohol agenda in maternity services and across the NHS.[17] Conversely, smoking has been prioritized for decades and enjoys specific guidelines and detailed patient pathways universally. Although antenatal alcohol guidance is available, alcohol is still only acknowledged within local substance misuse guidelines and is usually considered a lower priority than 'illegal' drugs in practice.[3, 45] This is despite alcohol exposure in pregnancy being a common but modifiable risk factor for poor pregnancy and childhood outcomes.[20] Differing commissioning agendas and funding streams have raised many challenges for staff and the recorded inconsistent approaches to staff training have compounded the issue.[46] The varying patient pathways and guidelines result in a 'postcode lottery' of care provision.[47, 48] Data reporting mechanisms are diverse and incomparable across the region regardless of electronic or paper format. The electronic alcohol data that feeds into National Maternal and Perinatal Institute (NMPI) were collected but not published in the last report (2015–16), and alcohol was not reported on the National Maternity Data set. The lack of audit and alcohol governance frameworks prevents any links to national clinical safety forums, which could potentially generate valuable health informatics.[49, 50]

It is important to acknowledge that healthcare professionals are working in a pressured environment of national staff shortages and large caseloads due to growing demand combined with a decade-long midwifery shortage, a rapidly ageing workforce and the discontinuation of student bursaries deterring potential applicants.[51] Yet, expectations of staff remain high and this should be recognized when implementing changes in practice.

Fortunately, the maternity workforce is generally very dedicated to delivering the best care possible, whilst embracing change when required. It is important to engage this vital resource to champion, own and lead this initiative. This service evaluation can inform the strategic decision makers in the region to improve the practice and delivery high quality care to dramatically improve the outcomes for women and their children.

Limitations of this study

This service evaluation is a cross-sectional study; a snapshot in time and the findings may change with progress, but it does provide useful insight into the strengths and limitations of current alcohol specific maternity care and the related local clinical practices in the NENC. We cannot directly compare the findings of this regional service evaluation to the rest of the UK as equivalent studies are not available, but there will undoubtedly be many relevant themes and commonalities. The recommendations could be adapted and implemented to suit local needs across the NHS and abroad. Given the documented high levels of alcohol consumption in the UK, and specifically in pregnancy, these findings could help to raise awareness, and stimulate a sea-change in alcohol-related maternity services as referenced in the APPG.[31] A patient experience perspective was not included which may have yielded further information, but was beyond the scope of this assignment.

Content analysis can be flawed if the category definitions are imperfect and if non-mutually exclusive; however, in this data, set each category was coded and checked ensuring accuracy and reliability.[36] Qualitative research data can be censured as subjective and unreliable, but the effective coding scheme has provided a systematic framework and improved the reliability and integrity of this study.[52] Moreover, content analysis has pragmatically facilitated the understanding of current regional variations in alcohol service provision within maternity care.

Conclusion

This service evaluation has successfully explored current alcohol prevention and treatment provision in maternity care across the NENC. A detailed assessment of the current level of service across the region found a high variation of regional clinical practices, service provision and staff training. The areas requiring improvement have been acknowledged and include the need for a standardized antenatal alcohol screening tool and an agreed threshold of referral. Data collection and documentation practices were also found requiring unification to facilitate audit, metrics monitoring and governance.

Many outstanding best practices were initiated by innovative champions in the field. The establishment of comprehensive staff training underpinned the successful delivery of patient-focused guidelines; and easy-access, seamless alcohol services for pregnant women are models to standardize.[5] Important themes were identified from the results and guided the development of evidence-based recommendations. Successful implementation of the recommendations requires appropriate leadership, commissioning and training strategies; but can be used to inform local decision making and meet the LMS primary objective of reducing alcohol in pregnancy.[29]

Author contributions

HH co-designed this service evaluation with Public Health England and Balance, the north-east alcohol office. HH

interviewed colleagues from each trust and collected analyzed and interpreted the data. HH drafted and submitted the paper.

Ethics

As this was a service evaluation, ethical approval was not required. No patient contact was made. Permissions were sought and sanctioned from each trust, in collaboration with Public Health Durham who initiated this project.

Conflict of interest

The author reports no conflicts of interest.

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10. Appendices

10.1 Appendix 1: Knowledge transfer strategies

- Poster at Research and Development Forum2021, postponed from 2020. 'Seven NIHR Senior Nursing & Midwifery Research Leaders based in the North East of England: The story so far.' Successful poster application illustrating our collective work aiming to embed research in clinical practice. https://annualrdforum.org.uk/

- First UKFASD Research Collaboration held in Manchester 4th-5th April 2019 to establish a UK research strategy across the life course. I was invited on the strength of my work which had been shared at previous conferences, especially EUFASD. Our first collaborative paper Fetal Alcohol Spectrum Disorders– an overview of current evidence and activities in the UK, has been accepted for publication.

- Society for the Study of Addictions. Newcastle 7th-9th November 2018 'Exploring the feasibility and clinical effectiveness of antenatal alcohol screening to clinicians, pregnant women and their partners.' Presentation & Poster (Won best student poster award). Awarded NHCT R&D department grant. Successful application which has showcased my work and facilitated networking and collaborative work. I now have an invitation to Queen's University Belfast to look at screening teenage pregnant populations. https://www.addiction-ssa.org/knowledge-hub/a-survey-of-health-care-professionals-knowledge-and-experience-of-fetal-alcohol-spectrum-disorder-fasd-and-alcohol-use-in-pregnancy/

- Public Health & Local Maternity System conference. Durham 15th October 2018. Alcohol in pregnancy. What's happening in our region? I was invited as a guest speaker to present the findings from my service evaluation project which was published in paper 6. This informed future service provision and identified the need for standardised antenatal alcohol screening and service provision across the region, guiding the alcohol work stream which it initiated.

- EUFASD BERLIN 24th -26th September 2018. 'Alcohol screening in pregnancy: an opportunity for support and education?' poster, & 'A survey of health care professionals' knowledge and experience of Fetal Alcohol Spectrum Disorder (FASD) and alcohol use in pregnancy' poster.

Successful application and awarded NHCT R&D department grant. This event is the highlight of the FASD calendar and provides the opportunity to share new research, initiatives, network and collaborate internationally. This is useful to ensure a coordinated approach to research strategy, avoiding unnecessarily duplication and to develop existing research projects. https://eufasd.org/pdf/Program_book_EUFASD2018.pdf

- Helena Biosciences IUGM Krakow, 19th-21st September 2018. Sponsored by Helena Biosciences. 'Prevalence survey of alcohol consumption at antenatal booking in pregnancy: Comparing blood biomarker analysis to self-report- An update'. Helena Biosciences had funded the first two years of my Professional Doctorate, so they invited me as a guest speaker to showcase my research and to illustrate how they were supporting my work which aimed to improve patient outcomes. This provided good insight into the mutual benefits of collaborating with industry. I maintain a good relationship with the company today and update them regularly on my progress.

- Best Start in Life: The Impact of Alcohol on Childhood. Arranged by Public Health and Balance. 6th December 2017. Durham. 'FASD and alcohol in pregnancy' presentation. This regional conference was a launch event to raise awareness around all aspects of alcohol in childhood. I was invited as a guest speaker by Balance due to my growing reputation as an expert in FASD and alcohol in pregnancy.

- Society for the Study of Addiction (SSA) 2017: Newcastle 8-9th November 2017. 'Assessing prevalence of alcohol consumption in early pregnancy: Self-report compared to blood biomarker analysis.' Successful poster application. Awarded NHCT R&D department grant. I have been encouraged by the society to apply for a post-doctorate fellowship as non-medical clinicians are underrepresented in their organisation. https://www.addiction-ssa.org/knowledge-hub/assessing-prevalence-of-alcohol-consumption-in-early-pregnancy-self-report-compared-to-blood-biomarker-analysis/

- Kettil Bruun Society 2017: Sheffield Alcohol Research Group at ScHARR at the University of Sheffield. 5-9 June 2017. 'Assessing prevalence of alcohol consumption in early pregnancy: Self-report compared to blood biomarker analysis' Guest speaker presentation. Successfully applied and was awarded NHCT R&D department grant. This raised my awareness of how my work fits within the general alcohol and addictions agenda and the

relevance to mental health issues.
https://www.kettilbruun.org/web_archive/sheffield_2017/participants_list.html

- Vancouver 7th International Conference on Fetal Alcohol Spectrum Disorder – Research: Results and Relevance 2017. 1-4th March 2017. 'Alcohol Screening in Pregnancy: An Opportunity for Support and Education?' Successful application to submit poster & abstract which is published on their website. Awarded travel grant of £500 from Northumbria University and Helena Biosciences. To attend an international conference was a privilege which allowed collaboration with global stakeholders, particularly the FASD birth mothers who have requested more research from their viewpoint. I have established good links with these women who have kindly advised and assisted with my research projects so far.
https://interprofessional.ubc.ca/files/2016/06/FASD2017_brochure.pdf

- Northumbria Healthcare NHS Trust Nursing Conference, Newcastle – 9th November 2016. 'Alcohol screening in pregnancy: an opportunity for support and education?' Poster & 'Dispelling the Myths of Research' clinical trials workshop. I was invited to submit the poster and as a guest speaker to deliver a teaching session encouraging clinical research engagement in practice, as my role at that time was Senior Research Nurse and Midwife in the Trust.

- Stirling university Alcohol and Pregnancy research seminar. 1st November 2016. I was invited to present 'Screening for Alcohol Consumption in Pregnancy' by a colleague from Newcastle University. I was awarded NHCT R&D department grant. This was a valuable conference because we met as a group of representatives from all countries in the UK to scope and coordinate research plans to ensure they would complement one another rather than compete. This was helpful because I met Tappin and Mactier, researchers from the pilot study upon which my second paper was based. They have since published a meconium study set in South West Scotland which I had planned for England. However, an English cohort would provide a comparison and contribute overall to these findings. The North East region's drinking patterns are the highest in England and very similar to those in Scotland.

- Helena Biosciences Royal Society for Medicine. London. 6th October 2016. 'Prevalence survey of alcohol consumption at antenatal booking in pregnancy; comparing blood biomarker analysis to self-report.' I was invited to present my research findings for paper 2 as Helena Biosciences had analysed my blood samples using their Clinical Capillary Electrophoresis assay. This exhibited our partnership working to other international researchers and clinicians.

- EUFASD conference London: 12-14 September 2016. 'Prevalence survey of alcohol consumption at antenatal booking in pregnancy; comparing blood biomarker analysis to self-report.' Successful application as guest speaker. 'Alcohol screening in pregnancy: an opportunity for support and education?' Successfully applied to present a poster, both abstracts published in EUFASD database. I was awarded a NHCT R&D department grant. This was my first national conference where I began my journey of presenting to a large audience of experts. It was a great opportunity to hear other experts in the field and recontextualise my work within the identified gaps in knowledge informed by international issues. Many of these individuals I now work alongside as equals. The lack of acknowledgement of FASD and alcohol in pregnancy in the UK was stark in 2016. The progress and momentum we have gained over the last few years through our coordinated and persistent endeavours is reassuring and inspiring. https://www.eufasd.org/pdf/EUFASD_2016_program.pdf

10.2 Appendix 2: Impact of research

I. Research-related impacts

Research networks

- I am a co-investigator on a National Institute for Health Research (NIHR) Research for Patient Benefit Programme (RfPB): CHAMPION - AlCohol HArM PreventIOn iN pregnancy study. https://fundingawards.nihr.ac.uk/award/NIHR201128 Research question: What are the components of an implementation intervention to support midwives' provision of recommended care addressing alcohol consumption with women attending antenatal appointments; is such an intervention feasible to implement in practice; and is it acceptable to service providers and service users? The intended impact of this is to design and provide a nationally recognised, evidence based best practice training programme for midwives.
- I am a founding member of the UKFASD Research Collaboration. We are the leading experts in FASD and PAE in the UK working to provide a coordinated research strategy by identifying and prioritising areas in most need. A key impact is the recent citation in the Commission on Alcohol Harm and published 'Fetal Alcohol Spectrum Disorders– an overview on current evidence and activities in the UK' (The Commission on Alcohol Harm, 2020; Schölin *et al.*, 2021). Building on my work, I plan to undertake a national alcohol in pregnancy prevalence study to compare regions, with the potential of targeting problem areas. I am also supporting the Irish FASD advisory group with their work in a consultancy capacity.
- Within my post as Senior Lecturer in Midwifery at Northumbria University, I pursue my research interests further and continue to share this knowledge with the next generation of health care professionals so that they can ensure appropriate care and recognition is provided for this often-neglected condition. I have achieved Research Excellence Framework (REF)

status on behalf of the university, and I am one of only 38 REF standard researchers in the Nursing, Midwifery and Health department.

- In addition, I act as second supervisor to two PhD students and a medical student who are replicating my survey instrument from Paper V: A survey of health care professionals' knowledge and experience of Fetal Alcohol Spectrum Disorder (FASD) and alcohol use in pregnancy. In an initiative to build upon the established knowledge base, I plan to evaluate and compare these new findings from each student's respective Scottish, American and Irish cohorts.

Leadership and awards

- In 2019 I was awarded the prestigious 70@70 Research Nurse and Midwife Leadership award to promote research in clinical practice across all specialities within the NHS. This has helped raise my research profile and has increased my fundability, adding further credibility to midwifery-led research in a currently medically focused hegemony.

- I have also been awarded The Green Shoots scheme funding from the Clinical Research Network (CRN) in recognition of my work as a Principal Investigator. This funding enabled me to gain further specialist training and present two posters to EUFASD BERLIN 24th-26th September 2018, helping to raise international awareness and enabling me to connect with researcher networks globally.

- I attended the Society for the Study of Addiction (SSA) conference in Newcastle 2018 and won the best student poster award for my unique research around alcohol in pregnancy and raising awareness of FASD, a secondary or 'passive' alcohol harm.

- My growing reputation for expertise in the field nationally and internationally has led to invitations to peer-review bids and publications for organisations including the NIHR RfPB, the Journal of Nursing in Practice and Addiction.

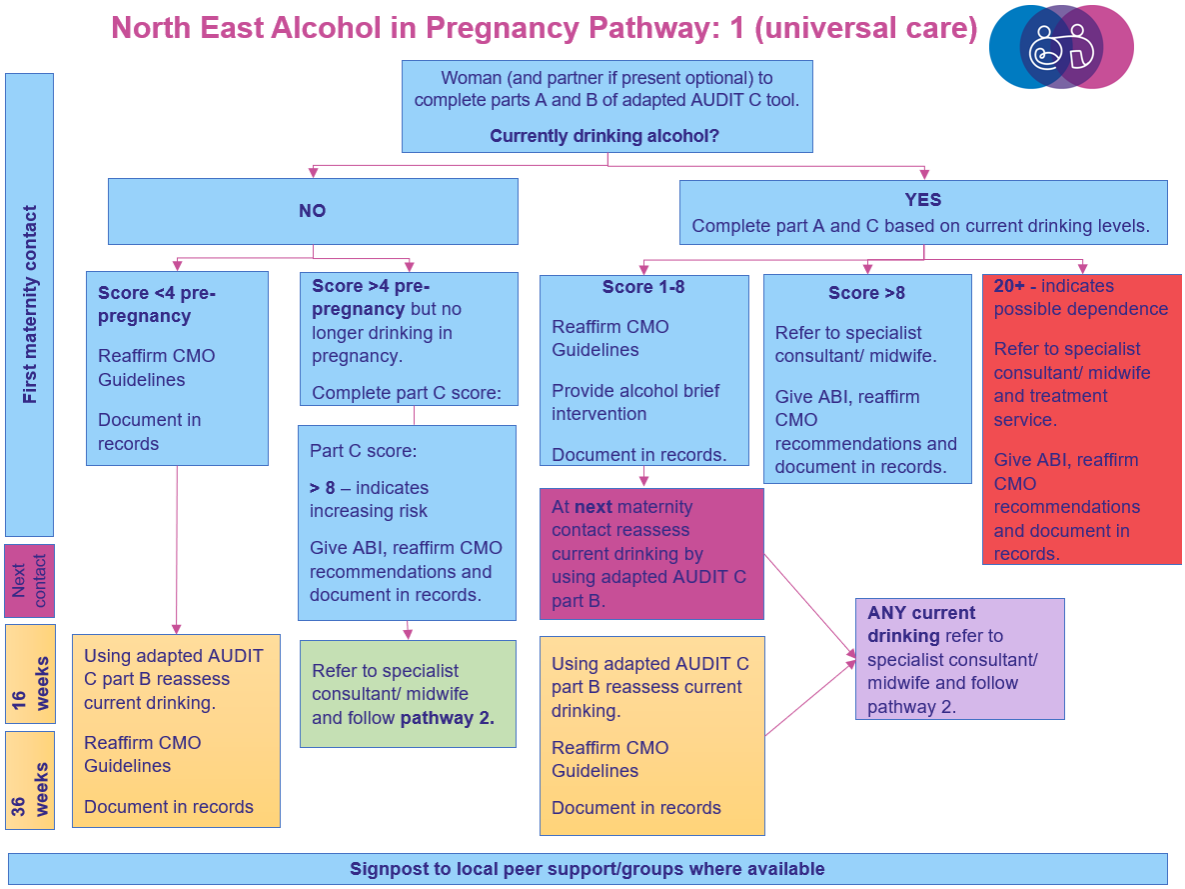
II. Policy impacts

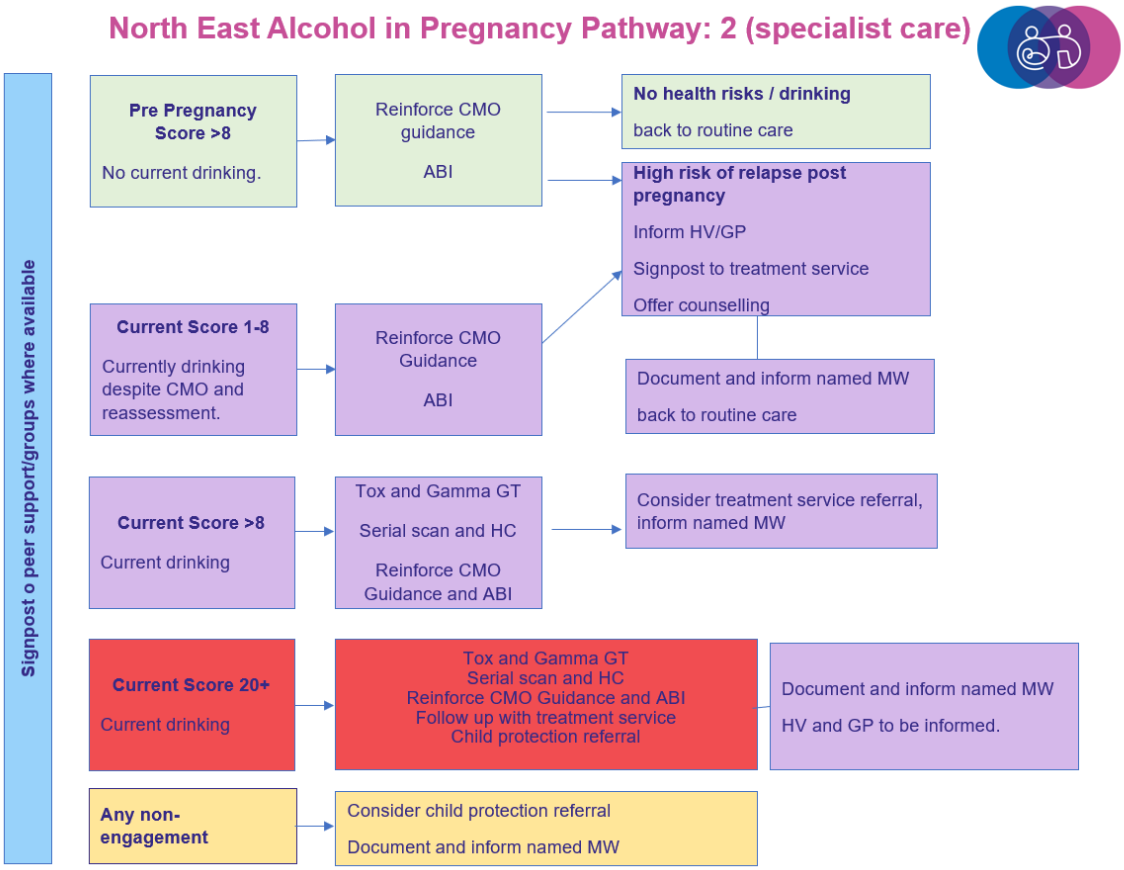
- My work is cited globally and has been referenced in the national PHE document: Maternity high impact area: Reducing the incidence of harms caused by alcohol in pregnancy (Public Health England, 2020).
- As a registered member for the advisory panel for NICE, supporting health and social policy improvements regarding the risks of alcohol in pregnancy, prevention and training around FASD. I have advised the NICE FASD consultation to implement the evidence-based service provision and clinical practice recommendations from Paper VI. A standardised pathway and service will promote clarity and equity of provision, and could even reduce the risk of confusion and error when doctors and other staff rotate to different localities thus improving care quality and patient experience. The mobilisation of support provided by my research findings adds to the growing political capital, bringing about a sea change of attitude and ultimately driving policy change.

III. Service impacts: health and intersectoral

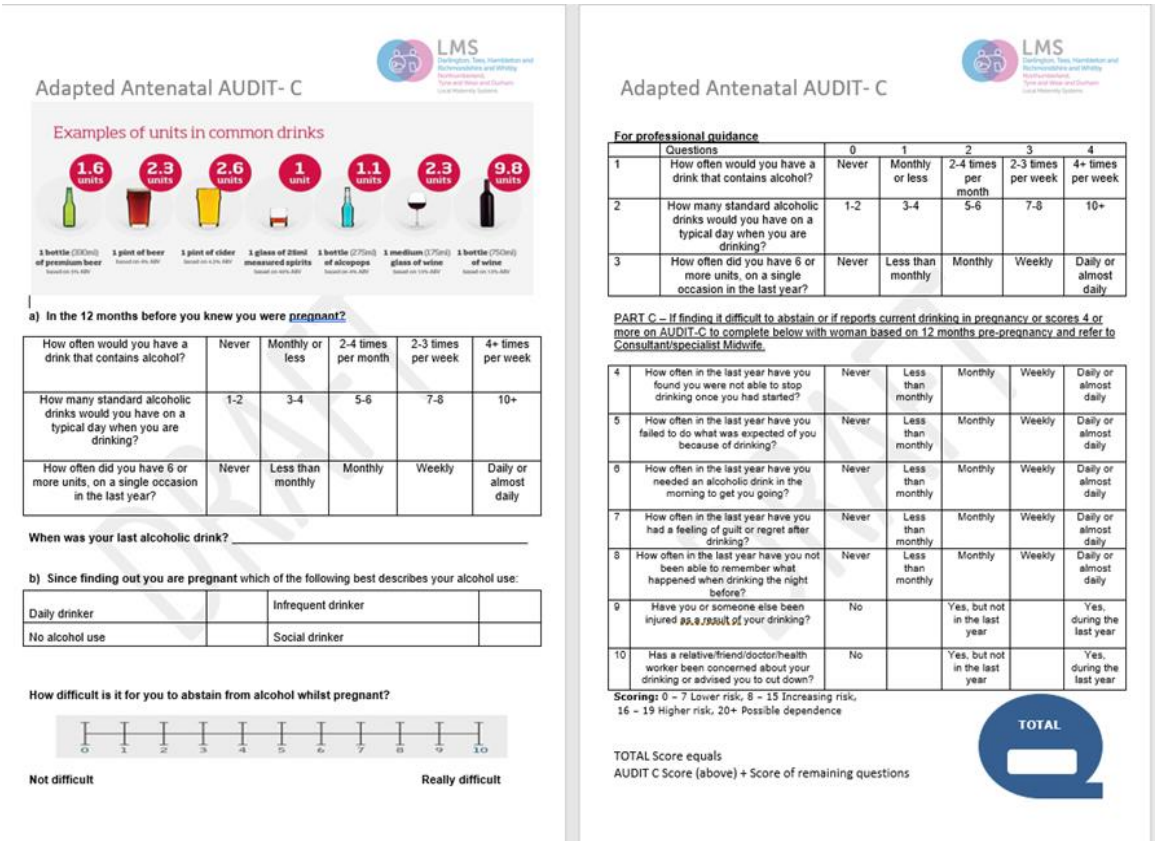
- I provide guidance and training to Northumbria Healthcare NHS Trust, the regional maternity network and now Northumbria University to raise awareness and change clinical practice in relation to alcohol in pregnancy and FASD to promote evidence-based practice.
- I advise and support Public Health Durham on the Regional Alcohol in Pregnancy Working Group after scoping the Local Maternity Service (LMS) priority for alcohol across the region. The findings of this exercise have informed strategic planning and the LMS recommendations

to improve practice and quality of care across the region. A coordinated antenatal alcohol screening programme was an identified requirement from my service evaluation (Paper VI). NHS Ayrshire and Arran have designed an effective FASD and alcohol service based on a Canadian model. (NHS Ayrshire and Arran, 2019). From my networking activities, I established links with the team and have begun to adapt and implement elements of the service in collaboration with the North-East LMS. I have co-designed and piloted an evidence-based antenatal alcohol pathway of care to improve patient outcomes across the region.





- My research (Paper I & II) identified that self-report only detected a minority of women who drank in pregnancy. I observed that none of the internationally recognised alcohol screening tools were specifically designed for a pregnant population. On merit, AUDIT C was the regionally adopted maternity screening tool. To maximise detection in a pregnant cohort, I initiated the design of a bespoke antenatal alcohol screening tool based on the adapted Audit C, which crucially asks women about pre-pregnancy drinking habits which can then help identify those at risk in pregnancy. It has been commended by PHE Maternity Transformation Programme Prevention for improving quality of care and has been shared as a nationally available resource.



Adapted Antenatal AUDIT- C

Examples of units in common drinks

1.6 units — 1 bottle (330ml) of premium beer
2.3 units — 1 pint of beer
2.6 units — 1 pint of cider
1 unit — 1 glass of 25ml measured spirits
1.1 units — 1 bottle (275ml) of alcopops
2.3 units — 1 medium (175ml) glass of wine
9.8 units — 1 bottle (750ml) of wine

a) In the 12 months before you knew you were pregnant?

How often would you have a drink that contains alcohol?	Never	Monthly or less	2-4 times per month	2-3 times per week	4+ times per week
How many standard alcoholic drinks would you have on a typical day when you are drinking?	1-2	3-4	5-6	7-8	10+
How often did you have 6 or more units, on a single occasion in the last year?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily

When was your last alcoholic drink? _____

b) Since finding out you are pregnant which of the following best describes your alcohol use:

Daily drinker		Infrequent drinker	
No alcohol use		Social drinker	

How difficult is it for you to abstain from alcohol whilst pregnant?

0 1 2 3 4 5 6 7 8 9 10

Not difficult — Really difficult

Adapted Antenatal AUDIT- C

For professional guidance

	Questions	0	1	2	3	4
1	How often would you have a drink that contains alcohol?	Never	Monthly or less	2-4 times per month	2-3 times per week	4+ times per week
2	How many standard alcoholic drinks would you have on a typical day when you are drinking?	1-2	3-4	5-6	7-8	10+
3	How often did you have 6 or more units, on a single occasion in the last year?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily

PART C – If finding it difficult to abstain or if reports current drinking in pregnancy or scores 4 or more on AUDIT-C to complete below with woman based on 12 months pre-pregnancy and refer to Consultant/specialist Midwife.

4	How often in the last year have you found you were not able to stop drinking once you had started?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
5	How often in the last year have you failed to do what was expected of you because of drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
6	How often in the last year have you needed an alcoholic drink in the morning to get you going?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
7	How often in the last year have you had a feeling of guilt or regret after drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
8	How often in the last year have you not been able to remember what happened when drinking the night before?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
9	Have you or someone else been injured as a result of your drinking?	No		Yes, but not in the last year		Yes, during the last year
10	Has a relative/friend/doctor/health worker been concerned about your drinking or advised you to cut down?	No		Yes, but not in the last year		Yes, during the last year

Scoring: 0 – 7 Lower risk, 8 – 15 Increasing risk, 16 – 19 Higher risk, 20+ Possible dependence

TOTAL Score equals
AUDIT C Score (above) + Score of remaining questions

TOTAL

- Advisor to the Alcohol Development Group at Northumbria Healthcare NHS Trust who meet regularly to share good practice and new developments in patient care. I also sit on the North-east Alcohol Network to plan and implement regional alcohol strategy with key stakeholders to share evidence-based practices and improve quality of care to all.
- Liaison with the manufacturers of pregnancy testing kits and pregnancy specific vitamin supplements to request that they advise women to abstain from alcohol for the duration of their pregnancy as they are both predominantly accessed during preconception or early pregnancy. I concluded that this would be a good resource to utilise, combining health and industry with a shared goal of improving health outcomes.
- Redesign of the Patient Administration System (PAS) booking form for all antenatal booking appointments in NHCT to facilitate robust, research-based alcohol documentation to assist clinicians to discuss alcohol with women.

- In accordance with the ‘Making Every Contact Count’ initiative, my research evidence from Paper VI advocates routine alcohol screening for all women of childbearing age in primary care settings, with an emphasis on preconception health advice and contraceptive counselling (Public Health England, 2019). This research also recommends referrals to substance misuse interventions for all women identified to have an alcohol use disorder as good practice to prevent future harms. These implementations are currently under review with my colleagues in Public Health and Balance to improve quality of care and patient outcomes.
- There is an expressed need for FASD service provision with routine standardised referral pathways. As a result of my special interest in PAE prevalence rates and the prevention of FASD from a midwifery perspective, I am part of a regional multidisciplinary strategy group which is establishing routine standardised evidence-based diagnostic criteria and management programmes in the UK. Increasing the efficacy, availability and accessibility of these services will benefit individuals and their families by mitigating the impact FASD and improving their quality of life.
- Paper V highlights the need for a FASD pre-registration training for all professions including health, social work and education to provide the knowledge, skills and confidence for practice. A universal FASD training programme for health professionals incorporated into continuous professional development and competency frameworks is also recommended to maintain evidence-based knowledge and practice. I have a significant demand by reputation for my training delivery across the professional disciplines. I have been intrinsic to the design and delivery of the LMS training package which is based on my research and resources, and meet the objectives of the Better Births directive which aims to minimise health inequalities and improve the health outcomes for all (National Maternity Review, 2016).

https://www.northernlms.org/online-learning-hub-launched-to-help-improve-maternity-care-across-the-north-east-and-north-cumbria/

IV. Societal impacts

Knowledge, attitudes and behaviour

- My research promotes UK public health directed alcohol in pregnancy and FASD awareness campaigns based on the successful Canada and Australia initiatives (Poole and Public Health Agency of Canada., 2008; Commonwealth Government of Australia, 2018). These initiatives contribute to the alcohol and FASD agenda promoted by local public health, Balance and FASD network stakeholders of which I am a part. My research has recently been cited by PHE in Maternity high impact area: Reducing the incidence of harms caused by alcohol in pregnancy (Public Health England, 2020). This document will undoubtedly lead to changes in knowledge, attitudes and behaviour of health care professionals and the general public.
- In collaboration with regional, national and international networks, I lead on the local Trust FASD Awareness day every year on the 9th of September which informs and educates the public, local maternity services and other stakeholders using a research-rich strategic and inclusive approach. This involves coordinated activities such as managing stalls in the reception area of hospitals, writing NHS Communication Team staff bulletins, designing Trust-wide FASD screen savers and speaking to the media. This campaign provides an effective vehicle of dissemination and praxis for my body of research findings and recommendations with the objective of improving the health status at a population level. http://www.chroniclelive.co.uk/news/health/durham-mum-tells-how-adopted-10012415
- Working closely with the FASD Network and the UK & European Birth Mother Network to raise awareness of FASD, facilitate prevention and diagnosis; and provide training to parents

and professionals. This collaboration promotes social capital and empowerment for this issue and these women affected. My research findings can also be argued to promote health equity and human rights by providing individuals with the vital information they require to make fully informed decisions that will affect their health and wellbeing.

- Collaboration with Balance, the local North-East alcohol office to contribute to a public health awareness campaign to prevent alcohol related harm to future generations. I presented an overview of FASD and a summary of my studies at the Balance conference 'Best start in life-alcohol and childhood', 06th December 2017. This knowledge exchange promotes health literacy in the community allowing individuals to make informed choices and on a larger scale, influences health and social care organisations to prioritise relevant public health strategies. My research into PAE and FASD therefore endorses sustainable development whereby people are able to meet their basic needs and experience a good quality of life without compromising the health and wellbeing of future generations (Kuruvilla *et al.*, 2006).

- Consultation with the media to give statements about FASD and clarify the best practice recommendation to avoid alcohol in pregnancy and raise awareness. This provides social capital for change and empowers women and their families to make informed decisions about their health.

Culture and art

- In my capacity as Research Midwife and FASD champion, I have contacted the main soap operas and popular television programmes such as 'Hollyoaks' whose target audience is young people of reproductive ages to include FASD story lines. I have had positive responses from directors and producers and the BBC radio programme 'The Archers' has recently introduced a FASD storyline. Culture and art can be powerful influencers of attitude and behaviours and

have been used to educate targeted audiences in the past. One original example is when Grange Hill joined the ‘Just say no’ to drugs campaign in the 1980s which significantly impacted upon a generation of viewers.

Appendix 2: Impact of research References

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10.3 Appendix 3: Declarations of co-authorship of published work

northumbria UNIVERSITY NEWCASTLE

Northumbria University NEWCASTLE

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

Name of candidate: Helen Howlett

Name of co-author: Nigel Brown

Full bibliographical details of the publication (*including authors*):

Howlett H, Abernethy S, Brown NW, Rankin J & Gray WK. (2017) How strong is the evidence for using blood biomarkers alone to screen for alcohol consumption during pregnancy? A systematic review. European Journal of Obstetrics & Gynaecology and Reproductive Biology 213 45–52 DOI: 10.1016/j.ejogrb.2017.04.005

Section B

DECLARATION BY CANDIDATE (*delete as appropriate*)

I declare that my contribution to the above publication was as:

(i) principal author

My specific contribution to the publication was (*maximum 50 words*):

I was the lead author on this paper and coordinated the specialist input from the research team. I was responsible the ethics, governance, study coordination and general management of the study. I led the systematic review and all authors contributed to the written article prior to publication.

Signed: Helen Howlett.....(candidate) ..30/3/2020.....(date)

Section C

STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

or **(ii)**

Signed: .....(co-author) 20/5/20 (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: Judith Rankin

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Abernethy S, Brown NW, Rankin J & Gray WK. (2017) How strong is the evidence for using blood biomarkers alone to screen for alcohol consumption during pregnancy? A systematic review. European Journal of Obstetrics & Gynaecology and Reproductive Biology 213 45–52 DOI: 10.1016/j.ejogrb.2017.04.005

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Signed: Helen Howlett**.....**(candidate) **..**30/3/2020.....(date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: Judith Rankin (co-author) 20.05.2020 (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: William K Gray

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Abernethy S, Brown NW, Rankin J & Gray WK. (2017) How strong is the evidence for using blood biomarkers alone to screen for alcohol consumption during pregnancy? A systematic review. European Journal of Obstetrics & Gynaecology and Reproductive Biology 213 45–52 DOI: 10.1016/j.ejogrb.2017.04.005

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Signed: . Helen Howlett**.....**(candidate) **..**30/3/2020.....(date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....WK Gray.....(co-author) **.....21-05-20.....** (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: Sarah Abernethy

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Abernethy S, Brown NW, Rankin J & Gray WK. (2017) How strong is the evidence for using blood biomarkers alone to screen for alcohol consumption during pregnancy? A systematic review. European Journal of Obstetrics & Gynaecology and Reproductive Biology 213 45–52 DOI: 10.1016/j.ejogrb.2017.04.005

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Signed: . Helen Howlett**.....**(candidate) **..**30/3/2020.....(date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: ...Sarah Abernethy.....(co-author) **.....21/05/20020.....** (date)

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DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

Name of candidate: Helen Howlett

Name of co-author: Shonag Mackenzie

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Langley K, Davidson C, Gray W.K., Dismore L, Rankin J & Mackenzie S. (2017) A survey of attitudes, belief and practice regarding alcohol use and screening in pregnancy: an opportunity for support and education? Journal of Research in Nursing. 22 (8) 618-633 https://doi.org/10.1177/1744987117745579

Section B

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I declare that my contribution to the above publication was as:

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Signed: Helen Howlett.....(candidate) ..30/3/2020.....(date)

Section C

STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....(co-author) **.....19/07/2020.....** (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: Catriona Davison

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Langley K, Davidson C, Gray W.K., Dismore L, Rankin J & Mackenzie S. (2017) A survey of attitudes, belief and practice regarding alcohol use and screening in pregnancy: an opportunity for support and education? Journal of Research in Nursing. 22 (8) 618-633 https://doi.org/10.1177/1744987117745579

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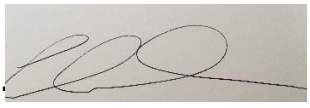
Signed: .Helen Howlett**.....**(candidate) **..**30/3/2020.....(date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....Catriona Davidson..  (co-author)
20/05/2020

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: Judith Rankin

Full bibliographical details of the publication (*including authors*)**:**

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Signed: Helen Howlett**.....**(candidate) **..**30/3/2020.....(date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: Judith Rankin (co-author) 20.05.2020 (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: William K Gray

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Langley K, Davidson C, Gray W.K., Dismore L, Rankin J & Mackenzie S. (2017) A survey of attitudes, belief and practice regarding alcohol use and screening in pregnancy: an opportunity for support and education? Journal of Research in Nursing. 22 (8) 618-633 https://doi.org/10.1177/1744987117745579

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Signed: .Helen Howlett**.....**(candidate) **..**30/3/2020.....(date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....WK Gray.....(co-author) **.....21-05-20.....** (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: Lorelle Dismore

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Langley K, Davidson C, Gray W.K., Dismore L, Rankin J & Mackenzie S. (2017) A survey of attitudes, belief and practice regarding alcohol use and screening in pregnancy: an opportunity for support and education? Journal of Research in Nursing. 22 (8) 618-633 https://doi.org/10.1177/1744987117745579

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DECLARATION BY CANDIDATE (*delete as appropriate*)

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(i) principal author

My specific contribution to the publication was (*maximum 50 words*):

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Signed: .Helen Howlett**.....**(candidate) **..**30/3/2020.....(date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: ..... Lorelle Dismore (co-author) **.20/05/2020** (date)

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DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

Name of candidate: Helen Howlett

Name of co-author: Eugen-Mattias Strehle

Full bibliographical details of the publication *(including authors)*:

Howlett H, Mackenzie S, Gray WK, Rankin J, Nixon L, Richardson A, Strehle, EM & Brown NW. (2018) Assessing prevalence of alcohol consumption in early pregnancy: Self-report compared to blood biomarker analysis. European Journal of Medical Genetics. Sep;61(9):531-538. doi: 10.1016/j.ejmg.2018.05.009.

Section B

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Signed: Helen Howlett.....(candidate) ..30/3/2020.....(date)

Section C

STATEMENT BY CO-AUTHOR *(delete as appropriate)*

Either **(i)** **I agree with the above declaration by the candidate** ✓

or **(ii)** **I do not agree with the above declaration by the candidate for the following reason(s):**

Signed: .....(co-author) 20 5 20 (date)

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DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

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Name of co-author: Shonag Mackenzie

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My specific contribution to the publication was (*maximum 50 words*):

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Signed: Helen Howlett.....(candidate) ..30/3/2020.....(date)

Section C

STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either (i) **I agree with the above declaration by the candidate**

Signed: .....(co-author) .....**19/07/2020**..... (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: Judith Rankin

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Mackenzie S, Gray WK, Rankin J, Nixon L, Richardson A, Strehle, EM & Brown NW. (2018) Assessing prevalence of alcohol consumption in early pregnancy: Self-report compared to blood biomarker analysis. European Journal of Medical Genetics. Sep;61(9):531-538. doi: 10.1016/j.ejmg.2018.05.009.

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Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: Judith Rankin (co-author) 20.05.2020 (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: William K Gray

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Mackenzie S, Gray WK, Rankin J, Nixon L, Richardson A, Strehle, EM & Brown NW. (2018) Assessing prevalence of alcohol consumption in early pregnancy: Self-report compared to blood biomarker analysis. European Journal of Medical Genetics. Sep;61(9):531-538. doi: 10.1016/j.ejmg.2018.05.009.

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Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....WK Gray.....(co-author) **.....21-05-20.....** (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Helen Howlett

Name of co-author: Leanne Nixon

Full bibliographical details of the publication (*including authors*)**:**

Howlett H, Mackenzie S, Gray WK, Rankin J, Nixon L, Richardson A, Strehle, EM & Brown NW. (2018) Assessing prevalence of alcohol consumption in early pregnancy: Self-report compared to blood biomarker analysis. European Journal of Medical Genetics. Sep;61(9):531-538. doi: 10.1016/j.ejmg.2018.05.009.

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Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

(i) I agree with the above declaration by the candidate

Signed: Leanne Nixon (co-author) 20/05/2020 (date)

northumbria UNIVERSITY NEWCASTLE

Northumbria University NEWCASTLE

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

Name of candidate: Helen Howlett

Name of co-author: Eugen-Mattias Strehle

Full bibliographical details of the publication *(including authors)*:

Howlett H, Mackenzie S, Rankin J, Strehle, EM & Gray WK. (2019) A Survey of Health Care Professionals' Knowledge and Experience of Foetal Alcohol Spectrum Disorder and Alcohol Use in Pregnancy. Clinical Medicine Insights: Reproductive Health. 13 (1–10) doi.org/10.1177/117955811983887.

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Section C

STATEMENT BY CO-AUTHOR *(delete as appropriate)*

Either **(i)** **I agree with the above declaration by the candidate** ✓

or **(ii)** **I do not agree with the above declaration by the candidate for the following reason(s):**

Signed: .....(co-author) 20 5 20 (date)

northumbria UNIVERSITY NEWCASTLE

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DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

Name of candidate: Helen Howlett

Name of co-author: Nigel Brown

Full bibliographical details of the publication (*including authors*):

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Section C

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northumbria UNIVERSITY NEWCASTLE

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Name of candidate: Helen Howlett

Name of co-author: Shonag Mackenzie

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Name of co-author: Judith Rankin

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Name of co-author: William Keith Gray

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Name of candidate: Helen Howlett

Name of co-author: Nigel Brown

Full bibliographical details of the publication (*including authors*):

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Section A
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Name of co-author: Leanne Nixon

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