Lewit-Mendes Miranda Felicia (Orcid ID: 0000-0001-7744-6471)
Archibald Alison (Orcid ID: 0000-0002-4496-8262)

Title Page

Title:

Experiences of receiving an increased chance of sex chromosome aneuploidy result from non-invasive prenatal testing in Australia: "A more complicated scenario than what I had ever realised"

Authors' names:

Miranda F. Lewit-Mendes, Hazel Robson, Joanne Kelley, Justine Elliot, Erica Brown, Melody Menezes and Alison D. Archibald.

Institutional affiliations:

Miranda F. Lewit-Mendes[1,2], Hazel Robson[1,3], Joanne Kelley[4], Justine Elliott[5,6], Erica Brown[7], Melody Menezes[1,8] and Alison D. Archibald[1,5,6]

Corresponding author:

Dr Alison Archibald

Phone: 61 3 9936 6729

Email: alison.archibald@vcgs.org.au

Suggested running head:

Experiences with an increased chance of SCA from NIPT

[1] Department of Paediatrics, University of Melbourne, Melbourne, VIC, Australia
[2] Monash Genetics, Monash Health, Melbourne, VIC, Australia
[3] Genetics Department, Number 1 Fertility, Melbourne, VIC, Australia
[4] Mercy Perinatal, Mercy Hospital for Women, Melbourne, VIC, Australia
[5] Victorian Clinical Genetics Services, Melbourne, VIC, Australia
[6] Murdoch Children's Research Institute, Melbourne, VIC, Australia
[7] Genetics Clinic, The Royal Women's Hospital, Melbourne, VIC, Australia
[8] Monash Ultrasound for Women, Monash IVF, Melbourne, VIC, Australia

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1002/jgc4.1635

Abstract:

Many non-invasive prenatal testing (NIPT) platforms screen for sex chromosome aneuploidy (SCA) and SCA analysis is generally included in Australia where NIPT is available as a self-funded test. Little is known about the experience of receiving an NIPT result indicating an increased chance of SCA. This study aimed to explore the experiences of people who received this result and their perspectives on the information, care and support they received from healthcare practitioners (HCPs). Semi-structured interviews were conducted with people who received an NIPT result indicating an increased chance of SCA and continued their pregnancy. Most participants only had contact with a genetic counselor after receiving their result. Transcribed data were analysed using rigorous thematic analysis to identify important patterns and themes. Participants (18 women, 2 male partners) described embarking on NIPT, primarily based on advice from their HCP and without much consideration. Consequently, participants expressed feeling unprepared for the unanticipated complexity of their NIPT result and were faced with making a time-sensitive decision about a condition they had not previously considered. While more pre-test information was desired, timely access to genetic counseling post-test assisted with adjustment to the result. These findings suggest that routinisation of NIPT may be compromising informed decision-making, resulting in unpreparedness for an increased chance result. Given the increasing uptake and expanding scope of NIPT, resources should be dedicated to educating HCPs offering NIPT and ensuring timely access to genetic counseling post-result. With appropriate funding, genetics services may be able to play a central role in offering information and support to both people who undertake NIPT and their HCPs ordering the testing. Implementing a publicly-funded screening program in Australia could assist with standardising prenatal screening care pathways and consequently better access to appropriate resources.

Keywords:

Sex chromosome aneuploidy; decision-making; genetic counseling; genetic counselling; lived experience; non-invasive prenatal screening; non-invasive prenatal testing; cell-free DNA screening

What is known about this topic

NIPT can include routine screening for sex chromosome aneuploidies (SCAs). Rates of diagnostic testing and pregnancy termination following an increased chance of SCA result through NIPT are much lower, compared to trisomy 21.

What this paper adds to the topic

People may be unprepared for complex and uncertain increased chance of SCA results and/or have misconceptions about the accuracy of NIPT for detecting SCAs. Timely genetic counseling appears to assist people to cope with, and adapt to, their result.

Main Body of Paper

INTRODUCTION

Non-invasive prenatal testing (NIPT) has the ability to identify fetal sex and pregnancies with an increased chance of sex chromosome aneuploidy (SCA) (Wang et al., 2016). While identifying SCA has not traditionally been an aim of prenatal screening (Hui et al., 2015), the inclusion of SCA analysis on NIPT has been a direct consequence of requests for fetal sex and is generally included in platforms commonly used in Australia, where NIPT is self-funded, and the United States, where NIPT is covered by private insurers and Medicaid in some situations (Ravitsky et al., 2021). However, there is variation in practice and in some countries, particularly those where NIPT is publicly-funded as a first- or second-tier test (such as in The Netherlands and the United Kingdom respectively), SCA analysis is not included on NIPT platforms (Bakkeren et al., 2020; Ravitsky et al., 2021).

The most common SCAs and associated conditions are: 45,X (Turner syndrome), 47,XXY (Klinefelter syndrome), 47,XXX (Triple X syndrome) and 47,XYY (Jacob's syndrome) (Skuse, Printzlau, & Wolstencroft, 2018). The phenotypic implications of SCA are less severe than the often-life-limiting complications of common autosomal aneuploidy. Individuals with SCA often have few or no dysmorphic features, few serious medical complications and normal lifespan (Boyd, Loane, Garne, Khoshnood, & Dolk, 2011). SCAs are variable, with many individuals being unaware of their SCA (Jaramillo et al., 2019). The potential for mosaicism, common in 45,X, can further complicate result interpretation and phenotype prediction (Papp et al., 2006). With the exception of 45,X, there are often no detectable abnormalities on prenatal ultrasound (Pieters, Kooper, van Kessel, Braat, & Smits, 2011). As such, prior to the introduction of NIPT, most cases of prenatally diagnosed SCAs were incidental findings

following diagnostic testing for an unrelated indication (Pieters, Kooper, van Kessel, et al., 2011).

NIPT has a high sensitivity for trisomy 13, 18, 21 (98-99%) and a low combined false positive rate (FPR) of 0.13% (Gil, Accurti, Santacruz, Plana, & Nicolaides, 2017). For SCAs, the FPR is higher and positive predictive values range from 30% for 45,X up to 80% for other SCAs (Lüthgens, Grati, Sinzel, Haebig, & Kagan, 2021). Underlying causes for false positive (FP) results and lower sensitivity include maternal factors (i.e. maternal SCA, malignancy or organ transplant), confined placental mosaicism, co-twin demise and technical errors (Bianchi, Chudova, et al., 2015; Bianchi, Parsa, et al., 2015). Additionally, there have been cases of discordance between the reported SCA and actual SCA at time of diagnosis (Sagaser, Stevens, Davis, Northrup, & Ramdaney, 2018).

Screening for SCA presents some unique challenges that screening for common aneuploidy does not. Expert groups have recommended that sex chromosome analysis should be optional and people undertaking this test should be made aware of the variable test performance for detection of SCAs, as well as the potential for unanticipated maternal findings (Audibert et al., 2017; Gregg et al., 2016; Human Genetics Society of Australasia and Royal Australian and New Zealand College of Obstetricians and Gynaecologists [HGSA/RANZCOG], 2018). Few studies have investigated the experiences of people receiving an NIPT result indicating an increased chance of SCA and existing studies focussed on people who received a confirmed SCA diagnosis in their child (Riggan, Gross, Close, Weinberg, & Allyse, 2021; Samango-Sprouse et al., 2020). Hence, this study aimed to explore the experiences of people receiving an increased chance result for SCA, with differing outcomes reflective of the various complexities associated with these results.

METHODS

A phenomenological framework informed the qualitative methodology used in this study, to gain an in-depth understanding of the lived experience of participants (Hesse-Biber & Leavy, 2006). Semi-structured interviews explored how pregnant people and their partners experienced receiving an NIPT result indicating an increased chance of SCA. All participants provided verbal consent before beginning the interview. Approval for this study was granted by the Human Research Ethics Committees (HREC) of both the Royal Children's Hospital (HREC 37016) and Mercy Health (HREC 2019-008) as part of a Master of Genetic Counseling research program.

Participants

Participants were recruited using purposive sampling through two genetics services (Victorian Clinical Genetics Services and Mercy Hospital for Women) and one private ultrasound service (Monash Ultrasound for Women) in Victoria, Australia between June 2017 and July 2019. NIPT was ordered by primarily by obstetricians and general practitioners (GPs), and less commonly genetic counselors (GCs), and results were usually disclosed by the HCP who ordered the NIPT. Most participants did not speak to a GC prior to having NIPT, however all participants had received post-test genetic counseling. People were invited to take part if they had: received an NIPT result indicating an increased chance of SCA at least one year ago, elected or declined diagnostic prenatal or postnatal testing, and continued their pregnancy. This was to understand experiences with an increased chance of SCA result in the context on an ongoing pregnancy, potential ongoing impacts of the NIPT result and how to best support individuals who choose to continue a pregnancy after receiving an increased chance result.

Procedures

Participants were recruited and interviewed by two of the researchers (MLM and HR). Semi-structured interviews were conducted via telephone between June 2017- June 2019. The interview guide was developed by a team experienced in qualitative research and genetic counseling, and was refined as the interviews progressed. Questions focused on the decision to have NIPT, experiences of receiving the result and reflections on the information, care and support received in relation to NIPT.

Data Analysis

Interviews were recorded and transcribed verbatim by MLM and HR. NVivo12 software (QSR International, Melbourne, Australia) (NVivo, 2018) was used to manage transcript data and facilitate coding. Two researchers independently coded transcripts for consistency. Transcripts were analysed using an inductive approach of thematic analysis to identify common themes and patterns emerging from the data (Braun & Clarke, 2006). The inductive approach involved forming codes based on the content of the data, rather than being influenced by pre-existing ideas or preconceptions (Braun & Clarke, 2006).

RESULTS

Demographics

Forty-seven people were invited to participate in the study and 20 people (18 women, 2 male partners) agreed to take part (42.5% response rate). The average age at the time of interview was 37.9 years (range 27-45 years). Participant characteristics are detailed in Table 1. Interviews lasted between 31-83 minutes, and all were individual interviews, except for one couple who chose to be interviewed together. Participants received a variety of SCA results and underwent different diagnostic testing pathways. Participants shared a range of experiences

of NIPT and key themes that arose from the data, along with illustrative participant quotes, are summarised below. Pseudonyms have been used in place of real names with quotes for confidentiality.

"With my eyes closed": embarking on NIPT without much consideration

When asked to reflect on their motivations for having NIPT, the most common reasons listed by participants were: screening for Down syndrome or other major disability, finding out the fetal sex as early as possible and/or because it was recommended by their (non-genetic) HCP. Many participants described having perceived NIPT to be a routine part of early pregnancy care, alongside ultrasound scans:

> So we just kind of thought that [NIPT] was becoming now the norm [...] a routine thing, like your other [ultrasound] scans […] you didn't choose to do [NIPT].
>
> (Cheryl - increased chance of 45,X, amniocentesis, FP result)

There was a perception that having NIPT was the typical choice or was just part of the process. As it was seen to be commonplace, participants did not see NIPT as a test requiring further consideration. When asked about their decision-making, most participants described doing little or none of their own research. Often, the decision to have NIPT was based entirely on recommendation by their obstetrician or GP:

> My obstetrician recommended that I did [NIPT], actually he didn't recommend, he basically made me do the test.
>
> (Claire - increased chance of 47,XXX, confirmed postnatally)

There was some regret expressed by those who felt they had blindly trusted their HCP's recommendation and underwent NIPT with a lack of understanding:

> I felt like I went into this experience and I didn't really understand the consequences of what could come out of it fully […] I just proceeded with the test based solely on [my obstetrician's] advice and I didn't do any independent research into the test myself, which I came to regret […] I feel like I went in with my eyes closed about it all.
>
> (Bianca – increased chance of 45,X, amniocentesis, FP result)

"There was no preparation": being unprepared for an increased chance of SCA

It was evident from participants' discourse that receiving an increased chance of SCA result was a shocking and unexpected event. Some participants commented they had felt prepared for a result indicating an increased chance of Down syndrome, yet little consideration was given to other types of results. Others simply expected to be reassured by their NIPT result. When reflecting on the decision-making process, one participant questioned the extent to which their decision had been informed:

> We really just thought we were doing the test that you could for Down Syndrome and very serious medical conditions […] I didn't know we were looking at sex chromosomes […] you just feel like you've made decisions and you're in control of things and then suddenly you're not […] I just think that there was no preparation, such limited information that was given to us.
>
> (Eloise – increased chance of 47,XXX, declined diagnostic testing)

For those who learnt about a previously unknown SCA in *themselves*, this was completely unforeseen and was not something that they had understood to be a possible outcome of NIPT:

> Someone gave me a brochure, but it was really brief […] and it never said it you could be finding things about yourself as well.
>
> (Alesha – increased chance of 47,XXX, maternal SCA (46,XX/47,XXX) confirmed on maternal karyotyping)

Receiving an increased chance of SCA appeared to be an emotionally difficult experience and participants described the initial period of shock and distress as being exacerbated by their lack of knowledge about the SCA. Finding out about an unfamiliar condition was compounded by the unanticipated complexity of SCA result, including the potential for mosaicism and a variable phenotype:

> There's just so much uncertainty […] the thing that no one could really tell me was what sort of quality of life a child would have with the condition, because it seems to vary so greatly from person to person and there's mosaicism and some people have it and they don't even realise and I guess it was just a more complicated scenario than what I had ever realised.
>
> (Bianca – increased chance of 45,X, amniocentesis, FP result)

"It was an unknown": a desire for immediate and accurate information

After receiving their NIPT result, participants expressed a desire for immediate and accurate information. When the clinician disclosing the result was unable to explain what it meant or was misinformed, participants perceived this as having a negative impact and described worrying about what kind of life their child may have with a SCA. The internet was usually the next source of information after the initial telephone call, but not always a helpful or balanced source:

> I got the phone call, and we sort of, we did the worst thing possible, we googled it. We were ready to make ill-informed decisions. Google kind of shows the extreme [...] the worst-case scenario.
>
> (Michael – increased chance of 45,X, fetal SCA (45,X/46,XX) confirmed on amniocentesis)

Receiving timely, accurate and balanced information from a genetic HCP was described as valuable, particularly if the HCP who initially disclosed the NIPT result had not provided much information. Participants described feeling more comfortable with their result and the possibility of having a child with a SCA after speaking to a GC and/or clinical geneticist:

> It was pretty awful because [my obstetrician] didn't know anything and he couldn't give me any information, I'm then suddenly freaking out […] all I saw was like this world ahead of me of specialists and therapists and disability […] [the GC] just alleviated all my fears […] I was terrified of this diagnosis because it was an unknown, until I spoke with the GC who explained more to me and then it was known […] and I wasn't so scared anymore.
>
> (Claire - increased chance of 47,XXX, confirmed postnatally)

For some participants, seeking information from people *not* involved in their pregnancy care, but rather from someone with a lived experience of having a child with SCA, was important in informing their decision-making:

> The GCs were giving me a lot of what ifs, and nothing real. She [a mother with a child with Klinefelter syndrome] outlined what was involved, and I thought, I can live with that. It completely changed my mind.
>
> (Carmen – increased chance of 47,XXY, amniocentesis, FP result)

"Living in this state of anxiety": contemplating (un)certainty and making decisions about diagnostic testing

The NIPT results participants received, and testing pathways they chose, varied greatly among the study sample. Yet, all participants described a process of decision-making about further testing when faced with an increased chance NIPT result. For some participants, the need for certainty was above all the most important factor guiding their decision to have diagnostic testing:

> I just felt like, living in this state of anxiety, for the remaining six months of the pregnancy was just going to be too stressful.
>
> (Bianca – increased chance of 45,X, amniocentesis, FP result)

Other participants expressed wanting a diagnosis to guide their decision-making about continuing the pregnancy or electing termination of pregnancy (TOP):

> If [the condition] is really severe, then we'd been more prone to considering ending it.
>
> (Cheryl - increased chance of 45,X, amniocentesis, FP result)

Participants who had decided to continue their pregnancy, regardless of the outcome, described considering whether the benefits of a prenatal diagnosis outweighed the risks of an invasive procedure:

> We had already made up our mind up to continue […] what's the point of a one in 1000 chance of losing this baby because of this test when I'm going to have this baby anyway?
>
> (Penelope – increased chance of 47,XXY, confirmed postnatally)

In some cases, participants felt diagnostic testing was warranted if the information was medically actionable prior to birth.

> Had we not known, we wouldn't have had those heart scans [during pregnancy].
>
> (Michael – increased chance of 45,X, fetal SCA (45,X/46,XX) confirmed on amniocentesis)

"The amount of clean up and stress involved is significant": Reflecting on the overall experience and lasting impacts

Upon reflection of their overall experience, participants discussed the perceived value of the information they received from NIPT and whether there were lasting impacts. For participants whose SCA result was confirmed in their baby or revealed mosaic SCA in themselves, they generally spoke positively about the usefulness of the NIPT result:

> Well knowledge is power, and being able to know that I actually have this condition has been fantastic.
>
> (Sarah – increased chance of 45,X, maternal SCA (45,X/46,XX) confirmed on maternal karyotyping)

Participants described the benefit of having information early in their child's life to allow them to be proactive with interventions:

> Knowing has definitely helped us prepare […] it means that we can get the help that he needs because we know.
>
> (George – increased chance of 47,XXY, confirmed postnatally)

For those who received a FP result, perspectives were mixed. Some spoke negatively about the experience, feeling frustrated about the unnecessary financial burden and anxiety they experienced, and the risk of invasive testing:

> I think it made me feel angry because it felt like I've gone through all that emotional stress and testing and potentially risking the life of my baby with the amniocentesis and then also it was quite expensive to have all the testing […] there was nothing that could be determined that was even wrong.
>
> (Bianca – increased chance of 45,X, amniocentesis, FP result)

Another participant also described being significantly impacted by the experience and feeling anxiety in relation to the result for the entire pregnancy even after having diagnostic testing:

> I really think that they need to prepare people a bit better for tests like that, because they seem quite innocent but unfortunately when things don't go well, the amount of clean up and stress involved is significant […] I wasn't sure if I was having a healthy baby so I started to disconnect from the baby […] I suffered a lot […] even though I had the CVS, I still didn't really truly let myself believe that everything was going to be alright […] I needed [postnatal testing] to happen, it might have been overkill, but I needed it.
>
> (Melinda – increased chance of 45,X, CVS and postnatal testing, FP result)

Conversely, some participants who received FP results did not appear to dwell on the experience and after having diagnostic testing, they were able to move forward in the pregnancy without ongoing impact:

> I haven't really sort of really reflected on it too much and I didn't really reflect on it too much for the rest of the pregnancy.
>
> (Helen – increased chance of 47,XXX, amniocentesis, FP result)

Despite some negative experiences, most participants in the study reflected they would have NIPT again in a future pregnancy:

> At the time, I remember thinking if I ever had another child, I'm not doing that test, it's a waste of money and it's a waste of time, and it causes unnecessary stress. But then

again, now I'm sitting here what 2 years down the track […] I probably would go and do the test again, because we'd want to know the gender.

(Juliet – increased chance of 45,X, amniocentesis, FP result)

DISCUSSION

The introduction of NIPT into clinical care has caused a paradigm shift in prenatal screening, with rapid uptake as a first-tier screening test in Australia, and expansion of scope to include SCA; driven by the desire to know fetal sex (Hui, Muggli, & Halliday, 2016). This research is one of the first studies to explore the experiences of people who received an NIPT result indicating an increased chance of SCA and the first to include those who received FP results, maternal SCA diagnoses or did not have any further testing. Findings highlight an unpreparedness to receive a SCA result and a desire for more information about possible NIPT outcomes. Timely and accurate information post-result, often through genetic counseling, was perceived as being important, to facilitate making meaning of results and inform decision-making about further testing. Additionally, this research offers insight into perspectives on the value of the NIPT result and lasting impacts of the experience. While our findings support those of other studies exploring experiences of NIPT, this study demonstrates how the variability and uncertainty surrounding SCAs presents additional challenge to prospective parents receiving an increased chance result.

The findings of this study suggest NIPT has become a routine element of early pregnancy care in Australia. This is evidenced by the fact that participants perceived NIPT as being as routine

as ultrasound scans and, in some cases, having NIPT was not considered a choice. Similarly, pregnant people have likened NIPT to "a simple blood test" (Yi, Hallowell, Griffiths, & Yeung Leung, 2013). Participants in the current study described NIPT as being convenient, while another Australian study also found participants were motivated by its ease and non-invasiveness (Bowman-Smart et al., 2019). Before its introduction, NIPT was predicted to be susceptible to becoming routinised, due to its safety and accuracy, and the findings of our study support this prediction (de Jong, Maya, & van Lith, 2015; Menezes, Meagher, & Costa Fda, 2013; van den Heuvel et al., 2010).

'Routinisation' describes the process whereby the ease and safety of NIPT lead to it being presented and perceived as a routine part of pregnancy care (Kater-Kuipers, de Beaufort, Galjaard, & Bunnik, 2018). The potential impact of routinisation on reproductive autonomy has been widely discussed with respect to prenatal screening (Searle, 1997; Smith, Shaw, & Marteau, 1994; Williams et al., 2005). It is feared that routinisation changes the perception of providers and pregnant people, and potential negative consequences of this may be that providers offer the test without adequate information, and pregnant people may not perceive the test as something requiring significant consideration and/or may feel compelled to undertake testing or act on a result (de Jong et al., 2015; Kater-Kuipers et al., 2018). Consequently, ethicists and prospective parents have raised concerns regarding how the routinisation of NIPT could pose a threat to informed decision-making (Cernat et al., 2019; Dondorp et al., 2015; Gekas et al., 2016; Lewis, Silcock, & Chitty, 2013; van Schendel et al., 2014). Van den Berg, Timmermans, ten Kate, van Vugt, and van der Wal (2006) constructed a measure of informed decision-making: requiring a person to receive all relevant, accurate and unbiased information, deliberate and make a value-consistent decision that is not influenced by external pressures. Participants in this study described doing little research, recalling minimal or non-existent information about SCAs or the potential for FP results presented to them pre-

test and being motivated to have NIPT based on recommendation by their HCP or desire to know fetal sex. These findings suggest participants were not fully informed or making a decision free of undue influence and past studies have also found that people may be influenced by, or even feel pressured by, HCPs to have NIPT (Bowman-Smart et al., 2019; Valentin, Smidt, Barton, Wilson, & How, 2019). While it may not be possible to prepare everyone for all possible results, it seems reasonable that people undertaking NIPT should at least be aware of what conditions are screened and FP results. When asked about NIPT implementation, people who had undertaken or been offered NIPT previously have described wanting readily available accurate information about test accuracy, scope and potential results, along with adequate pre-test counseling to help interpret that information, to allow informed decision-making (Bakkeren et al., 2020; Vanstone, Cernat, Nisker, & Schwartz, 2018). In The Netherlands where NIPT is offered routinely as a publicly-funded test, adequate pre-test counselling with provision of accurate information does appear to support informed decision-making and reproductive autonomy despite 'routinisation' (Horn, 2022). Contrastingly in Australia, there is no standardised pathway for offering NIPT and disclosing results. HCPs have to differentiate between the multiple NIPT providers that are available with differing costs and scope, and offer these alongside maternal serum screening. Pathways to access genetic counseling are also fragmented and dependent on the pregnant person's location, NIPT provider chosen and/or the HCP who arranged testing. A more standardised approach to delivery of NIPT services could allow more comprehensive and targeted education for HCPs to support informed decision-making and streamlined access to genetic counseling as required. Additionally, sex chromosomes are not analysed in The Netherlands and in countries where fetal sex is reported, it is important to consider how the social norms of finding out fetal sex in early pregnancy and the trend of gender-reveal parties, have now become curiously linked to NIPT (Gieseler, 2018). This may represent an influential, albeit non-health related, external

pressure encouraging people to undertake NIPT and raises questions about whether the desire to know fetal sex is a sufficient reason to report SCA on NIPT.

A lack of informed decision-making can lead to being unprepared for the result. This was demonstrated by participants describing the SCA result as "a shock", having unanticipated complexity and causing fear of the unknown. Participants reflected experiencing a significant emotional response to the result, exacerbated by the lack of preparation. Some participants expected to be reassured by a "negative" result, while others were prepared only for Down syndrome. These findings resonate with those of past studies on prenatal diagnosis of SCA, where prospective parents expressed similar feelings of unpreparedness, shock and fear of disability (Bourke, Snow, Herlihy, Amor, & Metcalfe, 2014; Riggan, Close, & Allyse, 2020; Riggan et al., 2021). The lack of knowledge regarding SCA raises concerns about how parents make decisions about diagnostic testing and potentially TOP, in the time-sensitive way that pregnancy demands. Additionally, the availability of prenatal screening for a condition can in itself imply intolerance for the severity of that condition, suggesting that individuals should consider diagnostic testing and TOP following an increased chance result (Gekas et al., 2016; Ravitsky, 2017). Hence, these findings highlight the importance of pre-test counseling, where anticipatory guidance can support prospective parents to consider the meaning of potential results for them, prior to undergoing testing (Veach, Bartels, & LeRoy, 2007).

Misconceptions about the purpose and scope of NIPT can also result in dissatisfaction with screening. Some participants described feeling deceived, as they did not understand the limitations of NIPT or the potential need for diagnostic testing to clarify results with associated costs and ongoing periods of uncertainty. These findings may be a reflection of test marketing, inadequate pre-test information and/or insufficient engagement in pre-test decision-making.

Participants expressed that having more information pre-test and being prepared for a possible FP would have reduced the shock of the result and associated anxiety. Another study similarly found participants were frustrated with the accuracy of NIPT and believed they would have benefited from more warning about FP results (Gammon, Jaramillo, Riggan, & Allyse, 2018). While it appears that people want more pre-test information, this may be difficult to implement. Evidence suggests that some HCPs may believe non-invasive tests do not require as stringent consent as invasive tests. HCPs may also lack confidence in providing counseling about NIPT if they are not familiar with the technology or conditions screened (Cernat et al., 2019; van den Heuvel et al., 2010). Additionally, given NIPT is becoming standard procedure, with social influences relating to desire to know fetal sex, and low chance results expected, not all people may be willing to engage in active deliberation about NIPT.

Following NIPT result disclosure, participants expressed trying to get as much information, as soon as possible. While the internet was a quick source of information, it appeared to cause more concern. Finding negative and alarming information on the internet is not an uncommon occurrence for people receiving a SCA result (Bourke et al., 2014; Jaramillo et al., 2019). Hodgson et al. (2016) have discussed the impact of web-based resources becoming a primary information source following prenatal diagnosis and HCPs needing to take on "a new and important role in assisting patients to navigate and discriminate between these resources". In the current study, participants did not indicate they had much guidance regarding suitable resources and some received their NIPT result from an apparently-uninformed HCP. Previous studies, including those capturing experiences from over 20 years ago until very recently, have also found parents felt information they received from HCPs about SCAs was unbalanced, inaccurate or outdated (Abramsky, Hall, Levitan, & Marteau, 2001; Jaramillo et al., 2019; Riggan et al., 2020, 2021). These findings indicate little improvement over time in provision of information by HCPs, despite a significant increase in detection of SCA relating to NIPT.

Therefore, this demonstrates an urgent need to increase HCP education and awareness of where to find accurate resources regarding SCAs. Whilst there were clearly issues with accessing information about the SCA online, participants in this study and another recent study reported finding connecting with parents of/people with SCAs through social media and/or support groups helpful (Riggan et al., 2021). Additionally, there is evidence that people having NIPT may seek and value information and opinions from social media or online forums (Marcon, Ravitsky, & Caulfield, 2021). These findings highlight the desire for real world, relatable perspectives of the condition. As such, HCPs offering NIPT could consider discussing these information sources with their patients, including their potential to be valuable and/or misleading.

Timely contact with a GC appeared to reduce anxiety and distress associated with a SCA result for participants in the current study. Genetic counseling was described as valuable through the provision of accurate, balanced information about the limitations of NIPT and the clinical features of the SCA. Participants described having their fears alleviated or feeling more at ease after speaking with a genetic HCP. In other studies, receiving information from genetic HCPs was also found to be helpful and calming, following an unforeseen result indicating SCA (Bourke et al., 2014; Pieters, Kooper, Eggink, et al., 2011) and described favourably compared to receiving information from non-genetic HCPs (Riggan et al., 2021). Additionally, participants in a study by Salema, Townsend, and Austin (2019) described the positive impact of how GCs supported them by affirming, but not influencing, their decision-making following an increased chance prenatal screening result. This affirmation was described as reducing guilt or conflict about their decision (Salema et al., 2019). These benefits are underpinned by the principles of genetic counseling, which value not only the provision of accurate balanced information, but information provision in an empathic way that considers psychosocial factors and supports patient autonomy, adaptation and empowerment (McAllister, Dunn, & Todd,

2011; McAllister et al., 2008; Veach et al., 2007). As a result, genetic counseling can empower parents to cope with, and adapt to, their result and their decisions in a generally more positive way.

STUDY LIMITATIONS

While this study involved a wide variety of experiences, there were some results and pregnancy outcomes that were not represented. Individuals who elected a TOP were not included in this study. Therefore, study findings may not be transferable to this population and further research is needed to understand experiences of people who choose TOP for SCA and how to support these individuals. All participants in this study were recruited via genetics services, so the sample may have been biased towards those who received genetic counseling and potentially had different outcomes than those who did not access genetic counseling. Thus, further research is required involving individuals who do *not* receive genetic counseling, to understand the value of genetics services for this population. Other sample biases include a lack of diversity in ethnicity, gender and possibly socioeconomic status, given NIPT is only currently accessible in Australia as a self-funded test. Specifically, people from regions experiencing disadvantage may be less likely to access NIPT than those from regions experiencing advantage (Hui, Barclay, Poulton, Hutchinson, & Halliday, 2018). People from regions experiencing disadvantage or speaking English-as-a-second-language may experience even more difficulty accessing appropriate information due to language and/or health literacy barriers. Finally, we acknowledge potential for recall or confirmation bias given people were interviewed at least a year after receiving their NIPT result. While qualitative data cannot be generalised, these interviews allowed an in-depth understanding of participant experiences. Exploration of HCP experiences could provide complementary insight into their attitudes and perspectives towards provision of this test.

PRACTICE IMPLICATIONS

The uptake of NIPT is increasing and the scope is rapidly expanding to include options for genome-wide screening and screening for targeted microdeletions. While currently a self-funded test in Australia, it is possible that NIPT may become publicly-funded in the future (Maxwell & O'Leary, 2018). Between 25-50% of pregnant people are choosing to have NIPT in Australia, the United States of America and Europe (Gadsbøll et al., 2020). The balance between providing a service at a population level and attempting to ensure informed decision-making will pose challenges to resources. As NIPT becomes more widely accessible, comprehensive, careful consideration should be given to developing strategies to support people who undertake NIPT and their HCPs ordering the testing. Ideally, HCPs ordering NIPT would be educated to prepare individuals for possible NIPT results. NIPT providers could develop web-based information and webinars to educate HCPs and provide HCPs with educational materials for their patients to access. While comprehensive education of HCPs is complex and resource intensive, implementation of publicly-funded NIPT in a more standardised prenatal screening pathway in Australia could support more targeted HCP education and better access for pregnant people to appropriate resources. Genetics services can also provide timely genetic counseling to people who do receive NIPT results indicating an increased chance of SCA and ongoing support for those who continue their pregnancy. Additionally, GCs can liaise with non-genetic specialists – such as endocrinologists – to help parents understand the medical implications of having a SCA and also discuss non-clinical sources of information such as social media and support groups. If appropriately funded, there may also be an opportunity for genetics services to play a more central role in offering support in relation to NIPT to non-genetic HCPs, who ultimately have greater involvement in ordering and disclosing NIPT results. In the era of NIPT, resources should be focussed on access to

genetic counseling and funding genetics services, who have a unique skillset and are well-placed to provide appropriate interventions for those who receive increased chance results.

CONCLUSION

This study adds to existing prenatal screening literature by providing in-depth data about how people experience receiving an NIPT result indicating an increased chance of SCA. These findings suggest that the routinisation of NIPT in the current context may compromise informed decision-making and can result in people feeling unprepared for increased chance results of which in turn may lead to long-term emotional impacts. However, the provision of information and support post-test through genetic counseling appeared to be valuable in empowering people to adapt to, and cope with, their result. More broadly, this data provides insight into pathways of care for people continuing pregnancies after an increased chance result for SCA on NIPT.

Author Contributions

Miranda Lewit-Mendes confirms that she had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All of the authors gave final approval of this version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Acknowledgements

We would like to thank Dr Jan Hodgson and Dr Sharon Lewis of the Department of Paediatrics, Faculty of Medicine, Dentistry and Health Sciences, University of Melbourne for their support in the conduct of this study. We acknowledge Mercy Hospital for Women Genetics Department, Monash Ultrasound for Women and Victorian Clinical Genetics Services for assisting with recruitment of participants. We thank the people who took part in this study and shared their experiences with us. The research presented in the paper was conducted while MFL and HR were in training and to fulfill a requirement for a Master of Genetic Counselling in 2019 (MFL) and 2017 (HR) respectively.

Conflict of interest statement

Miranda Lewit-Mendes, Hazel Robson, Joanne Kelley and Erica Brown declare that they have no conflict of interest. Alison D. Archibald and Justine Elliott are employed by Victorian Clinical Genetics Services, a not-for-profit genetic testing provider. Melody Menezes is employed by Monash IVF/Monash Ultrasound for Women, a private genetic testing provider.

Human studies and informed consent

Approval to conduct this research as part of a Master of Genetic Counseling research program was granted by the Human Research Ethics Committees (HREC) of both the Royal Children's Hospital (HREC 37016) and Mercy Health (HREC 2019-008), in accordance with the guidelines of the Australian National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007, updated 2018). Informed and written consent was obtained from all participants who were interviewed in this study.

Animal studies

No non-human animal studies were carried out by the authors for this article.

Data availability statement

The data that support the findings of this study are not publicly available due to privacy and ethical restrictions.

References

Abramsky, L., Hall, S., Levitan, J., & Marteau, T. M. (2001). What parents are told after prenatal diagnosis of a sex chromosome abnormality: Interview and questionnaire study. *BMJ, 322*(7284), 463-466. doi:10.1136/bmj.322.7284.463

Audibert, F., De Bie, I., Johnson, J. A., Okun, N., Wilson, R. D., Armour, C., . . . Kim, R. (2017). No. 348-Joint SOGC-CCMG Guideline: Update on prenatal screening for fetal aneuploidy, fetal anomalies, and adverse pregnancy outcomes. *Journal of Obstetrics and Gynaecology Canada, 39*(9), 805-817. doi:10.1016/j.jogc.2017.01.032

Bakkeren, I. M., Kater-Kuipers, A., Bunnik, E. M., Go, A., Tibben, A., de Beaufort, I. D., . . . Riedijk, S. R. (2020). Implementing non-invasive prenatal testing (NIPT) in the Netherlands: An interview study exploring opinions about and experiences with societal pressure, reimbursement, and an expanding scope. *Journal of Genetic Counseling, 29*(1), 112-121. doi:10.1002/jgc4.1188

Bianchi, D. W., Chudova, D., Sehnert, A. J., & et al. (2015). Noninvasive prenatal testing and incidental detection of occult maternal malignancies. *JAMA: The Journal of the American Medical Association, 314*(2), 162-169. doi:10.1001/jama.2015.7120

Bianchi, D. W., Parsa, S., Bhatt, S., Halks-Miller, M., Kurtzman, K., Sehnert, A. J., & Swanson, A. (2015). Fetal sex chromosome testing by maternal plasma DNA sequencing: clinical laboratory experience and biology. *Obstetrics and Gynecology, 125*(2), 375-382. doi:10.1097/AOG.0000000000000637

Bourke, E., Snow, P., Herlihy, A., Amor, D., & Metcalfe, S. (2014). A qualitative exploration of mothers' and fathers' experiences of having a child with Klinefelter syndrome and the process of reaching this diagnosis. *European Journal of Human Genetetics, 22*(1), 18-24. doi:10.1038/ejhg.2013.102

Bowman-Smart, H., Savulescu, J., Mand, C., Gyngell, C., Pertile, M. D., Lewis, S., & Delatycki, M. B. (2019). 'Small cost to pay for peace of mind': Women's experiences with non-invasive prenatal testing. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, *59*, 649-655. doi:10.1111/ajo.12945

Boyd, P. A., Loane, M., Garne, E., Khoshnood, B., & Dolk, H. (2011). Sex chromosome trisomies in Europe: prevalence, prenatal detection and outcome of pregnancy. *European Journal of Human Genetics, 19*(2), 231-234. doi:10.1038/ejhg.2010.148

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. doi:10.1191/1478088706qp063oa

Cernat, A., De Freitas, C., Majid, U., Trivedi, F., Higgins, C., & Vanstone, M. (2019). Facilitating informed choice about non-invasive prenatal testing (NIPT): A systematic review and qualitative meta-synthesis of women's experiences. *BMC Pregnancy and Childbirth, 19*(1), 27-27. doi:10.1186/s12884-018-2168-4

de Jong, A., Maya, I., & van Lith, J. M. (2015). Prenatal screening: Current practice, new developments, ethical challenges. *Bioethics, 29*(1), 1-8. doi:10.1111/bioe.12123

Dondorp, W., de Wert, G., Bombard, Y., Bianchi, D. W., Bergmann, C., Borry, P., . . . American Society of Human Genetics. (2015). Non-invasive prenatal testing for aneuploidy and beyond: Challenges of responsible innovation in prenatal screening. *European Journal of Human Genetics, 23*(11), 1438-1450. doi:10.1038/ejhg.2015.57

Gadsbøll, K., Petersen, O. B., Gatinois, V., Strange, H., Jacobsson, B., Wapner, R., . . . S. (2020). Current use of noninvasive prenatal testing in Europe, Australia and the USA: A graphical presentation. *Acta Obstetricia et Gynecologica Scandinavica, 99*(6), 722-730. doi:10.1111/aogs.13841

Gammon, B. L., Jaramillo, C., Riggan, K. A., & Allyse, M. (2018). Decisional regret in women receiving high risk or inconclusive prenatal cell-free DNA screening results. *The*

Journal of Maternal-Fetal & Neonatal Medicine, *33*(8), 1412-1418. doi:10.1080/14767058.2018.1519541

Gekas, J., Langlois, S., Ravitsky, V., Audibert, F., van den Berg, D. G., Haidar, H., & Rousseau, F. (2016). Non-invasive prenatal testing for fetal chromosome abnormalities: Review of clinical and ethical issues. *The Application of Clinical Genetics, 9*, 15-26. doi:10.2147/TACG.S85361

Gieseler, C. M. (2018). Gender-reveal parties: Performing community identity in pink and blue. *Journal of Gender Studies, 27*, 661 - 671. doi.org/10.1080/09589236.2017.1287066

Gil, M. M., Accurti, V., Santacruz, B., Plana, M. N., & Nicolaides, K. H. (2017). Analysis of cell-free DNA in maternal blood in screening for aneuploidies: Updated meta-analysis. *Ultrasound in Obstetrics and Gynecology, 50*(3), 302-314. doi:10.1002/uog.17484

Gregg, A. R., Skotko, B. G., Benkendorf, J. L., Monaghan, K. G., Bajaj, K., Best, R. G., . . . Watson, M. S. (2016). Noninvasive prenatal screening for fetal aneuploidy, 2016 update: A position statement of the American College of Medical Genetics and Genomics. *Genetics in Medicine, 18*(10), 1056-1065. doi:10.1038/gim.2016.97

Hesse-Biber, S., & Leavy, P. (2006). *The practice of qualitative research*. Thousand Oaks, CA: SAGE Publications.

HGSA/RANZCOG Joint Committee on Prenatal Diagnosis and Screening (2018). *Prenatal screening and diagnostic testing for fetal chromosomal and genetic conditions* . (Statement C-Obs 59). Human Genetics Society of Australasia and Royal Australian and New Zealand College of Obstetricians and Gynaecologists. https://www.hgsa.org.au/documents/item/6110

Hodgson, J., Pitt, P., Metcalfe, S., Halliday, J., Menezes, M., Fisher, J., . . . McClaren, B. (2016). Experiences of prenatal diagnosis and decision-making about termination of

pregnancy: A qualitative study. *Australian and New Zealand Journal of Obstetrics and Gynaecology, 56*(6), 605-613. doi:10.1111/ajo.12501

Horn, R. (2022). NIPT and the concerns regarding 'routinisation'. *European Journal of Human Genetics, 30*(6), 637-638. doi:10.1038/s41431-022-01053-6

Hui, L., Barclay, J., Poulton, A., Hutchinson, B., & Halliday, J. L. (2018). Prenatal diagnosis and socioeconomic status in the non-invasive prenatal testing era: A population-based study. *Australian and New Zealand Journal of Obstetrics and Gynaecology, 58*(4), 404-410. doi:10.1111/ajo.12778

Hui, L., Muggli, E., & Halliday, J. (2016). Population-based trends in prenatal screening and diagnosis for aneuploidy: A retrospective analysis of 38 years of state-wide data. *BJOG: An International Journal of Obstetrics and Gynaecology, 123*(1), 90-97. doi:10.1111/1471-0528.13488

Hui, L., Teoh, M., da Silva Costa, F., Ramsay, P., Palma-Dias, R., Richmond, Z., . . . Walker, S. (2015). Clinical implementation of cell-free DNA-based aneuploidy screening: Perspectives from a national audit. *Ultrasound in Obstetrics and Gynecology, 45*(1), 10-15. doi:10.1002/uog.14699

Jaramillo, C., Nyquist, C., Riggan, K. A., Egginton, J., Phelan, S., & Allyse, M. (2019). Delivering the diagnosis of sex chromosome aneuploidy: Experiences and preferences of parents and individuals. *Clinical Pediatrics, 58*(3), 336-342. doi:10.1177/0009922818817310

Kater-Kuipers, A., de Beaufort, I. D., Galjaard, R.-J. H., & Bunnik, E. M. (2018). Ethics of routine: A critical analysis of the concept of 'routinisation' in prenatal screening. *Journal of Medical Ethics, 44*(9), 626-631. doi:10.1136/medethics-2017-104729

Lewis, C., Silcock, C., & Chitty, L. S. (2013). Non-invasive prenatal testing for Down's syndrome: Pregnant women's views and likely uptake. *Public Health Genomics, 16*(5), 223-232. doi:10.1159/000353523

Lüthgens, K., Grati, F. R., Sinzel, M., Haebig, K., & Kagan, K. O. (2021). Confirmation rate of cell free DNA screening for sex chromosomal abnormalities according to the method of confirmatory testing. *Prenatal Diagnosis, 41,* 1258-1263. doi:10.1002/pd.5814

Marcon, A. R., Ravitsky, V., & Caulfield, T. (2021). Discussing non-invasive prenatal testing on Reddit: The benefits, the concerns, and the comradery. *Prenatal Diagnosis*, *41*(1), 100-110. doi:https://doi.org/10.1002/pd.5841

Maxwell, S., & O'Leary, P. (2018). Public funding for non-invasive prenatal testing for fetal aneuploidy – It's time. *Australian and New Zealand Journal of Obstetrics and Gynaecology, 58*(4), 385-387. doi:10.1111/ajo.12840

McAllister, M., Dunn, G., & Todd, C. (2011). Empowerment: Qualitative underpinning of a new clinical genetics-specific patient-reported outcome. *European Journal of Human Genetics, 19*(2), 125-130. doi:10.1038/ejhg.2010.160

McAllister, M., Payne, K., MacLeod, R., Nicholls, S., Donnai, D., & Davies, L. (2008). Patient empowerment in clinical genetics services. *Journal of Health Psychology, 13*(7), 895-905. doi:10.1177/1359105308095063

Menezes, M., Meagher, S., & Costa Fda, S. (2013). Ethical considerations when offering noninvasive prenatal testing. *Revista Brasileira de Ginecologia e Obstetrícia, 35*(5), 195-198. doi.org/10.1590/S0100-72032013000500001

NVivo. (2018). NVivo qualitative data analysis software (Version 12). Available from: https://qsrinternational.com/nvivo/nvivo-products/

Papp, C., Beke, A., Mezei, G., Szigeti, Z., Bán, Z., & Papp, Z. (2006). Prenatal diagnosis of Turner syndrome. *Journal of Ultrasound in Medicine, 25*(6), 711-717. doi:10.7863/jum.2006.25.6.711

Pieters, J. J., Kooper, A. J., Eggink, A. J., Verhaak, C. M., Otten, B. J., Braat, D. D., . . . van Leeuwen, E. (2011). Parents' perspectives on the unforeseen finding of a fetal sex chromosomal aneuploidy. *Prenatal Diagnosis, 31*(3), 286-292. doi:10.1002/pd.2707

Pieters, J. J., Kooper, A. J., van Kessel, A. G., Braat, D. D., & Smits, A. P. (2011). Incidental prenatal diagnosis of sex chromosome aneuploidies: Health, behavior, and fertility. *ISRN Obstetrics and Gynecology, 2011*. doi:10.5402/2011/807106

Ravitsky, V. (2017). The shifting landscape of prenatal testing: Between reproductive autonomy and public health. *Hastings Center Report, 47*(S3), S34-S40. doi:10.1002/hast.793

Ravitsky, V., Roy, M.-C., Haidar, H., Henneman, L., Marshall, J., Newson, A. J., . . . Nov-Klaiman, T. (2021). The emergence and global spread of noninvasive prenatal testing. *Annual Review of Genomics and Human Genetics*, *22*(1), 309-338. doi:10.1146/annurev-genom-083118-015053

Riggan, K. A., Close, S., & Allyse, M. A. (2020). Family experiences and attitudes about receiving the diagnosis of sex chromosome aneuploidy in a child. *American Journal of Medical Genetics. Part C: Seminars in Medical Genetics*. doi:10.1002/ajmg.c.31781

Riggan, K. A., Gross, B., Close, S., Weinberg, A., & Allyse, M. A. (2021). Prenatal genetic diagnosis of a sex chromosome aneuploidy: Parent experiences. *Journal of Genetic Counseling*, *30*(5), 1407-1417. doi:10.1002/jgc4.1407

Sagaser, K. G., Stevens, B., Davis, J., Northrup, H., & Ramdaney, A. (2018). Close but not quite: Two cases of sex chromosome aneuploidies outside the scope of cell free DNA screening. *Prenatal Diagnosis, 38*(8), 617-619. doi:10.1002/pd.5264

Salema, D., Townsend, A., & Austin, J. (2019). Patient decision-making and the role of the prenatal genetic counselor: An exploratory study. *Journal of Genetic Counseling, 28*(1), 155-163. doi:https://doi.org/10.1002/jgc4.1049

Samango-Sprouse, C. A., Porter, G. F., Lasutschinkow, P. C., Tran, S. L., Sadeghin, T., & Gropman, A. L. (2020). Impact of early diagnosis and noninvasive prenatal testing (NIPT): Knowledge, attitudes, and experiences of parents of children with sex chromosome aneuploidies (SCAs). *Prenatal Diagnosis, 40*(4), 470-480. doi:10.1002/pd.5580

Searle, J. (1997). Routine antenatal screening: Not a case of informed choice. *Australian and New Zealand Journal of Public Health, 21*(3), 268-274. doi:10.1111/j.1467-842X.1997.tb01698.x

Skuse, D., Printzlau, F., & Wolstencroft, J. (2018). Sex chromosome aneuploidies. *Handbook of Clinical Neurology, 147*, 355-376. doi:10.1016/B978-0-444-63233-3.00024-5

Smith, D. K., Shaw, R. W., & Marteau, T. M. (1994). Informed consent to undergo serum screening for Down's syndrome: The gap between policy and practice. *BMJ, 309*(6957), 776. doi:10.1136/bmj.309.6957.776

Valentin, C., Smidt, A., Barton, R., Wilson, N. J., & How, B. (2019). Mothers of a child with Down syndrome: A qualitative analysis of the perspectives on non-invasive prenatal testing. *Midwifery, 76*, 118-124. doi:10.1016/j.midw.2019.06.001

van den Berg, M., Timmermans, D. R. M., ten Kate, L. P., van Vugt, J. M. G., & van der Wal, G. (2006). Informed decision making in the context of prenatal screening. *Patient Education and Counseling, 63*(1), 110-117. doi:https://doi.org/10.1016/j.pec.2005.09.007

van den Heuvel, A., Chitty, L., Dormandy, E., Newson, A., Deans, Z., Attwood, S., . . . Marteau, T. M. (2010). Will the introduction of non-invasive prenatal diagnostic testing

erode informed choices? An experimental study of health care professionals. *Patient Education and Counseling, 78*(1), 24-28. doi:10.1016/j.pec.2009.05.014

van Schendel, R. V., Kleinveld, J. H., Dondorp, W. J., Pajkrt, E., Timmermans, D. R. M., Holtkamp, K. C. A., . . . Henneman, L. (2014). Attitudes of pregnant women and male partners towards non-invasive prenatal testing and widening the scope of prenatal screening. *European Journal of Human Genetics, 22*, 1345. doi:10.1038/ejhg.2014.32

Vanstone, M., Cernat, A., Nisker, J., & Schwartz, L. (2018). Women's perspectives on the ethical implications of non-invasive prenatal testing: A qualitative analysis to inform health policy decisions. *BMC Medical Ethics, 19*(1), 27. doi:10.1186/s12910-018-0267-4

Veach, P. M., Bartels, D. M., & LeRoy, B. S. (2007). Coming full circle: A reciprocal-engagement model of genetic counseling practice. *Journal of Genetic Counseling, 16*(6), 713-728. doi:10.1007/s10897-007-9113-4

Wang, T., He, Q., Li, H., Ding, J., Wen, P., Zhang, Q., . . . Li, H. (2016). An optimized method for accurate fetal sex prediction and sex chromosome aneuploidy detection in non-invasive prenatal testing. *PloS One, 11*(7), e0159648. doi:10.1371/journal.pone.0159648

Williams, C., Sandall, J., Lewando-Hundt, G., Heyman, B., Spencer, K., & Grellier, R. (2005). Women as moral pioneers? Experiences of first trimester antenatal screening. *Social Science and Medicine, 61*(9), 1983-1992. doi:10.1016/j.socscimed.2005.04.004

Yi, H., Hallowell, N., Griffiths, S., & Yeung Leung, T. (2013). Motivations for undertaking DNA sequencing-based non-invasive prenatal testing for fetal aneuploidy: A qualitative study with early adopter patients in Hong Kong. *PloS One, 8*(11), e81794. doi:10.1371/journal.pone.0081794

Tables

TABLE 1: Participant characteristics

Characteristic	N	%
Gender	n=20	
Female	18	90.0
Male	2	10.0
Non-binary/gender diverse	0	0.0
NIPT result	n=20	
45,X	9	45.0
47,XXX	4	20.0
47,XXY	6	30.0
47,XYY	1	5.0
Diagnostic testing	n=23[a]	
Maternal karyotype	2	8.7
CVS	2	8.7
Amniocentesis	10	43.5
Postnatal testing	6	26.1
No diagnostic testing	3	13.0
Outcome	n=20	
Maternal SCA	2	10.0
Fetal SCA	7	35.0
False positive	8	40.0
Unconfirmed	3	15.0

[a]Some participant underwent multiple types of testing.

Tables

TABLE 1: Participant characteristics

Characteristic	N	%
Gender	n=20	
Female	18	90.0
Male	2	10.0
Non-binary/gender diverse	0	0.0
NIPT result	n=20	
45,X	9	45.0
47,XXX	4	20.0
47,XXY	6	30.0
47,XYY	1	5.0
Diagnostic testing	n=23[a]	
Maternal karyotype	2	8.7
CVS	2	8.7
Amniocentesis	10	43.5
Postnatal testing	6	26.1
No diagnostic testing	3	13.0
Outcome	n=20	
Maternal SCA	2	10.0
Fetal SCA	7	35.0
False positive	8	40.0
Unconfirmed	3	15.0

[a]Some participant underwent multiple types of testing.