PROBING UNIVERSAL CORRELATES OF HUMAN SAME-SEX SEXUAL ORIENTATION: A STUDY IN IRAN

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ABSTRACT

In this thesis, I investigated several biodemographic, psychological, and behavioural traits to address gaps in our knowledge on biopsychological development of male and female same-sex sexual orientation and gender identity/expression. This study was conducted in Iran and included Iranian adult males and females with diverse sexual orientations and gender identities/expressions. Presented data indicated that expressions of sex-atypical psychology and behaviour in childhood and adulthood were associated with varying degrees of same-sex sexual attraction and gender identity/expression in both males and females. Examination of the biodemographic variables showed that aspects of sibship composition were associated with male androphilia and female gynephilia. Also, presented data suggested that both male and female same-sex sexual attractions cluster within families. Overall, this thesis provided cross-cultural empirical evidence supporting that aspects of expression and development of male and female same-sex sexual orientation are universal.

CONTRIBUTIONS OF AUTHORS

This dissertation includes six empirical chapters that are either published or currently under review in peer-reviewed journals. The presented chapters have slightly modified compared to respective submitted articles to prevent redundant presentation of information (e.g., in the Introduction sections) and improve consistency in style and writing. I, as the first author of all six articles, designed the studies, applied for ethics approval, prepared and launched the online survey, collected the data in Iran, performed the statistical analyses, and wrote all manuscripts. My supervisor, Dr. Paul Vasey, contributed to the design of all studies, guided and helped with the preparation of the ethics applications, and revised all manuscripts and chapters presented in this thesis. The specific contributions of other co-authors can be found below. All co-authors have read and approved the contents of the submitted articles, published or under-review.

Versions of Chapters 2 and 3 were published in Sadr-Bazzaz, M., Talaei, A., Sadeghi, M. J., Moradi, M., Ahmadisoleymani, Z., & Vasey, P. L. (2024). Association of recalled childhood sex-typed behaviour with sexual orientation and gender identity in Iranian adult males and females. *The Journal of Sex Research*, 1-14, and Sadr-Bazzaz, M., Talaei, A., Sadeghi, M. J., Moradi, M., Ahmadisoleymani, Z., & Vasey, P. L. (2024). Occupational Preferences, Childhood Behaviour, and Openness: The Role of Sex, Sexual Orientation, and Gender Identity in Iran. *Archives of Sexual Behavior*, 1-15, respectively. My co-authors including Dr. Ali Talaei, Mohammad Javad Sadeghi, Dr. Marjan Moradi, and Zahra Ahmadisoleymani helped with collecting portions of the data and statistical analysis. Paul Vasey aided in designing the study and revising the manuscripts. They all have given permission to include modified versions of these two articles in my dissertation.

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A version of Chapter 5, Sadr-Bazzaz, M. & Vasey, P. L. Direction and strength of hand preference in association with same-sex sexual attraction in Iran, is currently under review in *Laterality: Asymmetries of Brain, Behavior, and Cognition*. Paul Vasey aided in study design and revised the manuscript. He gave permission to use a modified version of this article in this thesis.

A version of Chapter 6, Sadr-Bazzaz, M. & Vasey, P. L. Birth order and sibling sex ratio predict same-sex sexual attraction in Iranian cisgender and transgender adult males and females, is currently under review in *Archives of Sexual Behavior*. Paul Vasey aided in study design and revised the manuscript. He gave permission to use a modified version of this article in this thesis.

A version of Chapter 7, Sadr-Bazzaz, M. & Vasey, P. L. The paradox of same-sex sexual orientation: Evidence for higher familial occurrence and lower reproductive output in Iran, is currently under review in *Human Nature*. Paul Vasey aided in study design and revised the manuscript. He gave permission to use a modified version of this article in this thesis.

ETHICS STATEMENT

All procedures performed in this dissertation were in accordance with 1964 Helsinki Declaration and its later amendments. The methodology used in this dissertation was approved by the University of Lethbridge Human Participant Research Committee for the project "The biopsychology and evolution of non-conceptive sex (NSERC)," No. 2021-063, 2021-08-01 and the University of Alberta Research Ethic Board for the same project, No. Pro00119877, 2022-04-18. Informed consent was obtained from all participants. I have no competing interests to declare that are relevant to the content of this dissertation.

USE OF GENERATIVE AI

My use of generative AI was limited to checking grammar, instances of language polishing, and double-checking scientific writing styles. The AI was not used to form research ideas, to search and cite research literature, to conduct statistical analysis, or to write up the manuscripts.

ACKNOWLEDGEMENT

It has been five years since I had my first meeting with Dr. Paul Vasey on Zoom. It went very well, we talked for three hours about research, politics, cinema, and food. He did not offer me a doctoral position that day, though. He was unsure of taking in another graduate student, and was contemplating about retiring himself, as he continues to do till this day. When I received his positive answer, a month later, we were still in the first year of COVID-19 pandemic, and there was no sign of an end to it. There were so many uncertainties, in my head, and out in the world. Two things encouraged me to crawl out of my perfectionism paralysis and start this program. The first was Paul's research ethos and intellectual character. Watching him on YouTube giving a talk and reading few of his articles, I saw a researcher who has tackled complex issues with a clear mind, arousing curiosity, and a humble attitude. It did not take me long to figure he was also a great supervisor and a very kind person. The second motivator was that I could do research in my country, Iran. For quite some time, that helped me tricking myself into believing that I was not leaving my home. I hope someday I can go back, invite Paul to visit the country and perhaps persuade him into giving some public talks as well. I know there are so many Iranian students and scholars all over the country who would love to hear him sharing pieces of his lifelong research.

Few months before coming to Canada, I met Mohammad Javad Sadeghi at a Café in Tehran. We visited *Daneshjoo Park* near *theatre-e-shahr*, where he provided male sex workers with onsite HIV screening test and council. It was my introduction to a world that I knew of only on papers. Since that day, he has been a great friend to me and a great contributor to this project. I thank him for his trust and professional conduct.

Being a newcomer—to Canada, to Lethbridge, to graduate studies, and to this lab—became much easier with the company of my lab mates and friends Francisco Gómez Jiménez, Scott Semenyna, Lambert Heatlie, and Saramarén García-Acosta. I am grateful for their kindness and collegial spirit.

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I am happy that I could spend two summers in Iran doing my research while being with my family and friends. In the late days of summer 2024, I lost my dear father. I simply miss him. I'm thankful, though, that I could spent one last summer together with him, my mother, and my brother. I could not have gone through this past difficult year if it were not for my beloved partner, Nikta, whose patience, love, and wholehearted support sustained me.

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LIST OF ABBREVIATIONS

2D:4D	Second to Fourth Digit Lengths Ratio
ANOVA	Analysis of Variance
ANCOVA	Analysis of Covariance
BFI	Big Five Inventory
BSSE	Brother–Sister Swap Effect
CAH	Congenital Adrenal Hyperplasia
CI	Confidence Interval
CGIS	Childhood Gender Identity Scale
CSAB	Childhood Sex-Atypical Behaviour
DSM	Diagnostic and Statistical Manual of Mental Disorders
EFA	Exploratory Factor Analysis
EHI	Edinburgh Handedness Inventory
FBOE	Fraternal Birth Order Effect
FFE	Female Fecundity Effect
GWAS	Genome Wide Association Study
HIV	Human Immunodeficiency Virus
HSD	Honestly Significant Difference
KMO	Kaiser-Meyer-Olkin
L.Q.	Laterality Quotient
LSD	Least Significant Differences
M	Mean
MANCOVA	Multivariate Analysis of Covariance
MF-Occ	Male-versus-Female-Typical Occupational Preferences
MIH	Maternal Immune Hypothesis
OBOR	Older Brothers Odds Ratio
OBSE	Older Brother Swap Effect
OSOR	Older Sisters Odds Ratio
OSSE	Older Sister Swap Effect
SAD	Separation Anxiety Disorder
SBOE	Sororal Birth Order Effect
SD	Standard Deviation
SE	Standard Error
YSAE	Younger Sibling Addition Effect

Chapter 1: Introduction

Sexual orientation can be defined as a mechanism that directs a person's attention, attraction, and arousal toward a specific target—typically adult males or females (Bailey et al., 2016; Seto, 2017). To measure individuals' sexual orientation, researchers have operationalized different phenotypical expressions such as self-reported sexual identity (i.e., self-identifying as straight, gay, etc.) (Skorska & Bogaert, 2017), sexual behaviour (i.e., history of having same- or/and other-sex sexual partners) (Ganna et al., 2019), sexual attraction (i.e., self-reported sexual feelings and interests) (Semenyna et al., 2025), marital/relationship status (i.e., being in a same- or other-sex union) (Ablaza et al., 2022), or a combination of these (Folkierska-Żukowska et al., 2022; Sell, 1997). Another phenotypic expression of sexual orientation is genital arousal to sexual stimuli, which is considered the most accurate measurement of sexual orientation in males (Bailey, 2009). However, nonspecific patterns of genital response in females, and the technical difficulties of measuring genital arousal, have limited its use (Bailey, 2009). There is consensus among sex researchers that a less constrained, and yet, a convenient approach for assessing sexual orientation is sexual attraction (Bailey et al., 2016). Throughout this thesis, sexual orientation would be viewed, discussed and assessed as patterns of sexual attraction (see Table 1-1 for definitions).

Most adult human males have a gynephilic sexual orientation and most adult females have an androphilic sexual orientation (Table 1-1). However, a minority of adults exhibits predominant/exclusive same-sex sexual attraction. The reported ratios for same-sex attraction differ slightly from country to country, influenced by the methodologies employed and participants' sexes, but they typically hover around a 5% ratio (Gates, 2011; Leser, 1961; Rahman et al., 2020). Sexual attraction toward same-sex individuals has a heritability of 0.32

(range = 0.08 to 0.60; Alanko et al., 2010; Bailey et al., 2000; Bailey et al., 2016; Burri et al., 2015; Kirk et al., 2000) and despite its costly effect on direct reproductive output (Apostolou, 2022; Coome et al., 2020; Vasey et al., 2014), has persisted across distant historical time periods and varied cultural contexts (Crompton, 2003; Murray, 2002). For these reasons, same-sex attraction has puzzled researchers and despite much speculation and study, our understanding of its proximate or ultimate causes, is still incomplete (Bailey et al., 2016).

Table 1-1 Terminologies

In undertaking any cross-cultural comparison, it is important to apply context-independent terminology as opposed to culturally-specific terminology, which may hold different inter-subjective meaning across cultures and among diverse sample populations (Vasey, 2023).
Throughout this dissertation, the term **sex** refers to biological sex. In biological terms, **sex** is defined in term of reproductive strategies involving the production of one type of gamete or the other, namely, sperm in **males** or ova (eggs) in **females**. These reproductive strategies are biological potentials that are not necessarily realized (Griffiths, 2020). In humans, sex is determined by sex chromosomes (e.g., X and Y chromosomes), and denoted by a variety of primary (e.g., gonads, internal reproductive organs, genitals) and secondary (e.g., facial hair, breast development) phenotypic markers (Goymann et al., 2022). In very rare cases of intersexuality, the traits that determine and denote sex can be a combination of both male- and female-typical (Sax, 200*2*). However, in humans, and indeed in all mammals, this is never the case for the traits that define sex (i.e., sperm or egg production) which, when they develop, are always binary. This definition of sex can be applied across all sexually reproducing species, which can otherwise vary in terms of sex determination and primary/secondary characteristics denoting sex.
Cisgender refers to an individual whose gender identity and expression/presentation align with the gender assigned to them at birth. ***Transgender*** refers to an individual whose gender identity and expression/presentation do not align with the gender assigned to them at birth.
Androphilia refers to predominant/exclusive sexual attraction to adult males, ***gynephilia*** refers to predominant/exclusive sexual attraction to adult females, and ***ambiphilia*** refers to sexual attraction to both adult males and females.
Gender dysphoria refers to a marked incongruence between one's experienced/expressed gender and assigned gender, which is associated with clinically significant distress or impairment (American Psychiatric Association, 2022)

To date, biopsychological research on sex and sexual orientation differences has been conducted predominantly within European/North American societies, and the cross-cultural research that exists has primarily focused on gynephilic males, androphilic females, and androphilic males. In contrast, relatively few cross-cultural studies have addressed female

gynephilia. This situation may be due, in part, to demographic realities, namely, the low population prevalence rate of gynephilic females (i.e., 1.1% - 6.5%) which appears even lower than that of androphilic males (i.e., 2.2% - 7.2%; Gates, 2011; Rahman et al., 2020). Furthermore, documentation of female gynephilia cross-culturally is relatively spotty (Murray, 2002) and, as such, the cross-cultural ubiquity of this trait, while probable, remains to be established with additional empirical data. Finally, across cultures, community formation among gynephilic females appears to be more attenuated and much less public compared to androphilic males, a situation which may also help account for the biases in research focus that has characterized the literature to date (Whitam, 1983; Whitam et al., 1998). Given this background, this research project was undertaken in Iran, a Middle Eastern country, with the aim of documenting correlates of sexual orientation in both adult males and females of varying sexual orientations and gender identities/expressions.

Diverse Expressions of Male Androphilia and Female Gynephilia

The behaviour and psychology of gynephilic females and androphilic males exist on separate spectrums that range from highly masculine to highly feminine (Whitam, 1987). For heuristic purposes, same-sex attracted males or females tend to be divided into two types—*cisgender* and *transgender*—although, as with any spectrum, absolute demarcation between the two forms does not exist (Murray, 2000; Whitam & Mathy, 1986; see Table 1-1). The cisgender individuals are relatively more sex-typical with respect to their behaviour and psychology, whereas transgender individuals exhibit more cross-sex behaviour and psychology. In the same vein, cisgender gynephilic females and cisgender androphilic males usually identify as *women* and *men*, respectively, in line with their gender assigned at birth, whereas transgender gynephilic females and transgender androphilic males do not.

In cultures where a binary view of gender has traditionally prevailed (i.e., boy/man vs. girl/woman), transgender gynephilic females often identify as *trans men* or simply men, and transgender androphilic males often identify as *trans women* or simply women, although other identities (e.g., non-binary) are sometimes expressed by a minority of such individuals. In cultures where additional gender categories are recognized, transgender gynephilic females and transgender androphilic males often identify as alternative genders that are distinct from men and women. Some relatively well documented examples for transgender gynephilic females include the *calabai* of Sulewasi (Davies, 2007), the *tombois* of Sumatra (Blackwood, 1998), the *toms* of Thailand (Sinnott, 2004), and the *mahu* of Tahiti (Elliston, 1999). For transgender androphilic males examples include Navajo *nádleeh* in the southwestern U.S. (Thomas, 1997), *fa'afafine* in Samoa (Vasey & VanderLaan, 2021), *muxes* in Mexico (Gómez Jiménez & Vasey, 2021), and *kathoey* in Thailand (Totman, 2011).

An Evolutionary Developmental Approach to Sexual Orientation

The extent human sexual orientation develops similarly or differently across human populations with varying cultural conditions can illuminate whether it is a universal trait grounded in human biology, or a culturally specific phenomenon that requires certain social conditions for its existence. Establishing the universality of human sexual orientation provides the empirical ground upon which informed hypotheses about its evolution can be formed and tested (Vasey & VanderLaan, 2015). As stated earlier, most research on this matter has been conducted in North America and Western Europe and focused on male androphilia, while cross-cultural research on the development of female gynephilia is scant. This might explain why far less theoretical and empirical research on evolution of female gynephilia has been done (Kanazawa, 2017; Luoto et al., 2019).

A promising starting point for this evolutionary developmental approach is to investigate how variation in sexual orientation is associated with the development of universal sexually dimorphic traits. Although the nature, degree, and even existence of sex differences in human behaviour have long been debated in social sciences (Eagly & Wood, 2013; Lippa, 2005a), evidence indicates that average differences between adult males and females go beyond physical features to differences in brain, cognitive abilities, temperament and personality, sexual interest and behaviour (DeCasien et al., 2022; Geary, 2021; Hines, 2010; Lippa, 2005a, 2005b; Schmitt, 2015). In recent decades, evolutionary frameworks such as Sexual Strategies Theory and Sexual Selection have garnered massive empirical evidence for explaining sexual dimorphism in human psychology and behaviour (Buss & Schmitt, 1993; Geary, 2021). Therefore, documenting cross-cultural variation in these sexually dimorphic traits in relation to sexual orientation could, within existing theoretical frameworks, facilitate hypothesizing about the development and evolution of same-sex sexual orientation.

Sexually Dimorphic Correlates of Sexual Orientation

Research shows that several sexually dimorphic physical, behavioural, and psychological traits are correlated with sexual orientation and gender identity/expression (Lippa, 2005a, 2005b). Some examples are childhood play behaviour, adulthood occupational preferences, childhood separation anxiety, hand preference, second to fourth digit lengths ratio (2D:4D), and otoacoustic emissions (Bogaert & Skorska, 2020; VanderLaan et al., 2022). Evidence indicates that several candidate mechanisms underlie this correlation including pre- and perinatal exposure to sex hormones, genetic and immunological factors (Breedlove, 2017; Swift-Gallant et al., 2022b; VanderLaan et al., 2022). However, how these factors interact with each other and with the social or nonsocial environment remains largely unknown (Balthazart & Roselli, 2022).

Providing further cross-cultural empirical data on how each of these traits vary with male and female sexual orientation and gender identity/expression could help with understanding these underlying mechanisms and how they interact. In next few paragraphs, I briefly review some of the correlates of sexual orientation investigated in my doctoral thesis.

Childhood sex-typed play behaviour is one of the largest sex differences in human psychology and behaviour and also a very strong psychodevelopmental correlate of sexual orientation (Bailey & Zucker, 1995; Hines, 2010). Retrospective research indicates that same-sex attracted individuals recall behaving in a more sex-atypical manner with respect to several aspects of their childhood play behaviour such as preferring other-sex peers as play partners, sex-atypical toys, and taking the role of other sex during pretend play compared to their other-sex attracted counterparts (e.g., Bailey & Zucker, 1995; Bartlett & Vasey, 2006; Gómez Jiménez et al., 2020a, 2020b; Rieger et al., 2008). In line with these findings, prospective research indicates that pre-androphilic boys and pre-gynephilic girls are more likely to display sex-atypicality in play behaviour compared to boys and girls who develop to be other-sex attracted (Li et al., 2017). Sex-atypicality in play behaviour is closely linked with gender identity/expression in childhood as well (Drummond et al., 2008; Singh et al., 2021; Wallien & Cohen-Kettenis, 2008). The association between childhood sex-atypicality, sexual orientation, and gender identity/expression has been replicated in different populations, although cross-cultural data for gynephilic females are much more limited than for androphilic males (for a thorough literature review see Chapter 2).

Another marked psychodevelopmental correlate of sexual orientation is adulthood occupational preferences. Some types of vocations are differentially preferred by human males and females, with males reporting higher interests in occupations such as car mechanic, truck

driver, and electrician, while females report higher interest in professions like school teacher, nurse, and clinical psychologist (Lippa, 2010). Androphilic males are more likely to prefer female-typical occupations, while gynephilic females more frequently preferring male-typical occupations (e.g., Lippa, 2008b). However, cross cultural evidence on occupational preferences of cisgender and transgender gynephilic females is very limited, and whether the patterns documented in Western cultures are universal remains to be explored through research non-Western populations (Whitam, 1987; for a thorough literature review see Chapter 3).

The average magnitudes of sex and sexual orientation differences in childhood play behaviour and adulthood occupational preferences are amongst the largest group differences in human psychology and behaviour that are comparable or even larger than sexually dimorphic physical traits such as height (Hines, 2010; Lippa, 2005b). Looking at the average effect sizes reported for sexual orientation differences in childhood and adulthood sex-atypicality, cisgender androphilic males and cisgender gynephilic females are shifted toward the average patterns of the other sex, scoring intermediate between cisgender other-sex attracted males and females (Lippa, 2005b). However, transgender androphilic males and transgender gynephilic females are entirely shifted toward typical patterns of the other sex, thus exhibiting a sex-reversed pattern (Bartlett & Vasey, 2006; Gómez Jiménez et al., 2020a, 2021; Roshan et al., 2019; Semenyna & Vasey, 2016). Further, the sex-atypicality expressed during childhood in play behaviour seems to be a developmental precursor for adulthood sex-atypicality expressed in occupational preferences (Gómez Jiménez et al., 2021; Lippa, 2008a; Semenyna & Vasey, 2016). With respect to gynephilic females, evidence on such developmental continuity is limited to North American/European countries and cisgender individuals (Lippa, 2008a). This highlights the

importance of studying female gynephilia in populations from regions other than North America and Western Europe, including individuals with diverse gender identity/expression.

Another psychodevelopmental correlate of sexual orientation is childhood separation anxiety. Children aged 5 to 12 years commonly express concerns about the wellbeing of, or separation from, attachment figures like their parents or siblings (Malgorzata et al., 2011; Weems & Costa, 2005). Childhood separation anxiety is sexually dimorphic as girls report higher levels compared to boys (Hale et al., 2011). Retrospective studies conducted in Canada, Mexico, Samoa, and Thailand have linked childhood separation anxiety to male androphilia, while evidence on its association with female gynephilia is more limited, mixed, and in need of further replications (e.g., Gómez et al., 2017; Petterson et al., 2017a; Vasey et al., 2011; Zahran et al., 2023; for a thorough literature review see Chapter 4).

The last sexually dimorphic correlate of sexual orientation examined in this thesis is hand preference (i.e., rates of left- or mixed-handedness is higher in males), which has attracted a lot of attention due to its relation to brain lateralization (Papadatou-Pastou et al., 2020). It is also thought to be under the influence of an array of hormonal, genetic, and immunological mechanims (Michel, 2021). Research indicates that both male androphilia and female gynephilia are associated with higher rates of non-right-handedness (Lalumiere et al., 2000). However, existing literature can be characterized by inconsistencies in methodology, heterogeneity in sampling, and limited cross-cultural replications, which, taken together, make solid generalizations difficult. Therefore, further research is needed to address these gaps and problems in the literature. Doing so will help elucidate the implications that handedness can have for understanding development and evolution of human sexual orientation.

Biodemographic Correlates of Sexual Orientation

One of the most reproducible biodemographic correlate of male androphilia is the finding that each older brother increases the likelihood of androphilic sexual orientation in later born males (Blanchard, 2018a, 2018b, 2020; Blanchard et al., 2021; Blanchard & Skorska, 2022). This biodemographic pattern is referred to in the literature as *fraternal birth order effect* (FBOE; Blanchard & Bogaert, 1996). The maternal immune hypothesis (MIH), proposed to explain the FBOE in androphilic males, posits that male-specific Y-linked antigens induce a maternal immune response that becomes progressively stronger following each successive pregnancy with male fetuses (Blanchard & Klassen, 1997). Substantial evidence has been gathered in support of MIH, making it the most developed mechanistic explanation for FBOE (Bogaert et al., 2018).

In addition to older brothers, some recent findings suggest that having more older sisters, or a *sororal birth order effect* (SBOE), may also increase the odds of male androphilia (Ablaza et al., 2022; Blanchard & Lippa, 2021; Fořt et al., 2024b; Kabátek & Blanchard, 2024; Semenyna et al., 2023). Recently, the question as to whether older siblings also influence female sexual orientation has gained more attention, however, existing data are limited and inconsistent (Blanchard, 2023). Studies of female gynephilia have found evidence for a FBOE (Kabátek & Blanchard, 2024), a SBOE (Khorashad et al., 2020), both (Ablaza et al., 2022; Fořt et al., 2024b), or neither (Blanchard, 2022; Blanchard & Skorska, 2022; Vilsmeier et al., 2023). The MIH predicts neither a SBOE in androphilic males, nor a FBOE or a SBOE in gynephilic females and currently, there exists no theoretical explanation to explain these patterns. The development of such a theoretic explanation will require further empirical data on sibship composition of androphilic males and gynephilic females.

Different types of genetic studies, including family studies, twin studies, and molecular genetic studies, conducted in North American/European countries, converge on the conclusion

that genes play a role in the development of same-sex sexual attraction in males and females (e.g., Bailey & Bell, 1993; Bailey & Pillard, 1991; Bailey et al., 1999; Bailey et al., 2016; Camperio Ciani et al., 2004, 2018; Felesina & Zietsch, 2025; Ganna et al., 2019; Hamer et al., 1993; Pattatucci & Hamer, 1995; Rahman et al., 2008; Schwartz et al., 2010). Outside of North America and Europe, familial studies show that Samoan *fa'afafine* and Istmo Zapotec *muxes* have higher ratios of same-sex attracted uncles and male cousins compared to gynephilic males (Gómez et al., 2018; Semenyna et al., 2017a; VanderLaan et al., 2013a, 2013b). To the best of our knowledge, there is no genetic study of female gynephilia in non-Western populations. Therefore, conducting familial clustering studies on both male androphilia and female gynephilia, cisgender and transgender, in a new non-Western population would improve our knowledge about the development of sexual orientation and gender identity/expression.

Sexuality and Gender in Iran

Societal attitudes about sexuality and gender in Iran, and the Middle Eastern countries in general, have varied over time. As such, the rigid and intolerant sentiments that characterize contemporary Middle Eastern societies are not necessarily reflective of their historical past (Najmabadi, 2005; Sadek, 1994). With respect to Iran, formation of the Islamic Republic after the 1979 revolution drastically transformed its political/social landscape, particularly with respect to women and sexual/gender minorities (Korycki & Nasirzadeh, 2013). The Islamic state has been trying to promote its values characterizing "manhood" and "womanhood" using several means. Some examples include different socialization of boys and girls in sex segregated primary and secondary schools, compulsory donning of the hijab for girls and women, and Sharia-based family laws limiting women's independence in marriage, education, and work.

Understandably, these policies have restricted the expression of masculine or feminine gender roles for all people, but especially for women and sexual/gender minorities.

Similarly, policies have been enforced to restrict certain types of sexual interactions including pre-marital sex or same-sex sexual behaviour. This is in compliance with predominant interpretations of Islam which regard same-sex sexual behaviour as a "deviation from nature" and a great sin against Allah (Jaspal, 2016). The Islamic Republic of Iran is among the few countries worldwide that considers same-sex sexual behaviour punishable by death (Amnesty International, 1996; Jaspal, 2016). The upshot of this is that same-sex attracted individuals are not only challenged for their sexuality within their own social circles (e.g., family, peers, etc.), but also at the broader social level, where they face risk of prosecution by the state. Not surprisingly, public discussion about same-sex sexuality, even within scientific circles, has been severely restricted. This may have contributed to the persistence of pseudoscientific, and often derogatory, views of people with same-sex attraction and behaviour. In addition, existing sociopolitical sensitivities around sexuality and gender have greatly restricted research on these topics in the Middle East.

An interesting deviation from the rigid and intolerant attitudes described above, that distinguishes Iran from most other Islamic countries in the region, involves people who express desire to live as the other sex. After a Fatwa was issued by Ayatollah Khomeini in the 1980s, permitting sex-change procedures, a new social space, albeit limited, became available for those who experience gender dysphoria (Jafari, 2014). Such individuals are known as *trans* among Iranians. Several factors have shaped trans identity in contemporary Iran. First, trans people commonly express the feeling of being born in the wrong body and identify as a gender different from the one that typically characterizes their sex (e.g., transgender females typically identify as

men or trans men; Javaheri, 2010). This narrative has been endorsed by Iranian religious and governing authorities, probably in an attempt to maintain a binary view of gender and may have contributed to elevated sexist views and attitudes among Iranian transgender people (Khorashad et al., 2019; Najmabadi, 2014). Second, Iranian transgender males are almost always androphilic and transgender females are almost always gynephilic (Alavi et al., 2014). Third, medical authorities must confirm the existence of a medical condition (e.g., gender dysphoria) that necessitates sex-reassignment before surgeries to remove sex organs (i.e., hysterectomy in females or orchiectomy/penectomy in males) and subsequently, change of identity documents can be undertaken. Fourth, as these interventions are not necessarily accessible to, or desired by, every transgender person, a lawful social life (i.e., concordance between gender expression and identity documents) is only possible for transgender people who experience enough distress and dissatisfaction with their bodies to warrant such a diagnosis of gender dysphoria and medical interventions (Najmabadi, 2011; Talaei et al., 2022).

In sum, the Islamic state of Iran regards cisgender and transgender expressions of male androphilia and female gynephilia as two categorically distinct phenomena (Najmabadi, 2011). While same-sex sexual attraction in cisgender individuals is treated as unnatural and a deviation, there is more tolerance toward transgender individuals who express sexual attraction toward members of their biological sex. This, perhaps, is because the rigid religious conception of manhood can more easily annex a masculine presenting female who self-identify as a trans man. A similar situation, *mutatis mutandis*, also holds for a feminine presenting male who self-identify as a trans woman.

My Thesis' Main Objectives

In this context, my doctoral thesis aimed at expanding cross-cultural evidence on developmental correlates of male androphilia and female gynephilia. My first objective was to *investigate normative developmental features of female gynephilia*. Considering that this topic is understudied, expanding the cross-cultural evidence on the development of female sexual orientation was an informative research objective and a necessary step toward solving the puzzle of sexual orientation. My expectation was to garner evidence supporting the presence of universal developmental features for female gynephilia.

My second objective was to *compare developmental psychobiology of cisgender and transgender gynephilic females*. Simultaneous study of both cisgender and transgender gynephilic females within a population has rarely been done. Conducting this comparison could inform us about similarities and differences in developmental trajectories of cisgender and transgender gynephilic females. I expected to find empirical data supporting the idea that the cisgender and transgender types of female gynephilia are variant expressions along the same continuum rather than categorically distinct phenomena.

My third objective was to *replicate cross-cultural correlates of male androphilia and provide a comparison between cisgender and transgender androphilic males within the same culture*. Collecting these data would expand the empirical evidence on male androphilia. In addition, comparing cisgender and transgender androphilic males within a new non-Euro-American population, especially one from a previously unstudied world region (i.e., the Middle East) could strengthen the existing evidence of their developmental differences and similarities. I reported on different developmental correlates of male and female sexual orientation in six empirical chapters. In each chapter, I addressed all three abovementioned objectives by reporting on cisgender gynephilic females, transgender gynephilic females, cisgender androphilic males,

and transgender gynephilic females. Data for these groups were compared against data on cisgender gynephilic males and cisgender androphilic females. I also reported on two additional groups including cisgender ambiphilic males and cisgender ambiphilic females. Although it was not my primary intention to collect and report such data, I was able to recruit fair number of participants in these additional groups and thus, in this thesis, I reported on male and female ambiphilia as well. In chapters 2 and 3, I presented results for childhood play behaviour and adulthood occupational preferences. I also investigated in chapter 3 if sex-atypicality in childhood play behaviour was associated with sex-atypicality in adulthood occupational preferences. In chapter 4, I compared childhood separation anxiety between different male and female groups. In chapter 5, hand preference was assessed and compared between groups. In chapter 6, I examined the effect of sibship composition (i.e., birth order and sibling sex ratio) on sexual orientation and gender identity/expression. In chapter 7, I reported data on familial clustering of same-sex sexual attraction and also average reproductive output across the different study groups. Finally, in chapter 8, I briefly reviewed findings from empirical chapters 2-7, highlighted their significant contributions in relation to the three main objectives of this thesis. I conclude by discussing directions for future research.

Chapter 2: Association of Recalled Childhood Sex-Typed Behaviour with Sexual Orientation and Gender Identity in Iranian Adult Males and Females

ABSTRACT

Same-sex sexual attraction in both males and females has been associated with childhood sex-atypical behaviour. Gynephilic females recall behaving in a manner that is less female-typical and more male-typical compared to cisgender androphilic females, whereas androphilic males recall behaving in a manner that is less male-typical and more female-typical compared to cisgender gynephilic males. In addition, male and female ambiphilic individuals exhibit intermediate levels of childhood sex-atypicality. In this study, we examined recalled childhood sex-typed behaviour among Iranian cisgender gynephilic males (n = 236), cisgender ambiphilic males (n = 51), cisgender androphilic males (n = 191), transgender androphilic males (n = 60), cisgender androphilic females (n = 243), cisgender ambiphilic females (n = 96), cisgender gynephilic females (n = 32), and transgender gynephilic females (n = 122). Both cisgender androphilic males and cisgender gynephilic females recalled elevated childhood sex-atypicality, scoring intermediate between cisgender gynephilic males and cisgender androphilic males. Male and female ambiphilic participants scored intermediate between their other- and same-sex attracted cisgender counterparts. Transgender androphilic males exhibited hyper-feminized childhood behaviour, scoring even more female-typical than cisgender androphilic females. Transgender gynephilic females recalled behaving as male-typical as cisgender gynephilic males. Consistent with previous research, our findings from Iran—a non-Western, Middle Eastern culture—provide cross-cultural support for the universality of childhood sex-atypicality as a normative developmental precursor of monosexual or ambisexual same-sex attraction in both males and females who are cisgender and transgender.

INTRODUCTION

A prominent example of the inter-relationship between sex, sexual orientation, and gender identity/expression is childhood sex-typed behaviour, which manifests most strongly in preschool age children (i.e., 3-5 years old). Childhood sex-typed behaviour is comprised of several strongly correlated interests and behaviours that are expressed differently in boys and girls (Weisgram, 2022). These include preference for same-sex peers (i.e., boys playing with boys and girls playing with girls), interest in sex-typed toys (e.g., boys preferring vehicles and weapons, girls preferring dolls), and sexually differentiated play styles, with girls favoring nurturing play with dolls (e.g., pretending to care for babies), and boys favoring more physical and rough-and-tumble play (e.g., wrestling, climbing, and play fighting). Accordingly, childhood sex-atypical behaviour (CSAB) in females involves interest in male-typical toys, a preference for boys as playmates, an interest in more physical rough-and-tumble play, and a disinterest in female-typical play. Conversely, CSAB in males involves an interest in female-typical toys, a preference for girls as playmates, an interest in female-typical pretend play, and a disinterest or aversion to male-typical play. CSAB is considered an early psychodevelopmental correlate of same-sex sexual orientation, which can be expressed as early as 2.5 years of age (Li et al., 2017).

Association of CSAB with Same-Sex Attraction in Cisgender People

In a meta-analysis of 48 measurements of CSAB conducted mostly in Euro-American cultures, Bailey and Zucker (1995) reported that, on average, cisgender androphilic males had higher CSAB than cisgender gynephilic males (Cohen's $d = 1.31$). Similarly, they reported that cisgender gynephilic females had higher CSAB than cisgender androphilic females ($d = 0.96$). The validity of these results has been enhanced by concordant findings that were obtained using novel methodological approaches for measuring CSAB in Euro-American contexts. For example,

raters of childhood home movies who were unaware of the participants' sexual orientation assessed the behaviour of cisgender androphilic males and cisgender gynephilic females as more sex-atypical than that of cisgender gynephilic males and cisgender androphilic females, respectively (Rieger et al., 2008; Watts et al., 2018). Furthermore, using Euro-American samples, community-based prospective studies undertaken in the last decade have clearly linked CSAB in male and female children with an elevated probability of androphilia and gynephilia later in life, respectively (Li et al., 2017; Steensma et al., 2013b; Xu et al., 2019).

Another line of evidence that links CSAB to cisgender male androphilia and, to a lesser degree, cisgender female gynephilia, comes from follow-up studies of clinically diagnosed gender dysphoric children who were no longer gender dysphoric at the time of follow-up in adulthood and thus, could be considered cisgender in terms of their gender identity outcome. Studies indicate that about 50% of males who were diagnosed with childhood gender dysphoria were androphilic at the time of follow-up in adulthood (Singh et al., 2021; Wallien & Cohen-Kettenis, 2008; Zucker, 1990), far higher than what is observed in the general population (Gates, 2011). In contrast, between 0-16% of the females that were diagnosed with childhood gender dysphoria were gynephilic at the time of follow-up in adulthood (Drummond et al., 2008; Steensma et al., 2013a; Wallien & Cohen-Kettenis, 2008). Two points deserve further comment with respect to the studies on females. First, the study reporting a complete absence of gynephilic sexual attraction at follow-up included only three cisgender female participants (Wallien & Cohen-Kettenis, 2008). Second, the rate of female gynephilia at follow-up reported by the other two studies (Drummond et al., 2008; Steensma et al., 2013a), while much lower than that of male androphilia, was still well above the rate of female gynephilia in the general population (Gates, 2011).

Cross-cultural studies conducted outside of European/North American countries corroborate the associations between CSAB, cisgender male androphilia, and cisgender female gynephilia. In various countries including Brazil, China, Guatemala, Iran, Japan, the Philippines, Thailand, and Turkey, cisgender androphilic males recall elevated CSAB compared to cisgender gynephilic males (Besharat et al., 2018; Cardoso, 2009; Petterson et al., 2017b; Whitam & Mathy, 1986; Xu & Rahman, 2023). Cross-cultural research on cisgender female gynephilia is much more limited. Whitam and Mathy (1991) were the first to examine cisgender gynephilic females' childhood behaviour in non-European/North American cultures (e.g., Brazil, Peru, and the Philippines) and found that, in line with their results from the United States, cisgender gynephilic females recalled more male-typical and less female-typical interests in toys, play styles, and costumes compared to cisgender androphilic females. Establishing the universality of these findings requires additional replications, especially considering the methodological limitations of Whitam and Mathy's (1991) study (e.g., using single-item scales; see Bailey and Zucker, 1995). Nevertheless, to our knowledge, only two published studies have provided further information (Xu & Rahman, 2024; Zheng & Zheng, 2016). Both studies have reported that Chinese cisgender gynephilic females recall higher CSAB than cisgender androphilic females.

In addition to the co-occurrence of CSAB with female gynephilia and male androphilia, there is evidence showing a positive correlation between CSAB and degree of same-sex attraction in both males and females. Two community-based prospective studies have reported that expression of CSAB was associated with increased probability of ambiphilia in adolescence and adulthood for both sexes (Li et al., 2017; Xu et al., 2019; but see Steensma et al., 2013b). Likewise, Rieger et al. (2020) examined the relation between recalled CSAB and sexual attraction in a large sample of European/North American cisgender ambiphilic participants and

found that as degrees of same-sex sexual attraction increased (i.e., along the Kinsey scale; Kinsey et al., 1948), the levels of recalled CSAB also increased. In a cross-cultural study, Cardoso (2009) compared childhood sex-typed behaviour among cisgender males from Brazil, Thailand, and Turkey who had varying degrees of same-sex attraction. Despite the methodological limitations (e.g., using single-item scales), he found intermediate levels of CSAB for ambiphilic males compared to their gynephilic and androphilic counterparts in all three countries. In a recent study of CSAB in China (Xu & Rahman, 2024), cisgender ambiphilic males recalled behaving in a sex-atypical manner that was not different from cisgender androphilic males. The same study found that cisgender ambiphilic females recalled elevated CSAB that was not different from cisgender gynephilic females.

Association of CSAB with Same-Sex Attraction in Transgender People

Elevated recalled CSAB among European/North American transgender androphilic males and transgender gynephilic females have been consistently documented (see Tables 1-4 in Lawrence, 2010). Retrospective research comparing androphilic and non-androphilic transgender males demonstrates that the androphilic group recalls greater CSAB compared to the non-androphilic group (Blanchard, 1988; Smith et al., 2005). Similarly, retrospective research comparing gynephilic and non-gynephilic transgender females confirms that the gynephilic group recalls greater CSAB compared to the non-gynephilic group (Chivers & Bailey, 2000; Smith et al., 2005). Additional retrospective research suggests that early onset of sex-atypical behaviour and cross-gender ideation occurs more often among transgender androphilic males compared to transgender gynephilic males (Cerwenka et al., 2014; Nieder et al., 2011). Among transgender females, gynephilic individuals report higher rates of early onset of sex-atypical behaviour and cross-gender ideation compared to those who are non-gynephilic (Cerwenka et al.,

2014; Nieder et al., 2011). Finally, follow-up studies of clinically diagnosed gender dysphoric children show that more than 90% of those whose gender dysphoria persisted into adulthood and thus, could be considered transgender, were either androphilic males or gynephilic females (Drummond et al., 2008; Singh et al., 2021; Steensma et al., 2013a; Wallien & Cohen-Kettenis, 2008).

In non-European/North American societies, despite limited evidence, transgender androphilic males have consistently reported more feminine and less masculine childhood behaviour (higher CSAB) in comparison to cisgender gynephilic males (Bartlett & Vasey, 2006; Gómez Jiménez et al., 2020a; Roshan et al., 2019; Semenyna & Vasey, 2016) and transgender gynephilic males (Whitam, 1987, 1997). Research on the expression of CSAB among non-European/North American transgender gynephilic females is even rarer. A single study conducted in Iran showed that gynephilic females diagnosed with gender dysphoria recalled elevated CSAB compared to cisgender androphilic females (Roshan et al., 2019).

Present Study

In this study, we investigated the relationship between childhood sex-typed behaviour and biological sex (male or female), sexual orientation (androphilia, gynephilia, or ambiphilia), and gender identity (cisgender or transgender) in Iranian samples. In line with previous research, we predicted that cisgender gynephilic males and cisgender androphilic females would differ in their recalled childhood behaviour, with the former exhibiting high levels of male-typical behaviours and low levels of female-typical behaviours, and the latter showing the reverse pattern. We also predicted that among cisgender males, androphilic and ambiphilic participants would recall elevated CSAB compared to their gynephilic counterpart, with the ambiphilic sample scoring intermediate between gynephilic and androphilic male samples. In addition,

transgender androphilic males were expected to score higher on CSAB compared to cisgender androphilic males. Among cisgender females, we predicted that gynephilic and ambiphilic participants would recall elevated CSAB compared to their androphilic counterpart, with the ambiphilic sample scoring intermediate between gynephilic and androphilic female samples. Finally, we predicted that transgender gynephilic females would recall higher CSAB than cisgender gynephilic females.

METHOD

Recruitment

In this study, we present merged data from two separate recruitment samples of the Iranian adult population. All participants completed a similar survey. The first sample was recruited using an online survey conducted with Qualtrics. Popular social media platforms among Iranians such as Twitter, Instagram, and Telegram were used as the main routes for distributing the invitation to participate in the study. An anonymous link was included in the message which was used by interested individuals to access the survey. The responses were recorded between November 2021 and July 2022.

The second sample was recruited in Mashhad and Tehran, Iran. A snowball sampling method was used to recruit participants. Data collection for this recruitment sample started in April 2022 and ended in April 2024. Some transgender participants were current or previous clients of a gender clinic in Mashhad and were recruited through that clinic. Most of these individuals had received the diagnosis of gender dysphoria and were at different stages of gender transition. The remaining transgender participants were not recruited from this clinic, nor were they clients of this clinic in the past. Diagnosis of gender dysphoria was not an inclusion criterion for participation in this study.

Participants

Participants were classified into sixteen groups using the recorded variations in gender identity (cisgender or transgender), sexual orientation (gynephilic, ambiphilic, androphilic or asexual), and sex (male or female). For instance, participants who reported a gender identity that differed from the one assigned to them at birth, had gynephilic sexual attraction, and reported they were assigned female at birth were classified as "transgender gynephilic females." Of the 1076 participants who provided information on their childhood behaviour, data pertaining to the eight groups of participants were included for statistical analysis. These groups included cisgender gynephilic males (n = 236), cisgender ambiphilic males (n = 51), cisgender androphilic males (n = 191), transgender androphilic males (n = 60), cisgender androphilic females (n = 243), cisgender ambiphilic females (n = 96), cisgender gynephilic females (n = 32), and transgender gynephilic females (n = 122). Due to small sample sizes, we did not analyze data for the other eight possible groups, including transgender gynephilic males (n = 4), transgender ambiphilic males (n = 6), transgender androphilic females (n = 2), transgender ambiphilic females (n = 8), cisgender asexual/analloerotic males (n = 9), transgender asexual/analloerotic males (n = 0), cisgender asexual/analloerotic females (n = 14), and transgender asexual/analloerotic females (n = 2).

Measures

The survey comprised standardized questionnaires that were translated to Farsi from English by a fluent bilingual (English and Farsi) speaker. The translation was reviewed by a professional translator. The interim translation was evaluated and finalized in consultation with two independent Iranian sex researchers after incorporating feedback from participants in a pilot

study. Participants who were recruited in Mashhad and Tehran could ask the researchers to explain the questions if they had difficulty understanding them.

Sex, Gender Identity/Expression, and Sexual Orientation

Participants were assigned to different groups based on their responses to questions about their sex, gender identity, and sexual orientation. Survey responses with incomplete information on these variables were removed from the dataset and are not reported here. In terms of sex, we categorized participants based on their answer to the following question: "Which biological sex were you assigned at birth? (*male*, *female*, and if *other* please specify.)" Of 1155 participants who reported their sex, 588 were male, 566 were female, and one participant chose the third option "*other"* but did not specify their sex; data from this participant were excluded.

Regarding gender identity, the participants were asked two questions: "What is your gender identity? (*man*, *woman*, and if *other* please specify)" and "Are you transgender or transsexual? (*yes* or *no*)". Overall, 642 participants identified as *man*, 470 identified as *woman*, and 43 selected *other* for their gender identity. Those who selected *other* often specified their gender identity as *non-binary* (n = 23), *gender fluid* (n = 5), or *queer* (n = 4). In response to the second question, 189 participants identified as *transgender*/*transsexual*, of whom 170 identified with a gender identity typical of the other sex, while 19 participants identified as neither *man* nor *woman*. When participants identified as the gender concordant with their sex (i.e., a female identifying as a woman or a male identifying as a man) and as neither transgender nor transsexual, they were categorized as *cisgender*. Data from participants who reported their gender identity to be concordant with their sex but also identified as transgender/transsexual (n = 10) were removed from subsequent analyses. Participants were classified as *transgender* if they: (1) identified as a *woman* while being identified as a male at birth, or (2) identified as a *man*

while being identified as a female at birth, or (3) identified as neither a *man* nor a *woman*. Data from those participants who identified with the gender identity typical of the other sex but did not identify as transgender/transsexual (n = 5) were excluded from analyses.

To assess sexual orientation, participants were asked to report their sexual feelings towards adult males/men or females/women during the previous 12 months, using a 7-point Likert scale (Kinsey et al., 1948). Participants who had sexual feelings only for females/women (score = 0), or had only an occasional fantasy about males/men (score = 1) were categorized as *gynephilic,* those who had stronger sexual feelings for both males/men and females/women (score = 2 to 4) were categorized as *ambiphilic,* and those who had only an occasional fantasy about females/women (score = 5), or were only attracted to males/men (score = 6) were categorized as *androphilic*. An eighth item was added for participants who "have not any sexual feelings toward any sex/gender," and these individuals were categorized as *asexual/analloerotic.* Since it was unclear from the item whether any other type of sexual feeling was present or not, this group could be either asexual (i.e., no sexual feelings whatsoever) or analloerotic (i.e., presence of sexual feelings but not directed toward males/men or females/women; Blanchard, 1989). Overall, 420 participants had gynephilic sexual orientation, 176 ambiphilic, 532 androphilic, and 27 had no sexual feelings.

Demographic Information

Participants were asked to report their age (i.e., year of birth), level of education, and financial status. Level of education was reported on a 7-point scale: 1= "no education" to 7= "postgraduate degree"; due to the limited number of participants in the first three levels of education, those levels were collapsed and are presented together, resulting in five levels of education. Participants were also asked to report their overall financial status on a 5-point scale

from 1= “very bad” (I need financial aid for my basic needs) to 5= “very good” (I have no concerns about money).

Childhood Gender Identity Scale

We used a modified version of the *Childhood Gender Identity Scale* (CGIS) developed by Bartlett and Vasey (2006) and adapted from Johnson et al.’s (2004) *Gender Identity Questionnaire for Children*. The questionnaire contained 10 items, with 5 items measuring childhood male-typical behaviour (e.g., playing with vehicles and guns, engaging in rough-and-tumble play), while the other 5 items assessed childhood female-typical behaviour (e.g., playing with dolls, imitating female characters during pretend play). Participants were asked to rate how often they engaged in these behaviours on a 5-point scale ranging from 1= “Never” to 5= “Always”. Exploratory factor analysis with Maximum Likelihood method revealed one factor with items pertaining to female-typical behaviour loading negatively (total variance explained = 61.2%; Sakaluk & Short, 2017); thus, the scores for these items were reverse coded. Then, each participant’s score on the CGIS was calculated by averaging all 10 items. Accordingly, higher CGIS scores are indicative of more frequent expression of childhood male-typical behaviour and less frequent expression of female-typical behaviour, whereas lower CGIS scores are indicative of less frequent childhood male-typical behaviour and more frequent female-typical behaviour. Internal consistency of the CGIS was assessed using Cronbach’s alpha for all participants (α = 0.94). Cronbach’s alphas for the individual groups were as follows: cisgender gynephilic males (α = 0.63), cisgender ambiphilic males (α = 0.86), cisgender androphilic males (α = 0.88), transgender androphilic males (α = 0.89), cisgender androphilic females (α = 0.84), cisgender ambiphilic females (α = 0.90), cisgender gynephilic females (α = 0.90), and transgender gynephilic females (α = 0.88). The lower Cronbach's alpha observed in cisgender gynephilic

males may be attributable to the limited variance in this sample, suggesting that the uniformity of their responses could be constraining the apparent reliability of the scale.

Statistical Analysis

We conducted an *a priori* power analysis using G*Power software (Faul et al., 2007) with a targeted type I error of 0.05 and type II error of 0.20 (power of 0.80) to determine group sizes for detecting differences in CSAB between other- and same-sex attracted individuals who shared the same sex and gender identity (e.g., cisgender gynephilic males versus cisgender androphilic males). Based on the expected direction and effect size of differences ($d \geq 0.8$), a power analysis determined that a minimum group size of n = 21 was needed. Since we also included two ambiphilic and two transgender groups, a post-hoc power analysis was undertaken. The achieved group sizes were found to be adequate for all predicted between-sample mean comparisons, with powers ranging from 0.80 to 1.00 except for the comparison between cisgender gynephilic males and transgender gynephilic females (power of 0.28).

We report statistical analyses on the merged recruitment sample (n = 1031) comprising two recruitment samples. The two recruitment samples differed with respect to some demographic variables; participants recruited online (n = 476) were on average 3.73 years older (95% CI, 3.05, 4.40; $t(1005) = 10.85$, $p < 0.001$), more educated ($U = 185970.50$, $z = 11.83$, $p < 0.001$), and had a better financial status ($U = 144416.00$, $z = 2.92$, $p = 0.004$) than participants recruited in Mashhad and Tehran (n = 555). Nevertheless, within-group comparisons of the variable of interest (i.e., CGIS score) between the two recruitment samples showed no difference for the most part, and observed patterns in both recruitment samples were similar to the observed pattern in the merged sample as illustrated in supplementary Figure s1-1. Therefore, we believe presenting merged data is justified because it provided higher statistical power for groups in

those situations where number of participants on their own were suboptimal. Data for both recruitment samples and their comparison are reported in the Supplementary Material.

To investigate the effects of sex and sexual orientation, a two-step hierarchical multiple regression analysis was performed with sex (dummy coded: male = 0, female = 1) entered in the first step followed by sexual orientation (two separate dummy variables were created for ambiphilic and androphilic sexual attractions, with gynephilic sexual attraction coded as zero). For each step, changes in F statistics and R^2 (ΔR^2) are reported to demonstrate the change in predictive power of the models. When we report between-group differences in mean CGIS scores, the statistics pertain to a post-hoc analysis (using LSD method) which was carried out following a one-way ANCOVA, including all eight groups (as fixed factor) and demographic variables (as covariates). Although ANCOVA is an omnibus test, bootstrapping with 2000 samples was performed to achieve bias-corrected and accelerated (BCa) 95% confidence intervals. *Cohen's d* is used to report effect sizes of between-group comparisons and is followed by 95% confidence intervals. Non-parametric tests, including the Mann-Whitney U test and Kruskal-Wallis H, were used for between-group comparison of level of education and financial status.

RESULTS

The average age was significantly different among the eight groups (Welch $F[7, 240.05] = 6.93$, $p < 0.001$). The post-hoc pairwise comparison showed that overall, cisgender males were older than transgender males, transgender females, and cisgender females (except for cisgender androphilic females; p's < 0.05). Also, cisgender androphilic females were significantly older than transgender gynephilic females ($p = 0.002$). Education was compared across samples using a Kruskal-Wallis H test and was found to be significantly different ($\chi^2[7] = 74.31$, $p < 0.001$);

overall, transgender males and females had lower levels of education compared to cisgender participants, in particular, cisgender gynephilic males and cisgender androphilic females (p's < 0.05). Similarly, financial status was found to be different among samples ($\chi^2[7] = 50.01$, $p <$ 0.001), with transgender participants reporting lower financial status compared to cisgender participants, in particular, cisgender gynephilic males and cisgender androphilic females (p's < 0.05). Demographic information for each group of participants is presented in Table 2-1.

A mean CGIS score was calculated for each group of participants (Table 2-1). Recall that higher CGIS scores indicate more male-typical behaviour, whereas lower CGIS scores indicate more female-typical behaviour in childhood. A one-way ANCOVA revealed significant differences in mean CGIS scores across the eight groups of participants ($F[7, 996] = 268.86$, $p <$ 0.001, partial $\eta^2 = 0.65$; Figure 2-1). A significant covariation was found for age ($F[1, 996] =$ 22.65, $p < 0.001$, partial $\eta^2 = 0.02$), but not for education ($F[1, 996] = 1.76$, $p = 0.185$, partial η^2 = 0.00) and financial status ($F[1, 996] = 3.31$, $p = 0.069$, partial $\eta^2 = 0.00$).

Effects of Sex and Sexual Orientation on the CGIS Scores among Cisgender Participants

A two-step hierarchical multiple regression analysis showed significant effects for sex ($F[1, 847] = 672.50$, $p < 0.001$, $\Delta R^2 = 0.44$) and sexual orientation ($F[2, 845] = 165.95$, $p <$ 0.001, $\Delta R^2 = 0.16$). The regression coefficients indicated that CGIS scores were negatively associated with female sex ($\beta = -0.51$, $t = -21.01$, $p < 0.001$), compared to male sex. Negative associations were also found for ambiphilic ($\beta = -0.17$, $t = -6.57$, $p < 0.001$) and androphilic attraction ($\beta = -0.48$, $t = -17.82$, $p < 0.001$), compared to gynephilic attraction. As predicted, cisgender gynephilic males were found to have a higher mean CGIS score than cisgender androphilic females ($d = 4.12$, $p < 0.001$). Another way to examine the effect of sex with respect

Table 2-1 Descriptive information and mean CGIS scores across study groups

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Number of participants	236	51	191	60	243	96	32	122
Age*								
Mean ± Standard deviation	27.53 ± 6.99	25.90 ± 6.35	27.53 ± 6.47	24.62 ± 4.80	26.98 ± 6.53	24.75 ± 5.22	23.34 ± 5.70	24.31 ± 4.78
Level of education**								
Junior high school	2.1%	2.0%	1.6%	5.0%	0.0%	2.1%	3.1%	4.1%
High school	23.7%	27.5%	25.8%	41.7%	17.3%	29.2%	43.8%	46.7%
College	11.9%	21.6%	16.3%	16.7%	14.4%	15.6%	18.8%	17.2%
Undergraduate	36.0%	33.3%	33.2%	26.7%	42.0%	34.4%	25.0%	24.6%
Post-graduate	26.3%	15.7%	23.2%	10.0%	26.3%	18.8%	9.4%	7.4%
Financial Status								
Very bad	0.4%	3.9%	3.1%	13.3%	0.4%	1.0%	0.0%	4.9%
Bad	9.7%	9.8%	12.6%	13.3%	4.5%	8.3%	6.3%	10.7%
Not bad Not good	60.2%	60.8%	57.1%	60.0%	55.6%	50.0%	50.0%	65.5%
Good	26.7%	23.5%	24.1%	11.7%	35.0%	34.4%	43.8%	18.0%
Very good	3.0%	2.0%	3.1%	1.7%	4.5%	6.3%	0.0%	0.8%
CGIS scores								
Mean ± Standard deviation	4.21 ± 0.37	3.83 ± 0.72	3.15 ± 0.84	1.85 ± 0.67	2.15 ± 0.59	2.58 ± 0.83	3.06 ± 0.95	4.29 ± 0.53

* Overall, 13 data points were missing: cisgender gynephilic males (n = 2), cisgender ambiphilic males (n = 2), cisgender androphilic males (n = 4), cisgender androphilic females (n = 3), and transgender gynephilic females (n = 2). ** One data point was missing for cisgender androphilic males.

to CGIS scores is to compare samples of cisgender participants that differ in terms of their sex, but that share the same sexual orientation. Accordingly, within each category of sexual orientation, cisgender males always had higher mean CGIS scores than cisgender females (Table 2-2).

Consistent with the reported effect for sexual orientation in the regression analysis, mean CGIS scores decreased significantly among cisgender males in the following descending order: gynephilic males, ambiphilic males, and androphilic males (Table 2-2). Conversely, mean CGIS scores increased significantly among cisgender females in the following ascending order: androphilic females, ambiphilic females, and gynephilic females (Table 2-2). The confidence intervals calculated for Cohen's *d* effect sizes (Table 2-2), and the post-hoc bootstrapped mean differences excluded zero, thereby providing statistical support for the observed differences in mean CGIS scores.

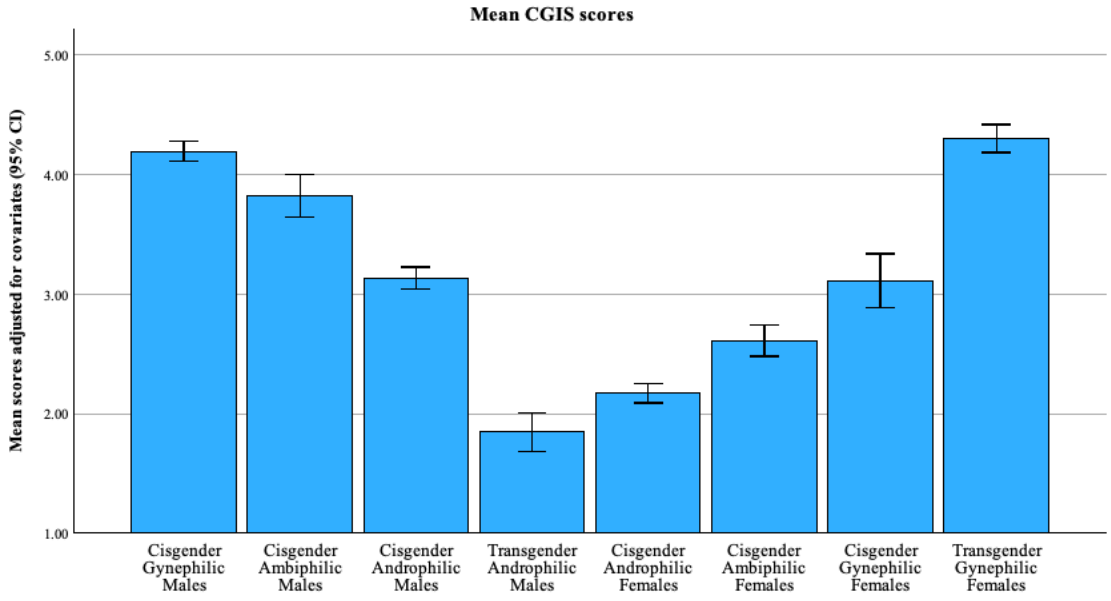


Figure 2-3 Between-sample comparison of mean CGIS scores. Bars indicate 95% confidence interval.

Table 2-2 Between-group comparison of mean CGIS scores

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Cisgender Gynephilic Males	-	d = 0.81 (0.50 – 1.12)	d = 1.69 (1.46 – 1.91)	d = 5.23 (4.72 – 5.73)	d = 4.12 (3.80 – 4.43)	d = 2.99 (2.66 – 3.32)	d = 2.40 (1.97 – 2.82)	d = -0.21 (-0.42 – 0.01)
Cisgender Ambiphilic Males	$p < 0.001$	-	d = 0.84 (0.52 – 1.15)	d = 2.84 (2.31 – 3.37)	d = 2.72 (2.34 – 3.09)	d = 1.59 (1.20 – 1.97)	d = 0.95 (0.48 – 1.41)	d = -0.77 (-1.11 – -0.44)
Cisgender Androphilic Males	$p < 0.001$	$p < 0.001$	-	d = 1.62 (1.30 – 1.94)	d = 1.40 (1.19 – 1.61)	d = 0.69 (0.44 – 0.94)	d = 0.11 (-0.27 – 0.48)	d = -1.56 (-1.82 – -1.30)
Transgender Androphilic Males	$p < 0.001$	$p < 0.001$	$p < 0.001$	-	d = -0.49 (-0.78 – -0.20)	d = -0.94 (-1.27 – -0.60)	d = -1.55 (-2.03 – -1.06)	d = -4.19 (-4.72 – -3.66)
Cisgender Androphilic Females	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	-	d = -0.63 (-0.87 – -0.39)	d = -1.41 (-1.80 – -1.02)	d = -3.73 (-4.07 – -3.38)
Cisgender Ambiphilic Females	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	-	d = -0.57 (-0.97 – -0.16)	d = -2.54 (-2.89 – -2.18)
Cisgender Gynephilic Females	$p < 0.001$	$p < 0.001$	p = 0.858	$p < 0.001$	$p < 0.001$	$p < 0.001$	-	d = -1.93 (-2.37 – -1.48)
Transgender Gyenphilic Females	p = 0.135	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	-

The presented p values are from a post-hoc pairwise comparison (using LSD method) following a one-way ANCOVA.

Comparing Cisgender and Transgender Samples

Transgender androphilic males had a lower mean CGIS score than all cisgender male groups (all p's < 0.001), including cisgender androphilic males (d = -1.62). Furthermore, the mean CGIS score of transgender androphilic males was even lower than that of cisgender androphilic females (d = -0.49). In contrast, transgender gynephilic females had a higher mean CGIS score than all cisgender female groups (all p's < 0.001), including that of cisgender gynephilic females (d = 1.93). Although the mean CGIS score of transgender gynephilic females was somewhat higher than cisgender gynephilic males (d = 0.21), no support for meaningful distinction between the two groups was provided by the post-hoc LSD method, post-hoc bootstrap method, and effect size confidence interval (Table 2-2).

DISCUSSION

In this study, we investigated variations in recalled childhood sex-typed behaviour in relation to sex, sexual orientation, and gender identity in Iran. Data from eight groups of participants, including cisgender gynephilic males, cisgender ambiphilic males, cisgender androphilic males, transgender androphilic males, cisgender androphilic females, cisgender ambiphilic females, cisgender gynephilic females, and transgender gynephilic females were analyzed. The CGIS questionnaire used in this study is comparable to those used previously to measure recalled childhood behaviour in Canada, Japan, Mexico, and Samoa (Bartlett & Vasey, 2006; Gómez Jiménez et al., 2020a, 2020b; Petterson et al., 2017a, 2017b; Semenyna & Vasey, 2016; Semenyna et al., 2017b; VanderLaan et al., 2017).

With respect to sex differences, as predicted, cisgender gynephilic males recalled behaving in a male-typical manner, scoring high on the CGIS, while cisgender androphilic females recalled behaving in a female-typical manner, and scoring lower on the CGIS. The effect

size for the observed sex difference (d = 4.12) was very large and comparable to previous assessments of recalled childhood behaviour in Iran and other cultures (d = 3.03 – 3.99; Khorashad et al., 2018; Petterson et al., 2017a, 2017b; Roshan et al., 2019). It was also comparable to behavioural sex differences reported in children (d = 2.7 - 3.2; Hines, 2010). In addition, we examined the effect of sex while controlling for sexual orientation and found that cisgender male participants recalled higher male-typical behaviour and lower female-typical behaviour than cisgender female participants, even when they shared the same sexual orientation (e.g., cisgender male gynephiles vs. cisgender female gynephiles).

With respect to male sexual orientation differences, as predicted, both cisgender ambiphilic and androphilic males recalled behaving in a more female-typical manner (i.e., lower CGIS scores) than cisgender gynephilic males, with cisgender ambiphilic males scoring intermediate between androphilic and gynephilic males. The difference in CSAB between cisgender gynephilic males and cisgender androphilic males was large (d = 1.69). This effect size is comparable to the one derived from a previous assessment of male sexual orientation differences in CSAB conducted in Iran (d = 1.78; Besharat et al., 2016). It is also comparable to the average effect size for male sexual orientation differences in CSAB reported in a meta-analysis by Bailey and Zucker (1995; d = 1.31). Taken together, this provides further support for the reliability and validity of our findings. Also, our results provide support for previous reports suggesting that increasing degrees of same-sex sexual attraction among males are associated with increased CSAB (Cardoso, 2009; Rieger et al., 2020). To our knowledge, this study is the first to report on the psychological correlates of sexual orientation among Iranian ambiphilic males.

With respect to female sexual orientation differences, as predicted, both cisgender ambiphilic females and cisgender gynephilic females recalled behaving in a more male-typical

manner (i.e., higher CGIS scores) than cisgender androphilic females, with cisgender ambiphilic females scoring intermediate between androphilic and gynephilic females. The difference in CSAB between cisgender gynephilic females and cisgender androphilic females was large (d = 1.41) and comparable to the average effect size for female sexual orientation differences in CSAB reported in a meta-analysis by Bailey and Zucker (1995; d = 0.96). To our knowledge, this is the first report of CSAB among Iranian ambiphilic and gynephilic cisgender females.

With respect to gender identity differences in males (cisgender vs. transgender), as predicted, transgender androphilic males recalled more female-typical behaviour (i.e., lower CGIS scores) than cisgender androphilic males, thus exhibiting a greater degree of CSAB. The difference in CSAB between cisgender and transgender androphilic males was large (d = 1.62). Few studies have provided evidence for gender identity differences in CSAB while controlling for sex and sexual orientation. In a study conducted in the Istmo region of Oaxaca, Mexico, androphilic males, including both masculine-presenting *muxe nguiiu* and feminine-presenting *muxe gunaa*, recalled elevated CSAB compared to gynephilic men. *Muxe gunaa* scored even more sex-atypical than *muxe nguiiu*, with a large effect size (d = 1.54) comparable to the one calculated in this study (Gómez Jiménez et al., 2020a).

With respect to gender identity differences in females (cisgender vs. transgender), as predicted, transgender gynephilic females recalled more male-typical behaviour (i.e., higher CGIS scores) than cisgender gynephilic females, hence exhibiting a greater degree of CSAB. The difference in CSAB between cisgender and transgender gynephilic females was large (d = 1.93). The one study in the United States that has compared CSAB in cisgender and transgender gynephilic females reported that 80% of their transgender group preferred boys as playmates in contrast to 40% of the cisgender group (Ehrhardt et al., 1979). In addition, 87%-93% of

transgender participants preferred male-typical toys and recalled behaving in a tomboyish manner, whereas only 67% of cisgender respondents did so. Despite the limitations of this study (e.g., the small sample size employed; $n = 15$ per group), the overall findings are consistent with our results.

Furthermore, both transgender groups scored in a manner that could be described as sex-reversed given that transgender gynephilic females had a mean CGIS score that was similar to that of cisgender gynephilic males, while the mean CGIS score of transgender androphilic males was lower than that of cisgender androphilic females. Considering that most studies that have examined childhood sex-atypicality among transgender gynephilic females or transgender androphilic males did not include cisgender gynephilic males or cisgender androphilic females as control samples, respectively, it is not easy to evaluate this finding in relation to previous research. Studies of non-European/North American transgender androphilic males, including the Samoan *fa'afafine* and Istmo Zapotec *muxe gunaa*, have, however, found similar sex-reversed patterns in recalled childhood sex-typed behaviour (Bartlett & Vasey, 2006; Gómez Jiménez et al., 2020a). With respect to transgender gynephilic females, the only other study of which we are aware was conducted in Iran, and while it supports the reliability of our results, it does not lend support to its cross-cultural validity given that it was conducted in the same culture (Roshan et al., 2019).

In summary, our results showed that compared to cisgender other-sex attracted groups, expression of CSAB increased in the following order: cisgender ambiphilic groups, cisgender same-sex attracted groups, and transgender same-sex attracted groups. This incremental change in recalled CSAB in association with variation in sexual orientation and gender identity suggests that (1) these phenotypes are interrelated, and similar mechanisms possibly influence their

development, (2) while working in opposite directions in males (e.g., producing gynephilia) and females (e.g., producing androphilia). A number of candidate mechanisms exist.

For instance, early exposure (or lack of exposure) to pre- or peri-natal androgens has been hypothesized to organize the brain in a sexually differentiated manner (Hines, 2008; Phoenix et al., 1959). In humans, the most rigorous evidence supporting this brain-organization hypothesis comes from conditions that affect sex development, for example, congenital adrenal hyperplasia (CAH). In females with CAH, overproduction of androgens prenatally, due to an enzyme deficiency, induces behavioural changes such as increased aggressive tendencies in childhood, adolescence and adulthood (Berenbaum & Resnick, 1997; Mathews et al., 2009; Pasterski et al., 2007). Similarly, on average, girls/women with CAH express more sex-atypical interests both in childhood and adulthood (e.g., preference for male-typical occupations) and report more gynephilic sexual feelings (Kreukels & van de Grift, 2022; Kung et al., 2024). CAH also impacts physical development in affected females whose external genitalia are virilized to varying degrees. In addition, putative biomarkers of prenatal testosterone such as otoacoustic emissions and finger length ratio (2D:4D) show shifts in a male-typical direction in women with CAH (Brown et al., 2002; Wisniewski et al., 2014). Assessment of these biomarkers in cisgender gynephilic females without CAH have provided similar results (Grimbos et al., 2010; McFadden, 2011). The convergence of this evidence in both gynephilic females without CAH and females with CAH further supports the hypothesis that a shared underlying mechanism, in particular, sex-atypical exposure to pre- or peri-natal androgens, is responsible for the observed correlation between gynephilia and CSAB in females. With respect to transgender female gynephilia and male androphilia (either cisgender or transgender), evidence for the developmental role of sex hormones is less clear and inconclusive (Breedlove, 2017; Sadr et al., 2020).

Genetic factors are also thought to influence the co-occurrence of CSAB and same-sex attraction. Twin studies have shown that variations in CSAB and same-sex sexual orientation are partly heritable in both males and females (Kirk et al., 2000). Moreover, part of the shared variation between CSAB and sexual orientation is due to shared genetics (Alanko et al., 2010; Burri et al., 2011). The remaining nonhereditary variation has been associated with both shared and non-shared environments (Bailey et al., 2000; Burri et al., 2011, 2015). Currently, it is not known if the relevant genes are the same in males and females or whether they influence the expression of CSAB and same-sex sexual orientation through regulation of the fetal hormonal environment or via other mechanisms.

In addition to the plausible genetic and hormonal mechanisms, other biological mechanisms involved in the development of same-sex sexual orientation may also explain, in part, its strong association with CSAB. For instance, some studies have found, on average, elevated CSAB in both transgender and cisgender androphilic males who exhibit more prominent fraternal birth order, suggesting maternal immunity may underlie expression of both androphilia and CSAB among males (Blanchard, 2018a; Swift-Gallant, 2018). However, the association of CSAB with fraternal birth order has not been found at an individual level (Bogaert, 2003; Kishida & Rahman, 2015; Semenyna et al., 2017b). Also, limited evidence is available supporting the presence of a parallel effect for number of older brothers on female gynephilia (Ablaza et al., 2022; Blanchard, 2023). Therefore, we think additional research is needed to make a well-informed opinion about the plausible role of fraternal birth order on expression of CSAB (for more nuanced discussion, see VanderLaan et al., 2022).

Finally, among both cisgender males and cisgender females, a large proportion of observed variance in CSAB could not be explained by between-group variation in sexual

orientation. This indicates that some of the factors influencing the development of childhood sex-typed behaviour may not play similar roles in the development of sexual orientation. For instance, several factors, in both the proximate (e.g., parents encouraging and facilitating sex-typed play; Caldera et al., 1989; Wood et al., 2002) and distal (e.g., media and advertising; Brown & Stone, 2018) social environments of children, in interaction with children's cognitive development, have been suggested to shape their preferences and behaviour in accordance with gender stereotypes (Dinella & Weisgram, 2018; Weisgram, 2016, 2022). In contrast, social factors do not seem to play a significant role in the development of sexual orientation (Bailey et al., 2016). Significantly, socialization of sex-typed behaviour in childhood cannot account for the existence of CSAB or its association with same-sex sexual attraction, given that both run *counter* to social norms and expectations in a Middle Eastern country like Iran. However, socialization might amplify or attenuate an existing propensity for CSAB, and thus, account for the variation in the expression of CSAB observed among individuals who have similar sex, sexual orientation, and gender identity.

Taken in the context of previous research, our findings provide further support for the conclusion that CSAB is a normative aspect of childhood development in ambiphilic males, ambiphilic females, androphilic males, and gynephilic females regardless of their gender presentation. Under-recognition of this fact, due in part to a lack of discussion in Iran, and more broadly, the Middle East, about same-sex attraction and transgenderism, may impede the provisioning of well-informed clinical care. This lack of discussion, at least in the case of Iran, is likely due to its homophobic and transphobic state policies, which seek to maintain and enforce categorical thinking about gender (Korycki & Nasirzadeh, 2013; Rahimi, 2015). This categorical thinking extends beyond preconceptions regarding male/female differences, to preconceptions

which disallow viewing cisgender and transgender gynephilic females (or cisgender and transgender androphilic males) as variant expressions along the same continuum (see Whitam, 1987). Taken together, these biases may render clinicians at risk of adopting false pseudoscientific beliefs about individuals with minority sexuality and gender expression, which in turn, would undermine their ability to provide optimal evidence-based care.

Limitations

We measured childhood sex-typed behaviour by asking participants about aspects of their childhood interests and behaviours. Critics of this retrospective approach have argued that people attempt to provide consistent narratives about themselves and, as such, selective recall bias or memory distortion might underlie the observed patterns of recalled CSAB (Gottschalk, 2003; Maughan & Rutter, 1997; Ross, 1980). Nevertheless, converging evidence from different methodological approaches (e.g., prospective designs or objective assessment of sex-typed behaviour using home movies) supports the reliability and validity of results obtained from retrospective self-report assessment of childhood behaviour (Bailey & Zucker, 1995; Rieger et al., 2008; Zucker et al., 2006). Also, we are not aware of any empirical evidence supporting the claim that recalled childhood behaviour among sexual or gender minorities might be affected by selective recall bias.

Although our network sampling method raises concerns about the degree to which it provides a representative sample, it was deemed the only way to examine sexuality, particularly same-sex sexuality, in Iran given the sociopolitical atmosphere. Also, our sample of transgender participants could be described as a mix of clinic- and community-based samples. Using a mixed sample may complicate the comparability of our results with previous research which has focused on clinic-based samples and only included participants with a psychiatric diagnosis of

gender dysphoria. In this context, it is noteworthy that some of the participants who were classified as transgender in our study and self-identified as *trans,* described the Iranian trans community as comprised of "true" trans versus "fake" trans ("*trans-nama*") individuals. Accordingly, "true" trans individuals describe themselves as extremely gender dysphoric and willing to undergo all state-mandated sex-reassignment interventions, whereas "*trans-nama*" individuals do not fulfill these criteria for claiming a "real" trans identity. Alternatively, this mixed approach could be seen as a methodological improvement since our sample may have included a broader range of markedly gender-nonconforming individuals. Further research is needed to elucidate the presumed heterogeneity that characterizes transgender participants in relation to the presence or severity of gender dysphoria.

Another related limitation in our methodology is the use of gender identity rather than gender expression for classifying participants into cisgender or transgender samples. It might be the case that not all the participants in this study had a similar understanding of the concept of gender identity given the cultural differences and that in contemporary Iran under the rule of the Islamic Republic, public discussion and education about gender and sexuality issues are greatly restricted. This speculation is supported by the fact that during data collection in Mashhad and Tehran, some trans identifying participants who had not started or completed the sex/gender reassignment process, and thus were not legally allowed to express gender roles discordant with their sex, asked whether gender identity referred to "*what I am now?* or *"what I want to become?*" Consequently, some participants, particularly in the online study, might have interpreted gender identity as their socially expected gender roles, not their subjectively experienced gender identity. On the other hand, not all who self-identify with labels like trans or nonbinary can express their gender identity due to the restrictions imposed by the state or their

families. For this reason, our use of gender identity, rather than gender expression may have been an advantage, rather than a limitation, as the latter is more constrained by social context than the former. Considering that participants provided responses to the additional question "Are you transgender or transsexual? (yes or no)", and only data from participants with consistent responses were included in the study (e.g., inclusion of a female who declares their gender identity a *man* and affirmed being transgender/transsexual or exclusion of a male whose gender identity was recorded as a man but reported being *transgender* or *transsexual*), we do not believe that discrepant understandings about gender identity have significantly impacted our results. Furthermore, we believe that our results reflect the overall situation in Iran because, while participants who gave discrepant answers to the questions outlined above did exist, they were quite rare.

Another limitation of our study pertains to the small number of cisgender gynephilic females that we were able to recruit. This may limit the generalizability of our results to this group of individuals. In addition, previous research demonstrates that gynephilic females who identify as women vary in their childhood and adulthood sex-typed behaviours and this variation is often linked with sexual identities such as *butch* and *femme* (Bailey et al., 1997; Singh et al., 1999; Zheng & Zheng, 2016). Although the use of such sexual identities among Iranian cisgender gynephilic females has not been documented, anecdotally, it seems that subcommunities exist in larger urban areas like Tehran where these sorts of Western sexual identities are employed. In this study, sexual orientation was operationalized by measuring sexual attraction and data pertaining to sexual identities were not collected. In the future, conducting larger and more representative studies involving measures of sexual identities (i.e.,

butch/femme) and erotic role preferences could elucidate the association between these variables and recalled CSAB.

Conclusion

Consistent with previous research, our findings from Iran—a non-Western, Middle Eastern culture—provide cross-cultural support for universality of childhood sex-atypicality as a normative developmental precursor of monosexual or ambisexual same-sex attraction in both males and females who are cisgender and transgender.

SUPPLEMENTARY MATERIAL

Of the 1031 participants who were assigned to eight groups (i.e., based on their sex, gender identity, and sexual orientation), 476 participants were recruited online, whereas 555 participants were recruited in Mashhad and Tehran, Iran. All participants completed the same survey. Comparisons between the two recruitment samples for demographic variables are provided in the section Method. In this supplementary section, we provide statistical information for each recruitment sample. Due to lower group sample sizes and lower statistical power for between-group comparisons, we do not report results from post-hoc analyses. Also, we present within-group comparisons of *Childhood Gender Identity Scale* (CGIS) scores between recruitment samples (e.g., cisgender gynephilic males recruited online versus cisgender gynephilic males recruited in Mashhad and Tehran).

Participants Recruited Online

Supplementary Table s2-1 presents data from participants who completed the CGIS online. Demographic variables were found to differ between groups recruited online similar to the observed pattern in the merged recruitment sample (see Results). Age was found to differ between groups using One-way ANOVA ($F[7, 453] = 2.41$, $p = 0.02$). Kruskal-Wallis H analysis revealed significant difference among groups in education level ($\chi^2[7] = 18.81$, $p = 0.009$) and financial status ($\chi^2[7] = 30.75$, $p < 0.001$). Comparing CGIS scores across all online groups revealed significant differences ($F[7, 468] = 112.65$, $p < 0.001$).

Participants Recruited in Tehran and Mashhad

Supplementary Table s2-2 presents data for participants who were recruited in Mashhad and Tehran. Demographic variables were found to differ between groups in a similar manner to the pattern observed in the merged recruitment sample (see Results). Age was found to differ

between groups using One-way ANOVA ($F[7, 538] = 5.72$, $p < 0.001$). Kruskal-Wallis H analysis revealed significant difference among groups in education level ($\chi^2[7] = 31.15$, $p < 0.001$) and financial status ($\chi^2[7] = 34.69$, $p < 0.001$). Comparing CGIS scores across all groups recruited in Mashhad and Tehran revealed significant differences ($F[7, 547] = 171.61$, $p < 0.001$).

Within-Group Comparison of Recruitment Type

In supplementary Figure s2-1, mean CGIS scores with 95% confidence interval for all eight groups of participants divided for recruitment type is presented. Overall, mean scores did not seem to differ between recruitment samples. This provides support for our decision to conduct and report statistical analyses on the merged recruitment sample.

Supplementary Table s2-0-1 Descriptive information for participants recruited online

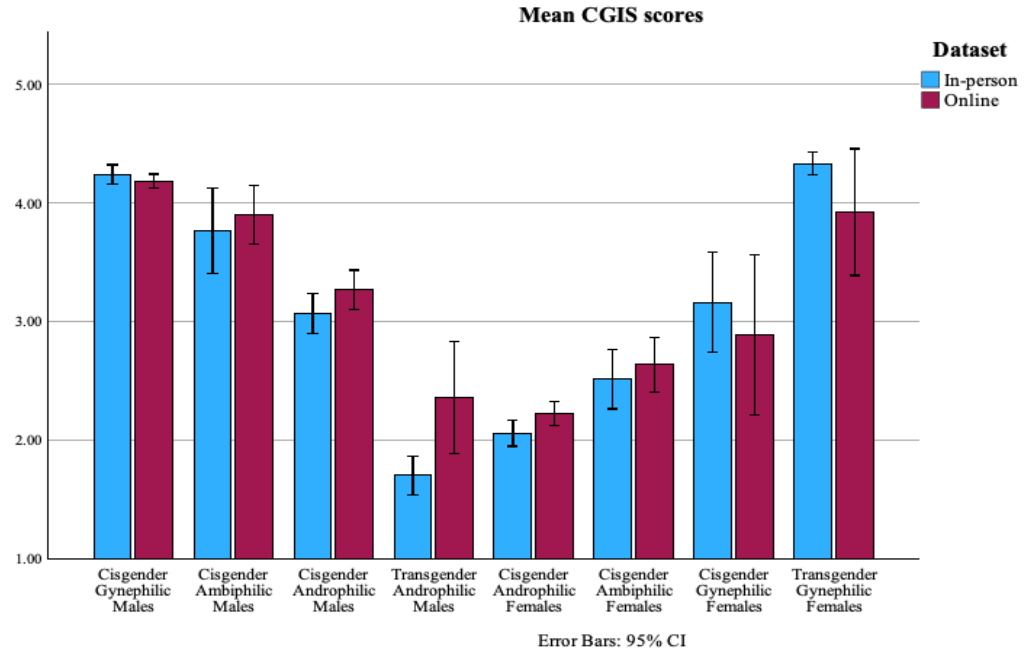
	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Number of participants	135	28	83	14	144	51	11	10
Age*								
Mean ± Standard deviation	30.37 ± 7.48	26.55 ± 6.75	28.55 ± 6.50	25.00 ± 4.08	28.69 ± 7.00	26.88 ± 5.93	26.82 ± 7.82	26.10 ± 7.40
Level of education**								
Junior high school	0.7%	0.0%	0.0%	0.0%	0.0%	3.9%	0.0%	0.0%
High school	8.1%	25.0%	22.0%	28.6%	13.2%	21.6%	36.4%	40.0%
College	8.9%	21.4%	14.6%	14.3%	8.3%	5.9%	0.0%	10.0%
Undergraduate	42.2%	28.6%	31.7%	28.6%	41.0%	39.2%	36.4%	40.0%
Post-graduate	40.0%	25.0%	31.7%	28.6%	37.5%	29.4%	27.3%	10.0%
Financial Status								
Very bad	0.7%	3.6%	2.4%	7.1%	0.0%	0.0%	0.0%	0.0%
Bad	9.6%	14.3%	13.3%	21.4%	5.6%	9.8%	9.1%	0.0%
Not bad Not good	57.0%	71.4%	57.8%	57.1%	50.7%	41.2%	72.7%	40.0%
Good	29.6%	7.1%	24.1%	14.3%	37.5%	43.1%	18.2%	50.0%
Very good	3.0%	3.6%	2.4%	0.0%	6.3%	5.9%	0.0%	10.0%
CGIS scores								
Mean ± Standard deviation	4.18 ± 0.34	3.90 ± 0.64	3.26 ± 0.77	2.36 ± 0.82	2.22 ± 0.62	2.63 ± 0.82	2.88 ± 1.00	3.92 ± 0.75

* Overall, 5 data points were missing: cisgender gynephilic males (n = 2), cisgender ambiphilic males (n = 1), and cisgender androphilic males (n = 2). ** One data point was missing for cisgender androphilic males.

Supplementary Table s2-2 Descriptive information for participants recruited in Mashhad and Tehran

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Number of participants	101	23	108	46	99	45	21	112
Age*								
Mean ± Standard deviation	23.80 ± 3.90	25.09 ± 5.89	26.74 ± 6.38	24.50 ± 5.04	24.42 ± 4.75	22.33 ± 2.77	21.52 ± 3.12	24.14 ± 4.49
Level of education								
Junior high school	4.0%	4.3%	2.8%	6.5%	0.0%	0.0%	4.8%	4.5%
High school	44.6%	30.4%	28.7%	45.7%	23.2%	37.8%	47.6%	47.3%
College	15.8%	21.7%	17.6%	17.4%	23.2%	26.7%	28.6%	17.9%
Undergraduate	27.7%	39.1%	34.3%	26.1%	43.4%	28.9%	19.0%	23.2%
Post-graduate	7.9%	4.3%	16.7%	4.3%	10.1%	6.7%	0.0%	7.1%
Financial Status								
Very bad	0.0%	4.3%	3.7%	15.2%	1.0%	2.2%	0.0%	5.4%
Bad	9.9%	4.3%	12.0%	10.9%	3.0%	6.7%	4.8%	11.6%
Not bad Not good	64.4%	47.8%	56.5%	60.9%	62.6%	60.0%	38.1%	67.9%
Good	22.8%	43.5%	24.1%	10.9%	31.3%	24.4%	57.1%	15.2%
Very good	3.0%	0.0%	3.7%	2.2%	2.0%	6.7%	0.0%	0.0%
CGIS scores								
Mean ± Standard deviation	4.24 ± 0.41	3.76 ± 0.83	3.07 ± 0.88	1.70 ± 0.54	2.06 ± 0.55	2.51 ± 0.84	3.16 ± 0.93	4.33 ± 0.50

* Overall, 8 data points were missing: cisgender ambiphilic males (n = 1), cisgender androphilic males (n = 2), cisgender androphilic females (n = 3), and transgender gynephilic females (n = 2).



Supplementary Figure s2-1 Mean CGIS scores compared between two recruitment samples. The 95% Confidence Interval is illustrated using error bars.

Chapter 3: Occupational Preferences, Childhood Behaviour and Openness: The Role of Sex, Sexual Orientation and Gender Identity in Iran

ABSTRACT

Previous research suggests that both same-sex attraction and the personality trait "openness" are associated with sex-atypical preferences and behaviours. Here, we examined the links between adulthood occupational preferences, childhood play behaviour and openness among Iranian cisgender gynephilic males (n = 228), cisgender ambiphilic males (n = 48), cisgender androphilic males (n = 178), transgender androphilic males (n = 58), cisgender androphilic females (n = 226), cisgender ambiphilic females (n = 94), cisgender gynephilic females (n = 31), and transgender gynephilic females (n =121). Cisgender and transgender same-sex attracted males and females exhibited sex-atypical occupational preferences with the latter group showing even more sex-atypicality than the former. The personality trait openness did not differ between cisgender groups. Transgender androphilic males had significantly higher mean score for openness compared to cisgender androphilic females and transgender gynephilic females, whereas transgender gynephilic females had significantly lower scores compared to cisgender androphilic males. In both males and females, childhood sex-atypicality, same-sex attraction and openness were associated with sex-atypical occupational preferences. Our findings from Iran provides cross-cultural support for interconnectedness of childhood and adulthood sex-atypicality, openness, and same-sex attraction in males and females who are cisgender and transgender.

INTRODUCTION

Research shows that occupational preferences differ between cisgender males and females (Lippa, 2010; Su et al., 2009). This sex difference aligns with People-Things dimension underlying Holland's model of vocational interests (also known as RIASEC). On average, cisgender males are interested in vocations that entail "manipulation of things, tools, animals, and machines" like "electrician, carpenter, [and] automobile mechanic" (p. 19-20; Holland, 1966), whereas cisgender females prefer professions that require "social skills" or need "social interaction" such as "high school teacher, clinical psychologist, [and] social worker" (p. 25; Holland, 1966). The sex difference in occupational preferences is often reported to be of large size (Cohen's $d > 0.8$), relatively stable across 53 nations (including many outside of North America/Western Europe), and existing independent of gender equality, lending more support to its reliability and validity as a universal sex differentiated psychological trait (Lippa, 2010).

Furthermore, research indicates that occupational preferences vary with sexual orientation along the same People-Things dimension that distinguishes cisgender males and females (Gómez Jiménez et al., 2021; Lippa, 1998, 2010, 2020; Semenyna & Vasey, 2016). Cross-cultural studies, conducted mostly in North America/Western Europe but also in countries such as Brazil, China, Guatemala, and the Philippines, have consistently shown that cisgender same-sex attracted males and females report sex-atypical occupational preferences (Ellis et al., 2012; Lippa, 2005b, 2008b, 2020; Whitam, 1987; Whitam & Mathy, 1986; Zheng et al., 2011). In North America/Western Europe cultures, ambiphilic sexual orientation in both cisgender males and females has also been associated with expression of sex-atypical occupational preferences with ambiphilic individuals reporting intermediate level of interest compared to their monosexual counterparts (Ellis et al., 2012; Lippa, 2008b, 2020).

Occupational preferences also seem to be closely linked to gender development in same-sex attracted individuals. Qualitative ethnographic studies in countries including Brazil, Guatemala, Indonesia, and the United States (Nanda, 2009; Whitam, 1987, 1997; Whitam and Mathy, 1986) have linked cross-gender behaviour with occupational preferences of transgender androphilic males (e.g., elevated interests in entertainment and the arts) and transgender gynephilic females (e.g., elevated interests in being a warrior or an athlete). Further quantitative evidence for the expression of sex-atypical occupational preferences among transgender androphilic males comes from studies of *bayot* in the Philippines (Hart, 1968), *hijra* in India (Stief, 2017), *fa'afafine* in Samoa (Semenyna & Vasey, 2016), and *muxes* in Mexico (Gómez Jiménez et al., 2021). We are not aware of any quantitative measurement of transgender gynephilic females' occupational preferences.

While studies support the presence of sex-atypical occupational preferences in same-sex attracted males, be they cisgender or transgender, direct within-culture comparison of the two types is rare. In a study conducted in Istmo region of Oaxaca in Mexico, androphilic males including both masculine presenting *muxe nguiiu* and feminine presenting *muxe gunaa* exhibited elevated interest in female-typical occupations and relative disinterest in male-typical occupations, with *muxe nguiiu* scoring similar to cisgender androphilic females and *muxe gunaa* scoring in a hyper-feminized manner above that of cisgender androphilic females (Gómez Jiménez et al., 2021). To our knowledge, no published study has compared occupational preferences between cisgender and transgender types of female gynephilia within a culture. This, together with previously discussed gaps in cross-cultural research on female gynephilia, highlights the importance of investigating cisgender and transgender gynephilic females' occupational preferences in new populations.

Correlates of same-sex attraction including childhood sex-atypical play behaviour (Bailey & Zucker, 1995) and the personality trait "openness" (Allen & Robson, 2020; Lippa, 2005b, 2010) seem to be associated with occupational preferences in adulthood. Although no prospective study of occupational preferences has followed children into adulthood, a longitudinal study of boys and girls has shown that childhood sex-typed behaviour, assessed at age 3.5 years, predicts interest in both male-typical and female-typical occupations expressed later in adolescence (Kung, 2021). In several retrospective studies, childhood sex-atypical behaviour has been linked with sex-atypical occupational preferences in adulthood among both cisgender and transgender individuals (Gómez Jiménez et al., 2021; Kung, 2022; Lippa, 2008a; Semenyna & Vasey, 2016; VanderLaan et al., 2016). Correlations between openness and several Holland's vocational types (e.g., Artistic type) including their underlying People-Things dimension have been reported (Holland et al., 1994; Lippa, 1998). Notably, research suggests that, across cultures, androphilic males generally exhibit higher interests in Artistic occupations (e.g., dancing) including those that involve embellishment (e.g., internal decorator), whereas gynephilic females are generally disinterested in these professions (Bailey & Oberschneider, 1997; Whitam, 1987; Whitam & Mathy, 1986).

In this study, we investigate for the first time, whether sex, sexual orientation, and gender identity are associated with occupational preferences in Iran. First, we predicted that sex differences in occupational preferences would exist with cisgender gynephilic males reporting more interest in things-oriented occupations and cisgender androphilic females reporting more interest in people- and embellishment-oriented occupations (Prediction 1). Second, we predicted that individuals with a gynephilic sexual orientation would endorse greater interest in male-typical occupations and lower interest in female-typical ones, compared to individuals with an

androphilic sexual orientation (Prediction 2). Third, we predicted that ambiphilic participants' occupational preferences scores would, on average, be intermediate between gynephilic and androphilic participants of the same sex (Prediction 3). Fourth, we predicted that transgender individuals would be more sex-atypical in terms of their occupational preferences compared to their cisgender counterparts who share a similar sex and sexual orientation (Prediction 4). Next, we assess the correlations between occupational preferences, childhood sex-typed behaviour, and openness while controlling for sexual orientation and gender identity within each sex. We predicted that higher sex-atypical childhood behaviour would be associated with higher sex-atypical adulthood occupational preferences (Prediction 5). We also predicted that openness would correlate positively with a preference for female-typical occupations, but negatively with a preference for male-typical occupations (Prediction 6). Finally, we predicted that androphilic males would exhibit greater interest in occupations involving embellishment, whereas gynephilic females would exhibit lower interest in such occupations (Prediction 7).

METHOD

Recruitment

Here, we present merged data from two separate Iranian samples. All participants completed a similar survey. The first sample was recruited using an online survey conducted with Qualtrics. The responses were recorded between November 2021 and July 2022. The second sample was recruited in-person in Tehran and Mashhad, Iran. A snowball sampling method was used to recruit participants. In-person data collection was undertaken from April 2022 to March 2024.

Participants

Participants were classified into sixteen groups using the recorded variations in gender identity (cisgender or transgender), sexual orientation (gynephilic, ambiphilic, androphilic or asexual), and sex (male or female). For instance, participants who reported a transgender identity, had gynephilic sexual orientation, and reported they were female were classified as "transgender gynephilic females". Of the 1024 participants that reported their occupational preferences, data pertaining to eight groups of participants (n = 984) were included for statistical analysis. These groups included cisgender gynephilic males (n = 228), cisgender ambiphilic males (n = 48), cisgender androphilic males (n = 178), transgender androphilic males (n = 58), cisgender androphilic females (n = 226), cisgender ambiphilic females (n = 94), cisgender gynephilic females (n = 31), and transgender gynephilic females (n = 121). Due to small group size, we did not analyze data pertaining to the other eight groups including transgender gynephilic males (n = 3), transgender ambiphilic males (n = 5), transgender androphilic females (n = 2), transgender ambiphilic females (n = 7), cisgender asexual/analloerotic males (n = 9), transgender asexual/analloerotic males (n = 0), cisgender asexual/analloerotic females (n = 12), and transgender asexual/analloerotic females (n = 2).

Measures

Sex, Gender Identity/Expression, and Sexual Orientation

Participants were designated into different groups based on their responses to questions about their sex, gender identity, and sexual orientation. In terms of sex, we categorized participants based on their answer to the following question: "Which sex were assigned to you at birth? (*male*, *female*, and if *other* please specify.)" In terms of gender, participants were asked two consecutive questions: "What is your gender identity? (*man*, *woman*, and if *other* please specify)" and "Are you transgender or transsexual? (*yes* or *no*)". When participants identified as

the gender concordant with their sex (i.e., a female identifying as woman or a male identifying as man) and as neither transgender nor transsexual, they were categorized *cisgender*. Participants were classified *transgender* if they: (1) identified as *woman* while being identified male at birth or (2) identified as *man* while being identified female at birth or (3) identified as neither *man* nor *woman*. Data from participants who did not meet the criteria to be classified as cisgender or transgender were excluded from analyses (n = 13).

To measure sexual orientation, participants were asked to report their sexual feelings towards adult males/men or females/women, during the previous 12 months, using a 7-point Likert scale (Kinsey et al., 1948). Participants who had sexual feelings only for females/women (score = 0), or had only an occasional fantasy about males/men (score = 1) were categorized as *gynephilic,* those who had a more substantial degree of sexual feelings for both males/men and females/women (score = 2 to 4) were categorized as *ambiphilic,* and those who had only an occasional fantasy about females/women (score = 5), or were only attracted to males/men (score = 6) were categorized as *androphilic*. An eighth item was added for participants who "have not any sexual feelings toward any sex/gender," and these individuals were categorized as *asexual/analloerotic.* Since it was unclear from the item whether any other type of sexual feeling was present or not, this group could be either asexual (i.e., no sexual feelings whatsoever) or analloerotic (i.e., presence of sexual feelings but not directed toward males/men or females/women; Blanchard, 1989).

Demographic Information

Participants were asked to report their age (i.e., year of birth), level of education, and financial status. Level of education was reported on a 7-point scale: 1= "no education" to 7= "postgraduate degree." Due to the limited number of participants in first three levels of

education, those levels were collapsed and are presented together resulting in five levels of education. Participants were also asked to report their overall financial status on 5-point scale from 1= "very bad" (I need financial aid for my basic needs) to 5= "very good" (I have no concerns about money).

Occupational Preferences

Occupational preferences were measured using a modified version of Lippa's (2010) questionnaire, which asked participants to rate 15 different occupations (irrespective of attributed social status, salary, and required skills) on a 7-point scale (1= "strongly dislike" to 7= "strongly like"). Five items were included to represent occupations involving object manipulation (i.e., car mechanic, carpenter, truck driver, electrician, and refrigerator repair). Another five items were included to represent occupations involving interactions with people (i.e., daycare worker, nurse, therapist, primary school teacher, and social worker). An additional five items were included to represented occupations involving artistic/creative manipulation of objects (i.e., clothing designer, floral designer, interior decorator, pastry chef, and jewelry designer). The questionnaire was translated to Farsi and back to English by the first author and reviewed by an independent researcher fluent in both languages. Exploratory factor analysis (EFA) was conducted using extraction method Maximum Likelihood with Promax rotation (Sakaluk & Short, 2017) which provided support for the three-factor structure of the questionnaire. The Kaiser-Meyer-Olkin (KMO) measure was above 0.50 indicating sampling adequacy for analysis (overall KMO = 0.79). Three-factors structure suggested by EFA accounted for 42.0% of the observed variance in participants' ratings of different items. The rotated loading factors are presented in Table 3-1. We named these factors as things-oriented, people-oriented, and embellishment-oriented occupations. Factor scores were calculated by averaging values of the items loaded on each

factor. Cronbach's alpha was used to assess internal consistency which was deemed acceptable for things-oriented ($\alpha = 0.79$), people-oriented ($\alpha = 0.73$), and embellishment-oriented occupations ($\alpha = 0.75$).

Childhood Sex-Typed Behaviour

A version of *Childhood Gender Identity Scale* (CGIS) developed by Bartlett and Vasey (2006) and adapted from Johnson et al.'s (2004) *Gender Identity Questionnaire for Children* was used to measure childhood sex-typed behaviour. The questionnaire contained 10 items and using a 5-point scale ranging from 1= "Never" to 5= "Always," participants were asked to rate how often they engaged in behaviour previously shown to be male-typical (five items; e.g., playing with vehicles and guns) or female-typical behaviour (five items; e.g., playing with dolls). The questionnaire was translated to Farsi and back to English by the first author and reviewed by an independent researcher fluent in both languages. EFA with Maximum Likelihood method revealed one factor with items pertaining to female-typical behaviour loading negatively (KMO = 0.93; total variance explained = 61.2%). To calculate the CGIS scores, reverse coded female-typical items were summed with male-typical items and averaged. Accordingly, higher CGIS scores are indicative of more frequent expression of childhood male-typical behaviour, whereas lower CGIS scores are indicative of more frequent expression of female-typical behaviour. Across the sample, Cronbach's alpha for CGIS was 0.94. The CGIS data presented here are derived from a larger sample reported in a previous study (Sadr-Bazzaz et al., 2024; Chapter 2 of this dissertation).

Table 3-1 Rotated extracted factors for occupational preferences

	Factor		
	1	2	3
Car mechanic	**0.73**	-0.04	-0.06
Clothing designer	-0.16	**0.70**	0.02

Carpenter	**0.59**	0.30	-0.10
Daycare worker	-0.07	0.07	**0.70**
Truck driver	**0.52**	-0.08	0.01
Nurse	0.00	-0.01	**0.45**
Electrician	**0.81**	-0.05	0.07
Floral designer	0.10	**0.58**	0.07
Refrigerator repair	**0.72**	-0.02	0.09
Interior decorator	0.07	**0.69**	-0.08
Dessert chef	-0.03	**0.44**	0.13
Therapist	-0.01	0.04	**0.42**
Primary school teacher	0.02	-0.02	**0.80**
Social worker	0.07	-0.02	**0.57**
Jewelry designer	0.00	**0.64**	-0.03

Extraction Method: Maximum Likelihood. Rotation Method: Promax with Kaiser Normalization. Items in bold are clustered together as one factor. Factor 1 was named things-oriented occupations, Factor 2 embellishment-oriented occupations, and Factor 3 people-oriented occupations.

Openness

To measure openness, a version of Big Five Inventory (BFI; John & Srivastava, 1999) was used. Participants rated 10 descriptive items (e.g., "is creative an inventive" or "likes artistic and creative experiences") on a 5-point scale (1= "Disagree strongly" to 5= "Agree Strongly"). We used the adapted translation by Nosrat-abadi and Joshanloo (2006). Performing EFA with Maximum Likelihood revealed a two-factor structure for the questionnaire. However, in both the original study by John and Srivastava (1999) and its adaption in Iran (Nosrat-abadi & Joshanloo, 2006), no underlying facets were introduced for the BFI openness factor. Also, systematic reviews suggest lack of empirical support for BFI measuring different facets, as opposed to a single facet (Woo et al., 2014a, 2014b). We calculated single score for openness by averaging reported ratings of nine items; the item "Likes works that is the same every time (routine)" was excluded because it showed no correlation with other items. Internal consistency of BFI was assessed using Cronbach's alpha across the sample and was deemed acceptable ($\alpha = 0.77$).

Statistical Analysis

The two recruitment samples differed with respect to some biodemographic variables as participants recruited online (n = 441) were on average 4.30 years older (95% *CI* [3.56, 5.05]; $t(970) = 11.32$, $p < 0.001$), more educated ($t(981) = 12.28$, $p < 0.001$), and had better financial status ($t(982) = 2.95$, $p = 0.003$) than participants recruited in-person (n = 543). Despite differences in biodemographic information, we only report data and statistical analyses for the merged recruitment sample ($n = 984$). We consider this approach justified because variables of interest (i.e., occupational preferences, childhood sex-typed behaviour, and openness) showed highly consistent patterns between two samples. This approach provided higher statistical power for groups in those situations where the sample sizes for the online or in-person samples were less optimal on their own. Data from each sample and their comparison are reported in the Supplementary Material.

A stepwise discriminant analysis including things-, people-, and embellishment-oriented occupations' factor scores was undertaken to assess potential sex difference between cisgender gynephilic males and cisgender androphilic females. Between group comparisons were undertaken using one-way ANOVA and post-hoc Tukey HSD method. The parameter *Cohen's d* is used to report effect sizes of between-groups comparisons and is followed by 95% confidence intervals in square brackets. Post-hoc power analysis showed that pairwise comparisons that were conducted with *a priori* predictions reached 0.8 threshold.

Separate three-step hierarchical multiple regression analyses were undertaken for each sex with occupational preferences as the dependent variable. In first step, age, education, and financial status were entered together to control for sociodemographic differences. Then, CGIS scores and gender identity status (cisgender = -1, transgender = 1) were included. At the final

step, sexual orientation (gynephilia = -1, ambiphilia = 0, androphilia = 1) and openness were entered into the model. Our rationale for entering childhood sex-typed behaviour and gender identity together and prior to sexual orientation and openness while minimizing the steps, and thus, avoiding unnecessary obscuration of the results, was their earlier concomitant expression during development. For each step, change in F statistics and R^2 (ΔR^2) are reported to demonstrate the change in predictive power of the models.

RESULTS

Considering that all three occupational classes contributed to the discrimination function between cisgender gynephilic males and cisgender androphilic females (Wilks' $\lambda = 0.65$, $\chi^2 = 191.46$, degree of freedom = 3, $p < 0.001$, Eigenvalue = 0.53, Canonical Correlation = 0.59; Prediction 1), a composite score for male- versus female-typical occupational preferences (MF-Occ) was calculated (Supplementary Table s3-4). Accordingly, higher MF-Occ score indicates higher interest in male-typical occupations, whereas lower MF-Occ score indicates higher interest in female-typical occupations. A one-way ANOVA provided statistical support for the observed between-group differences in mean MF-Occ scores: $F(7, 976) = 73.79$, $p < 0.001$, $\eta^2 = 0.35$ (Figure 3-1). Cohen's ds were calculated to examine the size difference between mean MF-Occ scores associated with different pairwise combinations (Table 3-2). Among male groups, MF-Occ scores changed significantly in the following descending order: cisgender gynephilic males, cisgender ambiphilic males, cisgender androphilic males, and transgender androphilic males (Predictions 2-4). Between female groups, MF-Occ changed significantly in following ascending order: cisgender androphilic females, cisgender ambiphilic females, cisgender gynephilic females, and transgender gynephilic females (Predictions 2-4).

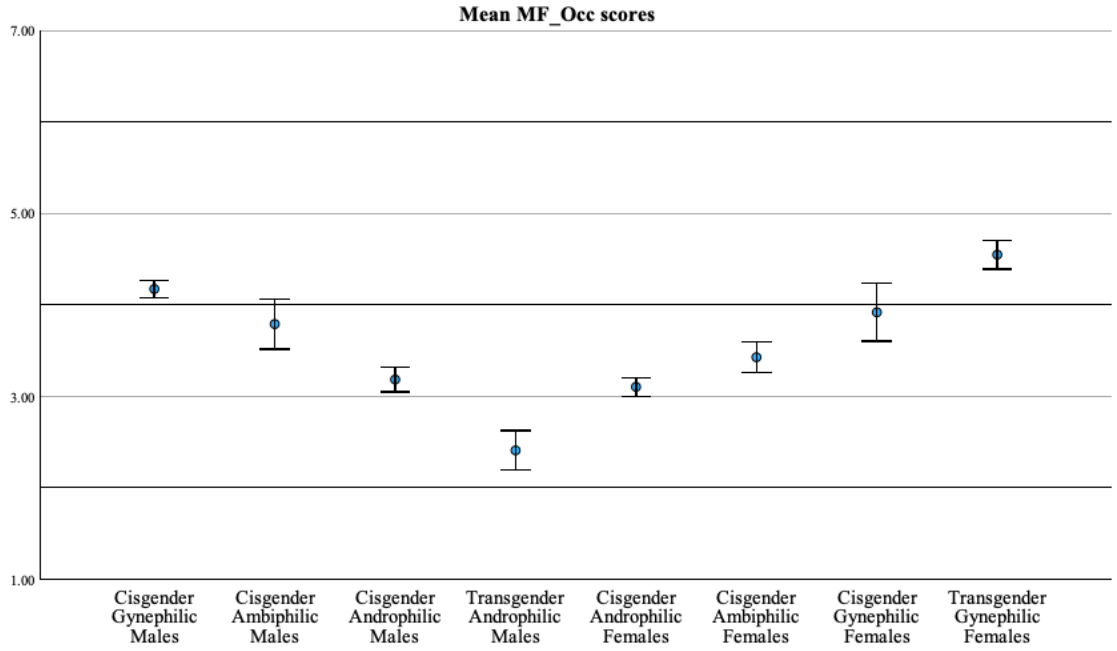


Figure 3-4 Mean MF-occ scores with 95% confidence interval error bars.

Correlates of Adulthood Occupational Preferences

Statistical analysis showed biodemographic parameters including age ($F[7, 954] = 5.70$, $p < 0.001$, $\eta^2 = 0.04$), education ($F[7, 975] = 11.21$, $p < 0.001$, $\eta^2 = 0.07$), and financial status ($F[7, 976] = 8.29$, $p < 0.001$, $\eta^2 = 0.06$) were different between groups. Overall, transgender participants, cisgender ambiphilic females, and cisgender gynephilic females were younger, had less education, and had weaker financial status compared to other groups, particularly, cisgender gynephilic males, cisgender androphilic males, and cisgender androphilic females (Supplementary Table s3-4). The possible effects of these variables on MF-Occ scores were explored by conducting regression analyses reported below.

Table 3-2 Between-group comparison of mean MF-Occ scores

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Cisgender Gynephilic Males	-	d = 0.49 (0.18 – 0.81)	d = 1.23 (1.01 – 1.44)	d = 2.20 (1.86 – 2.54)	d = 1.38 (1.17 – 1.58)	d = 0.97 (0.72 – 1.22)	d = 0.31 (-0.07 – 0.68)	d = -0.49 (-0.72 – -0.27)
Cisgender Ambiphilic Males	p = 0.065	-	d = 0.67 (0.35 – 1.00)	d = 1.44 (1.01 – 1.87)	d = 0.82 (0.50 – 1.14)	d = 0.41 (0.06 – 0.76)	d = -0.16 (-0.62 – 0.29)	d = -0.89 (-1.23 – -0.54)
Cisgender Androphilic Males	p < 0.001	p < 0.001	-	d = 0.79 (0.48 – 1.09)	d = 0.08 (-0.12 – 0.28)	d = -0.28 (-0.53 – -0.03)	d = -0.85 (-1.24 – -0.46)	d = -1.59 (-1.85 – -1.32)
Transgender Androphilic Males	p < 0.001	p < 0.001	p < 0.001	-	d = -0.78 (-1.08 – -0.48)	d = -1.11 (-1.46 – -0.76)	d = -1.67 (-2.17 – -1.17)	d = -2.47 (-2.87 – -2.06)
Cisgender Androphilic Females	p < 0.001	p < 0.001	p = 0.993	p < 0.001	-	d = -0.39 (-0.63 – -0.14)	d = -1.03 (-1.41 – -0.64)	d = -1.79 (-2.05 – -1.53)
Cisgender Ambiphilic Females	p < 0.001	p = 0.205	p = 0.275	p < 0.001	p = 0.043	-	d = -0.61 (-1.02 – -0.19)	d = -1.36 (-1.66 – -1.06)
Cisgender Gynephilic Females	p = 0.821	p = 0.993	p < 0.001	p < 0.001	p < 0.001	p = 0.053	-	d = -0.73 (-1.13 – -0.33)
Transgender Gyenphilic Females	p = 0.001	p < 0.001	p < 0.001	p < 0.001	p < 0.001	p < 0.001	p = 0.006	-

The upper part of table illustrates Cohen's d effect sizes of mean differences in MF-Occ scores followed by 95% confidence intervals in parenthesis. The lower part of table illustrates p values derived from post-hoc pairwise comparison using Tukey HSD method.

A one-way ANOVA showed that mean openness scores differed between groups (F[7, 968] = 3.77, $p < 0.001$, $\eta^2 = 0.03$). There were no significant differences in openness scores between cisgender groups. Transgender gynephilic females reported the lowest openness, significantly lower than cisgender androphilic males (d = -0.39 [0.63, -0.16], $p = 0.019$) and transgender androphilic males (d = -0.74 [-1.06, -0.41], $p < 0.001$), whereas transgender androphilic males had the highest mean score, that was significantly higher than cisgender androphilic females (d = 0.56 [0.27, 0.86], $p = 0.007$). In addition, mean CGIS scores were found to differ between groups (F[7, 976] = 256.11, $p < 0.001$, $\eta^2 = 0.65$); detailed description and in-depth analysis of CGIS data have been reported elsewhere (Sadr-Bazzaz et al., 2024; Chapter 2 of this dissertation).

For each sex, a three-step hierarchical multiple regression analysis was undertaken. Among males, the first model including age, education, and financial status significantly predicted the MF-occ scores (F[3, 492] = 4.11, $p = 0.007$, $\Delta R^2 = 0.02$). In the second step, the addition of CGIS scores and gender identity resulted in significant increase in the variation explained by the model (F[2, 490] = 165.91, $p < 0.001$, $\Delta R^2 = 0.39$). In the third step, entering sexual orientation and openness to the model resulted in a significant increase in the variation explained (F[2, 488] = 22.64, $p < 0.001$, $\Delta R^2 = 0.05$). The direction and significance level of estimated regression coefficients did not change from step one to three. Estimated parameters for the final model showed that CGIS scores (Prediction 5), sexual orientation (Predictions 2 and 3), and openness (Prediction 6) were significantly associated with MF-Occ scores among males (Table 3-3).

In females, the first model including age, education, and financial status significantly predicted MF-Occ scores (F[3, 455] = 9.62, $p < 0.001$, $\Delta R^2 = 0.06$). In second step, the addition

of CGIS scores and gender identity also resulted in a significant increase in model fitness (F[2, 453] = 159.42, $p < 0.001$, $\Delta R^2 = 0.39$). In the third step, entering sexual orientation and openness significantly increased the variation explained (F[2, 451] = 6.20, $p = 0.002$, $\Delta R^2 = 0.01$). Although in the first step significant regression coefficients were found for education ($\beta = -0.26$, $p < 0.001$), addition of variables in the second steps eliminated this significant. Similarly, while being identified as transgender was positively associated with MF-Occ in the second step ($\beta = 0.12$, $p = 0.020$), entering sexual orientation and openness in the third step eliminated this relationship. The final model showed that CGIS scores (Prediction 5), sexual orientation (Predictions 2 and 3), and openness (Prediction 6) were significantly associated with MF-Occ scores among female participants (Table 3-3).

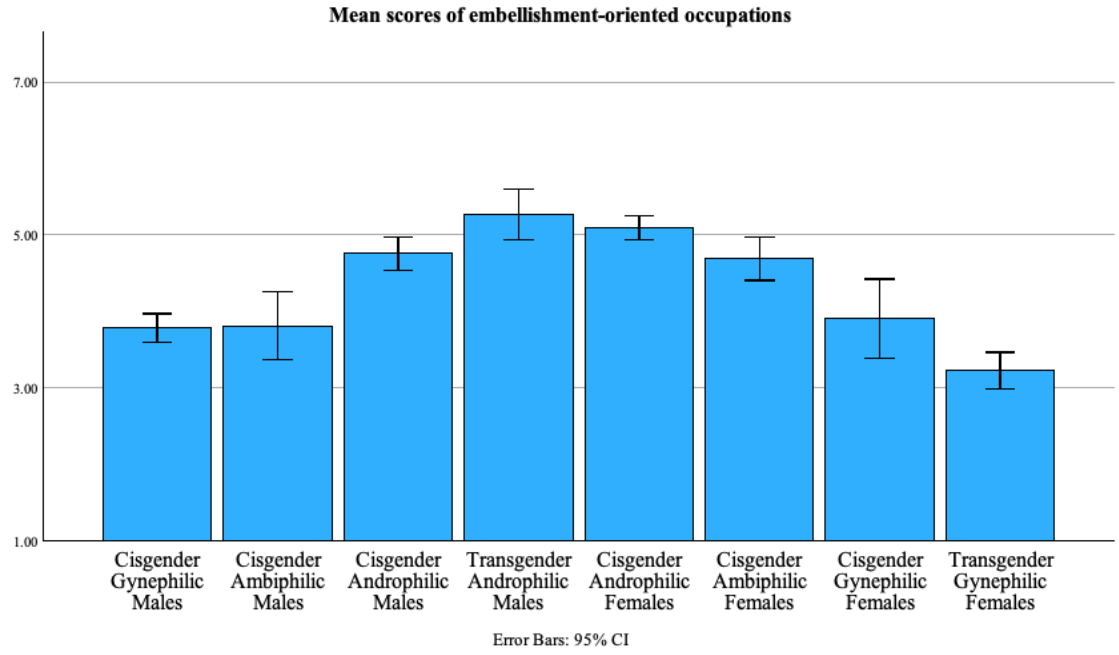


Figure 3-2 Mean scores for embellishment-oriented occupations with 95% confidence interval error bars.

Embellishment Occupations and Same-Sex Attraction

Comparing mean scores for embellishment-oriented occupations across groups showed between-groups differences ($F[7, 976] = 35.42$, $p < 0.001$; Figure 3-2; Supplementary Table s3-5) with transgender androphilic males, cisgender androphilic males, cisgender androphilic females, and cisgender ambiphilic females scoring significantly higher than other groups but not different from each other (Prediction 7). On the other hand, transgender gynephilic females scored lower than all other groups including cisgender gynephilic males, cisgender ambiphilic males, and cisgender gynephilic females who did not differ significantly with each other.

DISCUSSION

Here, we investigated patterns of occupational preferences among Iranian adult males and females who differed in their sexual orientation and gender identity. Participants were asked to report their interest in 15 occupations that were revealed to load on three different factors. We named these factors as things-, people-, and embellishment-oriented occupations echoing the type of activity they entail. In line with previous reports (Lippa, 2010), a composite occupational preferences score (MF-Occ) was calculated with higher scores indicating more male-typical occupational interests and lower scores indicating more female-typical interests. Notably, the effect size for the sex difference (i.e., cisgender gynephilic males versus cisgender androphilic females; Prediction 1) in MF-Occ ($d = 1.38$) was almost the same as the average effect size calculated by Lippa (2010) across 53 nations ($d = 1.40$).

Among both cisgender males and females, a change from gynephilic toward androphilic sexual orientation was negatively associated with change in MF-Occ scores. In other word, gynephilic participants reported the highest interests in male-typical occupations, whereas androphilic participants had the highest interests in female-typical occupations. The effect sizes

Table 3-3 Multiple regression analysis of MF-Occ scores among male and female participants

Model	Males (N = 495)			Females (N = 458)		
	$F(7, 488) = 61.26$, $p < 0.001$, adjusted $R^2 = 0.46$			$F(7, 451) = 55.52$, $p < 0.001$, adjusted $R^2 = 0.45$		
	Standardized β	t statistic	p value	Standardized β	t statistic	p value
Constant	-	7.31	< 0.001	-	8.08	< 0.001
Age	0.08	2.02	= 0.044	-0.01	-0.20	= 0.844
Education	-0.04	-0.91	= 0.361	0.01	0.26	= 0.796
Financial status	0.03	0.92	= 0.357	0.02	0.62	= 0.533
CGIS scores	0.45	8.55	< 0.001	0.52	9.12	< 0.001
Transgender identity	-0.02	-0.44	= 0.663	0.03	0.58	= 0.563
Sexual orientation*	-0.23	-5.04	< 0.001	-0.16	-2.72	= 0.007
Openness	-0.16	-4.83	< 0.001	-0.08	-2.37	= 0.018

* Dummy variable for sexual orientation was coded to reflect change from gynephilia (coded as -1) to ambiphilia (coded as 0) and androphilia (coded as 1), therefore, negative regression coefficients indicate that ambiphilic and androphilic sexual orientation were associated with decrease in MF-Occ scores.

for differences in mean MF-Occ scores between gynephilic and androphilic participants (Prediction 2) were in the range that is interpreted as large ($d > 0.8$). Thus, consistent with previous reports (Ellis et al., 2012; Gómez Jiménez et al., 2021; Lippa, 2005b, 2008b, 2020; Zheng et al., 2011), our study from a non-North American/Western European society provides support for the universal correlation between exclusive/predominant same-sex sexual attraction and adulthood sex-atypical occupational preferences. Furthermore, male or female ambiphilic participants scored intermediate to their gynephilic and androphilic counterparts (Prediction 3). The 95% confidence intervals for Cohen's *d* always excluded zero, although the *p* values were not always significant (Table 3-2). Therefore, we believe our results provide support for a graded relationship between sexual orientation and sex-typed interests in occupations (Ellis et al., 2012; Lippa, 2008b, 2020).

Variation in gender identity was also associated with occupational preferences given that both transgender groups scored differently than their cisgender counterparts who were of similar sex and sexual orientation (Prediction 4). Accordingly, transgender androphilic males reported higher interests in female-typical occupations compared to cisgender androphilic males ($d = 0.79$) and cisgender androphilic females ($d = 0.78$). This pattern is consistent with a study on Zapotec *muxe gunaa*, transgender androphilic males in Istmo region of Oxaca, Mexico, which reported overt interests in female-typical occupations not only compared to their more masculine presenting androphilic male counterparts, *muxe ngiuui* ($d = 0.57$), but also in comparison to cisgender androphilic females ($d = 0.59$; Gómez Jiménez et al., 2021). Semenyna and Vasey (2016) reported that average occupational preferences of *fa'afafine* (predominantly a transgender type of male androphilia in Samoa) were female-typical, but not hyper-feminized; (for more nuanced discussion see Gómez Jiménez et al., 2021). Regarding transgender gynephilic females,

they had greater interests in male-typical occupations than either cisgender gynephilic females (d = 0.73) or cisgender gynephilic males (d = 0.49). To our knowledge, this is the first study comparing occupational preferences of cisgender and transgender gynephilic females.

When examining developmental correlates of sexual orientation, the importance of childhood sex-typed behaviour cannot be overstated. Studies conducted across different cultures using various methodologies have consistently found, in both males and females, a large association between degree of childhood sex-atypicality and degree of same-sex attraction irrespective of gender identity/presentation (Bailey & Zucker, 1995; Bartlett & Vasey, 2006; Cardoso, 2009; Gómez Jiménez et al., 2020a; Li et al., 2017; Rieger et al., 2008, 2020; Roshan et al., 2019; Semenyna et al., 2017b; Whitam & Mathy, 1986, 1991; Xu et al., 2019; Xu & Rahman, 2024). In light of this, a regression analysis indicated that more male-typical childhood behaviour predicted higher MF-Occ or more male-typical occupational preferences (Prediction 5). This finding was in agreement with previous assessments (Gómez Jiménez et al., 2021; Kung, 2021; Lippa, 2008a; Semenyna & Vasey, 2016; VanderLaan et al., 2016). Notably, childhood play behaviour accounted for the majority of the variance explained by the models which included other variables like sexual orientation and gender identity.

Here, we also reported on openness, a personality trait, measured by Big Five Inventory (John & Srivastava, 1999). Unlike previous research that has associated same-sex sexual orientation, in both males and females, with higher levels of openness, such pattern was not evident in our data (Allen & Robson, 2020; Lippa, 2005b, 2010). Pairwise comparisons showed that most differences were trivial and statistically nonsignificant. The exceptions involved transgender androphilic males who scored higher than transgender gynephilic females. The regression analyses undertaken within each sex revealed that openness was negatively associated

with MF-Occ scores (Prediction 6), indicating that higher openness predicted higher interest in female-typical occupations (i.e., people- and embellishment-oriented occupations). This positive link between openness and occupations that involve interaction with people or have artistic component has previously been documented (Lippa, 1998), further supporting its contribution to individuals' occupational preferences.

In this study, we explored whether a class of occupations described by Whitam and Mathy (1986) as "embellishment" contributes to sex and sexual orientation differences in occupational preferences (Prediction 7). To do so, five occupations that involve artistic manipulation of objects were added to Lippa's questionnaire (2010). In support of Whitam and Mathy's observation (1986), common factor analysis showed these items clustering together on a separate factor than other items. Also, discriminant analysis revealed that embellishment occupations significantly contributed to the sex difference in occupational preferences between cisgender gynephilic males and cisgender androphilic females. In line with Whitam and Mathy (1986), both cisgender and transgender androphilic males exhibited elevated preference for embellishment occupations compared to cisgender gynephilic males. In line with Whitam's (1987) assertion that female gynephilia is associated with lower interests in artistic occupations, we found transgender and cisgender gynephilic females reporting lower interests in embellishment occupations compared to cisgender androphilic females. Overall, our explorative methodology confirmed the importance of embellishment, or Artistic, occupations in relation to sex and sexual orientation.

So far, we have provided evidence and discussed how sex, gender identity/presentation, and sexual orientation are associated with individuals' interests in different professions, but a remaining question is: *What causes these associations*? A common class of explanations

emphasizes the role of social environment in shaping sex differences in human behaviour and psychology through processes such as learning, imitating, and internalizing the stereotypes attributed to gender (Eagly & Wood, 2013; Lippa, 2005a). The Islamic Republic of Iran has promoted stereotypes and enforced policies regarding gender role expression which is reflected in the country's low rank (i.e., 143 among 146) with respect to gender equality in 2023 (World Economic Forum, 2023). However, attributing the observed sex difference in occupational preferences to gender inequality in Iran is not supported by existing evidence. Notably, in a study by Lippa (2010) across 53 nations, including countries with similar levels of gender inequality to Iran, no association was found between the size of sex differences in occupational preferences and the countries' gender equality indices. Moreover, when gender inequality is associated with sex differences in human psychology and behaviour, the direction of such an association cannot be consistently attributed to gender stereotypes as is demonstrated by *educational-gender-equality paradox* (Stoet & Geary, 2018).

Furthermore, in Iran, same-sex sexual behaviour is prosecuted and discussion of same-sex sexuality in the public media and other social domains (e.g., academia or arts) is severely restricted. In the absence of social endorsement and the presence of pervasive negative, if not lethal, views about same-sex sexuality, if nothing else, we would expect to observe attenuated sexual orientation differences among cisgender participants. In contrary, the results showed a sex-reversed pattern for cisgender androphilic males and cisgender gynephilic females who scored similar to cisgender androphilic females and cisgender gynephilic males, respectively. Assuming that shared developmental pathways mediate the effect of sex and sexual orientation on occupational preferences, inability of social explanations to account for variation in one (i.e., sexual orientation) can be interpreted as incapacity to explain variation in the other (i.e., sex).

This suggests that biology should be considered when formulating a causal explanation for traits showing universal sex and sexual orientation differences. Genetic studies, including identical and fraternal twins reared apart or together, have shown that variation in vocational interests is heritable and common rearing has "minimal effect" on vocational interests reported in adulthood (Betsworth et al., 1994; Bouchard et al., 1990). Similarly, higher correlations in vocational interests, including Holland's RIASEC types, have been found in biological versus adoptive parent-offspring pairs and siblings (Betsworth et al., 1994).

Another biological explanation for sex and sexual orientation differences in occupational preferences pertains to the possible role of early exposure to sex-(a)typical levels of androgens, particularly testosterone, in influencing human behaviour (also known as brain-organization hypothesis or neurohormonal theory; Balthazart, 2020; Breedlove, 2017; Ellis & Ames, 1987; Phoenix et al., 1959). Studies on females with congenital adrenal hyperplasia (CAH), a condition characterized by prenatal overproduction of androgens, have shown their higher interests in male-typical occupations and lower interests in female-typical occupations (Berenbaum, 1999; Meyer-Bahlburg et al., 2006; Servin et al., 2003).

An interesting, yet underappreciated, study by Ellis and Ratnasingam (2012) has provided more direct evidence for the role of androgens in sex-atypical occupational preferences of monosexual and ambisexual same-sex attracted males and females. They examined the correlations between reported interests in 26 occupations and eight self-rated androgen-related phenotypes such as masculine body appearance, physical strength, and low-deep voice. Among both sexes, interests in male-typical occupations positively correlated with androgen-related phenotypes, whereas interests in female-typical occupations negatively correlated with those measures. Occupations preferred by other-sex attracted males such as auto mechanic and

electrician correlated positively with androgen-related phenotypes while occupations like beautician or dress designer preferred by same-sex attracted males correlated negatively with those measures. Although the results on female participants were not as clear cut as for male participants, overall, they suggest a role for androgens in development of sex-atypical occupational preferences in same-sex attracted individuals.

While the patterns in our data and the evidence we have reviewed suggest that occupational preferences stem from a biological predisposition, it is useful to consider a more integrative approach that encompasses both biological and social factors. In a recent correlational study, Kung (2022) hypothesized that childhood play behaviour may help to shape adulthood occupational interests. Indeed, his research demonstrated that socio-cognitive processes (e.g., gender compatibility) mediate the link between childhood play behaviour and adult occupation preferences in a university sample of cisgender males and females. Extending this hypothesis, it can be speculated that observed sex-atypical play behaviour among same-sex attracted individuals (e.g., doll play in male children) might influence their sex-atypical occupational preferences (e.g., interest in being a teacher) helping to shape it through socio-cognitive processes. Looking at our data, the majority of the variance in occupational preferences was accounted for by variation in childhood play behaviour, consistent with Kung's (2022) suggestion. Accordingly, the observed heritability in occupational preferences or its correlations with androgen-related phenotypes might also be due to the mediation effect of childhood sex-typed behaviour which is both heritable and linked to prenatal androgens (Alanko et al., 2010; Bailey et al., 2000; Burri et al., 2011; Hines et al., 2015). However, several pieces of evidence should be considered before embracing such hypothetical mediation effect.

First, sex-typed interests in occupations begins early in life and has been documented in different countries including Iran (Hayes et al., 2018; Khorasani et al., 2023; Watson et al., 2015). Second, sex-atypical variations in occupational interests seems to be present around the same age as sex-atypical variations of childhood play behaviour. For instance, CAH girls with mean age of 5.5 years report heightened interests in male-typical occupations and lowered interests in female-typical occupations (Servin et al., 2003). The only evidence on age of onset of sex-atypical occupational preferences among same-sex attracted individuals, comes from the study of Whitam and Mathy (1986) who reported that as children, androphilic males in Brazil, the Philippines, and the United States, recalled elevated interests in combing or arranging the hair of their relative and wanting to become a movie actor. Evidence supporting an early expression of sex-(a)typical patterns in both occupational preferences and childhood play behaviour undermines the hypothesis that the former is shaped by the latter. Also, it is important to consider whether socio-cognitive processes suggested by Kung (2022), or other sophisticated cognitive functions could operate as early as childhood occupational interests are expressed. For instance, while preschool age children use vertical inferences to associate different categories (e.g., If he is a boy then he likes playing with airplanes), it seems that using horizontal inferences between categories of stereotypes (e.g., if he likes playing with airplane then he likes to be a pilot) develop later in school-age children (Martin & Ruble, 2010). Clearly, more research on development of occupational preferences and their correlates is needed to make a well-informed opinion about their underlying mechanisms.

Limitations

Our network sampling method may raise concerns about the degree to which it provides a representative sample, yet it was deemed the only way to examine sexuality, particularly same-

sex sexuality, in Iran given the sociopolitical atmosphere. Also, our sample of transgender participants could be described as a mix of clinic- and community-based samples. This mixed sample strategy may complicate the comparability of our results pertaining to transgender groups with previous research which used community-based samples (Gómez Jiménez et al., 2021; Hart, 1968; Semenyna & Vasey, 2016; Stief, 2017). In addition, classifying participants into cisgender or transgender based on concordance or discordance between their sex and gender identity may have induced heterogeneity to our transgender groups. In other words, those who identify as non-binary, but not "trans", might differ from those who identify with the gender identity typical of the other sex and also identify as "trans" (e.g., in their level of gender nonconformity). Our sample size did not allow for exploring such differences; however, future research would benefit from controlling this possible heterogeneity.

Another limitation of our study pertains to a relatively low number of recruited participants in groups such as cisgender ambiphilic males, transgender androphilic males, and cisgender gynephilic females. The performance of statistical tests assuming normality can be affected by inequal sample sizes, however, we used omnibus tests tolerant to such deviations from normality. Also, our focus in this study was not null hypothesis testing, rather, we were interested in patterns and differences demonstrated by Cohen's *d* effect sizes. Nonetheless, future studies would benefit from using larger more representative samples for these groups of individuals.

Also, occupational preferences were measured using a relatively short questionnaire that was modified to capture things-, people-, and embellishment-oriented occupations. Thus, our questionnaire could not explore the hexagonal structure of vocational interests and its underlying dimensions in relation to sex, sexual orientation, and gender identity (Holland, 1966; Lippa,

1998; Prediger, 1982). With respect to embellishment occupations, despite our success to quantitatively document Whitam and Mathy's observation (1986), our study is unable to show whether androphilic males' elevated interests in embellishment occupations is distinct and independent from interests in more people-oriented artistic occupations or whether it is a result of general interest in artistic occupations. Regarding gynephilic females, finding lower interests in artistic occupations was consistent with Whitam's (1987) observation, however, we did not address his other assertion of increased interests in athletics among gynephilic females. This interest in athletic professions may also be relevant to androphilic males as evidence suggest they are interested in different types of sports compared to gynephilic males (Cardoso, 2005, 2009). Therefore, future research would benefit from using more comprehensive list of occupations.

Conclusion

In this study, we examined variations in occupational preferences in adult Iranian cisgender ambiphilic males, cisgender androphilic males, transgender androphilic males, cisgender ambiphilic females, cisgender gynephilic females, and transgender gynephilic females in comparison to control groups of cisgender gynephilic males and cisgender androphilic females. Our results indicate that in both sexes, male-typical occupational interests are positively associated with gynephilic sexual orientation, whereas female-typical occupational interests positively correlate with androphilic sexual orientation. Accordingly, ambiphilic males and females scored intermediate to their monosexual counterparts. Transgender androphilic males exhibited the highest interests in female-typical occupations, even more feminine than cisgender androphilic females, and transgender gynephilic females mirrored this pattern, displaying the highest interests in male-typical occupations and one that was more masculine than cisgender gynephilic males. These findings support the conclusion that occupational preferences are cross-

culturally universal developmental correlates of same-sex attraction in both males and females, irrespective of degree of same-sex attraction or gender expression.

Investigating the developmental correlates of occupational preferences, we found that childhood sex-typed behaviour, sexual orientation, and openness predicted the reported interests in male- versus female-typical occupations. The strongest association was observed in relation to childhood play behaviour that accounted for majority of variance in occupational interests. This result demonstrates the interconnectedness between occupational preferences and childhood play behaviour, openness personality trait, and sexual orientation in both males and females, further highlighting the importance of studying occupational preferences as a piece in the puzzle of sexual orientation.

SUPPLEMENTARY MATERIAL

Of the 984 participants, 441 participants were recruited using social media and completed an online survey, while 543 participants were recruited in-person in Iran and were asked to complete the same survey. Comparison between two recruitment samples for biodemographic information is provided in the section Method of the main manuscript. Here, we provide statistical information pertaining to each recruitment sample (Supplementary Table s3-1 and s3-2). Also, we present descriptive data of MF-Occ, CGIS, and openness scores for eight groups of participants divided by recruitment samples (Supplementary Table s3-3) and in the merged sample (Supplementary Table s3-4). In supplementary Table s3-5, descriptive information for three types of occupations extracted using common factor analysis is presented.

Supplementary Table s3-1 Descriptive information for online recruitment sample

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Age (N)	124	27	73	14	128	50	10	10
Mean ± Standard deviation	30.16 ± 7.23	26.55 ± 6.75	28.89 ± 6.60	25.00 ± 4.08	29.17 ± 6.96	26.90 ± 5.99	27.10 ± 8.18	26.10 ± 7.40
Level of education (N)	126	28	74	14	128	50	10	10
Junior high school	0.8%	0.0%	0.0%	0.0%	0.0%	4.0%	0.0%	0.0%
High school	8.7%	25.0%	21.6%	28.6%	10.9%	22.0%	40.0%	40.0%
College	8.7%	21.4%	14.9%	14.3%	7.0%	6.0%	0.0%	10.0%
Undergraduate	42.1%	28.6%	31.1%	28.6%	41.4%	38.0%	30.0%	40.0%
Post-graduate	39.7%	25.0%	32.4%	28.6%	40.6%	30.0%	30.0%	10.0%
Financial Status (N)	126	28	75	14	128	50	10	10
Very bad	0.8%	3.6%	2.7%	7.1%	0.0%	0.0%	0.0%	0.0%
Bad	10.3%	14.3%	12.0%	21.4%	5.5%	10.0%	10.0%	0.0%
Not bad Not good	57.9%	71.4%	58.7%	57.1%	51.6%	42.0%	70.0%	40.0%
Good	27.8%	7.1%	24.0%	14.3%	35.9%	42.0%	20.0%	50.0%
Very good	3.2%	3.6%	2.7%	0.0%	7.0%	6.0%	0.0%	10.0%

Supplementary Table s3-2 Descriptive information for in-person recruitment sample

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Age (N)	102	20	101	44	95	44	21	109
Mean ± Standard deviation	23.82 ± 3.88	25.05 ± 5.69	26.46 ± 6.25	24.22 ± 5.15	24.47 ± 4.57	22.32 ± 2.80	21.52 ± 3.12	24.32 ± 4.53
Level of education (N)	102	20	103	44	98	44	21	111
Junior high school	3.9%	5.0%	2.9%	6.8%	0.0%	0.0%	4.8%	4.5%
High school	44.1%	25.0%	30.1%	43.2%	22.4%	38.6%	47.6%	45.9%
College	15.7%	25.0%	15.5%	18.2%	23.5%	27.3%	28.6%	18.0%
Undergraduate	28.4%	40.0%	35.0%	27.3%	43.9%	27.3%	19.0%	24.3%
Post-graduate	7.8%	5.0%	16.5%	4.5%	10.2%	6.8%	0.0%	7.2%
Financial Status (N)	102	20	103	44	98	44	21	111
Very bad	0.0%	5.0%	3.9%	15.9%	1.0%	2.3%	0.0%	5.4%
Bad	9.8%	5.0%	11.7%	11.4%	3.1%	6.8%	4.8%	11.7%
Not bad Not good	63.7%	50.0%	57.3%	59.1%	62.2%	59.1%	38.1%	67.6%
Good	23.5%	40.0%	23.3%	11.4%	31.6%	25.0%	57.1%	15.3%
Very good	2.9%	0.0%	3.9%	2.3%	2.0%	6.8%	0.0%	0.0%

Supplementary Table s3-3 Mean and standard deviation of MF-Occ, CGIS, and openness scores across recruitment samples

	Number of participants		MF-Occ		CGIS		Openness	
Groups	Online	In-person	Online	In-person	Online	In-person	Online	In-person
Cisgender Gynephilic Males	126	102	4.17 ± 0.73	4.17 ± 0.77	4.19 ± 0.34	4.22 ± 0.44	4.10 ± 0.60	3.95 ± 0.64
Cisgender Ambiphilic Males	28	20	3.87 ± 0.91	3.66 ± 1.03	3.90 ± 0.64	3.74 ± 0.85	4.05 ± 0.51	4.08 ± 0.58
Cisgender Androphilic Males	75	103	3.14 ± 0.72	3.19 ± 1.01	3.22 ± 0.75	3.04 ± 0.89	4.06 ± 0.67	4.04 ± 0.62
Transgender Androphilic Males	14	44	2.46 ± 0.90	2.47 ± 0.88	2.36 ± 0.82	1.70 ± 0.54	4.5 ± 0.39	4.12 ± 0.60
Cisgender Androphilic Females	128	98	3.10 ± 0.81	3.11 ± 0.78	2.22 ± 0.65	2.06 ± 0.55	3.94 ± 0.65	3.86 ± 0.58
Cisgender Ambiphilic Females	50	44	3.34 ± 0.85	3.50 ± 0.83	2.61 ± 0.81	2.49 ± 0.83	4.10 ± 0.59	3.87 ± 0.70
Cisgender Gynephilic Females	10	21	3.64 ± 0.70	4.08 ± 0.94	2.98 ± 1.00	3.16 ± 0.93	3.98 ± 0.60	4.01 ± 0.65
Transgender Gynephilic Females	10	111	4.34 ± 1.14	4.57 ± 0.80	3.92 ± 0.75	4.31 ± 0.58	3.80 ± 0.64	3.83 ± 0.60

Supplementary Table s3-4 Mean and standard deviation for MF-Occ, CGIS, openness, education, and financial status across groups

	MF-Occ	CGIS	Openness	Age*	Education	Financial Status
Cisgender Gynephilic Males (N = 228)	4.17 ± 0.75	4.20 ± 0.39	4.03 ± 0.62	27.30 ± 6.74	3.58 ± 1.17	3.21 ± 0.68
Cisgender Ambiphilic Males (N = 48)	3.78 ± 0.96	3.83 ± 0.73	4.06 ± 0.54	25.91 ± 6.30	3.37 ± 1.10	3.06 ± 0.75
Cisgender Androphilic Males (N = 178)	3.17 ± 0.90	3.12 ± 0.84	4.05 ± 0.64	27.48 ± 6.49	3.50** ± 1.16	3.12 ± 0.78
Transgender Androphilic Males (N = 58)	2.46 ± 0.88	1.86 ± 0.68	4.21 ± 0.58	24.64 ± 4.88	2.98 ± 1.15	2.74 ± 0.91
Cisgender Androphilic Females (N = 226)	3.10 ± 0.80	2.15 ± 0.62	3.90 ± 0.62	27.17 ± 6.53	3.81 ± 1.01	3.38 ± 0.67
Cisgender Ambiphilic Females (N = 94)	3.42 ± 0.84	2.56 ± 0.82	3.99 ± 0.65	24.75 ± 5.27	3.37 ± 1.16	3.36 ± 0.77
Cisgender Gynephilic Females (N = 31)	3.93 ± 0.88	3.10 ± 0.94	4.00 ± 0.62	23.32 ± 5.80	2.90 ± 1.11	3.39 ± 0.61
Transgender Gynephilic Females (N = 121)	4.55 ± 0.83	4.28 ± 0.60	3.82 ± 0.60	24.47 ± 4.81	2.887± 1.08	2.99 ± 0.72

*Overall, 12 data points were missing for age: cisgender gynephilic males (n = 2), cisgender ambiphilic males (n = 1), cisgender androphilic males (n = 4), cisgender androphilic females (n = 3), and transgender gynephilic females (n = 2). ** One data point was missing for education in cisgender androphilic males.

Supplementary Table s3-5 Mean and standard deviation for things-, people-, and embellishment-oriented occupations across groups

Groups	Things	People	Embellishment
Cisgender Gynephilic Males (N = 228)	3.18 ± 1.35	2.89 ± 1.28	3.78 ± 1.41
Cisgender Ambiphilic Males (N = 48)	2.75 ± 1.51	3.59 ± 1.43	3.81 ± 1.52
Cisgender Androphilic Males (N = 178)	2.15 ± 1.24	3.88 ± 1.61	4.76 ± 1.50
Transgender Androphilic Males (N = 58)	1.39 ± 0.64	4.73 ± 1.56	5.27 ± 1.25
Cisgender Androphilic Females (N = 226)	2.20 ± 1.21	3.80 ± 1.54	5.09 ± 1.17
Cisgender Ambiphilic Females (N = 94)	2.53 ± 1.49	3.59 ± 1.39	4.69 ± 1.39
Cisgender Gynephilic Females (N = 31)	2.64 ± 1.20	2.93 ± 1.51	3.90 ± 1.41
Transgender Gynephilic Females (N = 121)	4.16 ± 1.50	3.28 ± 1.35	3.22 ± 1.35

Chapter 4: Recalled Childhood Separation Anxiety in Iranian Adult Males and Females with Diverse Sexual Orientation and Gender Identity/Expression

ABSTRACT

This research, conducted in Iran, examined whether recalled childhood separation anxiety varied with sex (i.e., elevated in androphilic females compared to gynephilic males), sexual orientation (elevated in androphilic males and females compared to gynephilic males and females, respectively) and gender identity/expression (i.e., elevated in feminine males and females compared to masculine males and females, respectively). Iranian cisgender gynephilic males (n = 248), cisgender ambiphilic males (n = 104), cisgender androphilic males (n = 310), transgender androphilic males (n = 102), cisgender androphilic females (n = 234), cisgender ambiphilic females (n = 94), cisgender gynephilic females (n = 31), and transgender gynephilic females (n = 119) rated their recalled traits of childhood separation anxiety (i.e., Parent Separation and Parent Worry) between 6-12 years of age. For Parent Separation subscale, cisgender ambiphilic and androphilic males scored intermediate between cisgender gynephilic males and transgender androphilic males. In females, transgender gynephilic females scored lower than all other groups except cisgender gynephilic females. For Parent Worry subscale, only transgender androphilic males exhibited an elevated mean score compared to other male groups, while no between-group difference was found in females. Consistent with previous reports, our findings from Iran indicate positive associations exists in males among recalled childhood separation anxiety, androphilic sexual orientation and feminine gender identity/expression. In addition, this study provides evidence that recalled childhood separation anxiety is lowered in transgender gynephilic females.

INTRODUCTION

Experiencing fear or anxiety is part of normal development, and it is manifested differently in different age groups. Children aged 5 to 12 years commonly express concerns about the wellbeing of, or separation from, attachment figures like their parents or siblings (Malgorzata et al., 2011; Weems & Costa, 2005). A person may be diagnosed with Separation Anxiety Disorder (SAD) when such anxious feelings are excessive, distressing, and developmentally inappropriate (American Psychiatric Association, 2022). SAD is among the most common psychological disorders in middle childhood (i.e., 6-12 years; Polanczyk et al., 2015; Sacco et al., 2022; Vasileva et al., 2021). Childhood SAD can be comorbid with other psychological disorders and is a potential precursor for psychological problems that emerge later in life (e.g., Panic Disorder; Beesdo et al., 2009; Kossowsky et al., 2013; Mohammadi et al., 2020; Spence et al., 2018). Thus, studying developmental correlates of childhood separation anxiety and its predictors can contribute to the provisioning of more targeted and, thus, efficient mental health care.

Regarding the relationship between sex (i.e., male or female) and the prevalence of childhood SAD, previous research has produced mixed results. Some studies have reported higher rates in girls (Nair et al., 2013; Shear et al., 2006), whereas others, including a study conducted in Iran, have found no sex difference (Mohammadi et al., 2020; Spence et al., 2018). Despite the discrepancy among categorical assessments of childhood separation anxiety (i.e., presence or absence of SAD), evidence from dimensional evaluations indicates that girls are more likely than boys to experience separation anxiety. Indeed, a meta-analysis has shown that subclinical symptoms of childhood separation anxiety are higher in girls from Euro-American countries, China and South Africa (Hale et al., 2011). Retrospective research (i.e., adult

participants rating their experienced separation anxiety before the age of 12) in Samoa and Istmo Zapotec, Mexico, has also indicated that females experience more childhood anxiety disorder (Gómez et al., 2017; Vanderlaan et al., 2017; Vasey et al., 2011). This conclusion is consistent with findings that females are at risk of more anxiety related disorders compared to males (e.g., general anxiety disorder, social anxiety disorder; Jalnapurkar et al., 2018).

Regarding the relationship between sexual orientation (e.g., androphilia, gynephilia, ambiphilia) and the prevalence of childhood SAD, no prospective study has been conducted. However, retrospective studies in countries including Canada, Mexico, Samoa, and Thailand have consistently reported that androphilic males, be they cisgender or transgender, recall higher levels of separation anxiety compared to their gynephilic counterparts (Gómez et al., 2017; Petterson et al., 2017a; Swift-Gallant et al., 2022a; VanderLaan et al., 2011, 2015, 2016, 2017; Vasey et al., 2011; Zahran et al., 2023; see Table 4-1). In females, research on this matter has produced inconsistent results. A retrospective study of Canadian cisgender gynephilic females reported elevated childhood separation anxiety in this group compared to cisgender androphilic females (Petterson et al., 2017a). However, other studies conducted in Canada and Thailand have not found female sexual orientation differences in recalled childhood separation anxiety (Vanderlaan et al., 2011; 2015; Zahran et al., 2023). Limited number of studies assessing separation anxiety in same-sex attracted females highlights the need for further research in this group.

Evidence also suggests an association exists between childhood separation anxiety and sex-atypical gender identity/expression, particularly in boys. Clinical reports have shown a higher prevalence of SAD among markedly feminine boys referred to gender clinics, compared to the rates observed in the general population (Coates & Person, 1985; Zucker et al., 1996;

VanderLaan et al., 2018; but see Wallien et al., 2007). Furthermore, the association between separation anxiety and sex-atypicality in childhood has been reported in a community-based sample of Canadian boys (Santarossa et al., 2019). Consistently, retrospective reports from Mexico and Thailand have shown that more feminine presenting or transgender androphilic males recall more childhood separation anxiety compared to more masculine presenting, or cisgender, androphilic males (Gómez et al., 2017; Zahran et al., 2023). On the other hand, data on markedly masculine girls are rare and the limited data do not support a link between separation anxiety and gender expression in this group (Santarossa et al., 2019; Wallien et al., 2007). For example, a study conducted in Thailand found no significant differences in recalled childhood separation anxiety between *Toms* (i.e., masculine gynephilic females) and cisgender females, be they androphilic, gynephilic, or ambiphilic (Zahran et al., 2023).

In sum, the evidence suggests that female sex, sex-atypical gender expression in males (i.e., relatively more feminine expression), and male androphilia are correlated with childhood separation anxiety. As such, these phenotypes may share overlapping developmental pathways. Childhood separation anxiety often co-occurs with other psychological disorders in childhood and adulthood (e.g., Social Phobia, Panic Disorder, etc.; Kossowsky et al., 2013; Mohammadi et al., 2020). Furthermore, atypical sexual orientation and gender identity/expression have also been associated with increased mental health problems, including higher prevalence for anxiety and depressive disorders, self-harm, and suicide (King et al., 2008; Plöderl & Tremblay, 2015; Wittgens et al., 2022). Therefore, studying childhood separation anxiety and its developmental correlates can help us understand factors contributing to the elevated susceptibility for psychological disorders among people with diverse sexual and gender expressions.

Table 4-1 Studies of recalled childhood traits of separation anxiety

Author(s)/Country(ies)	Measure(s)	Effect size of difference (95% confidence interval)	
Vasey et al. (2011) Samoa	*Separation Anxiety Scale* (7-item) Symptoms of separation anxiety assessed based on DSM-IV-TR Average and item scores were reported.	Gynephilic men vs. Androphilic women Gynephilic men vs. *Fa'afafine*[*]	*d* = -0.20 (-0.43, 0.03) *d* = -0.41 (-0.63, -0.19)
Vanderlaan et al. (2011) Canada	*Separation Anxiety Scale* (8-item) Average and item scores were reported.	Heterosexual men vs. Heterosexual women Heterosexual men vs. Homosexual men Heterosexual women vs. Homosexual women	*d* = -0.33 (-0.61, -0.05) *d* = -0.30 (-0.58, -0.01) *d* = 0.00 (-0.27, 0.27)
Vanderlaan et al. (2015) Canada	*Separation Anxiety Scale-Revised* Average scores were reported for: Parent Worry Subscale (8 items) Parent Separation Subscale (5 items)	<u>Heterosexual males vs. Heterosexual females</u> Parent Worry Parent Separation <u>Heterosexual males vs. Homosexual males</u> Parent Worry Parent Separation <u>Heterosexual females vs. Homosexual females</u> Parent Worry Parent Separation	 *d* = -0.35 (-0.58, -0.11) *d* = -0.06 (-0.30, 0.17) *d* = -0.33 (-0.57, -0.09) *d* = -0.18 (-0.42, 0.06) *d* = -0.05 (-0.31, 0.21) *d* = -0.07 (-0.34, 0.18)
Vanderlaan et al. (2017) Samoa	Expanded version of *Separation Anxiety Scale-Revised* Average scores were reported for: The Parent Worry (8 items) The Parent Separation (5 items) The Sibling Worry (5 items) The Sibling Separation (5 items)	<u>Gynephilic men vs. Androphilic women</u> Parent Worry Parent Separation <u>Gynephilic men vs. *Fa'afafine*</u> Parent Worry Parent Separation	 *d* = -0.31 (-0.57, -0.06) *d* = -0.28 (-0.53, -0.03) *d* = -0.70 (-0.93, -0.47) *d* = -0.29 (-0.52, -0.07)
Petterson et al. (2017) Canada	A questionnaire based on DSM-IV-TR and DSM-V Average scores were reported for unspecified number of items	Heterosexual men vs. Heterosexual women Heterosexual men vs. Gay men Heterosexual women vs. Lesbian women	*d* = -0.28 (-0.54, -0.02) *d* = -0.39 (-0.63, -0.16) *d* = -0.40 (-0.69, -0.11)
Gomez et al. (2017) Mexico (Istmo Zapotec)	*Separation Anxiety Scale* (7-item) Average and item scores were reported.	Gynephilic men vs. Androphilic women Gynephilic men vs. *Muxe nguiiu*[**] Gynephilic men vs. *Muxe gunna*[*] *Muxe nguiiu* vs. *Muxe gunna*	*d* = -0.54 (-0.78, -0.30) *d* = -0.32 (-0.62, -0.01) *d* = -0.61 (-0.86, -0.36) *d* = -0.30 (-0.61, 0.01)

Swift-Gallant et al. (2022a) Australia, Canada, New Zealand, United Kingdom, and the United States	Separation Anxiety Scale-Revised Average scores are reported for: Worry subscale (8 items) Separation subscale (5 items)	<u>Heterosexual men vs. Gay men</u> Parent Worry Parent Separation	 *d* = -0.31 (-0.51, -0.12) *d* = -0.21 (-0.40, -0.02)
Zahran et al. (2023) Thailand	Expanded version of Separation Anxiety Scale-Revised Average scores are reported for these subscales: The Parent Worry (8 items) The Parent Separation (5 items) The Sibling Worry (5 items) The Sibling Separation (5 items)	<u>Heterosexual men vs. Heterosexual women</u> Parent Worry Parent Separation <u>Heterosexual men vs. Gay men</u> Parent Worry Parent Separation <u>Heterosexual men vs. *Sao prophet song**</u> Parent Worry Parent Separation <u>Gay men vs. Sao prophet song</u> Parent Worry Parent Separation <u>Heterosexual women vs. Bisexual women</u> Parent Worry Parent Separation <u>Heterosexual women vs. Lesbian women</u> Parent Worry Parent Separation <u>Heterosexual women vs. *Toms****</u> Parent Worry Parent Separation <u>*Lesbian women* vs. *Toms*</u> Parent Worry Parent Separation	 *d* = -0.41 (-0.58, -0.25) *d* = -0.12 (-0.28, 0.05) *d* = -0.59 (-0.77, -0.41) *d* = 0.02 (-0.16, 0.20) *d* = -0.47 (-0.66, -0.28) *d* = -0.25 (-0.44, -0.06) *d* = 0.13 (-0.07, 0.33) *d* = -0.27 (-0.47, -0.07) *d* = 0.07 (-0.22, 0.37) *d* = 0.43 (0.13, 0.72) *d* = -0.10 (-0.38, 0.18) *d* = -0.13 (-0.41, 0.15) *d* = 0.09 (-0.10, 0.27) *d* = 0.11 (-0.07, 0.30) *d* = 0.19 (-0.10, 0.49) *d* = 0.22 (-0.07, 0.52)

* Transgender androphilic males who identify, and are identified with, culturally specific identities. ** Androphilic males who are relatively more masculine compared to their more feminine presenting counterpart, muxe gunna. *** Transgender gynephilic females who present in a masculine manner.

Beyond the implications that elevated childhood separation anxiety may have for an individual's mental health, it has been suggested that, at sub-clinical levels, elevated separation anxiety may have a prosocial function (VanderLaan et al., 2010). Accordingly, Vanderlaan et al. (2010) has proposed that increased separation anxiety, particularly worrying about the wellbeing of close kin (i.e., parents and siblings), is a component of "generalized feminine development" that is expressed more intensely in pre-androphilic boys compared to pre-gynephilic boys. They further argued that among androphilic males, this tendency serves as a developmental precursor, which, in adulthood, manifests as heightened altruistic behaviour toward nieces and nephews (Vasey et al., 2007). These prosocial tendencies could, in theory (Hamilton, 1963), increase a same-sex attracted male's indirect fitness, by promoting the survival of kin children, thereby compensating for the male's decreased reproductive output (Apostolou, 2022; Coome et al., 2020; Vasey et al., 2014). Support for this hypothesis comes from studies that have shown (1) androphilic males recalling elevated worry about the wellbeing of their parents and siblings (Gómez et al., 2017; Swift-Gallant et al., 2022a; VanderLaan et al., 2011, 2015, 2016, 2017; Vasey et al., 2011; Zahran et al., 2023), (2) which is positively correlated with feminine gender expression (Petterson et al., 2017a; VanderLaan et al., 2015, 2016, 2017).

If childhood separation anxiety is an adaptation in pre-androphilic boys that serves as a precursor for altruistic tendencies toward kin in adulthood, then a key, selected aspect of this anxiety might be a heightened concern for the well-being of primary attachment figures, rather than solely for oneself. Accordingly, two closely related but distinct dimensions of childhood separation anxiety have been proposed: Parent/Siblings Worry, which involves symptoms related to concern for wellbeing of one's parents/siblings, and Parent/Siblings Separation, which entails anxiety about being alone and focusing on one's own safety (Vanderlaan et al., 2010, 2015).

Evidence for the proposed bidimensional structure of childhood separation anxiety is still emerging (Table 4-1), and more research is needed to establish its validity and reliability within and across cultures.

Present Study

In this study, we investigated if recalled childhood separation anxiety is associated with variation in sexual orientation and gender identity among Iranian adult males and females. Existing research has largely assessed psychological outcomes in Iranian cisgender and transgender same-sex attracted individuals (Kabir & Brinsworth, 2021, 2024; Khorashad et al., 2021). To our knowledge, this is the first study assessing recalled childhood separation anxiety in Iran.

In this paper, we report two related measures of childhood separation anxiety: Parent Separation and Parent Worry subscales. Based on our review of the literature summarized in Table 4-1, we predicted that: (1) Cisgender androphilic females would score higher in the Parent Separation and Parent Worry, particularly Parent Separation, compared to cisgender gynephilic males. (2) Androphilic males, cisgender or transgender, would score higher than cisgender gynephilic males for both subscales, particularly the Parent Worry. (3) Transgender androphilic males would score higher than cisgender androphilic males for both subscales, particularly the Parent Worry. (4) Cisgender ambiphilic males would score intermediate between cisgender gynephilic males and cisgender androphilic males for both subscales, in particular, the Parent Worry. (5) Gynephilic females, cisgender or transgender, would score lower than cisgender androphilic females for both subscales. (6) Transgender gynephilic females would score lower than cisgender gynephilic females for both subscales. (7) Cisgender ambiphilic females would

score intermediate between cisgender androphilic females and cisgender gynephilic females for both subscales.

METHOD

Recruitment

In this paper, we present data collected over three years from November 2021 to September 2024 through three recruitment attempts. The first recruitment sample was drawn from an online survey conducted using Qualtrics. Popular social media platforms among Iranians such as Twitter, Instagram, and Telegram were used as the main routes for distributing the invitation to participate in the study. The message began with "We are seeking Iranian men and women (18 years of age or older) to participate in a voluntary, anonymous and confidential study on childhood and adulthood behaviour and psychology. Participants can be heterosexual or homosexual, gender conforming or non-gender conforming, including trans individuals." An anonymous link was included in the message which was used by interested individuals to access the survey. The responses were recorded between November 2021 and July 2022.

The second recruitment sample was collected between April 2022 and April 2024 in Mashhad and Tehran, Iran. A snowball sampling method was used to recruit most participants. Some transgender participants were current or previous clients of a gender clinic in Mashhad and were recruited through that clinic. Most of these individuals had received the diagnosis of gender dysphoria and were at different stages of gender transition. These individuals would then sometimes introduce other transgender individuals who had not been clients of this clinic in the past. Diagnosis of gender dysphoria was not an inclusion criterion for participation in this study. Cisgender same-sex attracted participants were initially found through the personal social networks of first two authors. These individuals would then introduce other individuals who

were not in the authors' social networks. We also recruited some staff and students at a hospital in Mashhad and some participants from public social spaces such as coffee shops and malls. These individuals constituted our control groups of other-sex attracted males and females.

The third round of data collection was undertaken between June and September 2024. A poster was circulated in online social groups that targeted Iranians with diverse sexuality or gender. The invitation asked readers to contact the first two authors if interested in participation. The first author scheduled meetings with participants who agreed to meet in-person. Otherwise, the survey link was shared, and further communications remained online. Participants were also asked if they had participated in previous rounds of recruitment and duplicated data points were removed.

Participants

Overall, we had unique data recorded from 1601 participants, with 552 recruited in the first round, 592 in the second, and 472 in the third one. 1304 participants provided data on childhood separation anxiety (in the third round, this questionnaire was not presented to female participants). Data from eight groups of participants (n =1242) were considered for statistical analysis. These groups included cisgender gynephilic males (n = 248), cisgender ambiphilic males (n = 104), cisgender androphilic males (n = 310), transgender androphilic males (n = 102), cisgender androphilic females (n = 234), cisgender ambiphilic females (n = 94), cisgender gynephilic females (n = 31), and transgender gynephilic females (n = 119). Due to small group size, we did not analyze data from the other eight groups including transgender gynephilic males (n = 3), transgender ambiphilic males (n = 5), transgender androphilic females (n = 2), transgender ambiphilic females (n = 8), cisgender asexual/analloerotic males (n = 9), transgender

asexual/analloerotic males (n = 1), cisgender asexual/analloerotic females (n = 14), and transgender asexual/analloerotic females (n = 2).

Measures

Demographic Information

The survey comprised standardized questionnaires that were translated to Farsi from English by a fluent bilingual (English and Farsi) speaker. Participants were asked to report their age (i.e., year of birth), level of education, and financial status. Level of education was reported on a 7-point scale: 1 = "no education" to 7 = "postgraduate degree." Due to the limited number of participants in first three levels of education, those levels were collapsed and are presented together resulting in five levels of education. Participants were also asked to report their overall financial status on 5-point scale from 1 = "very bad" (I need financial aid for my basic needs) to 5 = "very good" (I have no concerns about money). Overall, cisgender gynephilic males, cisgender androphilic males, and cisgender androphilic females were older, had more education, and reported a better financial status compared to other groups (Table 4-2).

Sex, Gender Identity/Expression, and Sexual Orientation

In terms of sex, we categorized participants based on their answer to the following question: "Which sex were assigned to you at birth? (*male*, *female*, and if *other* please specify.)" In terms of gender, participants were asked two consecutive questions: "What is your gender identity? (*man*, *woman*, and if *other* please specify)" and "Are you transgender or transsexual? (*yes* or *no*)". When participants identified as a female identifying as a woman or a male

Table 4-2 Demographic characteristics of participants

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Number of participants	248	104	310	102	234	94	31	119
*Age**								
Mean ± Standard deviation	27.30 ± 6.77	24.56 ± 5.01	26.61 ± 6.29	23.99 ± 4.55	27.13 ± 6.61	24.75 ± 5.27	23.32 ± 5.80	24.45 ± 4.80
*Level of education***								
Junior high school	2.0%	1.0%	1.0%	3.0%	0.0%	2.1%	3.2%	4.2%
High school	22.2%	13.5%	15.9%	25.7%	16.7%	28.7%	45.2%	45.4%
College	14.1%	41.3%	25.6%	35.6%	14.5%	16.0%	19.4%	16.8%
Undergraduate	37.5%	32.7%	36.6%	27.7%	42.7%	34.0%	22.6%	26.1%
Post-graduate	24.2%	11.5%	21.0%	7.9%	26.1%	19.1%	9.7%	7.6%
Financial Status								
Very bad	0.8%	2.9%	4.2%	9.9%	0.4%	1.1%	0.0%	4.2%
Bad	9.3%	15.4%	11.9%	16.8%	4.3%	8.5%	6.5%	10.9%
Not bad Not good	58.1%	61.5%	60.3%	57.4%	56.4%	51.1%	48.4%	66.4%
Good	28.6%	19.2%	21.0%	13.9%	34.2%	33.0%	45.2%	17.6%
Very good	3.2%	1.0%	2.6%	2.0%	4.7%	6.4%	0.0%	0.8%

* Overall, 13 data points were missing: cisgender gynephilic males (n = 2), cisgender ambiphilic males (n = 1), cisgender androphilic males (n = 5), transgender androphilic males (n = 1), cisgender androphilic females (n = 3), and transgender gynephilic females (n = 2). ** One data point was missing for cisgender androphilic males and one for transgender androphilic males.

identifying as a man, and as neither transgender nor transsexual, they were categorized as *cisgender*. Participants were classified as *transgender* if they: (1) identified as a *woman* while being identified as a male at birth, or (2) identified as a *man* while being identified as a female at birth, or (3) identified as neither a *man* nor a *woman*. Of 102 transgender males included in this paper, 30 identified neither as a man nor a woman; their most common reported gender identity was *non-binary* (n = 17). Also, 16 out of 30 did not self-identify as transgender/transsexual. Of 119 transgender females, eight participants reported an alternative gender identity with non-binary being the most common (n = 4). Also, five out of eight did not self-identify as transgender/transsexual.

To assess sexual orientation, participants were asked to report their sexual feelings towards adult males/men or females/women, during the previous 12 months, using a 7-point Likert scale (Kinsey et al., 1948). Participants who had sexual feelings only for females/women (score = 0), or had only an occasional fantasy about males/men (score = 1) were categorized as *gynephilic,* those who had stronger sexual feelings for both males/men and females/women (score = 2 to 4) were categorized as *ambiphilic,* and those who had only an occasional fantasy about females/women (score = 5), or were only attracted to males/men (score = 6) were categorized as *androphilic*. An eighth item was added for participants who "have not any sexual feelings toward any sex/gender," and these individuals were categorized as *asexual/analloerotic.* Since it was unclear from the item whether any other type of sexual feeling was present or not, this group could be either asexual (i.e., no sexual feelings whatsoever) or analloerotic (i.e., presence of sexual feelings but not directed toward males/men or females/women; Blanchard, 1989).

Recalled childhood separation anxiety

Participants were asked to report their recalled childhood separation anxiety when 6 to 12 years old, on a 5-point scale (1 = "never true" to 5 = "always true") using a modified version of *Separation Anxiety Scale-Revised*, which contains two 7-item subscales: the Parent Separation and the Parent Worry (VanderLaan et al., 2017). Items 1, 3, 4, 5, 6, 7, and 8 constituted the Parent Separation subscale while items 2, 9, 10, 11, 12, 13, and 14 constituted the Parent Worry subscale (Table 4-3). To statistically assess the underlying structure of the scale, exploratory factor analysis (EFA) using the maximum likelihood extraction method was performed. Across the sample, the EFA revealed a 3-factor solution (Kaiser-Meyer-Olkin [KMO] measure = 0.88), explaining 45.0% of variation in items' scoring. As presented in Table 4-3, the rotated pattern diverged from assumed dual structure, particularly because the first three items clustered together as the third factor. Similarly, conducting EFA on subsamples divided based on sex or group did not lend support to assumed dual structure and instead, resulted in three- or four-factor solutions.

Table 4-3 Rotated extracted factors for Separation Anxiety Scale-Revised

	Factor		
	1	2	3
1- I got very upset if I had to be away from my parents or away from home			.569
2- I worried a lot about something terrible happening to my parents		.305	.563
3- I worried a lot about getting separated from my parents			.867
4- I did not want to go to school because it meant being away from my parents	.633		
5- I did not want to sleep alone	.568		
6- I had nightmares about being separated from my parents	.673		
7- If I knew that I would have to be away from my parents I would get physically ill	.768		
8- I was scared of being alone without a close family member at home or in another setting	.566		
9- I worried that my parents were overworked, stressed or tired	.404	.333	
10- I worried that my parents were not getting along with friends and family	.457		

11- I did not think about my parent's wellbeing*	-.305	.519	
12- I wanted my parents close by so I could take care of them or help them		.814	
13- When my parents left me, I wanted to go with them to make sure they were safe	.352	.469	
14- When my parents got sick, I did not want to leave them		.717	

Factor loadings below 0.3 are not presented.

Despite these results, we decided to calculate average scores for the Parent Separation and Parent Worry subscales based on presumed dual structure explained earlier. This allowed us to compare our results with previous reports (Table 4-3). Across the sample, Cronbach's alphas were 0.80 for the Parent Separation ranging from 0.65 in cisgender ambiphilic females to 0.88 in cisgender ambiphilic males. For the Parent Worry, Cronbach's alpha was 0.78, ranging from 0.71 in transgender androphilic males to 0.82 in transgender gynephilic females.

We also calculated an average score for the first eight items (Table 4-3) which correspond with eight symptoms listed under criterion A of the DSM-5-TR criteria for SAD (American Psychiatric Association, 2022). The Pearson correlation analysis showed that this score correlated almost completely with the Parent Separation score (Pearson correlation coefficients ranging from 0.97 to 0.99 across groups), which is not surprising given that they have seven shared items. To avoid redundancy, we only report Parent Separation score but also interpret it as an indicator of childhood separation anxiety according to DSM-5-TR symptomatology for SAD.

Statistical Analysis

The participants recruited in three rounds of data collection differed in demographic variables as those recruited in the first online round (n = 454) were on average older (F[2, 1225] = 78.66, $p < 0.001$, mean age difference ~ 4.30 years), more educated (F[2, 1237] = 83.56, $p < 0.001$), and had better financial status (F[2, 1238] = 11.29, $p < 0.001$) than participants recruited

during the second (n = 539) and third (n = 240) rounds. The participants in the second and third recruitment samples were of the same age (t[777] = 0.36, p = 0.721), but differed in financial status (t[785] = 2.22, p = 0.027), and education (t[785] = -6.85, p < 0.001). Nevertheless, of 16 within-group comparisons of the dependent variables (e.g., the Parent Separation) between recruitment samples only four comparisons resulted in significant differences (ps < 0.05). Of these, two scores pertaining to cisgender gynephilic males recruited during the last round (n = 21) stood out as their scores were remarkably larger than the other cisgender gynephilic males (Cohen's ds about 1.0). Inclusion of these data points did not change the results, and since we did not have a reason to exclude them, we decided to keep the data (see Supplementary Material). Finally, we believe presenting merged data is justified because it provided higher statistical power for groups in those situations where number of participants on their own were suboptimal.

To examine whether mean scores of recalled Parent Separation and Parent Worry differed between groups, a multivariate analysis of covariance (MANCOVA) was conducted with age, education, and financial status as covariates. The assumptions of multivariate normality were met, and *Pillai's Trace* criterion (*V)* was used to interpret the results because of its robustness. Post-hoc pairwise comparisons were performed using the Games-Howell method. We also report Cohen's *d* effect sizes with 95% confidence interval to compare differences in sex, sexual orientation, and gender identity.

RESULTS

A MANCOVA was performed with age, education, and financial status as covariates; significant effects were found for group (V = 0.09, F[14, 2432] = 8.00, p < 0.001) and education (V = 0.01, F[2, 1215] = 8.65, p < 0.001), but not for age (V = 0.00, F[2, 1215] = 0.58, p = 0.559) and financial status (V = 0.00, F[2, 1215] = 0.78, p = 0.459).

Parent Separation

For the Parent Separation subscale, a one-way ANCOVA indicated significant independent effects for group (F[7, 1231] = 15.82, $p < 0.001$, partial $\eta^2 = 0.08$; Figure 4-1a) and education (F[1, 1231] = 3.93, $p = 0.048$, $B = -0.04$, partial $\eta^2 = 0.00$). These results closely matched the result from a one-way ANOVA (F[7, 1234] = 15.07, $p < 0.001$, partial $\eta^2 = 0.08$; Figure 4-1b) and therefore, to include all data points (and save space), only the post-hoc pairwise comparisons for the unadjusted scores are reported in the upper section of Table 4-4 (see Supplementary Material for adjusted mean scores).

In relation to Prediction 1, no support was found for sex difference in the mean Parent Separation scores as they did not differ between cisgender gynephilic males and cisgender androphilic females ($d = 0.03$). Among males, cisgender and transgender androphilic participants recalled higher mean Parent Separation scores compared to cisgender gynephilic ones ($d = 0.28$ and $d = 0.80$, respectively), consistent with Prediction 2. Also, transgender androphilic males had a mean Parent Separation score higher than that of cisgender androphilic males ($d = 0.47$), consistent with Prediction 3. For Prediction 4, although the post-hoc pair-wise comparison did not reveal a statistically significant difference between cisgender ambiphilic males and their gynephilic counterpart, the 95% confidence interval for Cohen's d did not include zero ($d = 0.25$; see Table 4-4), providing partial support for an elevated mean Parent Separation score in the former group relative to the later.

Among females, transgender gynephilic participants had a mean Parent Separation score that was lower than that of cisgender androphilic females ($d = -0.42$) and cisgender ambiphilic females ($d = -0.53$), consistent with Prediction 5. Cisgender gynephilic females' mean Parent Separation score was similar to the mean score for transgender gynephilic females ($d = -0.03$). Their mean score was lower than that of cisgender androphilic females ($d = -0.37$), but it was not

statistically significant, providing only partial support for Prediction 5. Also, cisgender ambiphilic females did not differ from their androphilic counterparts (d = 0.07), providing no support for Prediction 6 (Table 4-4 – upper half).

Parent Worry

For the Parental Worry subscale, a follow-up univariate ANCOVA with levels of education as the covariate showed significant independent effects for group (F[7, 1231] = 4.24, p < 0.001, partial η^2 = 0.02; Figure 4-2a) and education (F[1, 1231] = 20.45, p < 0.001, B = -0.10, partial η^2 = 0.02). Since these results closely matched the result from a one-way ANOVA (F[7, 1234] = 4.04, p < 0.001, partial η^2 = 0.02; Figure 4-2b), for reasons similar to what discussed earlier for Parent Separation score, only the post-hoc pairwise comparisons for the unadjusted scores are reported in the lower section of Table 4-4 (see Supplementary Material for adjusted mean scores).

The post-hoc pairwise comparisons showed significant between-group differences in the mean Parent Worry scores between transgender androphilic males who scored highest and cisgender androphilic females, cisgender ambiphilic females, and transgender gynephilic females. However, no statistically significant differences were found in pairwise comparisons related to our predictions. Nevertheless, calculated 95% confidence intervals for effect sizes indicated that transgender androphilic males scored higher than cisgender gynephilic males and cisgender androphilic males, providing a partial support for Prediction 2. Another observed pattern was that male participants scored higher in the Parent Worry subscale than females, regardless of sexual orientation and gender identity/expression (Table 4-4 – lower half).

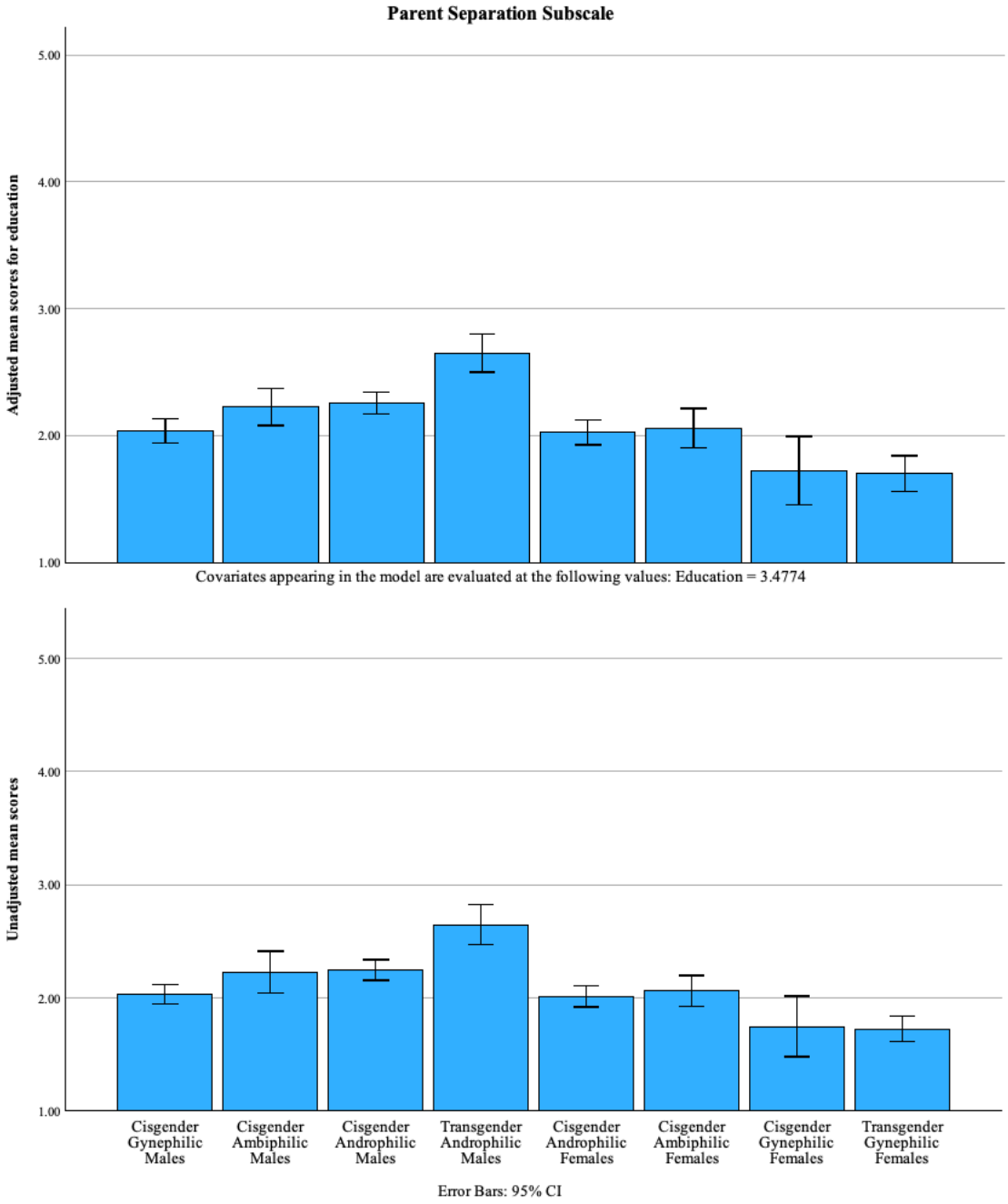


Figure 4-1 Adjusted (top Figure 4-1a) and unadjusted (bottom Figure 4-1b) mean Parent Separation scores across different groups.

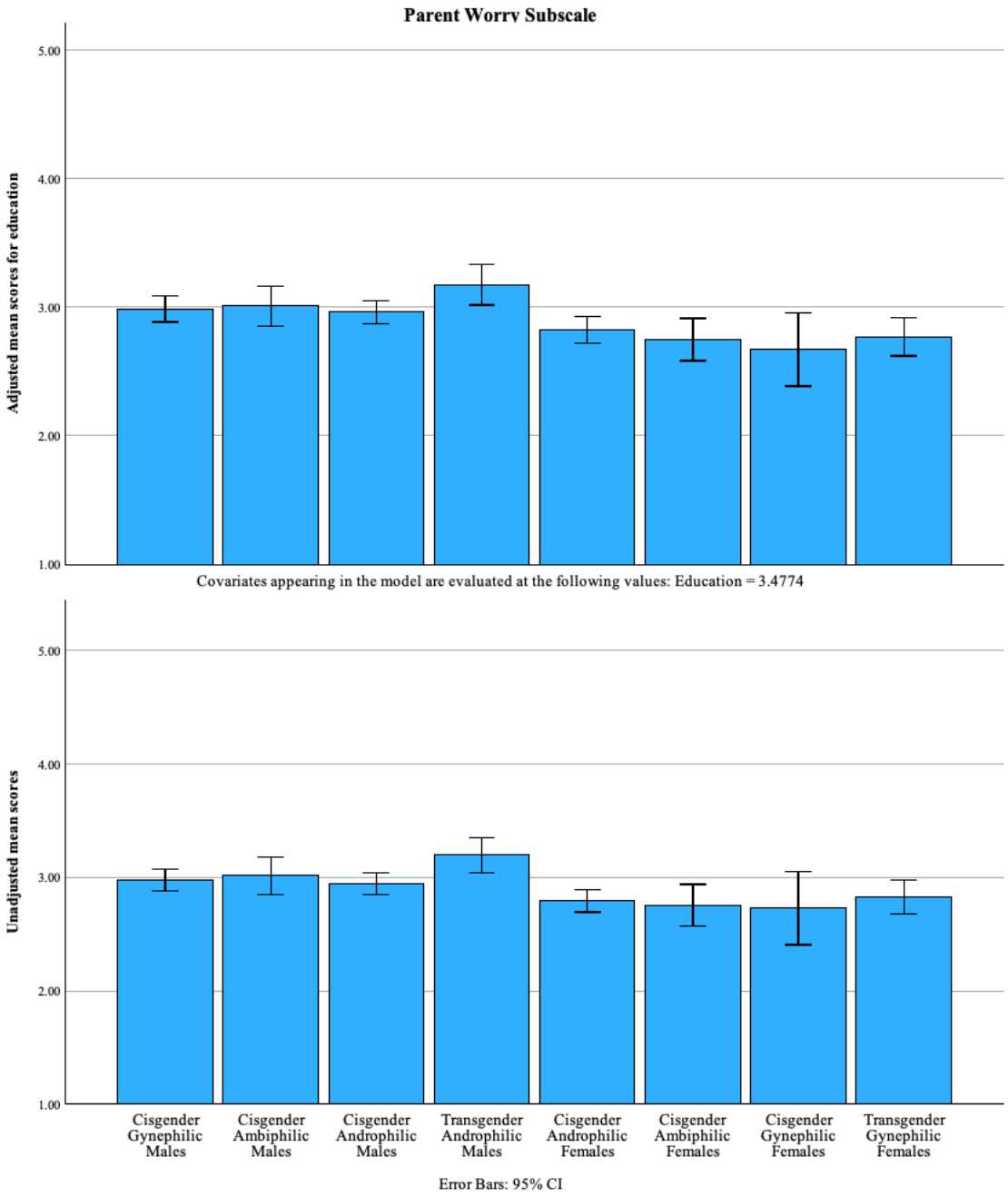


Figure 4-2 Adjusted (top Figure 4-2a) and unadjusted (bottom Figure 4-2b) mean Parent Worry scores across different groups.

Table 4-4 Between-group comparison of the mean Parent Separation scores (upper half) and the mean Parent Worry scores (lower half)

Groups (Mean ± Standard Deviation)	Cisgender Gynephilic Males 2.03 ± 0.70	Cisgender Ambiphilic Males 2.23 ± 0.94	Cisgender Androphilic Males 2.25 ± 0.83	Transgender Androphilic Males 2.65 ± 0.89	Cisgender Androphilic Females 2.01 ± 0.72	Cisgender Ambiphilic Females 2.06 ± 0.67	Cisgender Gynephilic Females 1.75 ± 0.73	Transgender Gyenphilic Females 1.72 ± 0.62
Cisgender Gynephilic Males 2.97 ± 0.76	-	d = -0.25 (-0.48, -0.02)	d = -0.28[a] (-0.48, -0.11)	d = -0.80[c] (-1.04, -0.57)	d = 0.03 (-0.15, 0.21)	d = -0.04 (-0.28, 0.19)	d = 0.40 (0.03, 0.78)	d = 0.45[c] (0.23, 0.68)
Cisgender Ambiphilic Males 3.01 ± 0.85	d = -0.05 (-0.28, 0.18)	-	d = -0.02 (-0.24, 0.20)	d = -0.46[a] (-0.73, -0.18)	d = 0.27 (0.04, 0.50)	d = 0.20 (-0.08, 0.48)	d = 0.54 (0.13, 0.94)	d = 0.64[c] (0.37, 0.91)
Cisgender Androphilic Males 2.94 ± 0.86	d = 0.04 (-0.11, 0.20)	d = 0.08 (-0.14, 0.30)	-	d = -0.47[b] (-0.70, -0.25)	d = 0.30[a] (0.13, 0.47)	d = 0.23 (0.00, 0.46)	d = 0.61[a] (0.24, 0.98)	d = 0.67[c] (0.46, 0.89)
Transgender Androphilic Males 3.21 ± 0.79	d = -0.29 (-0.52, -0.06)	d = -0.22 (-0.49, 0.05)	d = -0.30 (-0.52, -0.07)	-	d = 0.82[c] (0.57, 1.06)	d = 0.74[c] (0.45, 1.03)	d = 1.05[c] (0.63, 1.47)	d = 1.22[c] (0.93, 1.51)
Cisgender Androphilic Females 2.79 ± 0.77	d = 0.23 (0.05, 0.41)	d = 0.28 (0.05, 0.51)	d = 0.18 (0.01, 0.35)	d = 0.52[c] (0.28, 0.57)	-	d = -0.07 (-0.31, 0.17)	d = 0.37 (-0.01, 0.74)	d = 0.42[b] (0.19, 0.64)
Cisgender Ambiphilic Females 2.75 ± 0.89	d = 0.27 (0.03, 0.51)	d = 0.30 (0.02, 0.58)	d = 0.22 (-0.01, 0.45)	d = 0.52[b] (0.24, 0.81)	d = 0.05 (-0.19, 0.28)	-	d = 0.46 (0.05, 0.87)	d = 0.53[b] (0.25, 0.80)
Cisgender Gynephilic Females 2.73 ± 0.88	d = 0.31 (-0.06, 0.69)	d = 0.33 (-0.07, 0.74)	d = 0.25 (-0.12, 0.62)	d = 0.58 (0.17, 0.98)	d = 0.08 (-0.29, 0.46)	d = 0.03 (-0.37, 0.44)	-	d = 0.03 (-0.36, 0.43)
Transgender Gynephilic Females 2.83 ± 0.82	d = 0.19 (-0.03, 0.40)	d = 0.22 (-0.04, 0.49)	d = 0.14 (-0.07, 0.35)	d = 0.46[a] (0.19, 0.72)	d = -0.04 (-0.26, 0.18)	d = -0.08 (-0.35, 0.19)	d = -0.12 (-0.51, 0.28)	-

a: p value < 0.05, b: p value < 0.01, c: p value < 0.001. The p values are from a post-hoc pairwise comparison using the Games-Howell method following two one-way ANOVAs for Parent Separation and Parent Worry scores.

DISCUSSION

In this study, we examined variation in recalled childhood separation anxiety in relation to sex, sexual orientation, and gender identity/expression in Iran. Data from eight groups of participants, including cisgender gynephilic males, cisgender ambiphilic males, cisgender androphilic males, transgender androphilic males, cisgender androphilic females, cisgender ambiphilic females, cisgender gynephilic females, and transgender gynephilic females were analyzed. We first discuss findings about the Parent Separation subscale, which may also be interpreted as a dimensional assessment of symptoms listed in DSM-5-TR for SAD (American Psychiatric Association, 2022). Next, findings for the Parent Worry subscale and their implications for proposed adaptive function of childhood separation anxiety will be discussed.

With regard to sex, the mean scores for the Parent Separation did not differ between cisgender gynephilic males and cisgender androphilic females, providing no support for Prediction 1. Previous studies indicate that magnitude of sex difference in recalled childhood separation anxiety varies both within and across cultures. In studies conducted in Canada, sex differences ranged from $d = 0.06$ to 0.33 (Petterson et al., 2017a; VanderLaan et al., 2011; VanderLaan et al., 2015, 2016). Cross-culturally, the largest sex difference ($d = 0.54$) has been reported by Gomez et al. (2017) in the Istmo Zapotec, Mexico, whereas in a recent study conducted in Thailand, the observed sex difference in recalled childhood separation anxiety was trivial ($d = 0.12$; Zahran et al., 2023). It is noteworthy that lower effect sizes seem to have been reported when studies have used Separation Anxiety Scale-Revised with two subscales, rather than a single scale to measure separation anxiety (Vanderlaan et al., 2015, 2016, 2017; Zahran et al., 2023; see Table 4-1).

With regard to male sexual orientation, androphilic males, regardless of gender identity/expression, had higher scores for the Parent Separation subscale compared to cisgender gynephilic males, consistent with Prediction 2. The observed effect size for the difference in Parent Separation between cisgender androphilic males and cisgender gynephilic males (d = 0.29) was comparable with values reported in previous studies (ranging from d = 0.17 to 0.40; Gomez et al., 2017; Petterson et al., 2017a; Swift-Gallant et al., 2022a; Vanderlaan et al., 2015, 2016; but see Zahran et al., 2023). With regard male to gender identity/expression, transgender androphilic males had the highest mean Parent Separation score, which were significantly higher than all other groups, in particular, cisgender androphilic males, thus providing support for Predictions 3. This finding was consistent with previous reports of elevated separation anxiety among transgender androphilic males in Mexico, Samoa, and Thailand (Gomez et al., 2017; Vanderlaan et al., 2017; Vasey et al., 2011; Zahran et al., 2023).

Cisgender ambiphilic males had an elevated mean Parent Separation score compared to cisgender gynephilic males, but they did not differ from cisgender androphilic males, providing partial support for Prediction 4. To our knowledge, this is the first study reporting on recalled traits of separation anxiety among cisgender ambiphilic males. Therefore, we cannot compare this specific finding against previous research.

In relation to female sexual orientation, the mean Parent Separation scores for both cisgender and transgender gynephilic females were lower than that of cisgender androphilic females. However, the difference for cisgender gynephilic females was not statistically significant, providing partial support for Prediction 5. Contrary to Prediction 6, no evidence for an effect of female gender identity/expression was found since transgender gynephilic females did not score differently from cisgender gynephilic females. Interpretation of the results

pertaining to cisgender gynephilic females is challenging considering the small number of participants recruited in this group despite substantial recruitment effort. Furthermore, previous research on the possible association of female gynephilia and childhood separation anxiety is mixed and inconclusive (Petterson et al., 2017a; Vanderlaan et al., 2011, 2015; Zahran et al., 2023). Therefore, we remain cautious in interpreting these results until further research with larger and more representative samples are conducted.

Contrary to Prediction 7, Cisgender ambiphilic females did not score different from cisgender androphilic females in the Parent Separation subscale. To our knowledge, only one other study has assessed childhood separation anxiety among cisgender ambiphilic females and reported a decreased mean score for the Parent Separation subscale when compared to cisgender androphilic females (d = -0.43; Zahran et al., 2023). Again, more data is needed to make a well-informed statement on whether female ambiphilia is associated with childhood separation anxiety.

In sum, we found predicted associations between childhood separation anxiety, measured by Parent Separation subscale, male androphilia, male ambiphilia, female gynephilia, and gender identity/expression (in males). Nevertheless, it remains unknown what developmental factors and pathways underlie these relationships. Twin studies indicate that genetic and environmental factors (shared and non-shared environment) contribute to variation in separation anxiety (Scaini et al., 2012), comparable to evidence on sexual orientation (Bailey et al., 2016). Unlike sexual orientation, however, parenting behaviour seems to play a significant role in separation anxiety, either indirectly, through insecure attachment styles, or directly, by overprotective and intrusive parenting (Ehrenreich et al., 2008). Another plausible factor is temperament, namely predisposition to experience negative affect or Neuroticism, which is correlated with same-sex

attraction and behaviour, especially in males (Allen & Robson, 2020; Ganna et al., 2019). Neuroticism is also associated with increased risk for anxiety disorders like General Anxiety Disorder and Panic Disorder (Kotov et al., 2010). Future studies addressing these candidate links between childhood separation anxiety and same-sex sexual orientation would be informative for our understanding of developmental pathways leading to elevated childhood separation anxiety.

With respect to the Parent Worry subscale, variation in sex resulted in an unexpected outcome; cisgender gynephilic males scored even higher than cisgender androphilic females. This finding was in contrary to Prediction 1, which was based on cross cultural studies consistently reporting sex differences with cisgender androphilic females recalling more childhood separation anxiety (*d*s ranging from 0.31 to 0.42; Gómez et al., 2017; Vanderlaan et al., 2015, 2016, 2017; Vasey et al., 2011; Zahran et al., 2023). Further research is needed to investigate if this pattern holds in other Iranian samples.

In relation to male sexual orientation and gender identity/expression, the only significant finding related to transgender androphilic males who had a mean Parent Worry score that was higher than all other male groups. The 95% confidence intervals for Cohen's *d* effect sizes indicated transgender androphilic males scored higher than both cisgender gynephilic males and cisgender androphilic males, in alignment with Predictions 2 and 3. These results were partially consistent with existing literature showing elevated Parent Worry among both cisgender androphilic males (*d*s = 0.31 – 0.59; Swift-Gallant et al., 2022a; Vanderlaan et al., 2015, 2016; Zahran et al., 2023), and transgender androphilic males (*d*s = -0.13 – 0.70; Gómez et al., 2017; Vasey et al., 2011; Vanderlaan et al., 2017; Zahran et al., 2023).

With respect to female sexual orientation/gender identity-expression, we did not find any between-group difference in the Parent Worry subscale, thus providing no support for

Predictions 5 to 7. These results are consistent with two other studies that have compared the Parent Worry subscale between androphilic and gynephilic females and found no group differences (Vanderlaan et al., 2015; Zahran et al., 2023).

In sum, we found partial support for an elevated mean Parent Worry score in transgender androphilic males. However, important questions remain to be answered before concluding that excessive worrying about primary attachment figures is an adaptive trait linked to adulthood prosocial behaviour as proposed by Vanderlaan et al. (2010, 2015). From a theoretical perspective, research on androphilic males has failed to show a correlation between recalled childhood Parent Worry and adulthood prosocial tendencies (Vanderlaan et al., 2016, 2017), although the latter was found to correlate with childhood concern and worry about siblings (Vanderlaan et al., 2017). From a methodological perspective, the construct validity of Parent Worry subscale is yet to be established. The question remains whether the Parent Worry subscale has sufficiently narrow construct validity or if it is assessing a broader worry construct. In this regard, it is important to note that worry is, more broadly speaking, a characteristic of various childhood anxiety disorders (e.g., general anxiety disorder, special phobias, etc.) and a part of normal development (Weems & Costa, 2005; Weems et al., 2000). Studies that have used Parent Worry subscale only reported Cronbach's alphas as a measure of internal consistency but failed to report factor analysis as a measure of its unidimensionality (Tavakol & Dennick, 2011). In this study, we undertook exploratory factor analysis which did not support the homogeneity of the Parent Worry subscale. Investigating the structural validity becomes even more important when we consider literature that suggests three or four dimensions may underlie childhood separation anxiety (Méndez et al., 2008, 2022).

Limitations

Our sampling method may raise concerns about the degree to which it provides a representative sample. For instance, our participants were on average young, educated, and had a relatively good economic status. This is perhaps because most of our participants were recruited in Tehran and Mashhad, Iran's two largest metropolitans, using networking sampling method by two local researchers. This may also complicate the generalization of our findings to studies conducted in other cultures (Table 4-1). Nevertheless, this approach was deemed the only way to examine same-sex sexuality in Iran given the country's restrictive sociopolitical atmosphere. Also, our sample of transgender participants could be described as a mix of clinic- and community-based samples. This mixed sample strategy may complicate the comparability of our results pertaining to transgender groups with previous research which has been restricted to community-based samples (Gomez et al., 2017; Vasey et al., 2011; Vanderlaan et al., 2017; Zahran et al., 2023).

Another limitation of our study was a relatively low number of recruited participants in groups such as cisgender ambiphilic males, transgender androphilic males, cisgender ambiphilic females, and especially cisgender gynephilic females. Although the performance of statistical tests assuming normality can be affected by unequal sample sizes, however, we used omnibus tests tolerant to such deviations from normality. Future studies would benefit from using larger more representative samples for these groups of individuals.

Our finding that cisgender ambiphilic males did not differ from cisgender androphilic males either in the Parent Separation or the Parent Worry subscales might reflect an underlying bias in our assessment of sexual orientation. In this study, we compared participants using only sexual attraction patterns and no other dimensions of sexual orientation, including sexual identities, sexual behaviour, or sexual arousal patterns. While these dimensions of sexual

orientation are usually aligned, they are more likely to diverge in ambiphilic individuals (Bailey et al., 2016). Moreover, self-reported data on sexuality can be affected by social desirability responding through mechanisms such as self-deceptive enhancement or impression management (Meston et al., 1998). Hence, it is plausible that our sample of ambiphilic males be heterogenous and, if assessed using genital arousal measures, would be comprised of predominantly androphilic males (see, Rieger et al., 2005; Semon et al., 2017). Though we are not aware of previous reports on Iranian ambiphilic males that would inform us on this matter, assessment of childhood sex-atypical behaviour in this sample indicates cisgender ambiphilic males score intermediate between cisgender gynephilic males and cisgender androphilic males (Sadr-Bazzaz et al., 2024). This does not rule out the possible heterogeneity of our sample of cisgender ambiphilic males but undermines the probability that this sample is mostly comprised of truly androphilic males. More data is needed to address this question.

Finally, we assessed childhood traits of separation anxiety retrospectively by asking participants to rate their anxiety and worry at 6-12 years of age. Although current symptoms of anxiety or depression have been suggested to influence an individual's memory of emotional experiences, research on this matter is mixed and consequently difficult to interpret (Gorlin et al., 2019; Zlomuzica et al., 2014). Therefore, further research is needed to assess the direction and magnitude of the effect that current emotional status may have on recalled rating of childhood anxiety and worry. With regard to this issue, it is noteworthy that our retrospective results are consistent with previous prospective studies in gender dysphoric boys (e.g., Coates & Person, 1985; Zucker et al., 1996) who were probably pre-androphilic (e.g., Li et al., 2017).

Conclusion

This study provided support for the association of childhood separation anxiety with certain expressions of sexual orientation and gender identity in both males and females. In particular, we found male sexual orientation/gender expression-identity differences that are consistent with previous reports from a variety of diverse cultures including Canada, Samoa, Mexico and Thailand. This cross-cultural consistency dovetails with the conclusion that recalled elevated childhood separation anxiety is a cross-culturally universal aspect of male androphilia. Also, our assessment of recalled separation anxiety in females, adds to the existing literature, which can be characterized as limited and inconsistent. From a clinical perspective, understanding the (a)typical developmental characteristics of same-sex attracted individuals with diverse gender identity/expression can be beneficial for mental health care providers. Accordingly, an evidence-informed approach can help practitioners avoid over- or under-assessment and treatment of psychological or behavioural expressions common among these groups of individuals.

SUPPLEMENTARY MATERIAL

Data from eight groups of participants (n =1242) were considered for statistical analysis. 455 participants were recruited in the first round, 545 during the second round, and 243 in the third final round. All participants completed the same survey. Comparisons between the three recruitment samples for demographic variables are provided in the main manuscript under section Method. In this supplementary section, we provide statistical information for each recruitment round (Supplementary Tables s4-1 to s4-3). Also, we present within-group comparisons of Parent Separation and Parent Worry subscale between recruitment samples (Supplementary Figures s4-1 and s4-2). Finally, we presented adjusted mean scores for education derived from two one-way ANCOVAs for Parent Separation and Parent Worry subscales (Supplementary Table s4-4).

Supplementary Table s4-0-1 Descriptive information for participants recruited in first round

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Number of participants	128	28	80	14	135	49	10	10
Age*								
Mean ± Standard deviation	30.34 ± 7.53	26.55 ± 6.75	28.77 ± 6.52	25.00 ± 4.08	29.07 ± 7.07	26.98 ± 6.02	27.10 ± 8.18	26.10 ± 7.40
Level of education**								
Junior high school	0.8%	0.0%	0.0%	0.0%	0.0%	4.1%	0.0%	0.0%
High school	8.6%	25.0%	22.8%	28.6%	11.9%	20.4%	40.0%	40.0%
College	7.8%	21.4%	15.2%	14.3%	8.1%	6.1%	0.0%	10.0%
Undergraduate	43.0%	28.6%	30.4%	28.6%	42.2%	38.8%	30.0%	40.0%
Post-graduate	39.8%	25.0%	31.6%	28.6%	37.8%	30.6%	30.0%	10.0%
Financial Status								
Very bad	0.8%	3.6%	2.5%	7.1%	0.0%	0.0%	0.0%	0.0%
Bad	10.2%	14.3%	12.5%	21.4%	5.2%	10.2%	10.0%	0.0%
Not bad Not good	57.0%	71.4%	57.5%	57.1%	51.9%	42.9%	70.0%	40.0%
Good	28.9%	7.1%	25.0%	14.3%	36.3%	40.8%	20.0%	50.0%
Very good	3.1%	3.6%	2.5%	0.0%	6.7%	6.1%	0.0%	10.0%
Parent Separation	1.91 ± 0.63	2.24 ± 0.80	2.10 ± 0.72	2.61 ± 0.82	1.97 ± 0.74	1.96 ± 0.70	1.57 ± 0.34	1.63 ± 0.44
Parent Worry	2.82 ± 0.74	2.81 ± 1.00	2.77 ± 0.80	3.09 ± 0.87	2.70 ± 0.75	2.64 ± 0.97	2.37 ± 0.83	2.71 ± 0.87

* Overall, 5 data points were missing: cisgender gynephilic males (n = 2), cisgender ambiphilic males (n = 1), and cisgender androphilic males (n = 2). ** One data point was missing for cisgender androphilic males.

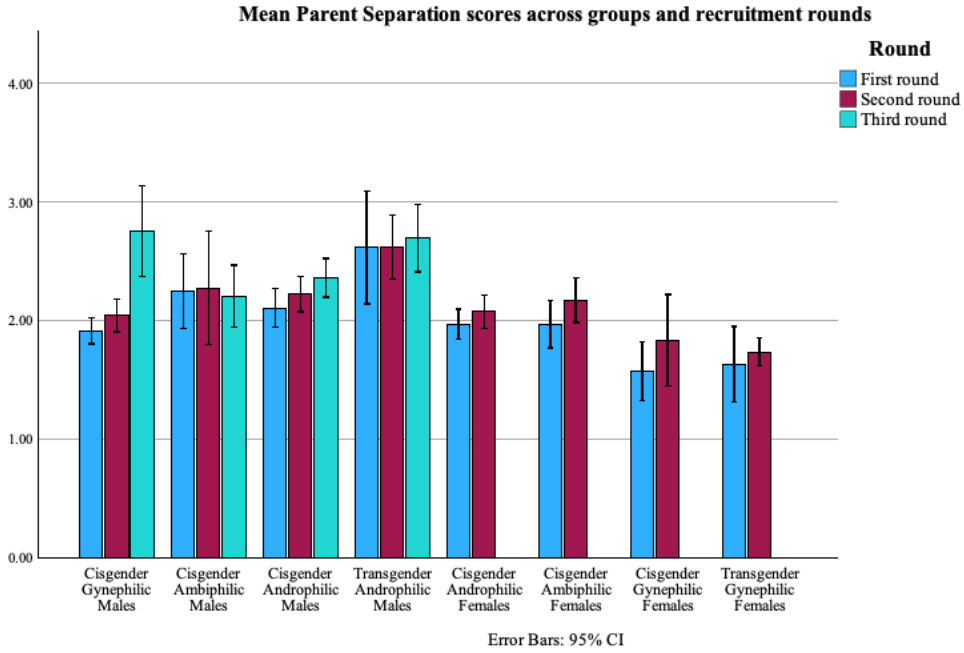
Supplementary Table s4-2 Descriptive information for participants recruited in Tehran and Mashhad

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Number of participants	99	22	105	45	99	45	21	109
Age								
Mean ± Standard deviation	23.87 ± 3.89	25.54 ± 5.69	26.68 ± 6.31	24.53 ± 5.09	24.42 ± 4.75	22.33 ± 2.77	21.52 ± 3.12	24.30 ± 4.51
Level of education								
Junior high school	4.0%	4.5%	1.9%	6.7%	0.0%	0.0%	4.8%	4.6%
High school	44.4%	27.3%	27.6%	44.4%	23.2%	37.8%	47.6%	45.9%
College	16.2%	22.7%	18.1%	17.8%	23.2%	26.7%	28.6%	17.4%
Undergraduate	28.3%	40.9%	35.2%	26.7%	43.4%	28.9%	19.0%	24.8%
Post-graduate	7.1%	4.5%	17.1%	4.4%	10.1%	6.7%	0.0%	7.3%
Financial Status								
Very bad	0.0%	4.5%	3.8%	15.6%	1.0%	2.2%	0.0%	4.6%
Bad	9.1%	4.5%	13.3%	11.1%	3.0%	6.7%	4.8%	11.9%
Not bad Not good	64.6%	54.5%	55.2%	60.0%	62.6%	60.0%	38.1%	68.8%
Good	23.2%	36.4%	23.8%	11.1%	31.3%	24.4%	57.1%	14.7%
Very good	3.0%	0.0%	3.8%	2.2%	2.0%	6.7%	0.0%	0.0%
Parent Separation	2.03 ± 0.68	2.27 ± 1.08	2.22 ± 0.77	2.61 ± 0.90	2.07 ± 0.70	2.17 ± 0.63	1.83 ± 0.85	1.73 ± 0.63
Parent Worry	3.12 ± 0.79	3.44 ± 0.83	2.99 ± 0.91	3.09 ± 0.80	2.92 ± 0.78	2.88 ± 0.80	2.90 ± 0.87	2.84 ± 0.82

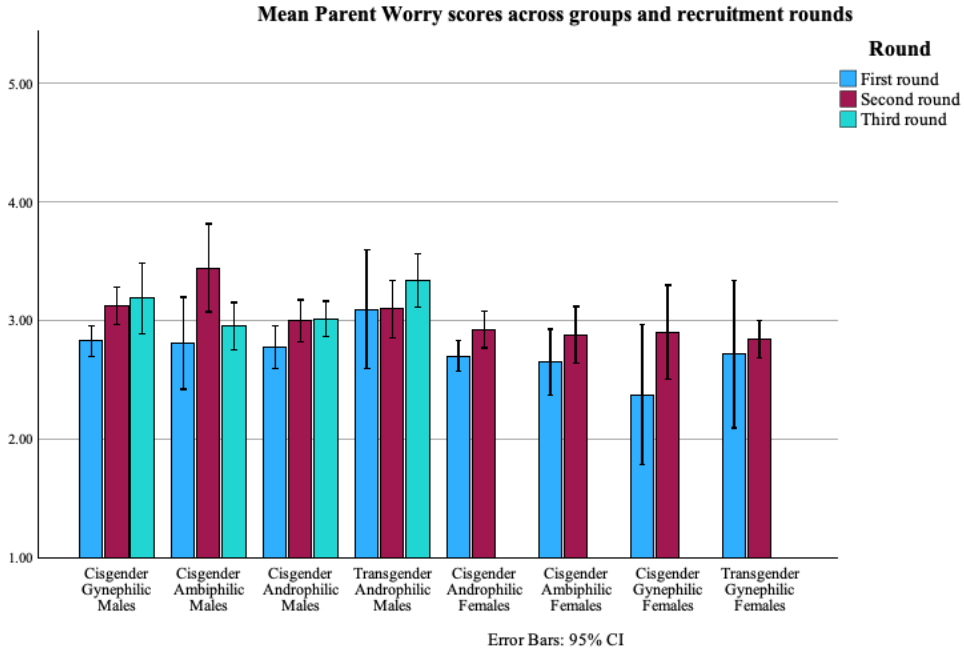
Supplementary Table s4-3 Descriptive information for participants recruited in Mashhad and Tehran

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Number of participants	21	54	125	43	-	-	-	-
Age*								
Mean ± Standard deviation	25.19 ± 3.41	23.17 ± 2.96	25.19 ± 5.74	23.07 ± 4.00	-	-	-	-
Level of education								
Junior high school	0.0%	0.0%	0.8%	0.0%	-	-	-	-
High school	0.0%	1.9%	1.6%	4.8%	-	-	-	-
College	42.9%	59.3%	38.4%	61.9%	-	-	-	-
Undergraduate	47.6%	31.5%	41.6%	28.6%	-	-	-	-
Post-graduate	9.5%	7.4%	17.6%	4.8%	-	-	-	-
Financial Status								
Very bad	4.8%	1.9%	5.6%	4.8%	-	-	-	-
Bad	4.8%	20.4%	10.4%	21.4%	-	-	-	-
Not bad Not good	33.3%	59.3%	66.4%	54.8%	-	-	-	-
Good	52.4%	18.5%	16.0%	16.7%	-	-	-	-
Very good	4.8%	0.0%	1.6%	2.4%	-	-	-	-
Parent Separation	2.75 ± 0.84	2.20 ± 0.96	2.36 ± 0.92	2.69 ± 0.92	-	-	-	-
Parent Worry	3.18 ± 0.66	2.95 ± 0.73	3.01 ± 0.84	3.33 ± 0.73	-	-	-	-

* Overall, 3 data points were missing: cisgender androphilic males (n = 2), and transgender androphilic males (n = 1).



Supplementary Figure s4-1 Mean Parent Separation scores across groups and recruitment rounds



Supplementary Figure s4-2 Mean Parent Worry scores across groups and recruitment rounds

Supplementary Table s4-4 Mean Parent Separation and Parent Worry scores adjusted for education

Groups	Parent Separation (Mean ± Standard Error)	Parent Worry (Mean ± Standard Error)
Cisgender Gynephilic Males (n = 248)	2.04 ± 0.05	2.98 ± 0.05
Cisgender Ambiphilic Males (n = 104)	2.22 ± 0.07	3.01 ± 0.08
Cisgender Androphilic Males (n = 309)	2.26 ± 0.04	2.96 ± 0.05
Transgender Androphilic Males (n = 101)	2.65 ± 0.08	3.17 ± 0.08
Cisgender Androphilic Females (n = 234)	2.02 ± 0.05	2.82 ± 0.05
Cisgender Ambiphilic Females (n = 94)	2.06 ± 0.08	2.75 ± 0.08
Cisgender Gynephilic Females (n = 31)	1.72 ± 0.14	2.67 ± 0.15
Transgender Gynephilic Females (n = 119)	1.70 ± 0.07	2.77 ± 0.08

Chapter 5: Direction and Strength of Hand Preference in Association with Same-Sex Sexual Attraction in Iran

ABSTRACT

Previous research has shown that same-sex sexual orientation is associated with hand preference. This study investigated this relationship by comparing Iranian cisgender gynephilic males (n = 242), cisgender ambiphilic males (n = 108), cisgender androphilic males (n = 314), transgender androphilic males (n = 103), cisgender androphilic females (n = 250), cisgender ambiphilic females (n = 96), cisgender gynephilic females (n = 32), and transgender gynephilic females (n = 123). Using a modified version of Edinburgh Handedness Inventory, two features of hand preference including its *direction* (i.e., the dominant hand in one or more activities) and *strength* (i.e., the degree of variability in preferring one hand over the other) were explored. We found that female sexual orientation was clearly linked to strength rather than direction of hand preference, with gynephilic females exhibiting a lowered strength shifted towards a male-typical pattern. While androphilic males' features of hand preference were found to be male-typical, ambiphilic males exhibited an extreme male-typical pattern in strength of hand preference (i.e., lowered strength). Our results suggest that the direction and strength of hand preference develop independently. This study highlighted the importance of studying both aspects of hand preference to understand underlying developmental factors influencing sexual orientation.

INTRODUCTION

Direction is a feature of hand preference that refers to the use of a dominant hand in one or more activities. Most people across different populations prefer using their right hand for a wide range of activities, while left hand preference is exhibited by about 10% of individuals (Papadatou-Pastou et al., 2020). This bias in handedness emerges early in human development (i.e., week 10 of gestation) and is established in most children before reaching puberty (Hepper, 2013; Scharoun & Bryden, 2014).

Variation in the direction of hand preference is considered to be modestly heritable (~25%) and despite early speculations of its single gene origin, evidence suggests it is a polygenic phenotype (Medland et al., 2006; Paracchini & Scerri, 2017). Paleo-osteological evidence (e.g., asymmetries in fossil skeletons and endocasts, ratio of left to right hand prints) has shown that right-hand dominancy and a low rate of left-hand preference characterized *Homo sapiens* and their hominin ancestors for at least the last two million years (Uomini & Ruck, 2018). Population-level right-hand bias in humans and their hominin ancestors (Uomini & Ruck, 2018), has been described as "an unmatched extreme" relative to other anthropoid primates (Caspar et al., 2022). Several evolutionary explanations have been proposed for the potential adaptive benefits of right-handedness (e.g., postural origin hypothesis, MacNeilage, 2007) or persistence of left-handedness (e.g., fighting hypothesis, Schaafsma et al., 2012; or kin selection hypothesis, Dong et al., 2024), however, quantitative evaulation of these hypotheses has rarely been undertaken (Caspar et al., 2022).

Biased hand preference has been associated with asymmetries in brain structure and function. Most notably, handedness has been linked to language-processing structures, as 97% of right handers show a dominant left hemisphere for language, while only 70% of left handers

have a dominant left hemisphere (Toga & Thompson, 2003). As a phylogenetically peculiar trait that is closely tied to language—another unique and highly lateralized brain function—human hand preference has been a subject of interest and regarded as a window to understand the evolution and development of brain lateralization (Badzakova-Trajkov et al., 2016; Caspar et al., 2022; Forrester, 2017; Michel, 2021; Uomini & Ruck, 2018).

Biases in hand preference are characterized by a small[1] but clear sex difference, with a higher rate of left-handedness in males (9.7% - 19.8%) compared to females (8.9% - 16.2%) (Papadatou-Pastou et al., 2020). Drawing on these observations and past research in developmental endocrinology (Phoenix et al., 1959), several hypotheses have been put forth by researchers suggesting that prenatal testosterone influences the sexually dimorphic development of human hand preference and brain lateralization (for reviews see Pfannkuche et al., 2009; Richards et al., 2021). For instance, Hines and Shipley (1984) postulated that exposure to elevated levels of prenatal testosterone results in greater brain lateralization and left-handedness in males, whereas a lack of exposure results in the reverse pattern in females. Nonetheless, existing evidence for the role of prenatal testosterone in brain lateralization and hand preference is mixed and inconclusive (Pfannkuche et al., 2009).

Biases in handedness are often conceptualized in a dichotomous manner. For example, people often identify, or are identified, with their dominant hand (i.e., right-handed or left-handed) and this bears significant implications in many cultures (Perelle & Ehrman, 2005). Similarly, researchers have commonly viewed hand preference as a discrete and binary trait, probably influenced by the apparent dichotomy and high consistency in hand preference for

[1] Using Cohen's arcsine transformation (d_{asin} = 2*[arcsine√p2 - arcsine√p1]), differences in proportions were found to be < 0.10, which can be regarded as small effects (Cohen, 1988).

manual activities like writing (McManus, 1985; Oldfield, 1971). As a result, most studies have focused on the *direction* of hand preference (Edlin et al., 2015). Despite the extensive research on handedness (i.e., in January 2025, our search of "left-handed" in Google Scholar produced 919,000 results), no consensus exists regarding whether a single behavioural exemplar can accurately classify individuals into dichotomous right- or left-handed groups (Edlin et al., 2015; Michel, 2021; Perelle & Ehrman, 2005).

As evidence of this, a recent meta-analytic review encompassing 56 studies with more than two million individuals had to conduct five different meta-analyses to capture the most common classifications used for hand preference, such as Right vs Left, Right vs non-Right, and Right vs Mixed vs Left (Papadatou-Pastou et al., 2020). This meta-analysis showed that considerable variation existed across studies in the assessment and categorization of hand preference, influencing the estimated prevalence of left-handedness (computed averages ranged from 9.3% to 18.1%). Additionally, some people exhibit an inconsistent or mixed hand preference, which researchers have commonly described, often interchangeably, as *ambidextrous* (i.e., equally preference for both hands) or *mixed-handed* (i.e., varying dominant hands for different tasks), with frequencies ranging from 1% to 9% (Papadatou-Pastou et al., 2020; Partida et al., 2019).

As an alternative to viewing hand preference as dichotomous, some researchers have characterized it as a continuous trait. This perspective examines hand preference in terms of its *strength*, which refers to the degree of variability in preference for one hand over the other, either within or between different activities. Viewing hand preference as a continuous trait has been argued to be more compatible with observed variation in its distribution (Annett, 1972; but see Dragovic et al., 2008). According to this view, categorizing individuals into separate groups

(e.g., right- or left-handed) is an arbitrary decision which underestimates actual variation in hand preference (Annett, 1998). Despite differing views, there is evidence highlighting the merit in studying the strength of hand preference in addition to its direction. Differences in manual performance tests indicate that separate processes underly direction and strength (McManus et al., 2016), which is supported by distinct patterns of cerebral activation, suggesting an independent coding of these features in the brain (Dassonville et al., 1997). Furthermore, inter-individual variation in strength, but not direction, has been associated with behavioural traits such as aggression (Dinsdale et al., 2011).

The limited data suggest that strength of hand preference might also be influenced differentially by developmental factors and evolutionary forces (Corballis, 2009). For instance, a study conducted in Taiwan reported a higher heritability for strength (0.67) compared to direction (0.39) (Lien et al., 2015). In addition, a recent study found no correlation between levels of prenatal sex hormones in amniotic fluid and direction of hand preference in adolescent males and females, whereas higher levels of prenatal testosterone and estradiol were associated with lower strength in females (Richards et al., 2021). The independent evolution of these features is supported by a recent large study in anthropoids finding that strength of hand preference varied with ecology and phylogeny, "point[ing] to a potential adaptive benefit of disparate lateralization strength in primates" (p. 1), while direction did not show any correlation with the biological predictors that were employed (Caspar et al., 2022). The existing evidence underscores the importance of studying and reporting both direction and strength of hand preference.

Sexual Orientation in Association with Hand Preference

Many studies have investigated the association between hand preference and same-sex sexual attraction (for a review and meta-analysis see Lalumiere et al., 2000), while fewer studies have assessed the plausible mechanisms underlying this association (e.g., Blanchard & Lippa, 2007; Ellis et al., 2017; Swift-Gallant et al., 2019). Research on the association between hand preference and same-sex sexual orientation has produced mixed results whether they were conducted in Euro-American (Kishida & Rahman, 2015; Swift-Gallant et al., 2017; but see Rahman et al., 2009; Schwartz et al., 2010) or non-Euro-American countries (Xu & Zheng, 2017; Skorska et al., 2020; but see Ellis et al., 2017). This may be, in part, due to the various criteria used by researchers to classify participants, which is also true for broader literature on human hand preference. Another limitation is lower statistical power associated with categorical analysis which requires larger sample sizes compared to continuous analysis (Royston et al., 2006).

Addressing these limitations in a meta-analysis, Lalumiere et al. (2000) clearly associated same-sex sexual orientation with non-right-handedness in both sexes. However, to include most studies in the meta-analysis, the authors constructed the category of non-right-handers by combining "nonconsistent right-handers" and those "who favored left hand," comparing them with a category of right-handers, which included "exclusive right-handers" plus those "who favored right hand" (Lalumiere et al., 2000). Consequently, the observed association with sexual orientation may involve direction of hand preference (i.e., more left-handers among same-sex sex attracted individuals), or it may involve strength of hand preference (i.e., more inconsistent hand preference among same-sex attracted individuals). Furthermore, if both aspects of hand preference are linked with sexual orientation, they may differentially contribute to observed correlations in males versus females considering that female gynephilia was more strongly linked

with non-right-handedness (Lalumiere et al., 2000). To test these possibilities, it is required to disentangle direction and strength of hand preference rather than combining them as is the case for the commonly used category of "non-right-handedness."

Present study

In sum, key questions remain unanswered about the correlation between hand preference and sexual orientation. First, which aspects of hand preference are responsible for the elevated odds ratio of non-right-handedness in same-sex attracted individuals? Second, do direction and strength of hand preference vary differentially between androphilic males and gynephilic females? Third, is variation in hand preference associated with different degrees of same-sex attraction and gender identity/expression?

To this end, we examined the associations between hand preference and sexual orientation and gender identity/expression using data collected in a Middle Eastern country, Iran. In doing so, we recruited adult males and females who varied in their sexual orientation (i.e., androphilic, gynephilic, or ambiphilic) and gender identity/expression (i.e., cisgender or transgender). We also explored both direction and strength of hand preference. Based on existing evidence, we formulated a number of hypotheses and predictions, which we used to structure our data presentation and the discussion of our results (Table 5-1).

For Hypothesis 1, we postulated that reported sex differences in hand preference is influenced by/associated with sexually dimorphic developmental pathways, and thus, we predicted a sex difference would exist for both direction and strength of hand preference in our Iranian sample. Male androphilia and female gynephilia have been associated with sex-atypicality in some sexually dimorphic traits such as childhood sex-typed behaviour (Bailey & Zucker, 1995), but with sex-typicality, or even extreme sex-typicality, in other traits such as

sociosexual attitudes and behaviours (Schmitt, 2013). Based on existing evidence, for Hypothesis 2, we speculated that androphilic males' hand preference is influenced by/associated with extremely male-typical developmental pathways. On the other hand, for Hypothesis 3, we speculated that gynephilic females' hand preference was influenced by/associated with sex-atypical (i.e., male-typical) developmental pathways. Relevant evidence and predictions for these hypotheses are presented in Table 5-1.

Table 5-0-1 List of hypotheses and predictions

Hypotheses	Evidence	Predictions	Summary of results
(H1) Hand preference is influenced by/associated with sex-typical developmental process(es): (H1-1) Right-hand bias in direction of hand preference is negatively influenced by/associated with male-typical developmental process(es). (H1-2) Strength of hand preference is negatively influenced by/associated with male-typical developmental process(es).	(H1-1) Higher rate of left-handedness in human males than females (Papadatou-Pastou et al., 2020). (H1-2) Higher rate of mixed-handedness in human males than females (Papadatou-Pastou et al., 2020).	(1-1) Higher rate of left-handedness in Iranian cisgender gynephilic males compared to cisgender androphilic females. (1-2) Higher rate of mixed-handedness in cisgender gynephilic males than cisgender androphilic females. (1-3) Absolute values of laterality quotients would be negatively associated with male sex (i.e., cisgender gynephilic males compared to cisgender androphilic females).	Prediction 1-1 Partially supported Prediction 1-2: Supported Prediction 1-3: Supported
(H2) Hand preference is influenced by/associated with developmental process(es) underlying male same-sex attraction: (H2-1) Right-hand bias in direction of hand preference is negatively influenced by/associated with extremely male-typical developmental process(es) underlying male same-sex attraction.	(H2-1) Higher rates of left-handedness among cisgender and transgender androphilic males and cisgender ambiphilic males (e.g., Blanchard & Lippa, 2007; Skorska et al., 2020). (H2-1) For some traits, androphilic males are masculine or even hypermasculine compared	(2-1) Higher rates of left-handedness in Iranian androphilic males compared to gynephilic males. (2-2) Higher rate of left-handedness in ambiphilic males, intermediate between gynephilic and androphilic males. (2-3) Higher rates of mixed-handedness in	Prediction 2-1: Partially supported Prediction 2-2: Partially supported Prediction 2-3: Not supported Prediction 2-4: Partially supported Prediction 2-5: Not supported Prediction 2-6: Supported

(H2-2) Strength of hand preference is negatively influenced by/associated with extremely male-typical developmental process(es) underlying male same-sex attraction.	to gynephilic males (e.g., Schmitt, 2013) (H2-2) Higher rates of non-right-handedness in androphilic males compared to gynephilic males (e.g., Lalumiere et al., 2000).	androphilic males compared to gynephilic males. (2-4) Higher rate of mixed-handedness in ambiphilic males, intermediate between gynephilic and androphilic males. (2-5) Absolute values of laterality quotients would have negative association with male androphilia. (2-6) Absolute values of laterality quotients would have negative association with male ambiphilia, but the association would be weaker than that of androphilic males.	
(H3) Hand preference is influenced by/associated with developmental process(es) underlying female same-sex attraction: (H3-1) Right-hand bias in direction of hand preference is negatively influenced by/associated with male-typical developmental process(es) underlying female same-sex attraction. (H3-2) Strength of hand preference is negatively influenced by/associated with male-typical developmental process(es) underlying female same-sex attraction.	(H3-1, H3-2) Higher rates of non-right-handedness in same-sex attracted females compared to other-sex attracted females (e.g., Lalumiere et al., 2000).	(3-1) Higher rates of left-handedness in Iranian gynephilic females compared to androphilic females. (3-2) Higher rates of left-handedness in ambiphilic females, intermediate between androphilic and gynephilic females. (3-3) Higher rates of mixed-handedness in gynephilic females compared to androphilic females. (3-4) Higher rate of mixed-handedness in ambiphilic females, intermediate between androphilic and gynephilic females. (3-5) Absolute values of laterality quotients would be negatively associated with female gynephilia.	Prediction 3-1: Not supported Prediction 3-2: Partially supported Prediction 3-3: Supported Prediction 3-4: Partially supported Prediction 3-5: Supported Prediction 3-6: Partially supported

		(3-6) Absolute values of laterality quotients would be negatively associated with female ambiphilia, but a weaker association than that of gynephilic females.	

METHODS

Recruitment

In this paper, we present data collected over three years from November 2021 to September 2024 during three recruitment attempts. The first recruitment sample was drawn from an online survey conducted using Qualtrics. Popular social media platforms among Iranians such as X (formerly, Twitter), Instagram, and Telegram were used as the main routes for distributing the invitation to participate in the study. The message began with "We are seeking Iranian men and women (18 years of age or older) to participate in a voluntary, anonymous and confidential study on childhood and adulthood behaviour and psychology. Participants can be heterosexual or homosexual, gender conforming or non-gender conforming, including trans individuals." An anonymous link was included in the message which was used by interested individuals to access the survey. The responses were recorded between November 2021 and July 2022.

The second recruitment sample was collected between April 2022 and April 2024 in Mashhad and Tehran, Iran. A snowball sampling method was used to recruit most of these participants. Some transgender participants were current or previous clients of a gender clinic in Mashhad and were recruited through that clinic. Most of these individuals had received the diagnosis of gender dysphoria and were at different stages of gender transition. These individuals would then sometimes introduce other transgender individuals who had not been clients of this clinic in the past. A diagnosis of gender dysphoria was not an inclusion criterion for participation

in this study. Some cisgender same-sex attracted males were clients of an HIV primary care clinic who were mainly seeking HIV screening test and consultation. Other cisgender same-sex attracted participants were initially found through the personal social networks of the researchers. These individuals would then introduce other individuals. Some staff and students were also recruited at a hospital in Mashhad and some participants from public social spaces such as coffee shops and malls. These individuals constituted, for the most part, our control groups of other-sex attracted males and females.

The third round of data collection was undertaken between June and September 2024. A poster was circulated in online social groups that targeted Iranians with diverse sexuality or gender. The invitation asked readers to contact the research team if interested in participation. Meetings were scheduled with participants who agreed to meet in-person. Otherwise, the survey link was shared, and further communications remained online. Data from participants who confirmed they had participated in previous rounds of recruitment were removed.

Participants

Overall, 1322 participants completed the questions about hand preference. Data from eight groups of participants (n =1268) were considered for statistical analysis. These groups included cisgender gynephilic males (n = 242), cisgender ambiphilic males (n = 108), cisgender androphilic males (n = 314), transgender androphilic males (n = 103), cisgender androphilic females (n = 250), cisgender ambiphilic females (n = 96), cisgender gynephilic females (n = 32), and transgender gynephilic females (n = 123). Due to small group size, we did not analyze data from the other eight groups including transgender gynephilic males (n = 6), transgender ambiphilic males (n = 9), transgender androphilic females (n = 2), transgender ambiphilic females (n =8), cisgender asexual/analloerotic males (n = 10), transgender asexual/analloerotic

males (n = 2), cisgender asexual/analloerotic females (n = 14), and transgender asexual/analloerotic females (n = 2).

Measures

Demographic information

The survey comprised standardized questionnaires that were translated to Farsi from English by a fluent bilingual (English and Farsi) speaker. Participants were asked to report their year of birth, level of education, and financial status. Level of education was reported on a 7-point scale from 1 = "no education" to 7 = "postgraduate degree." Due to the limited number of participants in first three levels of education, those levels were collapsed and are presented together resulting in five levels of education. Participants were also asked to report their overall financial status on 5-point scale from 1 = "very bad" (I need financial aid for my basic needs) to 5 = "very good" (I have no concerns about money). Overall, cisgender gynephilic males, cisgender androphilic males and cisgender androphilic females were older, had more education and reported a better financial status compared to other groups (Table 5-2).

Sex, Gender Identity/Expression, and Sexual Orientation

In terms of sex, we categorized participants based on their answer to the following question: "Which sex were assigned to you at birth? (*male*, *female*, and if *other* please specify.)" In terms of gender, participants were asked two consecutive questions: "What is your gender identity? (*man*, *woman*, and if *other* please specify)" and "Are you transgender or transsexual? (*yes* or *no*)". When participants identified as a female identifying as a woman or a male identifying as a man, and as neither transgender nor transsexual, they were categorized as *cisgender*. Participants were classified as *transgender* if they: (1) identified as a *woman* while being identified as a male at birth, or (2) identified as a *man* while being identified as a female at

birth, or (3) identified as neither a *man* nor a *woman*. Of 103 transgender males included in this paper, 30 identified neither as a man nor a woman and of these, the most common reported gender identity was *non-binary* (n = 17). Also, 16 individuals out of these 30 did not self-identify as transgender/transsexual. Of 123 transgender females, eight participants reported an alternative gender identity with non-binary being the most common (n = 5). Also, four individuals out of these eight did not self-identify as transgender/transsexual.

To assess sexual orientation, participants were asked to report their sexual feelings towards adult males/men or females/women, during the previous 12 months, using a 7-point Likert scale (Kinsey et al., 1948). Participants who had sexual feelings only for females/women (score = 0), or had only an occasional fantasy about males/men (score = 1) were categorized as *gynephilic,* those who had stronger sexual feelings for both males/men and females/women (score = 2 to 4) were categorized as *ambiphilic,* and those who had only an occasional fantasy about females/women (score = 5), or were only attracted to males/men (score = 6) were categorized as *androphilic*. An eighth item was added for participants who "have not any sexual feelings toward any sex/gender," and these individuals were categorized as *asexual/analloerotic*. Considering it was unclear from the item whether any other type of sexual feeling was present or not, this group could be either asexual (i.e., no sexual feelings whatsoever) or analloerotic (i.e., presence of sexual feelings but not directed toward males/men or females/women; Blanchard, 1989).

Assessing Hand Preference

In this study, a modified version of the 10-item Edinburgh Handedness Inventory (EHI) was used (Oldfield, 1971), with the eighth (i.e., broom) and tenth (i.e., opening box) items from the original questionnaire replaced with three new items. The participants answered multiple-

choice questions about 11 activities: writing, drawing, throwing, using a pair of scissors, using a tooth brush, using a knife (without a fork), using a spoon, using a key to open a door (new), striking a match, holding a computer mouse (new), and holding a cup to drink (new). In the first two rounds of data collection, participants were asked to report their preferred hand by choosing either "right", "left", or "both" for each activity. A subsequent question asked if they "ever use the other hand" for doing that activity. If a participant indicated the preferred hand as left (or right) and answered "no" to the latter question, the response was coded as -2 = "extremely left-handed" (or 2 = "extremely right-handed"), but if they answered "yes", the response was coded as -1 = "moderately left-handed" (or 1 = "moderately right-handed"). If a participant reported preferring both hands, the response was coded as 0 = "ambidextrous." In the third round of data collection, male participants (the questionnaire was not presented to female participants) were presented with a 5-point Likert scale ranging from -2 = "always use the left hand" to 2 = "always use the right hand." This change was mainly done to decrease the survey's length by limiting the number of questions and affected 225 participants who were mostly cisgender ambiphilic males (n = 54), cisgender androphilic males (n = 125), and transgender androphilic males (n = 43).

Statistical Analysis

Item-analysis and evaluation of the modified Edinburgh Handedness Inventory

To evaluate our modified EHI questionnaire and conduct item-analysis, we devised an analytical approach inspired by Oldfield's (1971) methodology. First, for each *participant*, the average scores of all items were calculated. Then, for each *item*, average scores were plotted against participants' scores. Hence, we examined how each item functioned along the distribution of participants' scores. In accordance to Oldfield (1971), one criterion for item selection was to observe a relatively linear relationship, with an item's average scores increasing

(i.e., preferring right hand for doing that activity) as the participants' scores increase (i.e., preferring right hand across all the activities).

The resulting chart (Figure 5-1) revealed a linear relationship for most activities. In Figure 5-1, the sharp fluctuations are mostly due to a few data points, particularly in the middle section of each distribution. In the case of item 10 "holding a mouse computer," the scores appeared to hover for the most part on the upper half of the chart (scores > 0) and only fall to the lower half at the extreme left side of distribution (i.e., < -1.50). This indicated that except for extremely left-handed participants, most participants reported to prefer using right hand to hold a computer mouse.

Another notable pattern in Figure 5-1 relates to scores for writing, as they appeared to occupy the extremes for the larger part of the distribution, with a sudden flip around -0.20 to 0.20. Data showed that 95.7% of participants with average scores ≤ 0 (average scores of all 11 items) preferred the left hand for writing, with a large majority (82.9%) reporting extreme left-handedness. On the other hand, 97.4% of participants with average scores > 0 preferred the right hand for writing, with 87.6% reporting extreme right-handedness. This pattern was also evident for drawing. This has two implications for our study. First, it does not appear that social pressure against using the left hand (e.g., in schools where children learn writing) has affected our Iranian sample as is the case for some East Asian cultures (Papadatou-Pastou et al., 2020). Second, writing and drawing are not very good at tracking gradual changes in hand preference, which together with the strong correlation between the two items ($r = 0.94$, $p < 0.001$), raise the question whether one of them should be removed from the questionnaire. The other items displayed a relatively linear relationship. Notably, the 11th item (holding a cup) had a marked plateau with sharp slopes at the extremes. This pattern is explicable insofar as 320 (25.2%)

participants reported being ambidextrous for holding a cup. This ratio is higher than ratios of ambidexterity reported for other items which ranged from 1.0% for drawing to 13.9% for using a key to open a door (Table 5-3).

In consideration of these analyses, we decided to remove: (1) drawing from our analyses, due to its multicollinearity with writing, and (2) holding a mouse computer, due to its poor detection of left-handedness. We conducted analyses with the remaining nine items (writing, throwing, using a pair of scissors, using a toothbrush, using a knife [without a fork], using a spoon, using a key to open a door, striking a match, and holding a cup). The exact replication of the item-analysis conducted by Oldfield (1971) is presented in the Supplementary Material.

An exploratory factor analysis was conducted using extraction method maximum likelihood (Sakaluk & Short, 2017). The Kaiser-Meyer-Olkin (KMO) measure was 0.95 indicating sampling adequacy and the one-factor solution accounted for 67% of the observed variance in participants' ratings of different items. The extracted item communalities ranged from 0.48 for holding a cup to 0.77 for writing, which is in line with what is expected in the social sciences (Costello & Osborne, 2005). Internal consistency was assessed using Cronbach's alpha which was deemed acceptable across the sample ($\alpha = 0.95$).

Laterality Quotient

A composite score was calculated by averaging the scores for nine items resulting in values ranging from -2 to 2. Our approach diverged from how Oldfield (1971) computed composite scores which he called *Laterality Quotient.* In the original EHI, participants were instructed to distinguish between extreme and moderate preferences for using a hand, however, the formula used for computing laterality quotient scores did not parse apart moderate and

extreme hand preferences (for more details see the Supplementary Material). This issue is resolved in the computation of our laterality quotient scores.

Direction and strength of hand preference

To address the methodological variation characterizing the literature on hand preference, we sought to adopt a conceptual and data-driven framework while presenting our data in a manner comparable to existing literature on sex and sexual orientation differences in human hand preference. Hence, instead of using an arbitrary threshold for classification, we used k-means cluster analysis with k = 2 (left vs right), k = 3 (left vs mixed vs right), and k = 5 (extremely left-handed vs moderately left-handed vs mixed vs moderately-right-handed vs extremely right-handed) to classify participants.

As discussed earlier, a person's hand preference can be described in terms of direction or strength. To evaluate the left-hand bias in direction of hand preference and compare it with meta-analyses reported by Papadatou-Pastou et al. (2020), we report data pertaining to (1) left handers from a dichotomic classification (i.e., left vs right) and (2) left handers from a trichotomic classification (i.e., left vs mixed vs right). Strength of hand preference was evaluated using both categorical and continuous approaches. For the categorical approach, rates of mixed-handers from k-means cluster analysis with k = 3 were compared. With respect to the continuous approach, absolute values of the laterality quotients were calculated, with values ranging from 0 (i.e., the least strength, or highest variation in preference and use), to 2 (i.e., the greatest strength, or lowest variation in preference and use).

In addition, left- and mixed-handed participants from the k-means cluster analysis with k = 3 were combined to constitute the category of non-right-handers. This allowed for comparisons of our data with a meta-analysis on the association of hand preference and sexual orientation that

used the category of non-right-handers (Lalumiere et al., 2000). For a similar reason, to compare our data with reported male sexual orientation differences in categories of extremely right- and left-handers (e.g., Kishida & Rahman, 2015; Skorska et al., 2020), results from a k-means cluster analysis with k = 5 (extremely left-handed vs moderately left-handed vs mixed vs moderately-right-handed vs extremely right-handed) were presented.

RESULTS

Distribution of Hand Preference

As illustrated in Figure 5-2, the expected J-shaped distribution of laterality quotient scores was present in our sample. Complete homogeneity in hand preference was apparent in 16.3% of participants who either scored -2.0 (1.2% reported extreme left-hand preference for all items) or 2.0 (15.1% reported extreme right-hand preference of all items). Only 2 out of 1268 participants reported equal preference for both hands across all reported activities (i.e., being truly ambidextrous). Overall, 3.7% of participants consistently responded that they preferred their left hand (either moderately or extremely) for all the activities listed in the questionnaire, while 54.6% of participants consistently preferred their right hand (either moderately or extremely) for all the activities. In the remaining 41.7% of the sample, the dominant hand varied between activities.

Table 5-0-2 Demographic characteristics of participants

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Number of participants	260	106	315	105	269	110	52	256
*Age**								
Mean ± Standard deviation	27.30 ± 6.77	24.48 ± 5.01	26.66 ± 6.29	24.10 ± 4.62	26.72 ± 6.46	24.18 ± 5.07	23.06 ± 5.00	23.98 ± 4.58
*Level of education***								
Junior high school	1.9%	0.9%	1.0%	2.9%	0.0%	1.8%	1.9%	2.7%
High school	21.9%	14.2%	16.5%	26.0%	17.1%	25.5%	26.9%	23.1%
College	13.8%	39.6%	25.1%	36.5%	15.6%	21.8%	28.8%	31.8%
Undergraduate	37.7%	34.0%	36.8%	26.9%	42.8%	35.5%	34.6%	34.9%
Post-graduate	24.6%	11.3%	20.6%	7.7%	24.5%	15.5%	7.7%	7.5%
*Financial Status***								
Very bad	0.8%	2.8%	4.1%	9.6%	0.7%	0.9%	0.0%	4.3%
Bad	9.2%	14.2%	12.7%	16.3%	4.5%	10.0%	5.8%	12.5%
Not bad Not good	58.1%	60.4%	60.0%	57.7%	55.4%	50.0%	51.9%	64.7%
Good	28.5%	20.8%	20.6%	13.5%	35.3%	33.6%	36.5%	16.5%
Very good	3.5%	1.9%	2.5%	2.9%	4.1%	5.5%	5.8%	2.0%

* Overall, 20 data points were missing: cisgender gynephilic males (n = 3), cisgender ambiphilic males (n = 2), cisgender androphilic males (n = 3), transgender androphilic males (n = 1), cisgender androphilic females (n = 5), cisgender gynephilic females (n = 1), and transgender gynephilic females (n = 5). ** One missing data point for a transgender androphilic male and one for a transgender gynephilic female.

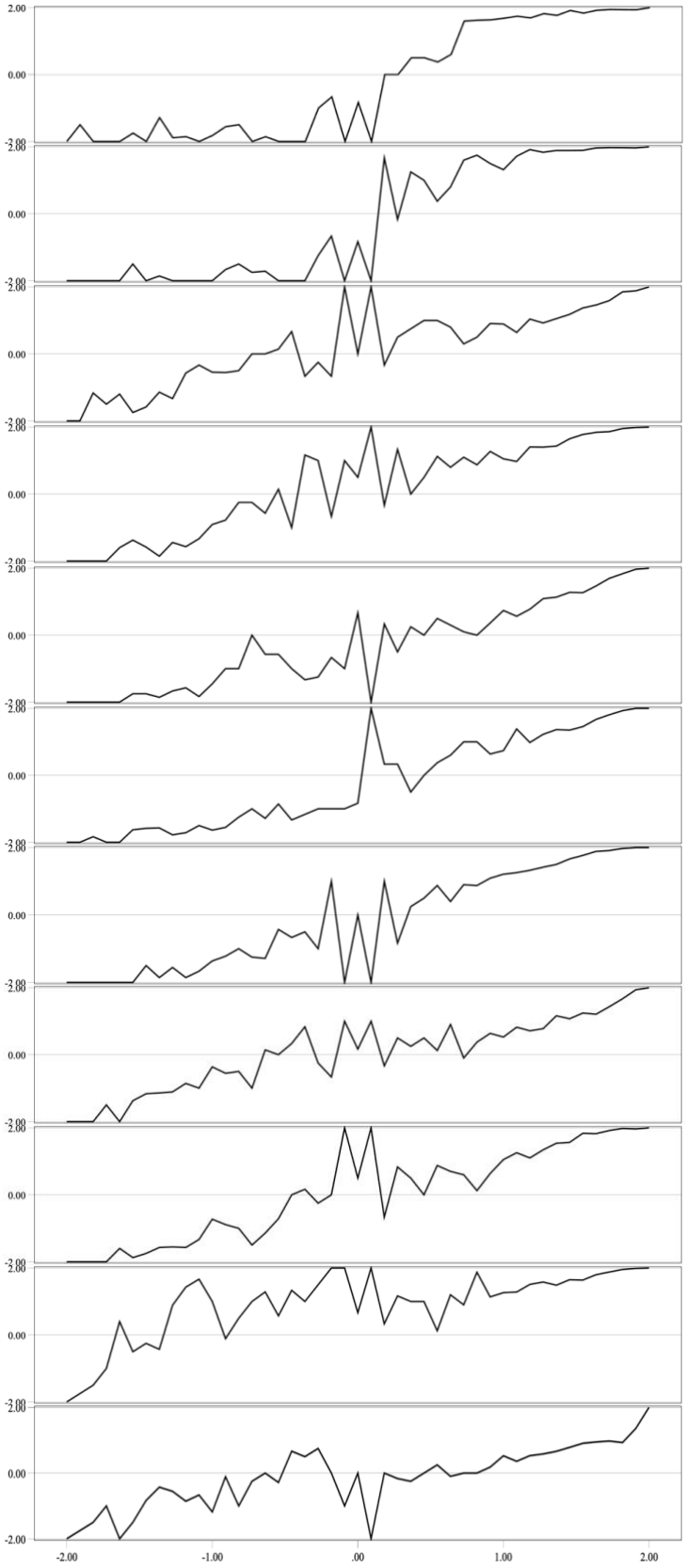


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Table 5-0-3 Distribution of items across the sample (n = 1268)

items	Absolute mean score ± standard deviation	Exclusive left-hand preference	Moderate left-hand preference	Equal hand preference	Moderate right-hand preference	Exclusive right-hand preference
Writing	1.86 ± 0.40	9.5%	1.7%	1.8%	8.8%	78.1%
Drawing	1.91 ± 0.31	10.6%	0.9%	1.0%	6.4%	81.2%
Throwing	1.44 ± 0.67	4.2%	3.9%	10.5%	31.0%	50.5%
Using scissors	1.69 ± 0.56	5.4%	3.4%	4.9%	17.7%	68.6%
Using toothbrush	1.47 ± 0.68	7.2%	2.9%	11.0%	28.4%	50.6%
Using a knife	1.64 ± 0.59	7.9%	4.4%	6.2%	18.8%	62.7%
Using spoon	1.73 ± 0.54	8.0%	2.1%	4.8%	15.3%	69.9%
Using a key to open a door	1.34 ± 0.71	3.9%	4.5%	13.9%	33.3%	44.5%
Striking a match	1.67 ± 0.60	6.2%	2.9%	7.2%	15.7%	68.1%
Holding a computer mouse	1.70 ± 0.55	2.2%	2.1%	4.9%	18.0%	72.8%
Holding a cup	1.02 ± 0.72	2.5%	5.5%	25.2%	42.2%	24.5%

Comparing Measures of Hand Preference Between Groups

Left-handedness (Left vs Right): A k-means cluster analysis (k = 2) assigned 11.7% of participants as left-handed with laterality quotient scores ≤ 0.11, and 88.3% of participants as right-handed with laterality quotient scores ≥ 0.22, (no score was between 0.11 and 0.22). Contrary to Predictions 1-1, 2-1, 2-2, 3-1, and 3-2, a contingency table and chi-square test did not reveal any significant association between the direction of hand preference and study groups (Table 5-4).

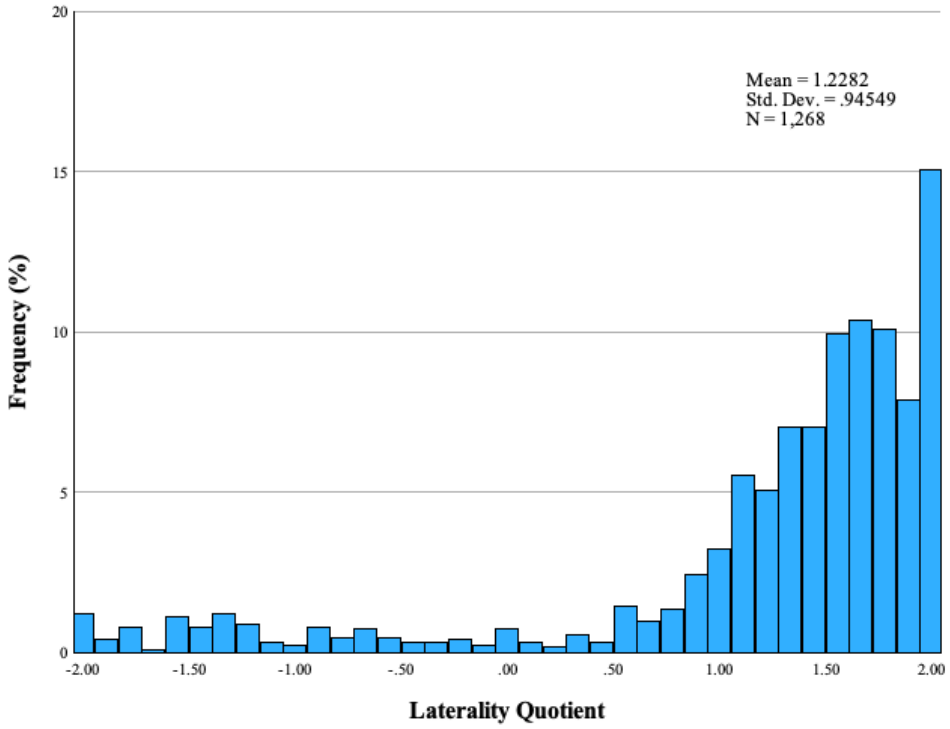


Figure 5-6 Distribution of laterality quotient scores calculated from a revised 9-item Edinburgh Handedness Inventory

Left-handedness (Left vs Mixed vs Right): A k-means cluster analysis (k = 3) assigned 10.4% of participants as left-handed with laterality quotient scores ≤ -0.22, and 67.3% of participants as right-handed with laterality quotient scores ≥ 1.33. To isolate the effect of the left-handed category, a chi-square test was performed for a contingency table excluding the mixed-

handed category, which did not reveal any significant association between direction of hand preference and study groups (Table 5-4). Therefore, no statistical support was provided for Predictions 1-1, 2-1, 2-2, 3-1, and 3-2.

However, the observed proportions of participants assigned left-handed using both dichotomous and trichotomous clustering were consistent with our predictions for sex (cisgender gynephilic males had a higher rate compared to cisgender androphilic females; Prediction 1-1 partially supported), male androphilia (cisgender androphilic males and transgender androphilic males had higher rates compared to cisgender gynephilic males; Prediction 2-1 partially supported), male ambiphilia (cisgender ambiphilic males had higher rates compared to cisgender gynephilic males; Prediction 2-2 partially supported), female ambiphilia (cisgender ambiphilic females had higher rates compared to cisgender androphilic females; Prediction 3-2 partially supported), but not with predictions for female gynephilia (cisgender and transgender gynephilic females had lower rates compared to cisgender androphilic females; Prediction 3-1 not supported)

Mixed-handedness (Left vs Mixed vs Right): In the trichotomous clustering (k = 3) reported previously, 22.2% of participants were assigned as mixed-handed, with laterality quotients ranging from -0.11 to 1.22. A chi-square test for the contingency excluding left-handed category, revealed significant association between variation in rates of mixed-handedness and group membership (Table 5-4). In line with Prediction 1-2, a sex difference was observed with a higher proportion of cisgender gynephilic males assigned as mixed-handed than cisgender androphilic females (11.2%, SE = 0.04, 95% CI [3.9%, 18.4%], z = 3.02, p = 0.003). Observed results for male sexual orientation were all nonsignificant, but the direction of change varied between groups. Contrary to Prediction 2-3, cisgender androphilic males (-4.5%, SE = 0.04, 95%

CI [-11.9%, 2.7%], z = -1.16, p = 0.248) and transgender androphilic males (-5.8%, *SE* = 0.05, 95% CI [-14.9%, 4.8%], z = -1.02, p = 0.307) had lower rates of mixed-handedness compared to gynephilic males. Partially in line with Prediction 2-4, a higher proportion of cisgender ambiphilic males were assigned as mixed-handed compared to cisgender gynephilic males (6.3%, *SE* = 0.05, 95% CI [-4.1%, 17.3%], z = 1.09, p = 0.276). Also, partially consistent with Prediction 3-3 and 3-4, higher proportions of cisgender gynephilic females (7.9%, *SE* = 0.08, 95% CI [-5.1%, 26.9%], z = 0.91, p = 0.360), transgender gynephilic females (17.7%, *SE* = 0.05, 95% CI [8.3%, 27.6%], z = 3.89, p < 0.001), and cisgender ambiphilic females (7.9%, *SE* = 0.05, 95% CI [-1.2%, 18.5%], z = 1.62, p = 0.106) were assigned mixed-handed in comparison to cisgender androphilic females (Table 5-4). However, the observed increase in the rate of mixed-handedness was only statistically significant in transgender gynephilic females.

Absolute values of laterality quotient scores: Between-group comparison of the absolute values of laterality quotient scores showed significant differences (Table 5-4). Consistent with Prediction 1-3, a binomial regression analysis (χ^2 [1] = 4.14, p = 0.042, Nagelkerke R^2 = 0.011) showed that an increase of one unit in the absolute values of laterality quotients significantly raised the odds ratio for being a cisgender androphilic female compared to a cisgender gynephilic male (*B* = 0.47, *SE* = 0.23, *Wald* = 4.07, p = 0.044, odds ratio = 1.61, 95% CI [1.01, 2.54]). Consistent with Prediction 2-6, a multinomial regression analysis (χ^2 [3] = 10.86, p = 0.013, Nagelkerke R^2 = 0.015) revealed that an increase of one unit in the absolute values of laterality quotients significantly lowered the odds ratio for being a cisgender ambiphilic male (*B* = -0.55, *SE* = 0.24, *Wald* = 5.32, p = 0.021, odds ratio = 0.58, 95% CI [0.36, 0.92]) compared to a cisgender gynephilic male.

Table 5-0-4 Comparison of direction and strength of handedness across groups

Groups	Left-handed (%) (k =2; Left vs Right)	Left-handed (%) (k = 3; Left vs Mixed vs Right)	Mixed-handed (%) (k = 3; Left vs Mixed vs Right)	Non-Right-handed (%) (non-Right vs Right)	Strength
Cisgender gynephilic males	10.7%	9.9%	25.2%	35.1%	1.48 ± 0.39
Cisgender ambiphilic males	17.6%	13.9%	31.5%	45.4%	1.35 ± 0.55
Cisgender androphilic males	11.8%	10.5%	20.7%	31.2%	1.52 ± 0.47
Transgender androphilic males	17.5%	17.5%	19.4%	36.9%	1.50 ± 0.45
Cisgender androphilic females	10.0%	9.2%	14.0%	23.2%	1.55 ± 0.38
Cisgender ambiphilic females	10.4%	10.4%	21.9%	32.3%	1.46 ± 0.40
Cisgender gynephilic females	6.3%	6.3%	21.9%	28.1%	1.50 ± 0.38
Transgender gyenphilic females	8.9%	5.7%	31.7%	37.4%	1.42 ± 0.46
Test of between-group difference	χ^2 (7) = 9.87, p = 0.196	χ^2 (7) = 11.78, p = 0.108	χ^2 (7) = 24.15, p = 0.001	χ^2 (7) = 21.48, p = 0.003	F(7, 1260) = 3.02, p = 0.004

Contrary to Prediction 2-5, positive associations, albeit nonsignificant ones, were present for being a cisgender androphilic male (B = 0.21, SE = 0.19, $Wald$ = 1.22, p = 0.269, odds ratio = 1.23, 95% CI [0.85, 1.80]) and a transgender androphilic male (B = 0.13, SE = 0.26, $Wald$ = 0.26, p = 0.610, odds ratio = 1.14, 95% CI [0.68, 1.91]).

Consistent with Prediction 3-5, a multinomial regression analysis (χ^2 [3] = 9.33, p = 0.025, Nagelkerke R^2 = 0.020) revealed that an increase of one unit in the absolute values of laterality quotients significantly lowered the odds ratio for being a transgender gynephilic female (B = -0.77, SE = 0.27, $Wald$ = 8.33, p = 0.004, odds ratio = 0.46, 95% CI [0.27, 0.78]) compared to a cisgender androphilic female. Similar, but nonsignificant, associations were found for being a cisgender ambiphilic female (B = -0.56, SE = 0.29, $Wald$ = 3.56, p = 0.059, odds ratio = 0.57, 95% CI [0.32, 1.02]; partially consistent with Prediction 3-6) and a cisgender gynephilic female (B = -0.29, SE = 0.47, $Wald$ = 0.39, p = 0.534, odds ratio = 0.75, 95% CI [0.30, 1.88]; Partially consistent with Prediction 3-5).

Extreme vs moderate hand preference: Participants were assigned to five categories by performing a k-means cluster analysis (k = 5) on laterality quotient scores. Overall, 6.4% of participants were classified as extremely left-handed (scores ≤ -1.22), 4.2% as moderately left-handed (-1.11 ≤ to ≤ -0.11 scores), 8.2% as mixed-handed (0.00 ≤ to ≤ 0.89 scores), 37.8% as moderately right-handed (1.00 ≤ to ≤ 1.56 scores), and 43.4% as extremely right-handed (scores ≥ 1.67). As illustrated in Figure 5-3 and supported by a chi-square test performed for a contingency table (χ^2 [28] = 59.17, p < 0.001), variation in hand categories was associated with study groups (Figure 5-3). A prominent pattern was that androphilic groups (male or female) had higher ratios of extreme to moderate right-handedness, while gynephilic groups (male or female) had a lower or reversed ratios. These results are consistent with H1-2 and H3-2 which postulated

lower strength of hand preference in cisgender gynephilic males and gynephilic females, respectively. However, these results do not support H2-2, as increased proportion of extremely right-handed androphilic males indicate higher rather than lower strength in hand preference.

Non-right-handedness: Left- and mixed-handed categories produced by the previously reported k-means clustering analysis (k = 3) were combined to form the category of non-right-handedness which included 32.6% of participants (laterality quotients ≤ 1.22). A chi-square test for the contingency table revealed a significant association between non-right-handedness and study groups (Table 5-4). Consistent with Hypothesis 1, a higher proportion of cisgender gynephilic males were assigned as non-right-handed compared to cisgender androphilic females (11.9%, *SE* = 0.04, 95% CI [3.6%, 20.0%], $z = 2.81$, $p = 0.005$). Contrary to Hypothesis 2, in comparison to cisgender gynephilic males, the proportions of participants assigned as non-right-handed were not significantly different for cisgender ambiphilic males (10.2%, *SE* = 0.06, 95% CI [-1.2%, 21.7%], $z = 1.70$, $p = 0.089$), transgender androphilic males (1.8%, *SE* = 0.06, 95% CI [-9.4%, 13.5%], $z = 0.19$, $p = 0.848$), and cisgender androphilic males (-3.9%, *SE* = 0.04, 95% CI [-12.1%, 4.2%], $z = -0.88$, $p = 0.377$). Partially consistent with Hypothesis 3, higher proportions of cisgender ambiphilic females (9.1%, *SE* = 0.05, 95% CI [-1.6%, 20.6%], $z = 1.59$, $p = 0.111$), cisgender gynephilic females (4.9%, *SE* = 0.08, 95% CI [-10.0%, 24.4%], $z = 0.40$, $p = 0.692$), and transgender gynephilic females (14.2%, *SE* = 0.05, 95% CI [4.0%, 24.7%], $z = 2.75$, $p = 0.006$) were assigned non-right-handed in comparison to cisgender androphilic females. However, only the difference for transgender gynephilic females reached statistical significance (Table 5-4).

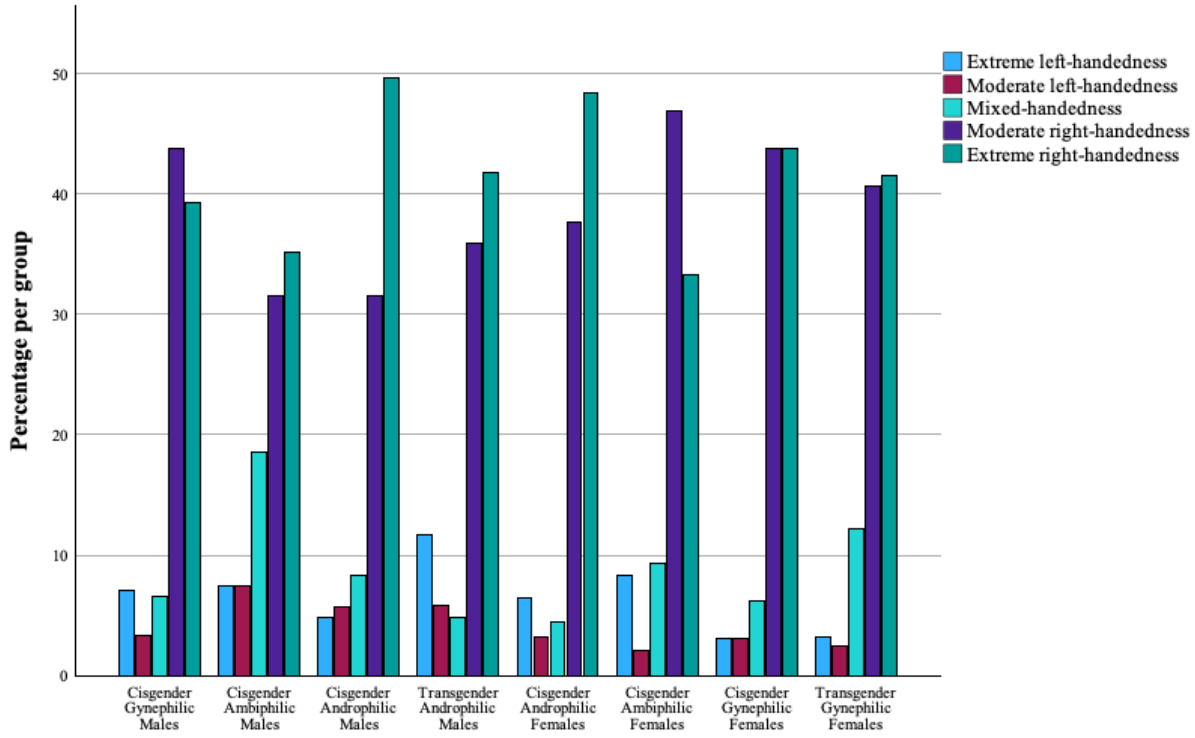


Figure 5-7 Categorical distribution of handedness obtained from a k-means cluster analysis with k = 5

DISCUSSION

In this study, we investigated the association between hand preference and variation in sex, sexual orientation, and gender identity/expression. Based on existing evidence, 6 hypotheses and 15 specific predictions were formulated (Table 5-1). Hypothesis 1-1 attributed possible biases in direction of hand preference to sexually dimorphic develpmental pathways. Contary to Prediction 1-1, the rate of left-handed cisgender gynephilic males was only slightly higher than that of cisgender androphilic females (Cohen's arcsine *d*s = 0.02) and the observed difference was not statistically significant. Further, the observed difference was smaller than what has been reported in a recent meta-analysis (Cohen's arcsine *d*s < 0.08; Papadatou-Pastou et al., 2020).

Hypothesis 1-2 held that male sex would have lesser strength in hand preference, which formed the basis for Predictions 1-2 and 1-3. Consistent with Prediction 1-2, the rate of mixed-

handedness was significantly higher in cisgender gynephilic males (Cohen's arcsine $d = 0.28$). Consistent with Prediction 1-3, absolute values of laterality quotients were associated with an elevated odds ratio for being a cisgender androphilic female (Cohen's $d = 0.27$ for differences in mean scores). The lower rate of non-right-handedness and higher rate of extreme-right-handedness in cisgender androphilic females were also consistent with Hypothesis 1. These categories, however, entailed both direction and strength of hand preference and thus, could not be used to form independent predictions about features of hand preference. In sum, cisgender androphilic females' hand preference was characterized by greater strength, which can be regarded as a female-typical pattern, whereas cisgender gynephilic males' hand preference was characterized by lesser strength, which can be viewed as a male-typical pattern.

In relation to male androphilia, Hypothesis 2-1 attributed the variation in androphilic males' direction of hand preference to extreme male-typical developmental pathways. Contrary to Prediction 2-1, rates of left-handedness in cisgender (Cohen's arcsine $d = 0.03$) and transgender androphilic males (Cohen's arcsine $d = 0.22$) were not significantly different from cisgender gynephilic males. Contrary to Hypothesis 2-2, which attributed the variation in strength of hand preference to extreme male-typical developmental factors, androphilic males had decreased rates of mixed-handedness (Cohen's arcsine $ds = -0.11$ and -0.14 for cisgender and transgender groups, respectively) and increased absolute values of laterality quotients compared to cisgender gynephilic males (Cohen's $ds = 0.10, 0.07$ for cisgender and transgender groups, respectively). However, observed differences were not statistically significant. Also, our study did not replicate previous reports of elevated non-right-handedness in androphilic males (e.g., Lalumiere et al., 2000).

There are a few nuanced findings in relation to male androphilia that cannot be explained by male-typicality of hand preference in this group. For example, consistent with previous reports, we found significantly higher rate of extreme right-handedness in cisgender androphilic males compared to cisgender gynephilic males (Kishida & Rahman, 2015; Skorska et al., 2020). Also, consistent with a previous report from Thailand (Skorska et al., 2020), our sample of transgender androphilic males had a higher ratio of extreme left-handedness compared to cisgender androphilic males and cisgender gynephilic males. These nuanced findings suggest that the interaction between direction and strength of hand preference is complex and, perhaps, distinct in cisgender and transgender androphilic males. Therefore, it may be informative to try disentangling direction and strength of hand preference in future studies with larger sample sizes.

In sum, variations in androphilic males' direction and strength of hand preference were found to be slight, nonsignificant, and in a direction opposite to what we predicted. Furthermore, none of the comparisons related to androphilic males reached statistical significance. Consequently, a conservative interpretation of these findings would reject Hypothesis 2 and conclude that male androphilia is not associated with variation in hand preference.

Results for cisgender ambiphilic males were more in line with predictions derived from Hypothesis 2. Their rates of left-, mixed-, and non-right-handedness were higher compared to cisgender gynephilic males (Cohen's arcsine *ds* = 0.20, 0.14, 0.22, respectively). These elevated rates were statistically nonsignificant, and thus, were partially in line with Predictions 2-2, 2-4, and previous reports on cisgender ambiphilic males (e.g., Blanchard & Lippa, 2007). The absolute values of laterality quotients, however, had a significant negative association with male ambiphilia, which supported Prediction 2-6 (Cohen's *d* = -0.29). Therefore, cisgender ambiphilic males exhibited a distinct pattern compared to androphilic males, as their hand preference, in

particular, strength, was extremely male-typical, even compared to cisgender gynephilic males. We note that samples included in the meta-analysis by Lalumiere et al. (2000) were "likely to contain a majority of homosexuals" and "could be composed of self-declared homosexuals, middle-aged men who never married, men diagnosed with HIV and considered likely to be homosexual by the original authors," (pp. 578). Thus, it is possible that the small male sexual orientation difference in non-right-handedness found in their meta-analysis was due to the inclusion of ambiphilic males.

In relation to females, Hypothesis 3-1 attributed the variation in gynephilic females' direction of hand preference to male-typical developmental pathways influencing female gynephilia. Contrary to Prediction 3-1 and 3-2, differences in female sexual orientation were not significantly associated with observed differences in rates of left-handedness. Notably, gynephilic females had lower rates of left-handedness (Cohen's arcsine d = -0.13), which, although being statistically nonsignificant, ran opposite to our prediction. Conversely, in support of Hypothesis 3-2, which attributed the variation in strength of hand preference to male-typical developmental factors, and consistent with Prediction 3-3, mixed- and non-right-handedness were found to be significantly more prevalent among transgender gynephilic females compared to cisgender androphilic females (Cohen's arcsine ds = 0.42, 0.31, respectively). This was also in line with a meta-analysis that showed increased odds ratio of non-right-handedness in same-sex attracted females (Lalumiere et al., 2000). In line with Prediction 3-5, absolute values of laterality quotients had a significant negative association with transgender female gynephilia (Cohen's d = -0.32). We note that the observed patterns for cisgender ambiphilic females (Cohen's d = -0.23) and cisgender gynephilic females (Cohen's d = -0.11) were in the same direction as transgender gynephilic females but were statistically nonsignificant. Also, as

illustrated in Figure 5-3, gynephilic females had lower frequencies of extreme left- and right-handedness compared to cisgender androphilic females.

Summarizing the findings in relation to females, transgender gynephilic females displayed male-typicality in strength, supporting Hypothesis 3-2, but not direction of hand preference, contrary to Hypothesis 3-1. These results indicated that, in all likelihood, it is methodologically inaccurate to use measures that do not differentiate these two aspects of hand preference. Based on these findings, we speculate that robust evidence of increased non-right-handedness in gynephilic females (Lalumiere et al., 2000) is indicative of weaker strength in hand preference and lesser brain lateralization, which might be due to increased exposure to prenatal testosterone. This speculation is consistent with evidence supporting: (1) the role of prenatal sex hormones on female gynephilia (for review see Breedlove, 2017), (2) ambidexterity or mixed-handedness being more common among gynephilic females (e.g., Ellis et al., 2017, Xu & Zheng, 2017), and (3) higher amniotic testosterone being associated with weaker hand preference and lesser brain lateralization in females in childhood (Lust et al., 2011) and adolescent (Richards et al., 2021).

Limitations

The representativeness of our sample may be a limitation. For instance, our participants were on average young, educated, and had relatively good economic status. This was perhaps because most of our participants were recruited in Tehran and Mashhad, Iran's two largest metropolitan areas, using networking sampling method. In addition, the number of participants recruited in different groups were unequal and sometimes quite small, especially for cisgender gynephilic females. Consequently, for some analyses, in particular, categorical analyses, we had less than optimal statistical power and, as such, some of our results, especially those pertaining to

cisgender gynephilic females, should be viewed as tentative. Future studies would benefit from using larger more representative samples.

Also, it is possible that our sample of ambiphilic males was heterogenous and, if assessed using genital arousal measures, would be comprised of predominantly androphilic males (see, Rieger et al., 2005; Semon et al., 2017). Though we are not aware of previous reports on Iranian ambiphilic males that would inform us on this matter, assessment of childhood sex-atypical behaviour in this sample indicates cisgender ambiphilic males score intermediate between cisgender gynephilic males and cisgender androphilic males (Sadr-Bazzaz et al., 2024a). This does not rule out the possible heterogeneity of our sample of cisgender ambiphilic males but undermines the probability that this sample is mostly comprised of truly androphilic males. More data is needed to address this question.

As discussed before, research literature on hand preference is characterized by abundance of approaches to measurement, categorization, and analysis. Our study was not exceptional considering that we used a modified version of EHI including new items. This may have negatively impacted the comparability of our results to previous studies that used the original version of EHI (e.g., Skorska et al., 2020). Further, two different sets of multiple-choice questions were used for assessing hand preference (see Methods, Handedness questionnaire). Although variation in response format does not seem to be associated with estimated rates of left-handedness (Papadatou-Pastou et al., 2020), it may nonetheless have induced some additional measurement error. Overall, a consistent methodological approach to measuring handedness is still lacking (Edlin et al., 2015).

Conclusions

In sum, we found that (1) female sex and female same-sex sexual orientation were linked to strength but not direction of hand preference, (2) with androphilic females exhibiting greater strength in hand preference compared to gynephilic males, and (3) gynephilic females, especially transgender individuals, exhibiting a shift in strength towards a male-typical pattern. Our study did not support an association between male same-sex sexual orientation and hand preference. Our results supported the evidence indicating independent development of direction and strength of hand preference. Also, this study showed the importance of studying both direction and strength in relation to sexual orientation and highlighted the complex interactions between these phenotypes which may plausibly be influenced by different mechanisms in males and females as well as cisgender and transgender individuals. We believe this study, despite its limitations, contributed significantly to existing literature as it examined the association between hand preference and sex, same-sex sexual orientation, and gender identity/expression within the restrictive sociopolitical atmosphere of Iran, a Middle Eastern country.

SUPPLEMENTARY MATERIAL

In the original Edinburgh Handedness Inventory, participants were instructed to indicate their preferred hands by putting + in the columns for left and/or right hands, and to put ++ "where the preference is so strong that you would never try to use the other hand unless absolutely forced to." (Oldfield, 1971, p. 111). To evaluate our modified version, we followed the methodology used by Oldfield (1971) for item-analysis in the original study. A *Laterality Quotient* (L.Q.) was calculated using the formula (1):

$$(1) \qquad H = 100 * \frac{\sum_{i=1}^{11} X(i,R) - \sum_{i=1}^{11} X(i,L)}{\sum_{i=1}^{11} X(i,R) + \sum_{i=1}^{11} X(i,L)}$$

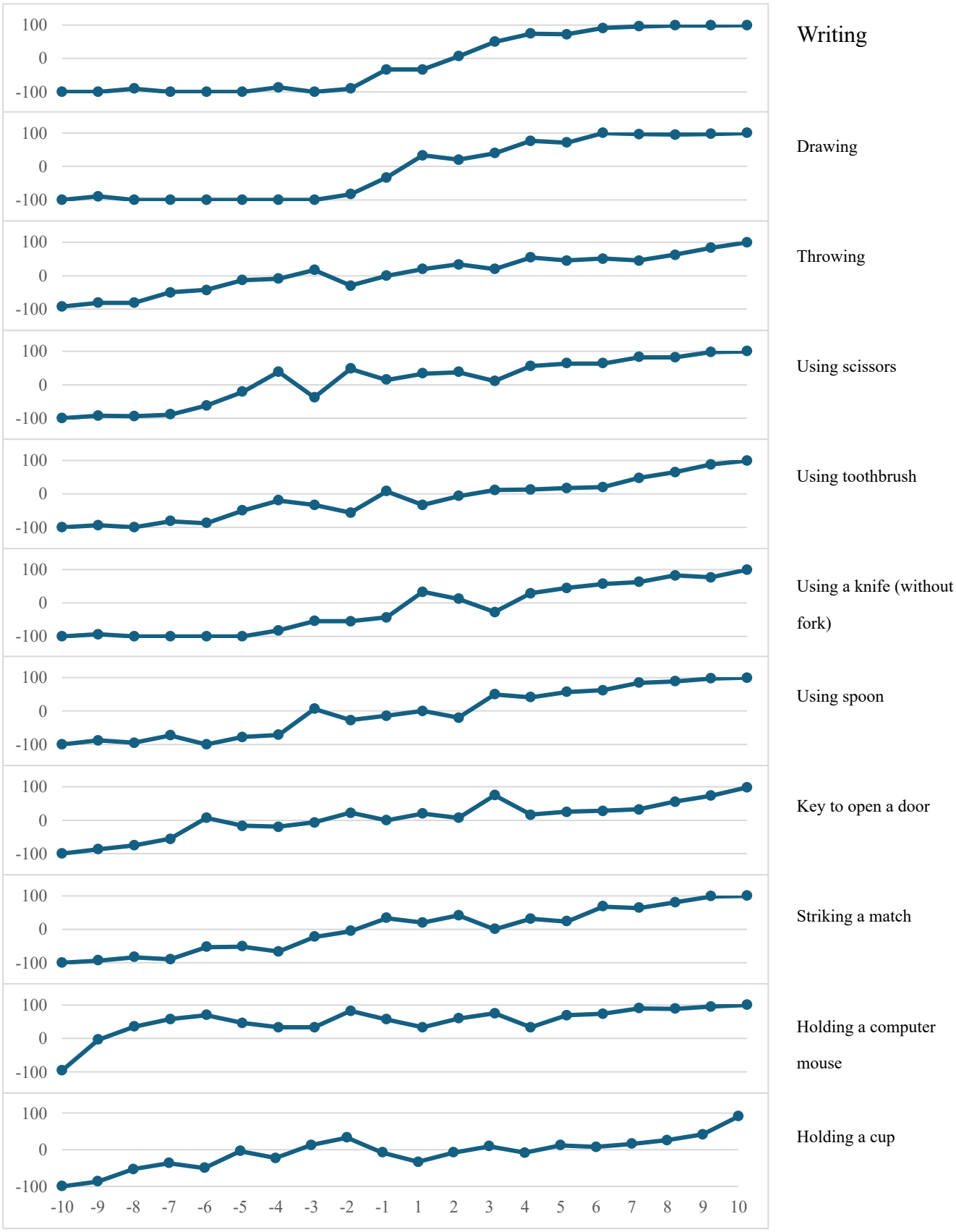
In above expression, the $X(i,R)$ and $X(i,L)$ are numbers of +'s for the *i*th item in the right and left hands, respectively. To this end, we transformed our numerical scores for each item into + sign. If participants were extremely left-handed (or extremely right-handed), ++ were assigned to the left (or right) hand. If participants were moderately left-handed (or moderately right-handed), a + was assigned to the left (or right) hand. When participants reported being ambidextrous for an item, a + was assigned to each hand. The values resulted from formula (1) ranged from -100 to 100. We note that formula 1 can result in extreme values of -100 (or 100) even if participants have not reported extreme left-handedness (or extreme right-handedness) for all items as long as they consistently report moderate left-handedness (or moderate right-handedness) for all items.

Next, L.Q. scores (H) were divided to 20 intervals (e.g., -100 to -90.01). For each item (i), the scores for the left, $X(i,j,h,L)$, and right, $X(i,j,h,R)$, hands of all participants (j) who fell in a L.Q. range (h; number of participants in each range is denoted as n_h) were incorporated in formula (2) to compute λ, which quantifies the contribution of each item to the L.Q scores of all participants in a given L.Q. range:

$$(2) \qquad \lambda i = 100 * \frac{\sum_{j=1}^{nh}\{X(i,j,h,R) - X(i,j,h,L)\}}{\sum_{j=1}^{nh}\{X(i,j,h,R) + X(i,j,h,L)\}}$$

Describing this approach, Oldfield's (1971) stated that "instead of—as in computing the L.Q.— summing the *X(R)* and *X(L)* scores for *all items* for *each subject*, we sum, for *each item*, the *X(R)* and *X(L)* scores for *all subjects* whose L.Q.s place them in each of the L.Q. ranges. In simpler, if looser, terms we compute the set of 'Laterality Quotients' for each item." (p. 102) Each item was assessed by inspecting the chart resulted from mapping the 20 λs computed (using formula 2) for L.Q. intervals (computed using formula 1; Figure s5-1). For most activities, as expected, a linear relationship was evident between an item's λs, or as Oldfield (1971) called "Laterality Quotients" for items, and change in L.Q. for participants. Nevertheless, in the case of item 10 "holding a mouse computer," λ appeared to reach 0 at h = -9 (i.e., L.Q. from -90 to -80.01) and cross to the bottom half of the chart only at -10 (i.e., L.Q. from -100 to -90.01). This indicates that except for extremely left-handed participants, most participants in any L.Q. interval reported to prefer using the right hand to hold a computer mouse. Therefore, this item did not seem to be a reliable measure for handedness in our sample and was removed.

Another notable pattern in Figure s5-1 relates to writing and drawing as they appeared to occupy the extremes for the larger part of the distribution of L.Q., with a sudden flip around L.Q. = 0. Data showed that 95% of participants with L.Q. =< 0 preferred the left hand for these activities, with a large majority (> 84%) reporting extreme left-handedness. On the other hand, about 97% of participants with L.Q. > 0 preferred the right hand, with at least 88% reporting extreme right-handedness. This pattern has two implications for our study.



Supplementary Figure s5-8 Item-analysis for 11 items

Chapter 6: Birth Order and Sibling Sex Ratio Predict Same-Sex Sexual Attraction in Iranian Cisgender and Transgender Adult Males and Females

ABSTRACT

This research examined if sibship composition (birth order and sibling sex ratio) was associated with sexual orientation among Iranian participants who varied in their gender identity/expression. Previous research shows androphilic males tend to have more older brothers, a pattern known as the fraternal birth order effect (FBOE). Recent findings have also highlighted the possible relationship between number of older sisters and male androphilia, a pattern known as the sororal birth order effect (SBOE). Evidence on possible influence of sibship composition on female gynephilia is still emerging. In this study, sibship data for Iranian cisgender gynephilic males (n = 239), cisgender ambiphilic males (n = 106), cisgender androphilic males (n = 315), transgender androphilic males (n = 105), cisgender androphilic females (n = 269), cisgender ambiphilic females (n = 110), cisgender gynephilic females (n = 52), and transgender gynephilic females (n = 256) were analyzed. Compared to gynephilic males, a significant FBOE was found in ambiphilic and both androphilic male groups, and a significant SBOE was found in cisgender androphilic males. Compared to androphilic females, a significant SBOE was found in transgender gynephilic females, and a suggestive trend toward a FBOE was found in cisgender gynephilic females. Our study provided further empirical support for the association between older biological brothers and sisters and androphilia in later born males. Our study also contributed to limited literature on the association between older biological sisters and gynephilia in later born females, particularly, those who are relatively more masculine and identify as transgender.

INTRODUCTION

Among the most reproducible biodemographic correlate of male androphilia is the finding that each older brother increases the likelihood of androphilic sexual orientation in later born males. This biodemographic pattern is referred to in the literature as *fraternal birth order effect* (FBOE; Blanchard & Bogaert, 1996). The robustness of the FBOE is demonstrated by several meta-analyses that used independent samples and/or different analytical approaches (Blanchard, 2018a, 2018b, 2020; Blanchard et al., 2021; Blanchard & Skorska, 2022; but see Vilsmeier et al., 2023). Compared to other proposed explanations (e.g., psychosocial, hormonal, etc.; see Blanchard, 1997), the maternal immune hypothesis (MIH) stands out as the most developed, empirically supported theoretical explanation for the correlation between FBOE and male androphilia (Blanchard & Bogaert, 1996; Blanchard & Klassen, 1997).

The MIH posits that male-specific Y-linked antigens induce a maternal immune response that becomes progressively stronger following each successive pregnancy with male fetuses. A direct immunological test of MIH assessed an antibody for the neuroligin 4 Y-linked protein revealing highest levels of the antibodies in mothers of androphilic males with older brothers, and incrementally lower levels of antibodies in mothers of androphilic males with no older brothers, mothers of gynephilic males, and women with no sons (Bogaert et al., 2018). Notwithstanding its uniqueness, this study provided substantial evidence for the MIH and thus, maternal immunity as a proximal causal mechanism influencing male androphilia. Throughout this article, the MIH will be the theoretical foundation for discussing recent evidence and new data with respect to male androphilia.

Evidence also indicates that the FBOE is detected across samples of androphilic males who are cisgender and transgender. A meta-analysis by Blanchard (2018a) showed that

transgender androphilic males exhibited a greater likelihood of having more older brothers compared to both cisgender gynephilic males and cisgender androphilic males. That said, comparison of sibship data between cisgender and transgender androphilic males *within* populations is rare. A study conducted in Istmo Zapotec, Mexico (Gomez Jimenez et al., 2020b), did not support the effect documented in Blanchard's (2018a) meta-analysis. Our understanding of the possible developmental pathways shared by sexual orientation and gender identity/expression in males could be informed by further within-population comparisons of this sort.

In addition to older brothers, some recent findings suggest that having more older sisters may also increase the odds of male androphilia. This *sororal birth order effect* (SBOE) was demonstrated among North-American/European cisgender androphilic males in recent re-analyses of previously published data (Blanchard & Lippa, 2021), a population-level study in the Netherlands (Ablaza et al., 2022), a large-scale data set from UK Biobank (Kabátek & Blanchard, 2024), and a convenient sample from Czechia and Slovakia (Fořt et al., 2024b). Similar findings were reported for transgender androphilic males in non-North American/European cultures, including Samoa (Semenyna et al., 2023), and Mexico (Gomez Jimenez et al., 2020b).

It does not appear to be the case that these SBOE findings for males are mere artifacts of a correlation between number of live-born older sisters and older brothers (Blanchard & Lippa, 2021). So far, a mechanistic explanation for the link between SBOE and male androphilia has been restricted to the MIH. Kabátek and Blanchard (2024) argued that the implications of a SBOE for the MIH rest on its relative strength compared to the FBOE. They suggested that a weaker SBOE would be compatible with the MIH, assuming a correlation existed between

number of live-born females and number of miscarried male fetuses (also predicted by Blanchard & Lippa, 2021). However, they argued that a SBOE of equal, or greater, magnitude to the FBOE would require modification of the MIH, possibly attributing maternal immune reaction to an autosomal gene (Kabátek & Blanchard, 2024). Regarding the relative size of the SBOE and the FBOE, evidence is mixed; some studies reported a weaker SBOE (Ablaza et al., 2022; Blanchard & Lippa, 2021; Study 1 in Blanchard & Skorska, 2022), some reported a SBOE equal in size to the FBOE (Kabátek & Blanchard, 2024; Semenyna et al., 2023), and one study reported a stronger SBOE (Fořt et al., 2024b). Further research is needed to elucidate the implications of the SBOE for the MIH.

Compared to males, research on female sexuality, in general, and a possible connection between older siblings and female sexual orientation, in particular, is limited. To date, the most important piece of evidence supporting a link between sibship order and female gynephilia is reported by Ablaza et al. (2022) using data from the Netherlands. In this population-level study, both a FBOE and a SBOE in females were associated with increased probability of entering into a same-sex union, which the authors treated as a proxy for same-sex sexual orientation. Using UK Biobank data and approximating same-sex sexual orientation (i.e., if a proportion of number of same-sex partners to total number of partners were < 20%, then participants were categorized as other-sex attracted; if the proportion was > 80%, then they were considered same-sex attracted), Kabátek and Blanchard (2024) found evidence for a FBOE, but not a SBOE among homosexual females. A recent convenient sample of cisgender participants from Czechia and Slovakia has reported evidence for a FBOE and a SBOE among gynephilic females (Fořt et al., 2024b). However, other recent studies have failed to find similar results (e.g., Blanchard, 2022;

Blanchard & Skorska, 2022; Vilsmeier et al., 2023). In sum, the evidence for the effect of sibship composition on cisgender female gynephilia is mixed at present.

Data on the sibship composition of transgender gynephilic females is even rarer. A study reported that the older sibling sex ratio (i.e., older brothers to older sisters) was lower in Iranian transgender gynephilic females diagnosed with gender dysphoria compared to the birth sex ratio in the general population, suggesting a presence of SBOE for this group (Khorashad et al., 2020). We are not aware of any study simultaneously reporting the sibship compositions of cisgender and transgender gynephilic females in the same population. Considering the limited and inconsistent data for females on this matter, further research is needed to establish whether sibship composition is associated with sexual orientation in females (Blanchard, 2023). Additionally, a theoretical explanation for the role of sibship composition in development of female gynephilia is currently lacking, and existing speculation relates, for the most part, to the MIH (e.g., Kabátek & Blanchard, 2024).

Other understudied populations in this area of research are ambiphilic males and females. Ambiphilic males have been shown to exhibit a FBOE that is intermediate between gynephilic and androphilic males in a Greek sample (Apostolou, 2020) and two reanalyses (Blanchard, 2022; see Supplementary Material for Blanchard & Lippa, 2021) of an earlier international BBC study (Blanchard & Lippa, 2007). Somewhat weaker evidence for a SBOE in ambiphilic males was reported by Blanchard (2022). However, no sibship order effect, FBOE or SBOE, was found for ambiphilic males in a more recent study which used a large international sample (Zdaniuk et al., 2025). With respect to female ambiphilia, two recent reports have found negative associations with the SBOE and marginally negative associations with the FBOE (Blanchard, 2022; Zdaniuk et al., 2025; but see Apostolou, 2020). Theoretical speculation about the role of

sibship order on the development of male and female ambiphilia is lacking and pending further empirical research in these groups.

Analytical Approaches to Investigating Sibship Composition

Different analytical approaches have been devised over many decades of research to investigate sibship composition. A common approach to investigating sibship order effects is to use binary logistic regression models that estimate the likelihood of being a same-sex attracted male (or female) compared to the baseline probability of being an other-sex attracted male (or female). In the regression model that is predominantly used, hereafter, referred to as the classic model, numbers of older brothers, older sisters, younger brothers, and younger sisters are simultaneously entered as predictors (Blanchard & Bogaert, 1996). Subsequently, the regression coefficients (B) and odds ratios (e^B) for numbers of older brothers and older sisters are interpreted as FBOE and SBOE, respectively.

In recent years, several methods have been introduced to improve the statistical and theoretical accuracy of measurements being used for quantifying the FBOE and the SBOE (e.g., Ablaza et al., 2022; Blanchard, 2014, 2020; Khovanova, 2020; Raymond et al., 2023; Vilsmeier et al., 2023; Zdaniuk et al., 2025). A novel regression model devised by Ablaza et al. (2022) and further modified by Blanchard (2022) and Zdaniuk et al. (2025), involves performing two binary logistic regression analyses which include four distinct predictors: numbers of all siblings, older siblings, older brothers, and older sisters (see Table 6-1). This approach is informative and efficient due to its independent evaluation of FBOE, SBOE, and sibship size effect. Consequently, researchers can disentangle any effect that numbers of older brothers and older sisters may have on development of same-sex sexual orientation from the plausible effect of the overall sibship size, which, in the literature, has been referred to as *female fecundity effect*

Table 6-1 Parameterization of new logistic regressions testing sibship effects

Predictor variable	Statistical interpretation of coefficient	Acronym	Full label	Theoretical interpretation
First model				
Number of Siblings	One younger sibling is added to sibship	YSAE	Younger Sibling Addition Effect	Female fecundity effect (FFE)
Number of Older Brothers	One older brother replaces one younger sibling	OBSE	Older Brother Swap Effect	Fraternal birth order effect (FBOE)
Number of Older Sisters	One older sister replaces one younger sibling	OSSE	Older Sister Swap Effect	Sororal birth order effect (SBOE)
Second model				
Number of Siblings	One younger sibling is added to sibship	YSAE	Younger Sibling Addition Effect	Female fecundity effect (FFE)
Number of Older Siblings	One older sister replaces one younger sibling	OSSE	Older Sister Swap Effect	Sororal birth order effect (SBOE)
Number of Older Brothers	One older brother replaces one older sister	BSSE	Brother–Sister Swap Effect	Difference between FBOE and SBOE

Note. From "Asexuality: Its relationship to sibling sex composition and birth order" by Zdaniuk, B., Milani, S., Makarenko, B., Marriott, N., Bogaert, A. F., & Brotto, L. A., 2025, *Archives of Sexual Behavior*, *54*(1), 51-64 (https://doi.org/10.1007/s10508-024-03043-9). Copyright 2025 by Springer Nature. Reprinted with permission.

(Camperio-Ciani et al., 2004). Using this novel approach, recent studies have consistently found no positive association between sibship size (female fecundity effect) and male androphilia (Ablaza et al., 2022; Blanchard, 2022; Fořt et al., 2024b; Kabátek & Blanchard, 2024; Semenyna et al., 2023; Zdaniuk et al., 2025).

In addition to sibship order and sibship size, there is another relevant sibship characteristic to be considered in studying sexual orientation. *Sibling sex ratio* has been associated with male androphilia, as androphilic males have a higher ratio of brothers to sisters when compared to: (1) control gynephilic males or (2) the ratio of male live birth to female live birth in general population (Blanchard, 1997). Recently, it has been suggested that sibling sex ratio can have another application by serving as a preliminary test to assess if other-sex attracted groups recruited as control are representative of the general population (Blanchard & Skorska, 2022).

In this study, we will use a combination of these older and newer approaches so that our findings are comparable to the larger body of evidence on the association between sibship composition and sexual orientation.

Present Study

In this study, we aimed to address some of the aforementioned gaps in the literature using data collected in a Middle Eastern country, Iran. In doing so, we recruited adult males and females who varied in their sexual orientation (i.e., androphilic, gynephilic, or ambiphilic) and gender identity/expression (i.e., cisgender or transgender). For males, cisgender gynephilic males were treated as the reference group. We predicted that both cisgender and transgender androphilic males would exhibit evidence of sibship order effect with a stronger FBOE compared to a SBOE. In addition, we expected to find an intermediate sibship order effect for

ambiphilic males for the FBOE and possibly the SBOE as well. For female participants, cisgender androphilic females were treated as the reference group. We predicted sibship order effect among cisgender and transgender gynephilic females, with stronger evidence for a FBOE than a SBOE. We also explored the reported negative association between sibship order effect and female ambiphilia in our Iranian sample. Consistent with the expectation of a stronger FBOE than SBOE in both males and females, we predicted elevated sibling sex ratio among cisgender and transgender androphilic males and gynephilic females. We did not expect to find a sibship size effect (female fecundity effect) for any group.

METHOD

Recruitment

In this paper, we present data collected over three years from November 2021 to September 2024 during three recruitment attempts. The first recruitment sample was drawn from an online survey conducted using Qualtrics. Popular social media platforms among Iranians such as Twitter, Instagram, and Telegram were used as the main routes for distributing the invitation to participate in the study. The message began with "We are seeking Iranian men and women (18 years of age or older) to participate in a voluntary, anonymous and confidential study on childhood and adulthood behaviour and psychology. Participants can be heterosexual or homosexual, gender conforming or non-gender conforming, including trans individuals." An anonymous link was included in the message which was used by interested individuals to access the survey. We used security measures provided by the Qualtrics including preventing multiple submission and bot detection to reduce the risk for fraudulent responding. Also, the data was screened for suspicious patterns of response such as repeating answers for multiple-choice

questions (e.g., selection of option A for all questions) or unusually short time of survey completion. The responses were recorded between November 2021 and July 2022.

The second recruitment sample was collected between April 2022 and April 2024 in Mashhad and Tehran, Iran. A snowball sampling method was used to recruit most of these participants. Some transgender participants were current or previous clients of a gender clinic in Mashhad and were recruited through that clinic. Most of these individuals had received the diagnosis of gender dysphoria and were at different stages of gender transition. These individuals would then sometimes introduce other transgender individuals who had not been clients of this clinic in the past. A diagnosis of gender dysphoria was not an inclusion criterion for participation in this study. Cisgender same-sex attracted participants were initially found through the personal social networks of the researchers. These individuals would then introduce other individuals who were not in the authors' social networks. We also recruited some staff and students at a hospital in Mashhad and some participants from public social spaces such as coffee shops and malls. These individuals constituted our control groups of other-sex attracted males and females.

The third round of data collection was undertaken between June and September 2024. A poster was circulated in online social groups that targeted Iranians with diverse sexuality or gender. The invitation asked readers to contact the researchers if interested in participation. Meetings were scheduled with participants who agreed to meet in-person. Otherwise, the survey link was shared, and further communications remained online. Participants were also asked if they had participated in previous rounds of recruitment and duplicated data points were removed.

Participants

Overall, 1531 participants provided data on numbers of older brothers, older sisters, younger brothers, and younger sisters who shared the same biological mother. Data from 1452

participants including 765 males and 687 females were considered for statistical analysis (participants from the first recruitment round n1 = 486, participants from the second recruitment round n2 = 559, participants from the third recruitment round n3 = 407). These participants were categorized into eight groups, including 239 cisgender gynephilic males (n1 = 136, n2 = 103), 106 cisgender ambiphilic males (n1 = 28, n2 = 24, n3 = 54), 315 cisgender androphilic males (n1 = 81, n2 = 109, n3 = 125), 105 transgender androphilic males (n1 = 14, n2 = 47, n3 = 44), 269 cisgender androphilic females (n1 = 153, n2 = 98, n3 = 18), 110 cisgender ambiphilic females (n1 = 53, n2 = 44, n3 = 13), 52 cisgender gynephilic females (n1 = 11, n2 = 21, n3 = 20), and 256 transgender gynephilic females (n1 = 10, n2 = 113, n3 = 133).

Due to small group size, we did not analyze data from the other eight groups including transgender gynephilic males (n = 6), transgender ambiphilic males (n = 9), transgender androphilic females (n = 2), transgender ambiphilic females (n =11), cisgender asexual/analloerotic males (n = 10), transgender asexual/analloerotic males (n = 1), cisgender asexual/analloerotic females (n = 16), and transgender asexual/analloerotic females (n = 3).

We did not aim to recruit cisgender gynephilic males during the third round of data collection rather, our aim was to collect further data on sexual minority males. Nevertheless, some cisgender gynephilic males (n3 = 21) were recruited at this time and these participants require additional commentary. Those males who were introduced to us through other sexual minority males were specifically asked if they were bisexual or androphilic, and only if they confirmed that they were, were they then invited to participate in the study. Nevertheless, 21 of these male participants who completed the survey reported their Kinsey scores as 0 or 1. A closer inspection of this subsample revealed that 17 out of 21 participants (81%) reported Kinsey score = 1, which was at odds with the samples recruited during previous rounds of data collection as

only 37 out of 239 (15.5%) cisgender gynephilic males reported Kinsey score = 1. Further, only 3 out of 21 reported having no sexual history with male sexual partner(s), while 17 reported having both male and female sexual partners (one participants responded they did not remember). Data on sexual history were collected only during the third round of data collection and therefore, cannot be used to compare this subsample with cisgender gynephilic males recruited earlier. Nevertheless, given these discrepancies in reporting, we decided to remove these 21 participants from our analyses. For the effects of this subsample on our results, see Tables s6-1 to s6-7 in the Supplementary Material.

Measures

The survey comprised standardized questionnaires that were translated to Farsi from English by a fluent English and Farsi speaker. Participants were asked to report their year of birth, and numbers of older brothers, older sisters, younger brothers, and younger sisters from the same biological mother.

Sex, Gender Identity/Expression, Sexual Orientation

In terms of sex, we categorized participants based on their answer to the following question: "Which sex were assigned to you at birth? (*male*, *female*, and if *other* please specify.)" In terms of gender, participants were asked two consecutive questions: "What is your gender identity? (*man*, *woman*, and if *other* please specify)" and "Are you transgender or transsexual? (*yes* or *no*)". When participants identified as a female identifying as a woman or a male identifying as a man, and as neither transgender nor transsexual, they were categorized as *cisgender*. Participants were classified as *transgender* if they: (1) identified as a *woman* while being identified as a male at birth, or (2) identified as a *man* while being identified as a female at birth, or (3) identified as neither a *man* nor a *woman*. Of 105 transgender males included in this

paper, 30 identified neither as a man nor a woman and of these, the most common reported gender identity was *non-binary* (n = 17). Also, 16 individuals out of these 30 did not self-identify as transgender/transsexual. Of 256 transgender females, nine participants reported an alternative gender identity with non-binary being the most common (n = 5). Also, five individuals out of these nine did not self-identify as transgender/transsexual.

To assess sexual orientation, participants were asked to report their sexual feelings towards adult males/men or females/women, during the previous 12 months, using a 7-point Likert scale (Kinsey et al., 1948). Participants who had sexual feelings only for females/women (score = 0), or had only an occasional fantasy about males/men (score = 1) were categorized as *gynephilic,* those who had stronger sexual feelings for both males/men and females/women (score = 2 to 4) were categorized as *ambiphilic,* and those who had only an occasional fantasy about females/women (score = 5), or were only attracted to males/men (score = 6) were categorized as *androphilic*. An eighth item was added for participants who "have not any sexual feelings toward any sex/gender," and these individuals were categorized as *asexual/analloerotic.* Since it was unclear from the item whether any other type of sexual feeling was present or not, this group could be either asexual (i.e., no sexual feelings whatsoever) or analloerotic (i.e., presence of sexual feelings but not directed toward males/men or females/women; Blanchard, 1989).

Statistical Analysis

The classic binary logistic regression analyses were conducted in SPSS Statistics (version 29.0) with group membership as a dependent variable, and numbers of older brothers, older sisters, younger brothers, younger sisters as predictors. The novel regression analyses introduced by Ablaza et al. (2022) and modified by Blanchard (2022) and Zdaniuk et al (2025) were also

reported here (hereafter referred to as the novel models). We believe that reporting both the classic and novel regression models would provide information on the use and comparability of the novel models in comparison to the classic one.

Consistent with the modifed novel regression models described and used by Zdaniuk et al. (2025), three predicting variables were entered into the first regression model, including number of siblings (sibship size), number of older brothers, and number of older sisters (see Table 6-1, reproducted from Table 1 in Zdaniuk et al., 2025). In the second model, three predicting variables were entered, including number of siblings, number of older siblings, and number of older brothers. The statistical interpretation of regression coefficients associated with each variable and their theoretical interpretations are described in Table 6-1. As presented in Table 6-1, the first two predictors entered into the second model (i.e., number of siblings and number of older siblings) reproduce two effects from the first model (i.e., Younger Sibling Addition Effect and Older Sister Swap Effect). Therefore, when reporting the results for the second model, only the parameters associated with the number of older brothers (or Brother-Sister Swap Effect) were presented in corresponding tables.

Table 6-2 Descriptive information of different sibship categories and year of birth (mean ± standard deviation)

Groups	Older brothers	Older sisters	Younger brothers	Younger sisters	Total siblings	Year of birth
Cisgender gynephilic males	0.49 ± 0.71	0.57 ± 0.91	0.46 ± 0.67	0.39 ± 0.62	1.91 ± 1.41	1994. 31 ± 7.45
Cisgender ambiphilic males	0.73 ± 0.95	0.58 ± 0.83	0.39 ± 0.68	0.42 ± 0.64	2.10 ± 1.47	1998.59 ± 5.45
Cisgender androphilic males	0.63 ± 0.96	0.77 ± 1.02	0.32 ± 0.56	0.30 ± 0.54	2.02 ± 1.66	1996.19 ± 6.66
Transgender androphilic males	0.77 ± 1.11	0.65 ± 0.98	0.45 ± 0.75	0.40 ± 0.79	2.27 ± 1.95	1998.74 ± 4.90
Cisgender androphilic females	0.54 ± 0.95	0.56 ± 0.91	0.47 ± 0.69	0.42 ± 0.65	1.99 ± 1.55	1995.24 ± 6.74
Cisgender ambiphilic females	0.35 ± 0.63	0.47 ± 0.71	0.42 ± 0.61	0.37 ± 0.62	1.62 ± 1.24	1998.15 ± 5.42
Cisgender gynephilic females	0.60 ± 0.87	0.54 ± 1.07	0.38 ± 0.63	0.31 ± 0.54	1.83 ± 1.58	1999.71 ± 5.35
Transgender gyenphilic females	0.71 ± 1.11	0.87 ± 1.32	0.37 ± 0.63	0.41 ± 0.61	2.35 ± 1.82	1999.10 ± 4.77

Further, we repeated the classic and novel regression models with the year of birth (converted to Gregorian Calendar) included as a predictor to see how year of birth might influence the sibship order effects. If participants were from different birth cohorts, their sibship composition could have been impacted differently by population-wide factors that influence a population birth rate (e.g., family planning policies) (Blanchard, 2014). Another rationale for including the year of birth was to replicate the analytical approach used in a previous study reporting on sibship order of transgender androphilic males and transgender gynephilic females in Iran (Khorashad et al., 2020). In addition, an Older Brothers Odds Ratio (OBOR) and an Older Sisters Odds Ratio (OSOR), which control for sibship size, were used to estimate the group-level likelihoods of having more older brothers and older sisters, respectively (Blanchard, 2014). We computed these ratios so that our results would be comparable to a meta-analysis which used these measures for assessing sibship order effect (Blanchard et al., 2018a). The results for these analyses (i.e., regression models with the year of birth, OBOR, and OSOR) were reported in the Supplementary Material.

In addition, sibling sex ratios (brothers to sisters) were calculated separately for older and younger siblings in each group of participants. The live birth sex ratio in Iran has fluctuated between 101:100 and 106:100 in past five decades ("Iran-sex ratio at birth," 2024). We compared siblings' sex ratios in our sample against both extremes, by calculating binomial probabilities using an online calculator (http://vassarstats.net/index.html; Lowrey, 2024). Only the results for 106:100 were reported but the instances of incongruency are noted.

We also examined if our sample was affected by stopping rules (i.e., rules used by parents when deciding to stop or continue having children). With respect to sexual orientation development, two types of stopping rules, male-preferring and diversity-preferring, have been

investigated previously (e.g., Blanchard, 2022). The male-preferring rule refers to a situation when parents stop having children after a son is born. The diversity-preferring rule refers to a situation when parents continue having children until at least one child of each sex is born. To examine whether the sibship compositions of our participants were influenced by these rules, we adopted the method used by Blanchard and Lippa (2007). Participants were categorized into three groups: those with only older sisters, those with only older brothers, and those with both older sisters and older brothers, thus excluding firstborns. We further classified participants based on whether they had younger siblings. A chi-square analysis was then conducted to determine if there was a relationship between the presence of younger siblings and variation in the sex composition of older siblings. Following this, post-hoc analyses were conducted using Wald H0 (continuity corrected) test in SPSS Statistics to compare the proportion of participants with younger siblings including those who had only older sisters, only older brothers, or both older brothers and older sisters.

An a priori power analysis using G*Power software (Faul et al., 2007) showed that to significantly detect ($\alpha = 0.05$, $\beta = 0.20$) an odds ratio of 1.47 (Blanchard, 2018a) for the number of older brothers as well as other sibling categories (R^2 of the other predictors were set a 0.3) in the classic regression model, we needed to have a sample of at least 380 gynephilic and androphilic males (30% being androphilic males). The numbers of participants recruited for cisgender gynephilic males, cisgender androphilic males, and transgender androphilic males met this condition. To detect an intermediate effect for ambiphilic males (i.e., odds ratio of 1.25), a sample of 1092 participants (30% being ambiphilic males) was needed, which was not attained. A power analysis for female participants and the novel regression model was not conducted prior to conducting the study. However, considering the odds ratios of about 1.10 reported by Ablaza

et al. (2022) and Blanchard (2022) for sibship order effects in females, our sample was markedly underpowered to detect a significant effect.

RESULTS

Sibship Composition in Male Participants

The classic binary logistic regression models showed that adding one older brother significantly increased the probability of being a cisgender ambiphilic male or being a transgender androphilic male, compared to a cisgender gynephilic male, by 47% and 45%, respectively (Tables 6-3 and 6-5). In contrast, adding an older brother did not change the probability of being a cisgender androphilic male compared to a cisgender gynephilic male (Table 6-4). As predicted, these results indicated the presence of a FBOE for both cisgender ambiphilic males and transgender androphilic males. In contrast, they did not support our prediction that a FBOE would exist for cisgender androphilic males.

In the classic regression model, adding an older sister increased the probability of being a cisgender androphilic male, compared to a cisgender gynephilic male, by 17%, although the result was not statistically significant (Table 6-4). Further, adding an older sister did not change the probability of being a cisgender ambiphilic male or a transgender androphilic male (Table 6-3 and 6-5). These results showed a statistically nonsignificant trend toward a SBOE in cisgender androphilic males, but there was no evidence for a SBOE in cisgender ambiphilic males and transgender androphilic males. Also, the numbers of younger brothers were negatively associated with being a cisgender androphilic male (Table 6-4).

The first novel regression model (see first model, Table 6-1) revealed relatively consistent results. Compared to cisgender gynephilic males, removing one younger sibling and adding one older brother, or the Older Brother Swap Effect (OBSE), increased the probabilities

of being a cisgender ambiphilic male by 44%, a cisgender androphilic male by 37%, or a transgender androphilic male by 37% (Tables 6-3 to 6-5). However, the finding in transgender androphilic males was not statistically significant and thus, demonstrated only a trend toward a FBOE in this group. Contrary to our predictions, removing one younger sibling and adding one older sister, or the Older Sister Swap Effect (OSSE), decreased the probabilities of being a cisgender ambiphilic male or a transgender androphilic male, although these effects were not significant (Tables 6-3 and 6-5). In contrast, the OSSE significantly increased the probability of being a cisgender androphilic male by 49%, consistent with our prediction for a SBOE in this group (Table 6-4).

The second novel regression model (see second model, Table 6-1) showed a significant effect when removing one older sister and adding one older brother, or the Brother–Sister Swap Effect (BSSE), only in cisgender ambiphilic males compared to cisgender gynephilic males (Table 6-3). Using the novel regression models, the effect of adding one younger sibling to the sibship composition, or Younger Sibling Addition Effect (YSAE), was assessed. No evidence was found for a YSAE in cisgender ambiphilic males and transgender androphilic males (Tables 6-3 and 6-5). However, YSAE significantly decreased the probability of being a cisgender androphilic male compared to a cisgender gynephilic male (Table 6-4). These results confirmed our prediction that male androphilia was not associated with larger sibship size (female fecundity effect).

We also compared sibship composition between cisgender and transgender androphilic males. A classic binary logistic regression model showed that adding one older brother significantly increased the probability of being a transgender androphilic male compared to a cisgender androphilic male by 26% (Table 6-6). No significant effect was found for the other

sibship categories. The novel regression models revealed that a YSAE significantly increased the probability of being a transgender androphilic male compared to being a cisgender androphilic male, while OSSE significantly decreased this probability. Also, BSSE significantly increased the probability of being a transgender androphilic male compared to a cisgender androphilic male by 50% (Table 6-6). These results suggested that cisgender androphilic males had a stronger SBOE and a smaller sibship size compared to transgender androphilic males.

Including the year of birth in the regression analyses resulted in slight changes in the size of regression coefficients, but the overall trends were largely similar to results reported in Tables 6-3 to 6-6. It was found that the year of birth was positively associated with being a cisgender ambiphilic male, a cisgender androphilic male, and a transgender androphilic males, indicating that these groups were younger in comparison to cisgender gynephilic males. For results obtained from the classic and novel regression methods with the year of birth included, see Tables s6-8 to s6-11 in the Supplementary Material.

The calculated sibling sex ratios for male participants were shown in Table 6-7. Older sibling sex ratios in both cisgender gynephilic males and cisgender androphilic males were lower than the birth sex ratio in population (i.e., 106:100 or 101:100), indicating a higher proportion of sisters among their older siblings. A reverse pattern was evident for cisgender ambiphilic males and transgender androphilic males. However, the only statistically significant difference was seen in cisgender androphilic males ($p = 0.009$). This result was consistent with evidence of a SBOE, but not a FBOE, for cisgender androphilic males.

Sibship Composition in Female Participants

The classic binary logistic regression models showed that adding one older brother increased the probability of being a transgender gynephilic female compared to a cisgender

Table 6-3 Binary logistic regression analyses comparing sibship composition between cisgender ambiphilic males and cisgender gynephilic males

Regression models	Predictors (Label)	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.39	0.15	6.42	0.011	**1.47 (1.09 – 1.98)**
	Number of Older Sisters	-0.08	0.14	0.32	0.570	0.92 (0.70 – 1.21)
	Number of Younger Brothers	-0.13	0.19	0.47	0.494	0.88 (0.61 – 1.27)
	Number of Younger Sisters	0.18	0.19	0.86	0.355	1.20 (0.82 – 1.76)
Novel model 1	Number of Siblings (YSAE)	0.02	0.12	0.02	0.883	1.02 (0.80 – 1.30)
	Number of Older Brothers (OBSE)	0.37	0.17	4.50	0.034	**1.44 (1.03 – 2.02)**
	Number of Older Sisters (OSSE)	-0.10	0.18	0.34	0.559	0.90 (0.64 – 1.27)
Novel model 2	Number of Older Brothers (BSSE)	0.47	0.23	4.15	0.042	**1.60 (1.02 – 2.51)**

Cisgender gynephilic males were coded as 0 and cisgender ambiphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.031$, Cox & Snell $R^2 = 0.022$, Model $\chi^2(4) = 7.76$, $p = 0.101$. Novel model 1: Nagelkerke $R^2 = 0.027$, Cox & Snell $R^2 = 0.019$, Model $\chi^2(3) = 6.61$, $p = 0.085$. Novel model 2: Nagelkerke $R^2 = 0.027$, Cox & Snell $R^2 = 0.019$, Model $\chi^2(3) = 6.61$, $p = 0.085$.

Table 6-4 Binary logistic regression analyses comparing sibship composition between cisgender androphilic males and cisgender gynephilic males

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.08	0.11	0.46	0.496	1.08 (0.87 – 1.34)
	Number of Older Sisters	0.16	0.10	2.50	0.114	1.17 (0.96 – 1.42)
	Number of Younger Brothers	-0.31	0.14	4.57	0.032	**0.73 (0.55 – 0.97)**
	Number of Younger Sisters	-0.16	0.15	1.10	0.294	0.85 (0.63 – 1.15)
Novel model 1	Number of Siblings (YSAE)	-0.24	0.10	5.60	0.018	**0.79 (0.64 – 0.96)**
	Number of Older Brothers (OBSE)	0.31	0.14	5.41	0.020	**1.37 (1.05 – 1.79)**
	Number of Older Sisters (OSSE)	0.40	0.13	8.60	0.003	**1.49 (1.14 – 1.94)**
Novel model 2	Number of Older Brothers (BSSE)	-0.08	0.17	0.23	0.634	0.92 (0.66 – 1.29)

Cisgender gynephilic males were coded as 0 and cisgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.032$, Cox & Snell $R^2 = 0.024$, Model $\chi^2(4) = 13.37$, $p = 0.010$. Novel model 1: Nagelkerke $R^2 = 0.031$, Cox & Snell $R^2 = 0.023$, Model $\chi^2(3) = 12.93$, $p = 0.005$. Novel model 2: Nagelkerke $R^2 = 0.031$, Cox & Snell $R^2 = 0.023$, Model $\chi^2(3) = 12.93$, $p = 0.005$.

Table 6-5 Binary logistic regression analyses comparing sibship composition between transgender androphilic males and cisgender gynephilic males

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.37	0.14	6.83	0.009	**1.45 (1.10 – 1.91)**
	Number of Older Sisters	0.00	0.13	0.00	0.997	1.00 (0.78 – 1.29)
	Number of Younger Brothers	0.05	0.18	0.08	0.774	1.05 (0.74 – 1.49)
	Number of Younger Sisters	0.06	0.18	0.10	0.747	1.06 (0.75 – 1.50)
Novel model 1	Number of Siblings (YSAE)	0.05	0.11	0.23	0.631	1.06 (0.85 – 1.32)
	Number of Older Brothers (OBSE)	0.32	0.16	3.70	0.054	1.37 (0.99 – 1.90)
	Number of Older Sisters (OSSE)	-0.05	0.16	0.11	0.744	0.95 (0.68 – 1.31)
Novel model 2	Number of Older Brothers (BSSE)	0.37	0.21	3.00	0.083	1.45 (0.95 – 2.21)

Cisgender gynephilic males were coded as 0 and transgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.031$, Cox & Snell $R^2 = 0.022$, Model $\chi^2(4) = 7.65$, $p = 0.105$. Novel model 1: Nagelkerke $R^2 = 0.031$, Cox & Snell $R^2 = 0.022$, Model $\chi^2(3) = 7.65$, $p = 0.054$. Novel model 2: Nagelkerke $R^2 = 0.031$, Cox & Snell $R^2 = 0.022$, Model $\chi^2(3) = 7.65$, $p = 0.054$.

Table 6-6 Binary logistic regression analyses comparing sibship composition between transgender androphilic males and cisgender androphilic males

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.23	0.12	3.84	0.050	**1.26 (1.00 – 1.58)**
	Number of Older Sisters	-0.17	0.13	1.92	0.166	0.84 (0.65 – 1.07)
	Number of Younger Brothers	0.32	0.18	3.15	0.076	1.37 (0.97 – 1.94)
	Number of Younger Sisters	0.23	0.18	1.67	0.196	1.26 (0.89 – 1.79)
Novel model 1	Number of Siblings (YSAE)	0.27	0.12	4.91	0.027	**1.31 (1.03 – 1.67)**
	Number of Older Brothers (OBSE)	-0.04	0.16	0.08	0.773	0.96 (0.70 – 1.30)
	Number of Older Sisters (OSSE)	-0.45	0.17	6.84	0.009	**0.64 (0.46 – 0.89)**
Novel model 2	Number of Older Brothers (BSSE)	0.40	0.20	4.07	0.044	**1.50 (1.01 – 2.21)**

Cisgender androphilic males were coded as 0 and transgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.032$, Cox & Snell $R^2 = 0.021$, Model $\chi^2(4) = 9.04$, $p = 0.060$. Novel model 1: Nagelkerke $R^2 = 0.031$, Cox & Snell $R^2 = 0.021$, Model $\chi^2(3) = 8.93$, $p = 0.030$. Novel model 2: Nagelkerke $R^2 = 0.031$, Cox & Snell $R^2 = 0.021$, Model $\chi^2(3) = 8.93$, $p = 0.030$.

Table 6-7 Males' siblings sex ratio (brothers to sisters)

	Cisgender gynephilic males	Cisgender ambiphilic males	Cisgender androphilic males	Transgender androphilic males
Older siblings				
Brothers	117	77	199	81
Sisters	136	61	242	68
Sex ratio	86	126	82	119
Binomial z-ratio	-1.59	0.94	-2.61	0.63
p value (two-tailed)	0.112	0.347	0.009	0.528
Younger siblings				
Brothers	111	41	102	47
Sisters	93	44	95	42
Sex ratio	119	93	107	112
Binomial z-ratio	0.78	-0.48	0.02	0.15
p value (two-tailed)	0.435	0.631	0.984	0.881

Binomial probabilities were also calculated based on a birth sex ratio of 101:100; however, none of the comparisons diverged from the results presented in the table for a birth sex ratio of 106:100.

androphilic female by 12%, although it was statistically nonsignificant (Table 6-10). This result only suggested a trend toward a FBOE in transgender gynephilic females. No evidence for a FBOE was found in cisgender gynephilic females (Table 6-9). Adding an older brother significantly decreased the probability of being a cisgender ambiphilic female, compared to a cisgender androphilic female (Table 6-8).

In the classic regression model, adding an older sister increased the probability of being a transgender gynephilic female compared to a cisgender androphilic female by 25% (Table 6-10). Conversely, adding an older sister decreased the probabilities of being a cisgender ambiphilic female (Table 6-8), or a cisgender gynephilic female (Table 6-9), though these reductions were not statistically significant. These results indicated the existence of a SBOE in transgender gynephilic females but suggested that a SBOE did not characterize cisgender ambiphilic and gynephilic females.

The first novel regression model (see first model, Table 6-1) revealed that, compared to cisgender androphilic females, an OBSE increased the probability of being a cisgender

gynephilic female by 32% and a transgender gynephilic female by 16% (Tables 6-9 and 6-10). However, these findings were not statistically significant, suggesting only a trend toward a FBOE in these groups. A reverse effect, albeit statistically nonsignificant, was found for cisgender ambiphilic female as OBSE lowered the probability of membership in this group (Table 6-8). An OSSE increased the probability of being a cisgender ambiphilic female by 10%, a cisgender gynephilic female by 20%, and a transgender gynephilic female by 32% (Tables 6-8 to 6-10). However, the only significant increase was for transgender gynephilic females, indicating the existence of a SBOE in this group.

The second novel regression model (see second model, Table 6-1) did not show any significant BSSE in any of three female groups compared to cisgender androphilic females. Also, a YSAE decreased the probabilities for being a cisgender ambiphilic female, a cisgender gynephilic female, or a transgender gynephilic female, compared to a cisgender androphilic female (Tables 6-8 to 6-10). However, the regression coefficients associated with a YSAE were statistically nonsignificant in all three groups.

We also compared sibship composition between cisgender and transgender gynephilic females. No significant effect was found using either the classic or the novel regression models. The only noteworthy, but statistically nonsignificant, trends were produced by the classic binary logistic regression model, which showed that adding one older sister or one younger sister increased the probability of being a transgender gynephilic female compared to a cisgender gynephilic female by 34% to 55% (Table 6-11).

Including the year of birth in the regression analyses resulted in smaller regression coefficients, but the overall trends were largely similar to results reported in Tables 6-8 to 6-11. In addition, the year of birth was positively associated with being a cisgender ambiphilic female,

a cisgender gynephilic female, and a transgender gynephilic female, indicating that these groups were younger in comparison to cisgender androphilic females. For results obtained from the classic and novel regression methods with the year of birth included, see Tables s6-12 to s6-15 in the Supplementary Material.

The sibling sex ratios calculated for female participants are shown in Table 6-12. Older sibling sex ratios in all female groups except cisgender gynephilic females were lower than the birth sex ratio in population (i.e., 106:100 or 101:100), indicating a higher proportion of sisters among their older siblings. However, the only statistically significant difference was seen in transgender gynephilic females ($p = 0.009$). This result was consistent with evidence of a SBOE, but not a FBOE, for transgender gynephilic females.

Table 6-8 Binary logistic regression analyses comparing sibship composition between cisgender ambiphilic females and cisgender androphilic females

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	-0.35	0.17	3.99	0.046	**0.71 (0.50 – 0.99)**
	Number of Older Sisters	-0.10	0.15	0.49	0.482	0.90 (0.67 – 1.20)
	Number of Younger Brothers	-0.18	0.20	.82	0.365	0.84 (0.57 – 1.23)
	Number of Younger Sisters	-0.22	0.19	1.39	0.238	0.80 (0.55 – 1.16)
Novel model 1	Number of Siblings (YSAE)	-0.20	0.14	2.10	0.147	0.82 (0.62 – 1.07)
	Number of Older Brothers (OBSE)	-0.14	0.19	0.55	0.460	0.87 (0.59 – 1.26)
	Number of Older Sisters (OSSE)	0.10	0.19	0.27	0.600	1.10 (0.76 – 1.59)
Novel model 2	Number of Older Brothers (BSSE)	-0.24	0.24	1.01	0.315	0.79 (0.49 – 1.26)

Cisgender androphilic females were coded as 0 and cisgender ambiphilic females were coded as 1. Classic model: Nagelkerke $R^2 = 0.025$, Cox & Snell $R^2 = 0.017$, Model $\chi^2(4) = 6.63$, $p = 0.157$. Novel model 1: Nagelkerke $R^2 = 0.025$, Cox & Snell $R^2 = 0.017$, Model $\chi^2(3) = 6.60$, $p = 0.086$. Novel model 2: Nagelkerke $R^2 = 0.025$, Cox & Snell $R^2 = 0.017$, Model $\chi^2(3) = 6.60$, $p = 0.086$.

Table 6-9 Binary logistic regression analyses comparing sibship composition between cisgender gynephilic females and cisgender androphilic females

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.02	0.17	0.01	0.903	1.02 (0.73 – 1.43)
	Number of Older Sisters	-0.06	0.17	0.14	0.705	0.94 (0.67 – 1.31)
	Number of Younger Brothers	-0.20	0.25	0.67	0.414	0.82 (0.50 – 1.33)
	Number of Younger Sisters	-0.30	0.27	1.23	0.268	0.74 (0.43 – 1.26)
Novel model 1	Number of Siblings (YSAE)	-0.25	0.18	1.82	0.177	0.78 (0.54 – 1.12)
	Number of Older Brothers (OBSE)	0.28	0.22	1.53	0.216	1.32 (0.85 – 2.05)
	Number of Older Sisters (OSSE)	0.18	0.24	0.60	0.440	1.20 (0.75 – 1.91)
Novel model 2	Number of Older Brothers (BSSE)	0.09	0.26	0.13	0.718	1.10 (0.66 – 1.84)

Cisgender androphilic females were coded as 0 and cisgender gynephilic females were coded as 1. Classic model: Nagelkerke $R^2 = 0.012$, Cox & Snell $R^2 = 0.007$, Model $\chi^2(4) = 2.26$, $p = 0.688$. Novel model 1: Nagelkerke $R^2 = 0.012$, Cox & Snell $R^2 = 0.007$, Model $\chi^2(3) = 2.18$, $p = 0.535$. Novel model 2: Nagelkerke $R^2 = 0.012$, Cox & Snell $R^2 = 0.007$, Model $\chi^2(3) = 2.18$, $p = 0.535$.

Table 6-10 Binary logistic regression analyses comparing sibship composition between transgender gynephilic females and cisgender androphilic females

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.11	0.09	1.43	0.232	1.12 (0.93 – 1.34)
	Number of Older Sisters	0.22	0.09	6.55	0.010	**1.25 (1.05 – 1.48)**
	Number of Younger Brothers	-0.15	0.13	1.19	0.276	0.86 (0.66 – 1.12)
	Number of Younger Sisters	0.06	0.14	0.20	0.656	1.07 (0.80 – 1.41)
Novel model 1	Number of Siblings (YSAE)	-0.05	0.10	0.24	0.622	0.95 (0.78 – 1.16)
	Number of Older Brothers (OBSE)	0.15	0.12	1.45	0.229	1.16 (0.91 – 1.48)
	Number of Older Sisters (OSSE)	0.27	0.12	5.24	0.022	**1.32 (1.04 – 1.67)**
Novel model 2	Number of Older Brothers (BSSE)	-0.13	0.14	0.87	0.351	0.88 (0.67 – 1.15)

Cisgender androphilic females were coded as 0 and transgender gynephilic females were coded as 1. Classic model: Nagelkerke $R^2 = 0.032$, Cox & Snell $R^2 = 0.024$, Model $\chi^2(4) = 12.84$, $p = 0.012$. Novel model 1: Nagelkerke $R^2 = 0.029$, Cox & Snell $R^2 = 0.022$, Model $\chi^2(3) = 11.67$, $p = 0.009$. Novel model 2: Nagelkerke $R^2 = 0.029$, Cox & Snell $R^2 = 0.022$, Model $\chi^2(3) = 11.67$, $p = 0.009$.

Table 6-11 Binary logistic regression analyses comparing sibship composition between transgender gynephilic females and cisgender gynephilic females

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.10	0.17	0.33	0.565	1.10 (0.79 – 1.54)
	Number of Older Sisters	0.29	0.17	2.98	0.084	1.34 (0.96 – 1.87)
	Number of Younger Brothers	0.09	0.25	0.11	0.735	1.09 (0.66 – 1.79)
	Number of Younger Sisters	0.44	0.29	2.26	0.133	1.55 (0.88 – 2.73)
Novel model 1	Number of Siblings (YSAE)	0.25	0.20	1.55	0.213	1.28 (0.87 – 1.89)
	Number of Older Brothers (OBSE)	-0.15	0.23	0.45	0.503	0.86 (0.55 – 1.34)
	Number of Older Sisters (OSSE)	0.05	0.23	0.04	0.844	1.05 (0.66 – 1.65)
Novel model 2	Number of Older Brothers (BSSE)	-0.20	0.26	0.60	0.437	0.82 (0.49 – 1.35)

Cisgender gynephilic females were coded as 0 and transgender gynephilic females were coded as 1. Classic model: Nagelkerke $R^2 = 0.032$, Cox & Snell $R^2 = 0.019$, Model $\chi^2(4) = 5.93$, $p = 0.204$. Novel model 1: Nagelkerke $R^2 = 0.027$, Cox & Snell $R^2 = 0.016$, Model $\chi^2(3) = 5.04$, $p = 0.169$. Novel model 2: Nagelkerke $R^2 = 0.027$, Cox & Snell $R^2 = 0.016$, Model $\chi^2(3) = 5.04$, $p = 0.169$.

Table 6-12 Females' siblings sex ratio (brothers to sisters)

	Cisgender androphilic females	Cisgender ambiphilic females	Cisgender gynephilic females	Transgender gynephilic females
Older siblings				
Brothers	146	39	31	181
Sisters	150	52	28	222
Sex ratio	97	75	111	81
Binomial z-ratio	-0.67	-1.54	0.04	-2.58
p value (two-tailed)	0.503	0.123	0.968	0.009
Younger siblings				
Brothers	126	46	20	95
Sisters	113	41	16	105
Sex ratio	111	112	125	90
Binomial z-ratio	0.33	0.16	0.32	-1.05
p value (two-tailed)	0.741	0.872	0.749	0.293

Binomial probabilities were also calculated based on a birth sex ratio of 101:100; however, none of the comparisons diverged from the results presented in the table for a birth sex ratio of 106:100.

Examining the Stopping Rules in Male and Female Samples

Among males, 303 (39.6%) participants were first-born children and were excluded from this analysis. Participants with older sibling(s) were reported here. Of 144 males who had only older sister(s), 42.4% had at least one younger sibling. Of 136 males with only older brother(s), 33.8% had younger sibling(s). Of 182 males who had both older brother(s) and sister(s), 29.1% had younger sibling(s). A Chi square test provided statistical support for the relationship between different categories of older siblings (e.g., only older brother[s], only older sister[s], both older brother[s] and sister[s]) and having younger sibling(s): $\chi^2(2) = 6.28$, $p = 0.043$. The proportions of having younger sibling(s) differed significantly between males with only older sisters and males with both older brother(s) and sister(s): Wald H0 $Z = 2.37$, $SE = 0.053$, $p = 0.018$. No other pairwise comparison was statistically significant.

Among females, 283 (41.2%) participants were first-born children and were excluded from this analysis. Participants with older sibling(s) were reported here. Of 141 females who had only older sister(s), 47.5% had at least one younger sibling. Of 133 females with only older brother(s), 37.6% had younger sibling(s). Of 130 females who had both older brother(s) and sister(s), 28.5% had younger sibling(s). A Chi square test provided statistical support for the relationship between different categories of older siblings and having younger sibling(s): $\chi^2(2) = 10.44$, $p = 0.005$. The proportions of having younger sibling(s) differed significantly between females with only older sisters and females with both older brother(s) and sister(s): Wald H0 $Z = 3.10$, $SE = 0.058$, $p = 0.002$. No other pairwise comparison was statistically significant.

In both males and females, the rates of having younger sibling(s) were highest in those with only older sister(s), which was consistent with a male-preferring stopping rule that operates when parents have a boy. In both males and females, the rates of having younger sibling(s) were

lowest in those with both older brother(s) and older sister(s), which was consistent with a diversity-preferring stopping rule which operates when parents have at least a boy and a girl. However, we note that observed lowest rates might also be a function of a cap on the total number of children parents decide to have.

DISCUSSION

In this study, we assessed sibship composition among Iranian adult males and females who varied in their sexual orientation and gender identity/expression. Results obtained from different analytical methods were relatively consistent regarding the FBOE and the SBOE. As predicted, statistical evidence was found for a FBOE and SBOE in cisgender androphilic males. The statistical support for sibship order effects were mainly from the novel regression models ($p < 0.050$). This result is consistent with the extensive evidence for the FBOE from other populations (e.g., Ablaza et al., 2022; Blanchard 2018a, 2018b, 2020). Finding a relatively stronger SBOE (although the BSSE was statistically nonsignificant) was unexpected considering that studies of cisgender androphilic males have mostly reported either a weaker (Ablaza et al., 2022; Blanchard & Lippa, 2021; Study 1 in Blanchard & Skorska, 2022), or an equal (Kabátek & Blanchard, 2024) SBOE compared to FBOE (but see Fořt et al., 2024b). We also found that when sibship order was controlled, sibship size negatively predicted cisgender male androphilia compared to cisgender male gynephilia. This finding does not support the existence of a generalized female fecundity effect as that would require that androphilic males had more older and younger male and female siblings (Camperio-Ciani et al., 2004).

In transgender androphilic males, statistical parameters derived from different analytical methods were suggestive of trend toward a FBOE in this group, although only the regression coefficient for the number of older brothers in the classic regression method was statistically

significant. This finding was consistent with previous reports from Iran (Khorashad et al., 2020) and other cultures (Blanchard, 2018a; Gomez Jimenez et al., 2020b; Semenyna et al., 2023). On the other hand, the analyses did not provide statistical support for the presence of a SBOE in this group, in line with a previous report from Iran (Khorashad et al., 2020), but in contrast with findings from other cultures (Gomez Jimenez et al., 2020b; Semenyna et al., 2023).

When comparing cisgender and transgender androphilic males, the classic regression model showed a stronger FBOE in the transgender group, but the novel regression model did not. Furthermore, both the classic and novel regression models indicated a stronger SBOE in cisgender androphilic males, though only the result from the latter was statistically significant. These findings contrast with those from a previous meta-analysis (Blanchard, 2018a). Although we found that sibship size positively predicted transgender male androphilia compared to cisgender male androphilia, this finding is likely an artifact of the negative sibship size effect found for cisgender male androphilia rather than true evidence for the female fecundity effect in the transgender group. To our knowledge, this is the first study to compare these two groups within a population using the novel regression model.

With respect to cisgender ambiphilic males, analytical methods yielded positive regression coefficients, suggesting the existence of a FBOE, but not a SBOE, in this group. Unlike male androphilia, sibship order data for male ambiphilia is sparse and inconsistent (Apostolou, 2020; Blanchard, 2022; Blanchard & Lippa, 2021; Zdaniuk et al., 2025). In contrast to previous reports of an intermediate FBOE in ambiphilic males (Apostolou, 2020; Blanchard, 2022; Blanchard & Lippa, 2021), the FBOE in our sample was equally as strong as that of transgender androphilic males. To the best of our knowledge, this is the first report of sibship order data in Iranian cisgender ambiphilic males. Additional research will be needed before more

definitive statements can be made regarding how the FBOE and the SBOE relate to ambiphilic sexual orientation in cisgender and transgender males.

In sum, we found evidence for varying sibship order effect for cisgender ambiphilic males, cisgender androphilic males, and transgender androphilic males. Although these results did not completely match our predictions, they are nonetheless at least partially compatible with the MIH. Thus, the data presented here contribute to our understanding about the possible link between sibship order and development of ambiphilic and androphilic males who are cisgender and transgender.

In female participants, the most robust evidence was for a SBOE in transgender gynephilic females. This finding was consistent with a previous report on Iranian transgender gynephilic females who had an elevated proportion of older sisters among their older siblings (Khorashad et al., 2020). Also, both the classic and the novel regression models produced elevated nonsignificant odds ratios suggestive of a trend toward a FBOE in transgender gynephilic females. Similarly, the novel regression method revealed a positive, but statistically nonsignificant, regression coefficient suggesting a trend toward a FBOE in cisgender gynephilic females, consistent with reports by Ablaza et al. (2022), Fořt et al. (2024b), and Kabátek and Blanchard (2024). In addition, comparing cisgender and transgender gynephilic females did not result in significant differences. We note that it is difficult to interpret our results in the cisgender gynephilic female group considering the small number of participants we were able to recruit and inconsistencies within the literature (Blanchard, 2022; Blanchard & Skorska, 2022; Vilsmeier et al., 2023).

In cisgender ambiphilic females, we found a significant negative association with number of older brothers using the classic regression method. This finding was in line with some recent

reports (Blanchard, 2022; Zdaniuk et al., 2025; but see Apostolou, 2020). The observed patterns for this group are difficult to interpret considering our small sample and the sparseness of the relevant research.

The presented study suggests that sibship order might influence at least a subgroup of gynephilic females who are relatively more masculine in their gender identity/expression. However, it is not known what mechanism(s) is responsible for the observed associations between sibship order effects, SBOE or FBOE, and female gynephilia. We should note that our finding of a SBOE, in transgender gynephilic females could potentially be explained by mechanisms other than the MIH, for example, socialization could play a role as well (for detailed discussion see Semenyna et al., 2022). Further theoretical and empirical research is needed to elucidate the mechanisms through which older sisters influence female sexual orientation development.

A possible factor influencing our findings, at least in part, is sibship (family) size, which Blanchard (2014) describes as "probably the single most important variable for birth order researchers to control" (p. 846). As predicted by the MIH, the higher the birth rate, and larger the sibship size, the more chance there is that a proband's sexual orientation will be associated with a FBOE. Conversely, lower birth rates, and smaller sibship size, decreases the probability of such an association. In Iran, after a decade of rapid population growth in the 1980s, the implementation of family planning policies at the end of the decade was associated with a sharp decline in the birth rate, from 5.5 in 1988 to slightly above 2 in 2000 (Abbasi Shavazi, 2009). Given that 80% of our sample were born after 1990, it is likely that reduced birth rate has impacted our findings. In particular, reduced birth rate might explain why transgender androphilic males in our study showed a weaker FBOE compared to another sample of Iranian

transgender androphilic males who were born a decade earlier in larger families (Khorashad et al., 2020). A meta-analysis by Blanchard (2018a) indicated that transgender androphilic male groups exhibit a stronger FBOE compared to cisgender groups. Therefore, it is possible that reduced birth rate affected both cisgender and transgender androphilic males in our sample.

Nevertheless, reduced birth rate alone cannot explain our finding of a SBOE in cisgender androphilic males. These discrepancies between our male groups in relation to the SBOE may be due to another factor, the stopping rules used by parents when deciding to stop (or continue) having children. Inspecting our data using sibling sex ratios and the analytical method suggested by Blanchard and Lippa (2007), we found evidence that our sample is likely affected by both male-preferring and diversity-preferring stopping rules. These rules increase the chance that a lastborn child be a male born to an older sister(s) (Blanchard, 2022), making it less likely to detect a FBOE in males. Be this as it may, it is unclear why these stopping rules would have affected cisgender androphilic males, but not transgender androphilic males or cisgender ambiphilic males, as both of the latter groups had normal to increased (i.e., male-biased) older sibling sex ratio and exhibited a trend toward FBOE. Although sampling bias is always a potential explanation, we cannot address this possibility using the current data.

As for the females, male-preferring and diversity-preferring stopping rules could have had somewhat opposite effects. While the male-preferring rule decreases the chance that a lastborn child be a female, the diversity-preferring rule increases the chance that a last-born female has only older brothers (Blanchard, 2022). This could potentially impact any effect that older siblings may have on female gynephilia. However, we are unable to assess the degree to which this might have influenced our results.

Limitations

Our sampling method may raise concerns about the degree to which it provides a representative sample since most of our participants were recruited using networking sampling method in Tehran and Mashhad, Iran's two largest metropolitans. Nevertheless, this approach was deemed the only way to examine same-sex sexuality in Iran given the country's restrictive sociopolitical atmosphere. Another limitation of our study was a relatively low number of recruited participants in certain groups, especially cisgender gynephilic females. Future studies would benefit from using larger more representative samples for these groups of individuals.

In this study, we compared participants using only sexual attraction patterns and no other dimensions of sexual orientation, including sexual identities, sexual behaviour, or sexual arousal patterns. While these dimensions of sexual orientation are usually aligned, they are more likely to diverge in ambiphilic individuals (Bailey et al., 2016). Moreover, self-reported data on sexuality can be affected by social desirability responding through mechanisms such as self-deceptive enhancement or impression management (Meston et al., 1998). Hence, it is possible that our sample of ambiphilic males may be heterogenous and, if assessed using genital arousal measures, would be comprised of predominantly androphilic males (see, Rieger et al., 2005; Semon et al., 2017). Though we are not aware of previous reports on Iranian ambiphilic males that would inform us on this matter, assessment of childhood and adulthood sex-atypical behaviour in this sample indicates cisgender ambiphilic males score intermediate between cisgender gynephilic males and cisgender androphilic males (Sadr-Bazzaz et al., 2024a, 2024b). This does not rule out the possible heterogeneity of our sample of cisgender ambiphilic males but undermines the probability that this sample is mostly comprised of truly androphilic males. More data would be valuable in addressing this question.

Conclusions

This study presented sibship data from a sample of Iranian adult males and females with diverse sexual orientation and gender identity/expression. The analyses indicated that both sororal and fraternal birth order effects were associated with increased likelihood of same-sex attraction in males. Support for the FBOE was found in cisgender and transgender androphilic males and cisgender ambiphilic males, while evidence for a SBOE was exhibited only by cisgender androphilic males. Among female participants, having more older sisters was significantly associated with being a transgender gynephilic female, providing support for a SBOE in this group. Our study contributed to limited literature on sibship composition of ambiphilic individuals, as well as gynephilic females, particularly, those who are relatively more masculine and identified as transgender.

SUPPLEMENTARY MATERIAL

Statistical Analyses for male participants including 21 excluded cisgender gynephilic males

Descriptive information for different sibship categories of 21 cisgender gynephilic males excluded from main statistical analyses were as follows: Older brothers (mean ± standard deviation): 1.19 ± 0.93; Older sisters: 0.81 ± 0.81; Younger brothers: 0.10 ± 0.30; Younger sisters: 0.43 ± 1.16; Total siblings: 2.52 ± 2.29; Year of birth: 1998.81 ± 3.41. In comparison with data presented in Table 2 (main body), it is evident that this subsample was an outlier in terms of their sibship data displaying the highest numbers of older brothers, older sisters, and older siblings, compared not only to other cisgender gynephilic males but also to cisgender ambiphilic males, cisgender androphilic males, and transgender androphilic males.

Supplementary Table s6-1 Binary logistic regression analyses comparing sibship composition between cisgender ambiphilic males and cisgender gynephilic males

Regression models	Predictors (Label)	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.29	0.14	3.87	0.049	**1.33 (1.00 – 1.77)**
	Number of Older Sisters	-0.10	0.14	0.48	0.487	0.91 (0.69 – 1.19)
	Number of Younger Brothers	-0.06	0.18	0.12	0.729	0.94 (0.65 – 1.34)
	Number of Younger Sisters	0.09	0.17	0.28	0.594	1.10 (0.78 – 1.55)
Novel model 1	Number of Siblings (YSAE)	0.02	0.12	0.02	0.883	1.02 (0.81 – 1.28)
	Number of Older Brothers (OBSE)	0.27	0.17	2.63	0.105	1.31 (0.94 – 1.83)
	Number of Older Sisters (OSSE)	-0.12	0.18	0.43	0.512	0.89 (0.63 – 1.26)
Novel model 2	Number of Older Brothers (BSSE)	0.39	0.23	2.90	0.089	1.48 (0.94 – 2.31)

Cisgender gynephilic males were coded as 0 and cisgender ambiphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.017$, Cox & Snell $R^2 = 0.012$, Model $\chi^2(4) = 4.40$, $p = 0.354$. Novel model 1: Nagelkerke $R^2 = 0.016$, Cox & Snell $R^2 = 0.011$, Model $\chi^2(3) = 4.06$, $p = 0.255$. Novel model 2: Nagelkerke $R^2 = 0.016$, Cox & Snell $R^2 = 0.011$, Model $\chi^2(3) = 4.06$, $p = 0.255$.

Supplementary Table s6-2 Binary logistic regression analyses comparing sibship composition between cisgender ambiphilic males and cisgender gynephilic males with year of birth as a predictor

Regression models	Predictors (Label)	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.41	0.16	6.67	0.010	**1.51 (1.10 – 2.06)**
	Number of Older Sisters	0.02	0.15	0.02	0.873	1.02 (0.76 – 1.38)
	Number of Younger Brothers	0.22	0.20	1.20	0.273	1.25 (0.84 – 1.87)
	Number of Younger Sisters	0.16	0.20	0.67	0.413	1.17 (0.80 – 1.72)
	Year of Birth	0.13	0.03	24.29	< 0.001	**1.13 (1.08 – 1.19)**
New model 1	Number of Siblings (YSAE)	0.19	0.14	1.84	0.175	1.21 (0.92 – 1.59)
	Number of Older Brothers (OBSE)	0.22	0.18	1.41	0.235	1.24 (0.87 – 1.79)
	Number of Older Sisters (OSSE)	-0.17	0.19	0.77	0.379	0.85 (0.58 – 1.23)
	Year of Birth	0.13	0.02	24.26	< 0.001	1.13 (1.08 – 1.19)
New model 2	Number of Older Brothers (BSSE)	0.39	0.24	2.58	0.108	1.47 (0.92 – 2.36)

Cisgender gynephilic males were coded as 0 and cisgender ambiphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.140$, Cox & Snell $R^2 = 0.098$, Model $\chi^2(5) = 37.12$, $p < 0.001$. New model 1: Nagelkerke $R^2 = 0.140$, Cox & Snell $R^2 = 0.098$, Model $\chi^2(4) = 37.07$, $p < 0.001$. New model 2: Nagelkerke $R^2 = 0.140$, Cox & Snell $R^2 = 0.098$, Model $\chi^2(4) = 37.07$, $p < 0.001$.

Supplementary Table s6-3 Binary logistic regression analyses comparing sibship composition between cisgender androphilic males and cisgender gynephilic males

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.00	0.11	0.00	0.974	1.00 (0.81 – 1.23)
	Number of Older Sisters	0.16	0.10	2.94	0.086	1.18 (0.98 – 1.42)
	Number of Younger Brothers	-0.25	0.14	3.09	0.079	0.78 (0.59 – 1.03)
	Number of Younger Sisters	-0.19	0.14	1.82	0.177	0.82 (0.62 – 1.09)
Novel model 1	Number of Siblings (YSAE)	-0.22	0.10	5.18	0.023	**0.80 (0.66 – 0.97)**
	Number of Older Brothers (OBSE)	0.22	0.13	2.82	0.093	1.24 (0.96 – 1.61)
	Number of Older Sisters (OSSE)	0.39	0.13	8.62	0.003	**1.47 (1.14 – 1.91)**
Novel model 2	Number of Older Brothers (BSSE)	-0.17	0.17	1.03	0.311	0.84 (0.61 – 1.17)

Cisgender gynephilic males were coded as 0 and cisgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.024$, Cox & Snell $R^2 = 0.018$, Model $\chi^2(4) = 10.52$, $p = 0.033$. Novel model 1: Nagelkerke $R^2 = 0.024$, Cox & Snell $R^2 = 0.018$, Model $\chi^2(3) = 10.43$, $p = 0.015$. Novel model 2: Nagelkerke $R^2 = 0.024$, Cox & Snell $R^2 = 0.018$, Model $\chi^2(3) = 10.43$, $p = 0.015$.

Supplementary Table s6-4 Binary logistic regression analyses comparing sibship composition between cisgender androphilic males and cisgender gynephilic males with year of birth as a predictor

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.02	0.11	0.04	0.834	1.02 (0.83 – 1.26)
	Number of Older Sisters	0.19	0.10	3.99	0.046	**1.22 (1.00 – 1.47)**
	Number of Younger Brothers	-0.13	0.15	0.78	0.376	0.88 (0.65 – 1.17)
	Number of Younger Sisters	-0.16	0.15	1.19	0.275	0.85 (0.64 – 1.13)
	Year of Birth	0.03	0.01	6.24	0.012	**1.03 (1.01 – 1.06)**
New model 1	Number of Siblings (YSAE)	-0.15	0.10	2.02	0.156	0.86 (0.71 – 1.06)
	Number of Older Brothers (OBSE)	0.17	0.13	1.59	0.208	1.18 (0.91 – 1.54)
	Number of Older Sisters (OSSE)	0.34	0.13	6.41	0.011	**1.41 (1.08 – 1.83)**
	Year of Birth	0.03	0.01	6.25	0.012	**1.03 (1.01 – 1.06)**
New model 2	Number of Older Brothers (BSSE)	-0.17	0.17	1.07	0.301	0.84 (0.61 – 1.17)

Cisgender gynephilic males were coded as 0 and cisgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.036$, Cox & Snell $R^2 = 0.027$, Model $\chi^2(5) = 15.36$, $p = 0.009$. New model 1: Nagelkerke $R^2 = 0.036$, Cox & Snell $R^2 = 0.027$, Model $\chi^2(4) = 15.34$, $p = 0.004$. New model 2: Nagelkerke $R^2 = 0.036$, Cox & Snell $R^2 = 0.027$, Model $\chi^2(4) = 15.34$, $p = 0.004$.

Supplementary Table s6-5 Binary logistic regression analyses comparing sibship composition between transgender androphilic males and cisgender gynephilic males

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.30	0.14	4.78	0.029	**1.35 (1.03 – 1.76)**
	Number of Older Sisters	-0.01	0.13	0.01	0.928	0.99 (0.77 – 1.27)
	Number of Younger Brothers	0.11	0.18	0.41	0.524	1.12 (0.79 – 1.58)
	Number of Younger Sisters	0.01	0.16	0.00	0.957	1.01 (0.73 – 1.39)
Novel model 1	Number of Siblings (YSAE)	0.06	0.11	0.27	0.600	1.06 (0.86 – 1.31)

	Number of Older Brothers (OBSE)	0.23	0.16	2.11	0.146	1.26 (0.92 – 1.73)
	Number of Older Sisters (OSSE)	-0.07	0.16	0.16	0.688	0.94 (0.68 – 1.29)
Novel model 2	Number of Older Brothers (BSSE)	0.30	0.21	1.99	0.159	1.35 (0.89 – 2.04)

Cisgender gynephilic males were coded as 0 and transgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.020$, Cox & Snell $R^2 = 0.014$, Model $\chi^2(4) = 5.15$, $p = 0.273$. Novel model 1: Nagelkerke $R^2 = 0.019$, Cox & Snell $R^2 = 0.014$, Model $\chi^2(3) = 4.99$, $p = 0.173$. Novel model 2: Nagelkerke $R^2 = 0.019$, Cox & Snell $R^2 = 0.014$, Model $\chi^2(3) = 4.99$, $p = 0.173$.

Supplementary Table s6-6 Binary logistic regression analyses comparing sibship composition between transgender androphilic males and cisgender gynephilic males with year of birth as a predictor

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.35	0.15	5.81	0.016	**1.42 (1.07 – 1.89)**
	Number of Older Sisters	0.18	0.14	1.67	0.197	1.20 (0.91 – 1.58)
	Number of Younger Brothers	0.38	0.20	3.68	0.055	1.46 (0.99 – 2.15)
	Number of Younger Sisters	0.02	0.18	0.02	0.894	1.02 (0.72 – 1.46)
	Year of Birth	0.14	0.03	27.82	< 0.001	**1.15 (1.09 – 1.22)**
New model 1	Number of Siblings (YSAE)	0.19	0.13	2.06	0.151	1.20 (0.93 – 1.56)
	Number of Older Brothers (OBSE)	0.13	0.18	0.578	0.447	1.14 (0.81 – 1.62)
	Number of Older Sisters (OSSE)	0.00	0.18	0.00	0.984	1.00 (0.70 – 1.42)
	Year of Birth	0.14	0.03	26.85	< 0.001	**1.15 (1.09 – 1.21)**
New model 2	Number of Older Brothers (BSSE)	0.14	0.22	0.39	0.535	1.15 (0.74 – 1.78)

Cisgender gynephilic males were coded as 0 and transgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.165$, Cox & Snell $R^2 = 0.116$, Model $\chi^2(5) = 44.31$, $p < 0.001$. New model 1: Nagelkerke $R^2 = 0.160$, Cox & Snell $R^2 = 0.112$, Model $\chi^2(4) = 42.71$, $p < 0.001$. New model 2: Nagelkerke $R^2 = 0.160$, Cox & Snell $R^2 = 0.112$, Model $\chi^2(4) = 42.71$, $p < 0.001$.

Supplementary Table s6-7 Males' siblings sex ratio (brothers to sisters)

	Cisgender gynephilic males	Cisgender ambiphilic males	Cisgender androphilic males	Transgender androphilic males
Older siblings				
Brothers	142	77	199	81
Sisters	153	61	242	68
Sex ratio	93	126	82	119

Binomial z-ratio	-1.08	0.94	-2.61	0.63
p value (two-tailed)	0.280	0.347	0.009	0.528
Younger siblings				
Brothers	113	41	102	47
Sisters	102	44	95	42
Sex ratio	111	93	107	112
Binomial z-ratio	0.26	-0.48	0.02	0.15
p value (two-tailed)	0.795	0.631	0.984	0.881

Binomial probabilities were also calculated based on a birth sex ratio of 101:100; however, none of the comparisons diverged from the results presented in the table for a birth sex ratio of 106:100.

The Classic and New Regression Models with Year of Birth as a Predictor

In the supplementary tables s1 to s8, the results from the classic and novel regression models are presented with the year of birth included as a predictor. Data from 239 cisgender gynephilic males were included in these analyses.

Supplementary Table s6-8 Binary logistic regression analyses comparing sibship composition between cisgender ambiphilic males and cisgender gynephilic males with year of birth as a predictor

Regression models	Predictors (Label)	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.58	0.17	11.33	< 0.001	**1.79 (1.27 – 2.50)**
	Number of Older Sisters	0.08	0.15	0.29	0.590	1.08 (0.80 – 1.47)
	Number of Younger Brothers	0.18	0.21	0.75	0.385	1.20 (0.79 – 1.81)
	Number of Younger Sisters	0.37	0.22	2.87	0.090	1.45 (0.94 – 2.22)
	Year of Birth	0.14	0.03	28.48	< 0.001	**1.15 (1.09 – 1.21)**
New model 1	Number of Siblings (YSAE)	0.27	0.15	3.23	0.072	1.31 (0.98 – 1.77)
	Number of Older Brothers (OBSE)	0.31	0.19	2.63	0.105	1.36 (0.94 – 1.97)
	Number of Older Sisters (OSSE)	-0.19	0.19	1.00	0.317	0.83 (0.57 – 1.20)
	Year of Birth	0.14	0.03	28.74	< 0.001	**1.15 (1.09 – 1.21)**
New model 2	Number of Older Brothers (BSSE)	0.50	0.24	4.20	0.041	**1.65 (1.02 – 2.66)**

Cisgender gynephilic males were coded as 0 and cisgender ambiphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.182$, Cox & Snell $R^2 = 0.129$, Model $\chi^2(5) = 46.94$, $p < 0.001$. New model 1: Nagelkerke $R^2 = 0.181$, Cox & Snell $R^2 = 0.128$, Model $\chi^2(4) = 46.56$, $p < 0.001$. New model 2: Nagelkerke $R^2 = 0.181$, Cox & Snell $R^2 = 0.128$, Model $\chi^2(4) = 46.56$, $p < 0.001$.

Supplementary Table s6-9 Binary logistic regression analyses comparing sibship composition between cisgender androphilic males and cisgender gynephilic males with year of birth as a predictor

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.12	0.11	1.04	0.307	1.12 (0.90 – 1.41)
	Number of Older Sisters	0.19	0.10	3.66	0.056	1.21 (0.99 – 1.48)
	Number of Younger Brothers	-0.18	0.15	1.36	0.243	0.84 (0.62 – 1.13)
	Number of Younger Sisters	-0.10	0.16	0.43	0.513	0.90 (0.66 – 1.23)
	Year of Birth	0.04	0.01	9.17	0.002	**1.04 (1.01 – 1.07)**
New model 1	Number of Siblings (YSAE)	-0.14	0.11	1.72	0.190	0.87 (0.70 – 1.07)
	Number of Older Brothers (OBSE)	0.26	0.14	3.45	0.063	1.30 (0.99 – 1.70)
	Number of Older Sisters (OSSE)	0.34	0.14	5.82	0.016	**1.40 (1.06 – 1.84)**
	Year of Birth	0.04	0.01	9.35	0.002	**1.04 (1.01 – 1.07)**
New model 2	Number of Older Brothers (BSSE)	-0.08	0.17	0.19	0.661	0.93 (0.66 – 1.30)

Cisgender gynephilic males were coded as 0 and cisgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.050$, Cox & Snell $R^2 = 0.037$, Model $\chi^2(5) = 20.92$, $p < 0.001$. New model 1: Nagelkerke $R^2 = 0.050$, Cox & Snell $R^2 = 0.037$, Model $\chi^2(4) = 20.82$, $p < 0.001$. New model 2: Nagelkerke $R^2 = 0.050$, Cox & Snell $R^2 = 0.037$, Model $\chi^2(4) = 20.82$, $p < 0.001$.

Supplementary Table s6-10 Binary logistic regression analyses comparing sibship composition between transgender androphilic males and cisgender gynephilic males with year of birth as a predictor

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.46	0.16	8.31	0.004	**1.58 (1.16 – 2.15)**
	Number of Older Sisters	0.23	0.14	2.54	0.111	1.25 (0.95 – 1.66)
	Number of Younger Brothers	0.32	0.20	2.45	0.117	1.38 (0.92 – 2.05)
	Number of Younger Sisters	0.16	0.20	0.62	0.431	1.17 (0.79 – 1.75)
	Year of Birth	0.16	0.03	30.95	< 0.001	**1.17 (1.11 – 1.23)**
New model 1	Number of Siblings (YSAE)	0.24	0.14	2.87	0.090	1.27 (0.96 – 1.68)
	Number of Older Brothers (OBSE)	0.21	0.19	1.24	0.265	1.23 (0.85 – 1.77)

	Number of Older Sisters (OSSE)	-0.01	0.18	0.00	0.959	0.99 (0.69 – 1.42)
	Year of Birth	0.15	0.03	30.67	< 0.001	**1.17 (1.10 – 1.23)**
New model 2	Number of Older Brothers (BSSE)	0.22	0.23	0.90	0.344	1.24 (0.79 – 1.94)

Cisgender gynephilic males were coded as 0 and transgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.201$, Cox & Snell $R^2 = 0.142$, Model $\chi^2(5) = 52.18$, $p < 0.001$. New model 1: Nagelkerke $R^2 = 0.200$, Cox & Snell $R^2 = 0.142$, Model $\chi^2(4) = 51.89$, $p < 0.001$. New model 2: Nagelkerke $R^2 = 0.200$, Cox & Snell $R^2 = 0.142$, Model $\chi^2(4) = 51.89$, $p < 0.001$.

Supplementary Table s6-11 Binary logistic regression analyses comparing sibship composition between transgender androphilic males and cisgender androphilic males with year of birth as a predictor

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.28	0.12	5.26	0.022	**1.32 (1.04 – 1.67)**
	Number of Older Sisters	-0.13	0.13	1.10	0.294	0.87 (0.68 – 1.12)
	Number of Younger Brothers	0.41	0.19	4.78	0.029	**1.51 (1.04 – 2.17)**
	Number of Younger Sisters	0.30	0.19	2.57	0.109	1.35 (0.93 – 1.96)
	Year of Birth	0.84	0.02	14.37	< 0.001	**1.09 (1.04 – 1.14)**
New model 1	Number of Siblings (YSAE)	0.36	0.13	7.31	0.007	**1.43 (1.10 – 1.85)**
	Number of Older Brothers (OBSE)	-0.08	0.16	0.23	0.628	0.92 (0.67 – 1.27)
	Number of Older Sisters (OSSE)	-0.49	0.17	7.85	0.005	**0.61 (0.43 – 0.86)**
	Year of Birth	0.08	0.02	14.30	< 0.001	**1.09 (1.04 – 1.14)**
New model 2	Number of Older Brothers (BSSE)	0.41	0.20	4.14	0.042	**1.51(1.01 – 2.24)**

Cisgender androphilic males were coded as 0 and transgender androphilic males were coded as 1. Classic model: Nagelkerke $R^2 = 0.090$, Cox & Snell $R^2 = 0.061$, Model $\chi^2(5) = 26.21$, $p < 0.001$. New model 1: Nagelkerke $R^2 = 0.090$, Cox & Snell $R^2 = 0.061$, Model $\chi^2(4) = 26.05$, $p < 0.001$. New model 2: Nagelkerke $R^2 = 0.090$, Cox & Snell $R^2 = 0.061$, Model $\chi^2(4) = 26.05$, $p < 0.001$.

Supplementary Table s6-12 Binary logistic regression analyses comparing sibship composition between cisgender ambiphilic females and cisgender androphilic females with year of birth as a predictor

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	-0.32	0.17	3.44	0.064	0.72 (0.51 – 1.02)

	Number of Older Sisters	-0.08	0.15	0.27	0.606	0.92 (0.69 – 1.25)
	Number of Younger Brothers	-0.10	0.21	.22	0.639	0.91 (0.61 – 1.36)
	Number of Younger Sisters	-0.09	0.20	0.20	0.656	0.92 (0.62 – 1.35)
	Year of Birth	0.08	0.02	13.27	< 0.001	**1.08 (1.04 – 1.13)**
New model 1	Number of Siblings (YSAE)	-0.09	0.15	0.39	0.531	0.91 (0.68 – 1.22)
	Number of Older Brothers (OBSE)	-0.23	0.20	1.39	0.238	0.79 (0.54 – 1.17)
	Number of Older Sisters (OSSE)	0.01	0.19	0.00	0.944	1.01 (0.69 – 1.48)
	Year of Birth	0.08	0.02	13.33	< 0.001	1.08 (1.04 – 1.13)
New model 2	Number of Older Brothers (BSSE)	-0.25	0.24	1.01	0.315	0.78 (0.48 – 1.26)

Cisgender androphilic females were coded as 0 and cisgender ambiphilic females were coded as 1. Classic model: Nagelkerke $R^2 = 0.082$, Cox & Snell $R^2 = 0.057$, Model $\chi^2(5) = 22.07$, $p < 0.001$. New model 1: Nagelkerke $R^2 = 0.082$, Cox & Snell $R^2 = 0.057$, Model $\chi^2(4) = 22.07$, $p < 0.001$. New model 2: Nagelkerke $R^2 = 0.082$, Cox & Snell $R^2 = 0.057$, Model $\chi^2(4) = 22.07$, $p < 0.001$.

Supplementary Table s6-13 Binary logistic regression analyses comparing sibship composition between cisgender gynephilic females and cisgender androphilic females with year of birth as a predictor

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.14	0.18	0.68	0.411	1.15 (0.82 – 1.63)
	Number of Older Sisters	-0.14	0.19	0.56	0.454	0.86 (0.59 – 1.26)
	Number of Younger Brothers	-0.01	0.26	0.00	0.959	0.99 (0.60 – 1.63)
	Number of Younger Sisters	-0.18	0.29	0.39	0.531	0.83 (0.47 – 1.47)
	Year of Birth	0.16	0.04	16.61	< 0.001	**1.18 (1.09 – 1.27)**
New model 1	Number of Siblings (YSAE)	-0.09	0.19	0.22	0.639	0.91 (0.63 – 1.33)
	Number of Older Brothers (OBSE)	0.24	0.23	1.09	0.296	1.28 (0.81 – 2.02)
	Number of Older Sisters (OSSE)	-0.05	0.26	0.04	0.836	0.95 (0.57 – 1.57)
	Year of Birth	0.16	0.04	16.63	< 0.001	**1.18 (1.08 – 1.27)**
New model 2	Number of Older Brothers (BSSE)	0.30	0.28	1.10	0.295	1.35 (0.77 – 2.36)

Cisgender androphilic females were coded as 0 and cisgender gynephilic females were coded as 1. Classic model: Nagelkerke $R^2 = 0.138$, Cox & Snell $R^2 = 0.081$, Model $\chi^2(5) = 26.63$, $p < 0.001$. New model 1:

Nagelkerke $R^2 = 0.137$, Cox & Snell $R^2 = 0.081$, Model $\chi^2(4) = 26.44$, $p < 0.001$. New model 2: Nagelkerke $R^2 = 0.137$, Cox & Snell $R^2 = 0.081$, Model $\chi^2(4) = 26.44$, $p < 0.001$.

Supplementary Table s6-14 Binary logistic regression analyses comparing sibship composition between transgender gynephilic females and cisgender androphilic females with year of birth as a predictor

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.21	0.10	4.20	0.040	**1.24 (1.01 – 1.52)**
	Number of Older Sisters	0.33	0.09	12.41	< 0.001	**1.40 (1.16 – 1.68)**
	Number of Younger Brothers	0.02	0.14	0.01	0.910	1.02 (0.76 – 1.35)
	Number of Younger Sisters	0.26	0.16	2.65	0.103	1.30 (0.95 – 1.77)
	Year of Birth	0.14	0.02	50.67	< 0.001	**1.15 (1.11 – 1.20)**
New model 1	Number of Siblings (YSAE)	0.13	0.11	1.34	0.247	1.13 (0.92 – 1.41)
	Number of Older Brothers (OBSE)	0.07	0.14	0.27	0.606	1.07 (0.82 – 1.40)
	Number of Older Sisters (OSSE)	0.21	0.13	2.67	0.102	**1.23 (0.96 – 1.59)**
	Year of Birth	0.14	0.02	50.56	< 0.001	**1.15 (1.11 – 1.20)**
New model 2	Number of Older Brothers (BSSE)	-0.14	0.15	0.91	0.340	0.87 (0.65 – 1.16)

Cisgender androphilic females were coded as 0 and transgender gynephilic females were coded as 1. Classic model: Nagelkerke $R^2 = 0.185$, Cox & Snell $R^2 = 0.138$, Model $\chi^2(5) = 76.77$, $p < 0.001$. New model 1: Nagelkerke $R^2 = 0.182$, Cox & Snell $R^2 = 0.136$, Model $\chi^2(4) = 75.44$, $p < 0.001$. New model 2: Nagelkerke $R^2 = 0.182$, Cox & Snell $R^2 = 0.136$, Model $\chi^2(4) = 75.44$, $p < 0.001$.

Supplementary Table s6-15 Binary logistic regression analyses comparing sibship composition between transgender gynephilic females and cisgender gynephilic females with year of birth as a predictor

Regression models	Predictors	*B*	SE	Wald	*p*	Odds ratio (95% CI)
Classic model	Number of Older Brothers	0.07	0.17	0.14	0.705	1.07 (0.76 – 1.50)
	Number of Older Sisters	0.34	0.18	3.52	0.061	1.41 (0.98 – 2.02)
	Number of Younger Brothers	0.06	0.26	0.05	0.823	1.06 (0.64 – 1.75)
	Number of Younger Sisters	0.41	0.29	1.96	0.162	1.50 (0.85 – 2.67)
	Year of Birth	-0.01	0.04	0.04	0.847	0.99 (0.93 – 1.07)
New model 1	Number of Siblings (YSAE)	0.22	0.20	1.19	0.275	1.24 (0.84 – 1.85)

	Number of Older Brothers (OBSE)	-0.16	0.23	0.49	0.485	0.85 (0.54 – 1.33)
	Number of Older Sisters (OSSE)	0.12	0.24	0.27	0.601	1.13 (0.71 – 1.81)
	Year of Birth	0.00	0.04	0.02	0.885	0.99 (0.93 – 1.07)
New model 2	Number of Older Brothers (BSSE)	-0.28	0.26	1.15	0.284	0.75 (0.45 – 1.26)

Cisgender gynephilic females were coded as 0 and transgender gynephilic females were coded as 1. Classic model: Nagelkerke $R^2 = 0.036$, Cox & Snell $R^2 = 0.022$, Model $\chi^2(5) = 6.62$, $p = 0.250$. New model 1: Nagelkerke $R^2 = 0.032$, Cox & Snell $R^2 = 0.019$, Model $\chi^2(4) = 5.74$, $p = 0.219$. New model 2: Nagelkerke $R^2 = 0.032$, Cox & Snell $R^2 = 0.019$, Model $\chi^2(4) = 5.74$, $p = 0.219$.

An Alternative Analytical Method

An Older Brothers Odds Ratio (OBOR) and an Older Sisters Odds Ratio (OSOR) were used to estimate the group-level likelihoods of having more older brothers and older sisters, respectively (Blanchard, 2018a). In male participants, the reference odds were related to cisgender gynephilic group, while in females it was related to cisgender androphilic group. For each same-sex attracted group, the calculated odds of having older brothers (or older sisters) were divided by the odds of the reference group. For instance, for cisgender androphilic males, the OBOR was calculated as: (cisgender androphilic males' number of older brothers ÷ cisgender androphilic males' number of other siblings) ÷ (cisgender gynephilic males' number of older brothers ÷ cisgender gynephilic males' number of other siblings), expressing the likelihood of having more older brothers given an androphilic sexual orientation. An online calculator was used for the two-tailed *p* values and rechecking the calculated 95% confidence intervals (https://www.medcalc.org/calc/odds_ratio.php; "Odds ratio calculator," 2024). The family size (total number of siblings) was controlled for using OBOR and OSOR.

Male participants

We calculated OBORs for cisgender ambiphilic males ($\frac{77 \div 146}{117 \div 340} = 1.53$, 95% CI = 1.08 – 2.17, $p = 0.018$), cisgender androphilic males ($\frac{199 \div 439}{117 \div 340} = 1.32$, 95% CI = 1.01 – 1.72, $p = 0.044$),

and transgender androphilic males ($\frac{81 \div 157}{117 \div 340}$ = 1.49, 95% CI = 1.07 – 2.11, p = 0.021). In addition, we calculated OSORs for cisgender ambiphilic males ($\frac{61 \div 162}{136 \div 321}$ = 0.89, 95% CI = 0.62 – 1.27, p = 0.530), cisgender androphilic males ($\frac{242 \div 396}{136 \div 321}$ = 1.44, 95% CI = 1.12 – 1.86, p = 0.005), and transgender androphilic males ($\frac{68 \div 170}{136 \div 321}$ = 0.94, 95% CI = 0.67 – 1.33, p = 0.792).

Female participants

We calculated OBORs for cisgender ambiphilic females ($\frac{39 \div 139}{146 \div 389}$ = 0.75, *SE* = 0.20, 95% CI = 0.50 – 1.12, p = 0.157), cisgender gynephilic females ($\frac{31 \div 64}{146 \div 389}$ = 1.29, *SE* = 0.24, 95% CI = 0.81 – 2.06, p = 0.286), and transgender gynephilic females ($\frac{181 \div 422}{146 \div 389}$ = 1.14, *SE* = 0.13, 95% CI = 0.88 – 1.48, p = 0.310). In addition, we calculated OSORs for cisgender ambiphilic females ($\frac{52 \div 126}{150 \div 385}$ = 1.06 , *SE* = 0.19, 95% CI = 0.73 – 1.54, p = 0.762), cisgender gynephilic females ($\frac{28 \div 67}{150 \div 385}$ = 1.07, *SE* = 0.24, 95% CI = 0.66 – 1.73, p = 0.774), and transgender gynephilic females ($\frac{222 \div 381}{150 \div 385}$ = 1.49, *SE* = 0.13, 95% CI = 1.16 – 1.92, p = 0.002).

Chapter 7: The Paradox of Same-Sex Sexual Orientation: Evidence for Higher Familial Occurrence and Lower Reproductive Output in Iran

ABSTRACT

Same-sex sexual orientation negatively impacts one's direct reproductive output, but paradoxically, it is persistently expressed across cultures and genetic variation plays a significant role in its development. Existing research has mostly focused on Western cisgender monosexual same-sex attracted males, while comparative evidence pertaining to non-Western cultures, transgender individuals, ambisexuals, and females is more limited. In this study, we presented data in relation to familial occurrence of same-sex attraction. We also compared offspring production in Iranian cisgender gynephilic males (n = 270), cisgender ambiphilic males (n = 110), cisgender androphilic males (n = 324), transgender androphilic males (n = 106), cisgender androphilic females (n = 281), cisgender ambiphilic females (n = 119), cisgender gynephilic females (n = 63), and transgender gynephilic females (n = 261). Ambisexual and monosexual, cisgender and transgender, same-sex attracted males and females had more same-sex attracted kin and fewer offspring compared to monosexual, cisgender gynephilic males and androphilic females. This study conducted in Iran, a Middle Eastern country, provided empirical evidence for familial clustering of same-sex sexual attraction and reduced reproductive output in same-sex attracted males and females with diverse sexual orientations and gender identities/expressions.

INTRODUCTION

Most human males and females have predominant or exclusive sexual attraction toward adult females (i.e., gynephilia) and adult males (i.e., androphilia), respectively (Rahman et al., 2020). This pattern may seem unremarkable for a sexually reproducing species considering the clear adaptive benefit of a trait that directs one's sexual attention, attraction, arousal, and behaviour towards adult members of the other sex. In contrast, the persistent occurrence of same-sex attraction (i.e., male androphilia or female gynephilia) across different human populations (Murray, 2002) and over time (Leser, 1961) requires explanation when viewed from an evolutionary perspective. This is particularly true when same-sex sexual attraction is expressed to the exclusion of any opposite-sex attraction.

In Western countries, findings from different types of genetic studies converge on the conclusion that genes play a role in the development of same-sex sexual attraction (Bailey et al., 2016; Felesina & Zietsch, 2025). Family studies show that both male androphilia and female gynephilia cluster in families (e.g., Bailey & Bell, 1993; Bailey & Pillard, 1991; Bailey et al., 1999; Camperio Ciani et al., 2004, 2018; Hamer et al., 1993; Pattatucci & Hamer, 1995; Rahman et al., 2008; Schwartz et al., 2010). Twin studies demonstrate that concordance rates for same-sex sexual orientation are larger for monozygotic than dizygotic twins (for a review see Table 4 in Bailey et al., 2016). The average heritability of same-sex attraction in males and females derived from these twin studies is estimated to be 0.32 (Bailey et al., 2016). Molecular genetic studies indicate that same-sex sexual orientation is polygenic (Felesina & Zietsch, 2025; Ganna et al., 2019). The largest genome wide association study (GWAS) to date, using the UK Biobank and 23andMe data, found that genetic factors accounted for 8-25% of the variation in male and female same-sex sexual behaviour (a proxy of sexual orientation) (Ganna et al., 2019). This same

study also showed that male and female same-sex sexual behaviour had genetic influences that were partially distinct.

Outside of North America and Europe, we know of two cultures in which familial clustering studies were conducted on androphilic males who are recognized as "third genders" in their local cultures. These studies showed that Samoan *fa'afafine* and Istmo Zapotec *muxes* have higher ratios of same-sex attracted uncles and male cousins compared to gynephilic males (Gómez et al., 2018; Semenyna et al., 2017a; VanderLaan et al., 2013a, 2013b). In addition, a GWAS conducted in a Chinese Han population found two genetic loci for cisgender male androphilia (Hu et al., 2021). To the best of our knowledge, there is no genetic study of female gynephilia in non-Western populations.

Although the existing evidence indicates that same-sex attraction has a genetic component, it is known to be associated with reduced reproductive output. Most of these data come from Western cultures and focus on cisgender androphilic males, while empirical evidence pertaining to non-Western populations, transgender individuals, and gynephilic females remains scarce. Research on males shows that, compared to cisgender gynephilic males, cisgender androphilic males exhibit lower reproductive output in Europe (e.g., Ciani et al., 2009; Fořt et al., 2025; King et al., 2005), North America (e.g., Apostolou, 2022; Bell & Weinberg, 1978; Schwartz et al., 2010), and Southeast Asia (Coome et al., 2020; Nila et al., 2018). Two studies of transgender androphilic males, in Samoa (Vasey et al., 2014) and Thailand (Coome et al., 2020), reported no offspring production among these participants. The only report of reproductive output in Iranian same-sex attracted individuals compared a small number of cisgender androphilic males who were older than 40 years old (n = 27) with their gynephilic counterpart (n

= 22) and found significantly lower number of children in the former group (Besharat et al., 2016).

In recent years, more studies have reported on reproductive output in relation to female same-sex attraction. Compared to cisgender androphilic females, cisgender gynephilic females exhibit lower reproductive output in the Czech Republic and Slovakia (Fořt et al., 2024a; Fořt et al., 2025), Italy (Camperio Ciani et al., 2018), Thailand (Coome et al., 2020), and the USA (Apostolou, 2022; Bell & Weinberg, 1978). The only study reporting on transgender gynephilic females was conducted in Thailand and found that the members of this group had a reduced number of offspring when compared to cisgender androphilic females (Coome et al., 2020). We are not aware of any similar study on females conducted in Iran.

It is noteworthy that alternative approaches to operationalizing sexual orientation have produced similar findings. In an Australian national probability sample, participants were asked about their sexual identities as well as number of children (Sabia et al., 2017). This study found lower reproductive output in gay men, lesbians, and bisexual women when compared to their heterosexual male or female counterparts, although bisexual men had an elevated number of children. Using information on sexual behaviour recorded in UK Biobank dataset, Ganna et al. (2019) found that an increase in the proportion of same-sex sexual partners to total partners was associated with decrease in direct reproductive output in both males and females.

Regarding the important distinction between monosexual and ambisexual attraction to the same-sex, limited evidence suggests that reproductive output decreases gradually as same-sex attraction increases. Evidence on this matter is restricted to a few studies (Apostolou, 2022; Camperio Ciani et al., 2018; Ciani et al., 2009; Coome et al., 2020) and a limitation of this work is that the number of ambiphilic individuals (i.e., sexually attracted to both adult males and

females) recruited is often modest ($12 \leq n \leq 86$). Another research limitation affecting our understanding of this phenomenon is that data pertaining to ambisexuals may not be reported, either because only a small number of ambiphilic participants were recruited, or because data on ambiphlic and monsexual individuals were combined (Nila et al., 2018).

In this study, we surveyed adult Iranian males and females who varied in their sexual orientation and gender identity. We aimed to address some of the aforementioned gaps in the literature. Data on the familial occurrence of same-sex attraction is presented. Furthermore, we compared offspring production in cisgender gynephilic, ambiphilic, and androphilic males and females. We also report on transgender androphilic males and transgender gynephilic females.

Methods

Recruitment

In this paper, we present data collected over three years from November 2021 to September 2024 during three recruitment attempts. The first recruitment sample was drawn from an online survey conducted using Qualtrics. Popular social media platforms among Iranians such as Twitter, Instagram, and Telegram were used as the main routes for distributing the invitation to participate in the study. The message began with "We are seeking Iranian men and women (18 years of age or older) to participate in a voluntary, anonymous and confidential study on childhood and adulthood behaviour and psychology. Participants can be heterosexual or homosexual, gender conforming or non-gender conforming, including trans individuals." An anonymous link was included in the message which was used by interested individuals to access the survey. The responses were recorded between November 2021 and July 2022.

The second recruitment sample was collected between April 2022 and April 2024 in Mashhad and Tehran, Iran. A snowball sampling method was used to recruit most of these

participants. Some transgender participants were current or previous clients of a gender clinic in Mashhad and were recruited through that clinic. Most of these individuals had received the diagnosis of gender dysphoria and were at different stages of gender transition. These individuals would then sometimes introduce other transgender individuals who had not been clients of this clinic in the past. A diagnosis of gender dysphoria was not an inclusion criterion for participation in this study. Cisgender same-sex attracted participants were initially found through the personal social networks of the researchers. These individuals would then introduce other individuals who were not in the authors' social networks. We also recruited some staff and students at a hospital in Mashhad and some participants from public social spaces such as coffee shops and malls. These individuals constituted, for the most part, our control groups of other-sex attracted males and females.

The third round of data collection was undertaken between June and September 2024. A poster was circulated in online social groups that targeted Iranians with diverse sexuality or gender. The invitation asked readers to contact the researchers if interested in participation. Meetings were scheduled with participants who agreed to meet in-person. Otherwise, the survey link was shared, and further communications remained online. Data from participants who confirmed they had participated in previous rounds of recruitment were removed.

Participants

Data from 1534 participants were presented in this study, including cisgender gynephilic males (n = 270), cisgender ambiphilic males (n = 110), cisgender androphilic males (n = 324), transgender androphilic males (n = 106), cisgender androphilic females (n = 281), cisgender ambiphilic females (n = 119), cisgender gynephilic females (n = 63), and transgender gynephilic females (n = 261). Considering that number of participants varied between different questionnaires, we also reported group sizes separately for each measure. Due to small group

size, we did not analyze data from the other eight groups including transgender gynephilic males (n = 6), transgender ambiphilic males (n = 9), transgender androphilic females (n = 2), transgender ambiphilic females (n =11), cisgender asexual/analloerotic males (n = 10), transgender asexual/analloerotic males (n = 1), cisgender asexual/analloerotic females (n = 17), and transgender asexual/analloerotic females (n = 3).

Measures

Sex, Gender Identity/Expression, Sexual Orientation

In terms of sex, we categorized participants based on their answer to the following question: "Which sex were assigned to you at birth? (*male*, *female*, and if *other* please specify.)" In terms of gender, participants were asked two consecutive questions: "What is your gender identity? (*man*, *woman*, and if *other* please specify)" and "Are you transgender or transsexual? (*yes* or *no*)". When participants identified as a female identifying as a woman or a male identifying as a man, and as neither transgender nor transsexual, they were categorized as *cisgender*. Participants were classified as *transgender* if they: (1) identified as a *woman* while being identified as a male at birth, or (2) identified as a *man* while being identified as a female at birth, or (3) identified as neither a *man* nor a *woman*. Of 106 transgender males included in this paper, 30 identified neither as a man nor a woman and of these, the most common reported gender identity was *non-binary* (n = 17). Also, 16 individuals out of these 30 did not self-identify as transgender/transsexual. Of 261 transgender females, 9 participants reported an alternative gender identity with non-binary being the most common (n = 6). Also, four individuals out of these eight did not self-identify as transgender/transsexual.

To assess sexual orientation, participants were asked to report their sexual feelings towards adult males/men or females/women, during the previous 12 months, using a 7-point

Likert scale (Kinsey et al., 1948). Participants who had sexual feelings only for females/women (score = 0), or had only an occasional fantasy about males/men (score = 1) were categorized as *gynephilic,* those who had stronger sexual feelings for both males/men and females/women (score = 2 to 4) were categorized as *ambiphilic,* and those who had only an occasional fantasy about females/women (score = 5), or were only attracted to males/men (score = 6) were categorized as *androphilic*. An eighth item was added for participants who "have not any sexual feelings toward any sex/gender," and these individuals were categorized as *asexual/analloerotic*. Considering it was unclear from the item whether any other type of sexual feeling was present or not, this group could be either asexual (i.e., no sexual feelings whatsoever) or analloerotic (i.e., presence of sexual feelings but not directed toward males/men or females/women; Blanchard, 1989).

Demographic information

The survey comprised standardized questionnaires that were translated to Farsi from English by a fluent bilingual (English and Farsi) speaker. Participants were asked to report their year of birth, level of education, and financial status. Level of education was reported on a 7-point scale from 1 = "no education" to 7 = "postgraduate degree." Due to the limited number of participants in first three levels of education, those levels were collapsed and are presented together resulting in five levels of education. Participants were also asked to report their overall financial status on 5-point scale from 1 = "very bad" (I need financial aid for my basic needs) to 5 = "very good" (I have no concerns about money). Overall, cisgender gynephilic males, cisgender androphilic males and cisgender androphilic females were older, had more education and reported a better financial status compared to other groups.

Familial occurrence of same-sex attraction

Participants were asked whether they had brother(s) or sister(s) who were "attracted to the same sex" and reported the number. Using data collected separately on numbers of siblings (from a biological mother), we could compute ratios of same-sex attracted brothers (or sisters) to total numbers of brothers (or sisters) for each group of participants. For other kinship categories including (1) nephews, (2) nieces, (3) maternal male kins (i.e., uncles and cousins), (4) paternal male kins (i.e., uncles and cousins), (5) maternal female kins (i.e., aunts and cousins), and (6) paternal female kins (i.e., aunts and cousins), we asked participants if they "had any same-sex attracted relative." However, we did not record participants' numbers of relatives in those categories. Therefore, we could not compute proportions of same-sex attracted relatives to total numbers of relatives for different kinship categories. Instead, we conducted between-group comparison for rates of having any same-sex attracted relative in each kinship category.

We also investigated if exclusive same-sex sexual attraction was associated with increased probability for having a same-sex attracted relative. To statistically test this matter, categories of first- and second-degree relatives, including maternal and paternal relatives, were combined to form two categories of male and female same-sex attracted kin. Then, odds ratios were computed for having at least one same-sex attracted kin member in each of these categories. These odds ratios were calculated separately for exclusively androphilic males (compared to exclusively gynephilic males) and exclusively gynephilic females (compared to exclusively androphilic females).

Reproductive output

Participants were asked if they had any children and to report numbers of their biological and adopted children. The numbers of biological children were compared between groups. Also, within each sex, cisgender and transgender individuals who were exclusively same-sex attracted

were compared to their cisgender exclusively other-sex attracted counterparts. Demographic information including age, education, and financial status were reported. To control for the possible effect of age, we also compared offspring production in participants ≥ 30 years old.

Statistical analysis

To examine the normality of distributions, we considered skewness statistics, Kolmogorov-Smirnov tests, and normal Q-Q plots. If normality could not be assumed, non-parametric tests, including the Mann-Whitney *U* test and Kruskal-Wallis *H* were used for between-group comparisons. Variations in proportions reported in the contingency tables were evaluated using Chi square tests. To compare proportions between independent samples, we used Wald H0 (continuity corrected) test. All the statistical analyses were performed using IBM SPSS statistics version 29.0.

RESULTS

Familial Occurrence of Same-Sex Attraction

Due to non-normal distributions of numbers of brothers and sisters who were same-sex attracted (Table 7-1), between-group comparisons were conducted using non-parametric tests. In male participants, Kruskal-Wallis *H* tests did not show any between-group difference in numbers of same-sex attracted brothers ($\chi^2[3] = 1.92$, $p = 0.588$) or sisters ($\chi^2[3] = 3.10$, $p = 0.376$). Similarly, the calculated 95% confidence intervals did not indicate statistically significant increases in likelihoods of having a same-sex attracted brother or sister. Among female groups, no statistical difference was found in numbers of same-sex attracted brothers ($\chi^2[3] = 0.47$, $p = 0.926$). However, numbers of same-sex attracted sisters were significantly different ($\chi^2[3] = 9.10$, $p = 0.028$). The pairwise comparison revealed that cisgender ambiphilic females had significantly higher number of same-sex attracted sisters compared to cisgender androphilic

females ($p = 0.021$, adjusted by the Bonferroni correction for multiple tests). No other pairwise comparisons were statistically significant (Table 7-1).

The proportions of participants who reported having at least one same-sex attracted relative in the six different kinship categories are reported in Table 7-2. For the male groups, Pearson Chi-square tests for contingency tables of kinship categories revealed significant associations for maternal male kin ($\chi^2[3] = 20.65$, $p < 0.001$), paternal male kin ($\chi^2[3] = 13.78$, $p = 0.003$), and paternal female kin ($\chi^2[3] = 8.08$, $p = 0.044$), but not for maternal female kin ($\chi^2[3] = 3.62$, $p = 0.306$), nieces ($\chi^2[3] = 3.13$, $p = 0.372$), or nephews ($\chi^2[3] = 1.50$, $p = 0.681$). The pairwise comparison showed that a significantly higher proportion of cisgender androphilic males reported having a same-sex attracted maternal male relative compared to cisgender gynephilic males ($Z = 4.13$, $p < 0.001$) and cisgender ambiphilic males ($Z = 2.25$, $p = 0.025$). Similarly, a significantly higher proportion of cisgender androphilic males reported having a same-sex attracted paternal male relative compared to cisgender gynephilic males ($Z = 3.12$, $p = 0.002$) and cisgender ambiphilic males ($Z = 2.21$, $p = 0.027$). Also, a significantly higher proportion of cisgender ($Z = 2.14$, $p = 0.033$) and transgender androphilic males ($Z = 2.14$, $p = 0.032$) reported having a same-sex attracted paternal female relative compared to cisgender gynephilic males. No other pairwise comparison reached statistical significance.

For the female groups, Pearson Chi-square tests for contingency tables of kinship categories revealed a significant association only for maternal female kin ($\chi^2[3] = 28.80$, $p <$

Table 7-1 Proportions of same-sex attracted brothers and sisters across groups

	Brothers			Sisters		
	Average number of same-sex attracted sibling	Number of same-sex attracted/total number (%)	Odds ratio (95% confidence interval)	Average of same-sex attracted sibling	Number of same-sex attracted/total number (%)	Odds ratio (95% confidence interval)
Cisgender gynephilic males (n = 258)	0.019 ± 0.164	5/255 (1.96%)	Reference odd for males	0.008 ± 0.088	2/255 (0.78%)	Reference odd for females
Cisgender ambiphilic males (n = 106)	0.019 ± 0.137	2/118 (1.69%)	0.86 (0.16, 4.51)	0.028 ± 0.167	3/105 (2.86%)	3.72 (0.61, 22.60)
Cisgender androphilic males (n = 315)	0.022 ± 0.148	7/301 (2.32%)	1.19 (0.37, 3.80)	0.016 ± 0.125	5/337 (1.48%)	1.90 (0.37, 9.90)
Transgender androphilic males (n = 104)	0.058 ± 0.306	6/125 (4.80%)	2.52 (0.75, 8.43)	0.038 ± 0.238	4/109 (3.67%)	4.82 (0.87, 26.71)
Cisgender androphilic females (n = 251)	0.012 ± 0.109	3/249 (1.20%)	Reference odd for females	0.016 ± 0.125	4/239 (1.67%)	Reference odd for females
Cisgender ambiphilic females (n = 97)	0.010 ± 0.101	1/72 (1.39%)	1.15 (0.12, 11.27)	0.093 ± 0.325	9/84 (10.71%)	7.05 (2.11, 23.55)
Cisgender gynephilic females (n = 32)	0.000 ± 0.000	0/34 (0.00%)	1.02 (0.05, 20.19)	0.031 ± 0.177	1/19 (5.26%)	3.26 (0.35, 30.75)
Transgender gynephilic females (n = 123)	0.008 ± 0.090	1/151 (0.66%)	0.55 (0.06, 5.30)	0.057 ± 0.265	7/166 (4.22%)	2.62 (0.75, 9.10)

0.001), but not for maternal male kin ($\chi^2[3] = 5.52$, $p = 0.137$), paternal male kin ($\chi^2[3] = 1.20$, $p = 0.754$), paternal female kin ($\chi^2[3] = 0.74$, $p = 0.864$), nieces ($\chi^2[3] = 1.20$, $p = 0.753$), or nephews (Chi square could not be performed as no female participants reported having a same-sex attracted nephew). The pairwise comparison showed that a significantly higher proportions of cisgender gynephilic females and cisgender ambiphilic females reported having a same-sex attracted maternal female relative compared to cisgender androphilic females ($Z = 3.65$, $p < 0.001$; $Z = 4.25$, $p < 0.001$, respectively) and transgender gynephilic females ($Z = 2.61$, $p = 0.009$; $Z = 2.94$, $p = 0.003$, respectively). No other pairwise comparison reached statistical significance.

As illustrated in Table 7-3, males with exclusive androphilic sexual attraction were 2.48 times more likely to have at least one same-sex attracted male kin and 2.71 times more likely to have a same-sex attracted female kin compared to exclusively gynephilic males. Although exclusively gynephilic females were more likely to reported having at least one same-sex attracted relative (male or female) compared to exclusively androphilic females, the 95% confidence intervals for odds ratios covered a wide range including values ≤1.0 and thus were statistically nonsignificant.

A pattern evident in Table 7-1 and 7-2 was that male participants more frequently reported having a male same-sex attracted kin, whereas female participants more frequently reported having a female same-sex attracted kin. Across the sample, 20.5% (156/762) of males reported having at least one male kin member who was same-sex attracted compared to 4.9% (24/485) of females (Wald H0 $Z = 7.60$, $SE = 0.018$, $p < 0.001$). Conversely, 17.0% (82/482) of females reported having at least one female kin member who was same-sex attracted compared to 9.8% (74/756) of male participants (Wald H0 $Z = 3.73$, $SE = 0.020$, $p < 0.001$). We also

Table 7-2 Proportions of participants reporting having at least one same-sex attracted relative across groups

	Cisgender Gynephilic Males	Cisgender Ambiphilic Males	Cisgender Androphilic Males	Transgender Androphilic Males	Cisgender Androphilic Females	Cisgender Ambiphilic Females	Cisgender Gynephilic Females	Transgender Gyenphilic Females
Ratio of participants who had any same-sex attracted:								
Nephew(s)	0.4% (1/224)	1.1% (1/92)	1.1% (3/285)	0.0% (0/91)	0.0% (0/201)	0.0% (0/90)	0.0% (0/30)	0.0% (0/121)
Niece(s)	0.4% (1/224)	2.1% (2/94)	1.1% (3/285)	0.0% (0/92)	0.5% (1/201)	0.0% (0/90)	0.0% (0/30)	0.0% (0/121)
Maternal male kin(s)	8.9% (20/224)	11.7% (11/94)	23.2% (66/285)	15.1% (14/93)	1.0% (2/204)	4.4% (4/90)	6.7% (2/30)	2.5% (3/121)
Paternal male kin(s)	6.7% (15/224)	6.4% (6/94)	16.1% (46/285)	11.8% (11/93)	2.4% (5/205)	3.3% (3/90)	0.0% (0/30)	3.3% (4/121)
Maternal female kin(s)	3.6% (8/224)	5.3% (5/94)	6.3% (18/285)	8.6% (8/93)	3.9% (8/204)	20.0% (18/90)	23.3% (7/30)	5.8% (7/121)
Paternal female kin(s)	1.3% (3/224)	2.1% (2/94)	5.3% (15/285)	6.5% (6/92)	6.4% (13/203)	5.6% (5/90)	10.0% (3/30)	6.6% (8/121)

observed another sex difference, namely, in males having a same-sex attracted male kin was correlated with having a same-sex attracted female kin (Pearson $\chi^2 = 29.00$, Phi coefficient = 0.20, $p < 0.001$), whereas in females, no such correlation existed (Pearson $\chi^2 = 0.25$, Phi coefficient = 0.02, $p = 0.615$). These patterns did not change when data pertaining to other- and same-sex attracted males and females were investigated separately. There were significant correlations for cisgender gynephilic males (Pearson $\chi^2 = 4.68$, Phi coefficient = 0.14, $p = 0.031$) and cisgender and transgender androphilic males (Pearson $\chi^2 = 12.80$, Phi coefficient = 0.18, $p < 0.001$), but nonsignificant correlations for cisgender androphilic females (Pearson $\chi^2 = 0.00$, Phi coefficient = 0.00, $p = 0.967$) and cisgender and transgender gynephilic females (Pearson $\chi^2 = 0.30$, Phi coefficient = 0.04, $p = 0.582$).

Table 7-3 Proportions and odds ratios of having at least one-same sex attracted kin in exclusively same-sex attracted participants

	Males		Females	
	Exclusive gynephilic	Exclusive androphilic	Exclusive androphilic	Exclusive gynephilic
Proportion of participants who had at least one male same-sex attracted kin	10.5% (21/200)	26.0% (83/319)	2.4% (4/169)	4.8% (6/125)
odds ratio	odds ratio = 2.48 (1.49, 4.13), z = 3.48, p < 0.001		odds ratio = 2.08 (0.57, 7.53), z = 1.11, p = 0.265	
Proportion of participants who had at least one female same-sex attracted kin	5.1% (10/198)	12.0% (38/316)	8.9% (15/168)	14.5% (18/124)
Difference in proportion and odds ratio	odds ratio = 2.71 (1.32, 5.56), z = 2.71, p = 0.007		odds ratio = 1.73 (0.83, 3.59), z = 1.48, p = 0.139	

Reproductive Output

In male participants, the average number of offspring produced (Table 7-4) was higher in cisgender gynephilic males (Mean = 0.101, Standard deviation = 0.398) compared to cisgender ambiphilic males (M = 0.018, SD = 0.135), cisgender androphilic males (M = 0.003, SD = 0.056), and transgender androphilic males (M = 0.000, SD = 0.000). Due to skewed distributions not passing normality tests, a non-parametric independent samples Kruskal-Wallis *H* test was performed which revealed a significant effect of group on offspring production ($\chi^2[3] = 29.62$, $p < 0.001$). Pairwise comparisons adjusted by the Bonferroni correction for multiple tests showed that offspring production for cisgender gynephilic males was significantly higher than that of cisgender androphilic males ($p < 0.001$), transgender androphilic males ($p = 0.001$), and cisgender ambiphilic males ($p = 0.026$).

To compare exclusive gynephilia and androphilia in males, the number of offspring produced by participants with Kinsey scores 0 versus 6 were compared using a non-parametric Mann-Whitney *U* test. Exclusive androphilic males (Kinsey 6s) had significantly fewer of offspring compared to exclusive gynephilic males (Kinsey 0s): $U = 32670.00$, $z = -5.18$, $p < 0.001$. To inspect the effect of age differences between the two groups, and considering that our participants were relatively young, we limited the analysis to those who were ≥ 30 years old. Similar results were found with this analysis as the number of offspring produced by exclusively androphilic males (n = 75, M = 0.000, SD = 0.000) was significantly lower than exclusively gynephilic males (n = 66, M = 0.318, SD = 0.683): $U = 1950.00$, $z = -4.18$, $p < 0.001$.

In female participants, the average number of offspring produced (Table 7-5) was higher in cisgender androphilic females (M = 0.152, SD = 0.465) compared to cisgender ambiphilic

Table 7-4 Offspring production and demographic information in male participants

	Age*	Education	Financial status	No. of participants having offspring (%)	No. of offspring
Cisgender gynephilic males (n = 268)	27.27 ± 6.72	3.58 ± 1.17	3.26 ± 0.69	19 (7.1%)	27
Cisgender ambiphilic males (n = 109)	24.55 ± 5.01	3.11 ± 1.15	3.04 ± 0.73	2 (1.8%)	2
Cisgender androphilic males (n = 323)	26.62 ± 6.21	3.44 ± 1.17	3.05 ± 0.77	1 (0.3%)	1
Transgender androphilic males (n = 104)	23.96 ± 4.57	2.80 ± 1.10	2.84 ± 0.88	0 (0.0%)	0
Exclusive gynephilic males (n = 215)	27.49 ± 7.04	3.63 ± 1.18	3.23 ± 0.66	17 (7.9%)	24
Exclusive androphilic males (n = 330)	25.81 ± 6.03	3.24 ± 1.20	3.02 ± 0.81	0 (0.0%)	0

* There were few missing data points for age: cisgender gynephilic males (n = 5), cisgender ambiphilic males (n = 3), cisgender androphilic males (n = 5), transgender androphilic males (n = 1), exclusive gynephilic males (n = 4), exclusive androphilic males (n = 5).

females (M = 0.076, SD = 0.415), cisgender gynephilic females (M = 0.016, SD = 0.126), and transgender gynephilic females (M = 0.019, SD = 0.163).Due to skewed distributions not passing normality tests, a non-parametric independent samples Kruskal-Wallis *H* test was performed which revealed a significant effect of group on numbers of offspring produced ($\chi^2[3] = 26.47$, $p < 0.001$). Pairwise comparisons adjusted by the Bonferroni correction for multiple tests showed that offspring production for cisgender androphilic females was significantly higher than cisgender gynephilic females ($p = 0.017$), transgender gynephilic females ($p < 0.001$), and cisgender ambiphilic females ($p = 0.037$).

To compare exclusive gynephilia and androphilia in females, the number of offspring produced by participants with Kinsey scores 0 and 6 were compared using a non-parametric Mann-Whitney *U* test. Exclusively gynephilic females (Kinsey 0s) had significantly lower numbers of offspring compared to exclusive androphilic females (Kinsey 6s): $U = 29503.50$, $z = -4.69$, $p < 0.001$. Similar results were found when the analysis was limited to those who were ≥ 30 years old, as exclusively gynephilic females (n = 31, M = 0.097, SD = 0.396) had fewer offsprings than exclusively androphilic females (n = 52, M = 0.538, SD = 0.779): $U = 1048.00$, $z = -2.99$, $p = 0.003$.

DISCUSSION

In this study, we found evidence for familial clustering of same-sex attraction. In male participants, higher proportions of cisgender androphilic males compared to cisgender gynephilic males reported having at least one same-sex attracted uncle or male cousin on both the paternal and maternal sides of their families. This finding was consistent with reports on cisgender (gay) androphilic males from the USA (Bailey et al., 1999; Schwartz et al., 2010), third gender

Table 7-5 Offspring production and demographic information in female participants

	Age	Education	Financial status	No. of participants having children (%)	No. of children
Cisgender androphilic females (n = 276)	26.83 ± 6.61	3.68 ± 1.06	3.36 ± 0.68	31 (11.2%)	42
Cisgender ambiphilic females (n = 119)	24.06 ± 5.03	3.28 ± 1.14	3.33 ± 0.75	5 (4.2%)	9
Cisgender gynephilic females (n = 63)	23.03 ± 4.71	3.03 ± 1.12	3.43 ± 0.69	1 (1.6%)	1
Transgender gynephilic females (n = 260)	23.91 ± 4.60	2.96 ± 1.11	3.00 ± 0.73	4 (1.5%)	5
Exclusive androphilic females (n = 194)	27.12 ± 6.82	3.69 ± 1.06	3.38 ± 0.70	24 (12.4%)	35
Exclusive gynephilic females (n = 275)	23.87 ± 4.77	2.98 ± 1.13	3.01 ± 0.72	5 (1.8%)	6

* Overall, 14 data points were missing: cisgender androphilic females (n = 6), cisgender gynephilic females (n = 2), and transgender gynephilic females (n = 5), exclusive androphilic females (n = 6), and exclusive gynephilic females (n = 6)

androphilic males from Samoa (*fa'afafine*) who present in a largely feminine/transgender manner (Semenyna et al., 2017a; VanderLaan et al., 2013a, 2013b). In contrast, other research conducted in Western countries has found evidence for familial clustering of male androphilic in the maternal line, but not the paternal line (Hamer et al., 1993; Camperio Ciani et al., 2004; Rahman et al., 2008). Conversely, a study of Istmo Zapotec third gender males (*muxes*) who presented in both a feminine/transgender manner (*muxe gunaa*) and a more cisgender (*muxe nguiiu*) manner, found evidence for familial clustering of male androphilic in the paternal line, but not the maternal line (Gómez et al., 2018). When all the categories of first and second degree male relatives were combined, we found that exclusively androphilic males, regardless of whether they were cisgender or transgender, were 2.48 times more likely to report having a same-sex attracted male relative compared to exclusively cisgender gynephilic males.

Furthermore, higher proportions of both cisgender and transgender androphilic males reported having a same-sex attracted aunt or female cousin on the paternal side of their families (Table 7-2). To the best of our knowledge, this is the first study reporting on a preponderance of second-degree same-sex attracted female relatives in androphilic males versus gynephilic controls. Hence, we cannot assess this result in the context of existing literature. However, previous studies have shown cisgender androphilic males are more likely to have same-sex attracted sisters (Bailey et al., 1999), which is partially consistent with our results as both cisgender and transgender androphilic males had elevated, but nonsignificant, odds ratios for having a same-sex attracted sister. We also found that exclusively androphilic cisgender and transgender males (Kinsey 6s) were 2.71 times more likely to report having a same-sex attracted first or second degree female relative compared to exclusively cisgender gynephilic males (Kinsey 0s; Table 7-3). Additionally, a modest correlation was observed in both androphilic and

gynephilic male participants between having a male and a female same-sex attracted relative. This finding is consistent with a previous molecular genetic study that reported partially distinct genetic factors underlying male versus female same-sex sexual orientation (Ganna et al., 2019).

In comparison to cisgender androphilic females, cisgender ambiphilic females had more same-sex attracted sisters. In contrast to previous studies (e.g., Bailey & Bell, 1993; Pattatucci & Hamer, 1995), we did not find a significant increase in the likelihood of having a same-sex attracted sister or brother in cisgender or transgender gynephilic females. A higher proportion of cisgender ambiphilic and gynephilic females had at least one same-sex attracted aunt or female cousin on the maternal side of their families. These results differ from previous studies which found that both cisgender ambiphilic and gynephilic females had higher ratios of same-sex attracted female relatives on the paternal (Pattatucci & Hamer, 1995) or both maternal *and* paternal sides of their families compared to cisgender androphilic females (Camperio Ciani et al., 2018). Transgender gynephilic females and cisgender androphilic females in our sample did not differ in their reporting of same-sex attracted female or male relatives. When exclusively gynephilic cisgender and transgender females (Kinsey 0s) were compared with exclusively androphilic cisgender females (Kinsey 6s), the odds ratios for having a same-sex attracted male or female relative were not significantly increased (Table 7-3). This nonsignificant finding could be due to the smaller number of cisgender gynephilic females we were able to recruit compared to the much larger number of transgender gynephilic females. In sum, these findings from Iran, a Middle Eastern country, contributes to existing evidence for the familial clustering of same-sex sexual attraction and are consistent with the conclusion that genetic factors play a role in expression of male androphilia and female gynephilia (Bailey et al., 2016; Felesina & Zietsch, 2025).

As part of this study, we also investigated the reproductive output of Iranian cisgender and transgender males and females who varied in their degree of same-sex attraction. As expected, and consistent with reports from Western (e.g., Apostolou, 2022; Bell & Weinberg, 1978; Ciani et al., 2009; Fořt et al., 2024a, 2025; King et al., 2005; Schwartz et al., 2010) and non-Western countries (e.g., Coome et al., 2020; Nila et al., 2018; Vasey et al., 2014), we found that both cisgender and transgender male androphiles had fewer offspring compared to cisgender gynephilic males. This was also in line with a previous report from Iran (Besharat et al., 2016), however, the reproductive output of androphilic males was much lower in our sample. Besharat et al. (2016) reported that the average number of children was 1.7 in a subsample of cisgender males who were androphilic (Kinsey 5 or 6) and older than 40 years old (n = 27). While only 10 cisgender androphilic males in our sample were older than 40 years, none of them had any offspring. Further, the reproductive output of ambiphilic males in our sample was intermediate between that of gynephilic and androphilic males, although the difference was only significant in comparison to the former group. The lower reproductive output observed in ambiphilic males was consistent with previous reports from other countries (Apostolou, 2022; Ciani et al., 2009).

In females, both cisgender and transgender gynephilic participants had lower numbers of offspring compared to cisgender androphilic females, a pattern that is consistent with previous reports in Western (e.g., Apostolou, 2022; Bell & Weinberg, 1978; Camperio Ciani et al., 2018; Fořt et al., 2024a; Fořt et al., 2025) and non-Western countries (Coome et al., 2020). In addition, the reproductive output of ambiphilic females was significantly lower than that of cisgender androphilic females, a pattern that is also consistent with previous Western studies (Apostolou, 2022; Camperio Ciani et al., 2018) and non-Western (Coome et al., 2020) studies. In sum, monosexual and ambisexual same-sex attraction in both cisgender and transgender males and

females was associated with lower offspring production when compared to cisgender indivdiuals who were exclusively heterosexual.

In addition to these findings, we also observed a sex difference in reproductive output. The frequency with which cisgender and transgender gynephilic females had a child (1.5%) was approximately 7.5 times higher than that of cisgender and transgender androphilic males (0.2%) (see Tables 7-4 and 7-5). This observation matched previous Western and non-Western studies reporting zero (Study 1 in Apostolou, 2022; Ciani et al., 2009; Coome et al., 2020; Vasey et al., 2014) or near zero (Study 2 in Apostolou, 2022; King et al., 2005; cf. Fořt et al., 2024a, 2025) reproductive output in androphilic males, but invariably higher than zero reproductive output for gynephilic females (Apostolou, 2022; Campero Ciani et al., 2018; Coome et al., 2020; Fořt et al., 2024a, 2025). This discrepancy between androphilic males and gynephilic females may reflect sex difference in sexual fluidity, as female sexual attraction is thought to be more dependent on prevailing socio-cultural contexts (Bailey et al., 2016). With respect to the Iranian socio-cultural context, sex difference exist for age at marriage, with a relatively high prevalence of arranged early marriages for females, some of whom can be as young as 13 years old (Torabi & and Bagi, 2024). This cultural practice may have contributed to the higher reprodcutive rates observed among cisgender and transgender gynephilic females compared to cisgender and transgender androphilic males. However, we were not able to test this possibility using exisiting data.

Another relevant socio-cultural feature of contemporary Iran is the country's rigid and intolerant sentiments regarding sexuality and gender, which has been reinforced by the Islamic Republic since its establishment in 1979 (Korycki & Nasirzadeh, 2013). Iran is among the few countries worldwide that considers same-sex sexual behaviour punishable by death (Amnesty International, 1996; Jaspal, 2016). Consequently, same-sex attracted individuals are challenged

for their sexuality within their own social circles (e.g., family, peers, etc.), as well as at the broader social level where they face the risk of prosecution by the state. These social constrains may delay sexual orientation awareness and acceptance, thus facilitating heterosexual marriage by same-sex oriented individuals. Consistent with this possibility, a previous study on Iranian cisgender androphilic males found that ~22% of the sample (n = 258) were currently or previously married (Besharat et al., 2016).

Marriage by same-sex attracted individuals has been documented in other non-Western cultures that are relatively intolerant of same-sex sexuality. In China, it is suggested that up to 80% of androphilic males (also known as *tongzhi*) enter heterosexual marriages in their lifetime (Original Tang, 2018, as cited in Song et al., 2023). In Sub-Saharan Africa, a recent meta-analysis on males who engage in same-sex sexual behaviour found that up to 34% were married during their lifetime (Fiorentino et al., 2025). One of the common reasons reported for marriage or the formation of stable partnerships with females was desire to conform to social and religious norms (Fiorentino et al., 2025). Even in relatively liberal Western societies, some same-sex attracted males and females enter into heterosexual marriages before coming out (Carneiro et al., 2017; Clarke & Earley, 2021; Costa & Bidell, 2017; Gates, 2015; Giunti & Fioravanti, 2017).

In the US, it is estimated that up to 37% of individuals identifying as lesbian, gay, bisexual, or transgender (i.e., LGBT) have become parents, mostly through partnerships or marriages with other-sex individuals (Gates, 2015). This outcome seems to be more probable in communities that are intolerant of same-sex sexuality (for the inverse situation in tolerant societies, see Coome et al., 2020). Hence, future studies in Iran or the Middle East may benefit from recruiting older monosexual and ambisexual same-sex attracted males and females who

experienced even more intolerant social condition compared to younger generations (Mahdavi, 2007).

Also, same-sex attracted individuals may plausibly produce offspring in same-sex marriages and partnerships as same-sex unions are increasingly legalized around the world (Pew Research Center, 2024). However, existing data from two national surveys in the US suggest the rates of having any children (i.e., biological or adopted) in same-sex marriages/partnerships is about one third of that of other-sex marriages and partnerships (Manning et al., 2022). As mentioned earlier, same-sex sexual behaviour is criminalized under the Islamic Republic of Iran, and thus, offspring production in same-sex unions does not seem relevant to our sample of Iranian same-sex attracted individuals (Amnesty International, 1996; Jaspal, 2016).

Limitations

Our recruitment method may raise concerns about the degree to which it provided a representative sample. For instance, our participants were, generally speaking, young, educated, and had a relatively good economic status. This particular biodemographic profile was perhaps owing to the fact that most of our participants were recruited in Tehran and Mashhad, Iran's two largest metropolitan areas, using networking sampling method by two local researchers. In addition, the number of participants recruited in different groups were unequal and sometimes quite small, especially for cisgender gynephilic females. Consequently, for some analyses, in particular, categorical analyses, we had less than optimal statistical power which weakened confidence in the results. Future studies would benefit from using larger, more representative samples. Also, the observed differences in reproductive output might have been different in magnitude if an older sample was recruited.

Unlike previous family studies on same-sex sexual orientation, we did not ask participants to report their total numbers of relatives, nor did we ask them to report their number of same-sex attracted relatives in different kinship categories. Therefore, we could not test evolutionary and genetic hypotheses about same-sex sexual orientation like those that have been previously conducted (e.g., Gómez et al., 2018; Semenyna et al., 2017a). Rather, participants were asked if they had any same-sex attracted relative across different kinship categories. This approach was influenced by our initial skepticism about the extent our participants would have access to information about the sexual orientation of their relatives, considering that open discussion about these issues has not been the norm in Iran. In support of this idea, the concordence observed between participants' sex and that of their same-sex attracted relatives (i.e., males reporting more male same-sex attracted kin and females reporting more female same-sex attracted kin) suggests that participants' sex limited their knowledge about the sexuality of opposite-sex relatives.

Conclusions

This study conducted in Iran, a Middle Eastern country, provided empirical evidence that same-sex attracted individuals were more likely to have same-sex attracted kin. Compared to cisgender gynephilic males, both cisgender and transgender male androphiles were significantly more likely to have at least one same-sex attracted male or female relative. In addition, compared to cisgender androphilic females, both cisgender ambiphilic and gynephilic females were significantly more likely to have at least one same-sex attracted female relative on their mother side of their families. Furthermore, our results indicated lowered reproductive output in both monosexual and ambisexual same-sex attracted males and females, regardless of whether they

were cisgender and transgender. Despite its limitations, this study added to sparce cross-cultural evidence on familial clustering and reproductive output in same-sex attracted individuals.

Chapter 8: General Summary and Discussion

In this thesis, I examined variations in childhood sex-typed play behaviour, adulthood occupational preferences, childhood separation anxiety, hand preference, sibship composition, familial clustering, and reproductive output in relation to sex, sexual orientation, and gender identity/expression in an Iranian sample. My first objective was to *investigate normative developmental features of female gynephilia*. My second objective was to *compare developmental psychobiology of cisgender and transgender gynephilic females*. My third objective was to *replicate cross-cultural correlates of male androphilia and provide a comparison between cisgender and transgender androphilic males within the same culture*. To address these objectives, data collected from eight groups of participants including cisgender gynephilic males, cisgender ambiphilic males, cisgender androphilic males, transgender androphilic males, cisgender androphilic females, cisgender ambiphilic females, cisgender gynephilic females, and transgender gynephilic females were analyzed and findings were presented in six empirical chapters of this thesis (Chapters 2-7).

As reported in Chapters 2-5, the expected sex differences in childhood play behaviour, adulthood occupational preferences, childhood separation anxiety, and hand preference were replicated in the Iranian sample. The cisgender gynephilic males displayed patterns of play behaviour (i.e., playing with boys, preferring vehicles and guns, frequently engaging in rough and tumble play, and taking the male roles during pretend play), occupational preferences (i.e., higher interest in "thing-oriented" vocations like car mechanic, truck driver, etc.), separation anxiety (i.e., lower recalled separation anxiety), and hand preference (i.e., lower strength or higher variability in preferring one hand over the other) that can be considered "male-typical" given the overwhelming predominance of these males in the population.

Conversely, cisgender androphilic females exhibited different patterns of play behaviour (i.e., playing with girls, preferring dolls, aversion to rough and tumble play, and taking the female roles during pretend play; Chapter 2), occupational preferences (i.e., higher interest in "people-oriented" vocations like school teacher, nurse, etc.; Chapter 3), separation anxiety (i.e., higher recalled separation anxiety; Chapter 4), and hand preference (i.e., greater strength or lower variability in hand preference; Chapter 5) that can be considered "female-typical" given the overwhelming predominance of these females in the population. Successful replication of previously documented sex differences vis-à-vis these traits provides further support for the conclusion that they are influenced by sexually differentiated developmental processses that are cross-culturally universal. These sex differences provided a foundation for interpreting the developmental patterns associated with variation in sexual orientation and gender identity/expression.

With respect to female sexual orientation, both cisgender and transgender gynephilic females exhibited sex-atypical childhood play behaviour and adulthood occupational preferences. The cisgender group were shifted toward male-typical patterns, scoring intermediate between cisgender androphilic females and cisgender gynephilic males. The transgender group were more male-typical in these traits, exhibiting sex-reveresed patterns. Further, cisgender ambiphilic females were more sex-atypical compared to cisgender androphilic females, both in their childhood play behaviour and adulthood occupational preferences (Chapters 2-3). In relation to childhood separation anxiety and hand preference, significant male-shifted patterns were found only for transgender gynephilic females, although cisgender gynephilic females showed trends toward male-typical patterns as well (Chapters 4-5). Overall, these findings showed that same-sex sexual attraction and transgender identity/expression in females were

associated with male-shifted patterns in all of the sexually dimorphic traits that were explored. In line with my first and second objectives, studies reported in Chapters 2-5 garnered evidence for the presence of a developmental pattern in cisgender and transgender same-sex attracted females which is characterized by varying degrees of masculinization. This pattern appears to be cross-culturally universal (e.g., Bailey & Zucker, 1995; Gómez Jiménez et al., 2025; Lippa, 2008b; Whitam & Mathy, 1991). Furthermore, although sex-atypical, this masculine developmental pattern could be described as normative for same-sex attracted females.

With respect to male same-sex sexual attraction, both cisgender and transgender androphilic males exhibited sex-atypicality in their childhood play behaviour and adulthood occupational preferences. While cisgender androphilic males were shifted toward female-typical patterns scoring intermediate between cisgender gynephilic males and cisgender androphilic females, transgender androphilic males showed sex-reversed patterns that were similar to cisgender androphilic females. In addition, cisgender ambiphilic males were more sex-atypical in both of these traits compared to cisgender gynephilic males (Chapters 2-3). Childhood separation anxiety was significantly shifted toward a female-typical pattern in cisgender and transgender androphilic males, but not cisgender ambiphilic males (Chapter 4). No significant association was found between androphilic and ambiphilic males and hand preference (Chapter 5). In sum, male same-sex sexual attraction and transgender identity/expression was associated with female-shifted patterns in three out of four explored sexually dimorphic traits (e.g., childhood play behaviour, childhood separation anxiety, and adulthood occupational preferences). In line with the third objective of this thesis, studies reported in Chapters 2-4, but not Chapter 5, supported the conclusion that the development of cisgender and transgender same-sex attracted males involves varying degrees of feminization. This pattern appears to be cross-culturally universal

(e.g., Bailey & Zucker, 1995; Cardoso, 2009; Gómez Jiménez et al., 2025; Lippa, 2008b; Whitam & Mathy, 1986). Furthermore, although sex-atypical, this feminine developmental pattern could be described as normative among same-sex attracted males.

In addition to the sexually dimorphic traits reported in Chapters 2-5, I investigated if sibship composition was related to development of female same-sex sexual attraction, the results of which were presented in Chapter 6. The analyses revealed that among female participants, having more older sisters was significantly associated with being a transgender gynephilic female, providing support for a sororal birth order effect in this group. Although data for cisgender gynephilic females were nonsignificant, they showed a trend for both fraternal and sororal birth order effects. In line with first and second objectives of this thesis, the data I presented demonstrated that sibship composition was associated with female gynephilia, particularly, with the relatively more masculine transgender group.

In male participants, a fraternal birth order effect was associated with being a cisgender androphilic male, a transgender androphilic male, and a cisgender ambiphilic male, while a sororal birth order effect was found to be correlated with being a cisgender androphilic male. Finding a FBOE in transgender androphilic males was consistent with a previous report from Iran (Khorashad et al., 2020). To the best of my knowledge, no previous report on the sibship order of Iranian cisgender androphilic and ambiphilic males exist. Thus, further research is needed, preferably with even larger sample sizes, to assess the generalizability of our findings in relation to Iranian population. These results expanded the cross-cultural evidence of sibship order effect on male androphilia, fulfilling the third objective of this thesis.

In Chapter 7, I reported data for the familial clustering of same-sex sexual attraction. It was shown that both cisgender ambiphilic and gynephilic females were significantly more likely

to have at least one same-sex attracted female relative on their mother side of their families compared to cisgender androphilic females. In line with the first objective of this thesis, this evidence is consistent with a role for genetic factors in development of female same-sex sexual attraction. However, contrary to my expectation of finding similarities in the development of cisgender and transgender gynephilic females, data did not show familial clustering in the former group. As discussed in Chapter 7, this discrepant finding might be due to methodological limitations such as small number of cisgender gynephilic females that I was able to recruit. Also, some participants, particularly transgender ones, might not have recognized their transgender relatives as same-sex attracted considering that these individuals identify as members of the other sex. This may have biased their reporting. In addition, the "same-sex attracted" category might have been interpreted too broadly (i.e., including incidental same-sex interactions) by some groups such as cisgender androphilic females, and thus, resulted in an overestimation of same-sex attracted relatives in those groups. Further research using larger sample sizes, and perhaps more nuanced questioning, is needed to address these possibilities.

In line with my third objective, both cisgender and transgender male androphiles were significantly more likely to have at least one same-sex attracted male or female relative compared to cisgender gynephilic males. These findings expanded existing cross-cultural knowledge pertaining to familial clustering of male androphilia (reviewed in Chapter 7).

Finally, number of offsprings were reported and compared in Chapter 7. For females, the results indicated lowered reproductive output in cisgender ambiphilic females, cisgender gynephilic females, and transgender gynephilic females compared to cisgender androphilic females. A similar result was found for males as cisgender ambiphilic males, cisgender androphilic males, and transgender androphilic males had lower numbers of offsprings compared

cisgender gynephilic males. These findings remind us that same-sex sexual orientation remains an evolutionary puzzle—despite evidence of its universal expression and development, it is associated with reduced reproductive output.

Development of Human Sexual Orientation and Future Directions

The observed male-shifted traits in gynephilic females and female-shifted traits in androphilic males suggest a role for sexually dimorphic developmental mechanisms. A candidate mechanism is sex-atypical early life exposure to sex hormones which result in sex-atypical brain development (Arnold, 2009; Hines, 2008, 2010; Hines et al., 2015). Evidence from human studies on the role of sex hormones in development of sex and sexual orientation differences in psychology and behaviour are correlational, and in all likelihood, future research on this topic will remain correlational as well. However, converging evidence from rodent and primate experimental research has shown the casaul effects of prenatal androgens or estrogen metabolites on sexual behaviour and sexual partner preference (Balthazart, 2012, 2020; Wallen, 1996; Wallen et al., 2022). A refined correlational approach to assessing the role of sex hormones involves measuring sexually differentiated physical/physiological traits which are indirect biomarkers of prenatal sex hormones. Examples include second to fourth digits length ratio (2D:4D) and otoacoustic emissions, both of which correlate with prenatal sex hormones in humans (e.g., McFadden, 2017; Swift-Gallant et al., 2022b). Animal research also supports the casaul relationship between these traits and sex steroid hormone exposure prenataly (McFadden, 2008; Zheng & Cohn, 2011). It is highly improbable that these physical/phyisiological traits are influenced by social factors, therefore, investigating their correlations with the traits measured in this thesis could provided a more confident and comprehensive picture of the role hormones play

in development of sexual orientation and gender identity/presentation (Swift-Gallant & Breedlove, 2025).

Genetic mechanisms could also explain the observed shifts in masculinity and femininity seen in gynephilic females and androphilic males, respectively. Studies indicate the existence of a genetic component for male and female sexual orientation (e.g., Bailey & Bell, 1993; Bailey et al., 2000; Burri et al., 2015), childhood play behaviour (e.g., Alanko et al., 2010; Burri et al., 2011), adulthood occupational preferences (e.g., Betsworth et al., 1994), childhood separation anxiety (Scaini et al., 2012), and hand preference (e.g., Medland et al., 2009). In line with previous cross-cultural studies (Camperio Ciani et al., 2018; Gómez et al., 2018; Semenyna et al., 2017a; VanderLaan et al., 2013a, 2013b), evidence presented in this dissertation supports the conclusion that male and female same-sex sexual attraction cluster within families of same-sex attracted individuals. These patterns are consistent with the conclusion that genetic factors influence sexual orientation. However, it remains unknown as to whether shared genes underly the observed correlations between male and female sexual orientations and childhood play behaviour, adulthood occupational preferences, childhood separation anxiety, and hand preference. Unfortunately, conducting twin studies or large-scale molecular genetic studies does not seem feasible considering the sociopolitial context of Iran, which limits the capacity of future research in addressing the genetic factor underlying observed patterns in relation to sex, sexual orientation, and gender identity/expression.

In addition to genetic and hormonal factors, evidence suggests that immunological factors play a role in development of male androphilia. This is supported by a robustly replicated correlation between number of older brothers and male androphilia, which has been explained in terms of the maternal immune hypothesis (Blanchard & Klassen, 1997). However, emerging

evidence of a correlation between number of older sisters and male sexual orientation (e.g., Ablaza et al., 2022), and correlations between number of older brothers and older sisters with female sexual orientation (e.g., Ablaza et al., 2022), have challenged the maternal immune hypothesis, or at the very least, highlight how its explanatory value may be limited. Evidence presented in this thesis contributed to emerging empirical evidence on these additional correlations helping to pave the way for future theoretical research on this topic.

Although evidence supports different factors playing a role in development of sexual orientation, it also shows that no single factor, in isolation, can fully explain its development. For instance, fraternal birth order effect has been estimated to account for sexual orientation of about 29% of cisgender androphilic males (Blanchard & Bogaert, 2004). A rarely investigated question in development of sexual orientation is how the underlying genetic, hormonal, and immunological factors interact with each other (VanderLaan et al., 2022). One possibility is that they influence the development of sexual orientation in an independent or orthogonal manner (Balthazart & Roselli, 2022). In other words, different developmental pathways could result in same-sex sexual attraction, and thus, different same-sex attracted individuals may owe their sexual orientation to the action of different factors. In recent years, two studies have investigated this matter. Using latent profile analysis, Swift-Gallant et al. (2019) found separate categories of androphilic males in relation to fraternal birth order, handedness, and familiality, and a fourth category with none of these markers. In another latent profile analysis of correlates of male androphilia including 2D:4D ratios and childhood sex-typed behaviour, Folkierska-Żukowska and Dragan (2024) found six different categories which supported “at least partially independent” biodevelopmental pathways underly development of male sexual orientation.

Yet another possibility is that developmental factors may have an additive effect (Balthazart & Roselli, 2022). Possible evidence in support of this additive effect include the fact that some correlates of male androphilia cluster in certain subgroups of androphilic males. Transgender androphilic males who are more sex-atypical in their childhood play behaviour (Chapter 2), show a greater fraternal birth order effect (Blanchard, 2018a), and a female-shifted 2D:4D ratio (Sadr et al., 2020). Similarly, cisgender androphilic males who prefer a receptive role in anal sex (bottoms) are more sex-atypical in their childhood and adulthood behaviour (Swift-Gallant et al., 2018), display a greater fraternal birth order (Swift-Gallant et al., 2018), and have a feminized 2D:4D ratio (Swift-Gallant et al., 2022b) compared to those who prefer insertive role (tops).

Other research on different expressions of female gynephilia such as butch versus femme lesbians, suggests that these subgroups may owe their sexual orientation to distinct independent mechanisms (Swift-Gallant et al., 2022b). For instance, compared to femmes, butch lesbians recall more masculine childhood behaviour (Zheng & Zheng, 2016), perform better on visuospatial tasks (Zheng et al., 2018), and have more masculine 2D:4D ratios (Brown et al., 2002). Evidence for the differences and similarities between cisgender and transgender gynephilic females are mixed. While transgender gynephilic females are more sex-atypical (Chapter 2), two meta-analyses of 2D:4D ratio in gender dysphoric females have not found that they exhibit masculinized pattern (Sadr et al., 2020; Siegmann et al., 2020), despite the evidence supporting a masculinized 2D:4D in cisgender gynephilic females (Grimbos et al., 2010). In addition, to the best of my knowledge, no published study has similtanously investigated the relation between different correlates of female gynephilia.

Apart from biological factors, it is conceivable that social and cultural factors also help to explain the observed variation in psychology and behaviour of androphilic males and gynephilic females. However, hypotheses that reject biological influence and attribute any variation to socialization cannot explain why androphilic males, on average, would behave in a relatively feminine manner, and why gynephilic females, on average, would behave in a masculine manner, as sex-atypical phenotypical expressions run counter to social expectations regarding how individuals should behave (Bailey et al., 2016; Lippa, 2005a). The cultural context of Iran, which is characterized by rigid streotypes about manhood and womanhood, further underscores that sexual orientation differences in childhood play behaviour, adulthood occupational preferences, chidhood separation anxiety, and hand preference are more likely to be grounded in human biology, rather than culturally-specific gender role expectations. Therefore, future research on the possible effects of social conditions on sexual orientation differences would benefit by adopting a more complex view of human development than the binary nature versus nurture debate.

In line with an evolutionary developmental approach explained in Chapter 1, existing evidence on female-shifted psychodevelopment of andropilic males have been used to form and test evolutionary hypotheses about male androphilia (for a review see Vasey & Vanderlaan, 2015). However, few attempts have been made to explain male-shifted psychodevelopment of female gynephilia (Luoto et al., 2019). It could be that more cross-cultural data are need to establish and further elucidate the universal developmental patterns associated with female gynephilia before developed theorizing can take place. Future theoretical research on evolution of female gynephilia could therefore benefit from cross-cultural research into the development and psychobiology of female gynephilia.

Conclusion

In this thesis, I presented original, novel research which significantly contributed to our understanding about universal features of the development of male and female same-sex sexual orientation. The diverse recruited sample made it possible to examine which developmental features were associated with variations in sex (i.e., male versus female) sexual orientation (i.e., androphilia versus ambiphilia versus gynephilia) and gender identity/expression (i.e., cisgender versus transgender). The research provided empirical evidence for the cross-cultural ubiquity of female same-sex attraction by reporting on Iranian gynephilic females, and expanded the existing cross-cultural evidence on androphilic males, substantiating universal aspects of the development of male same-sex sexual attraction.

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