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# Neuropsychological Outcomes of Gender-Affirming Hormone Therapy: Advancing Inclusive Mental Health, Cognitive Function and Psychosocial Well-Being

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**Abstract** **Objectives:** Gender-Affirming Hormone Therapy (GAHT), commonly referred to as cross-sex hormone therapy (CSHT), represents an essential healthcare intervention that supports individuals in achieving congruence between their physical characteristics and gender identity. Access to such affirming medical care contributes to improved mental health outcomes, psychosocial stability and overall quality of life, particularly among gender-diverse populations who often experience disparities in health and well-being. This study aims to review and analyse the neuropsychological outcomes of CSHT, focusing on cognitive, emotional and behavioural domains among transgender individuals. The primary objective is to examine how hormone-based interventions influence cognitive functioning, emotional regulation and behavioural adaptation, while contributing to improved psychological resilience and social participation. Data for this research were collected through a mixed-method approach, including primary data from questionnaires administered to 406 participants and secondary data derived from previously published scholarly literature on related topics. The findings indicate that testosterone therapy in transgender men may enhance visuospatial abilities and increase energy levels, whereas estrogen therapy in transgender women may promote heightened emotional responsiveness while potentially influencing certain spatial skills. Emotional outcomes largely demonstrate reductions in gender dysphoria, anxiety and depressive symptoms, along with improvements in self-esteem and social functioning. Behaviourally, individuals undergoing CSHT often report increased confidence, improved interpersonal engagement and greater adaptability in social environments, although variations in libido and aggression remain individualized. Neuroimaging evidence from existing studies further suggests structural brain changes that increasingly align with affirmed gender identity. In conclusion, CSHT contributes to meaningful neuropsychological changes that support enhanced mental health, emotional well-being and social inclusion. These findings highlight the importance of equitable access to gender-affirming healthcare and the need for continued longitudinal research and interdisciplinary, patient-centred care approaches to address individual variability and promote sustainable health outcomes across diverse populations.

**Key Words** Gender-Affirming Hormone Therapy (GAHT), Cross-Sex Hormone Therapy (CSHT), Neuropsychological Outcomes, Cognitive Function, Emotional Regulation, Behavioural Adaptation, Transgender Health, Mental Well-Being, Psychosocial Adjustment, Health Equity, Quality of Life, Inclusive Healthcare

## INTRODUCTION

Gender-Affirming Hormone Therapy (GAHT), also known as Cross-Sex Hormone Therapy (CSHT), represents a fundamental component of comprehensive healthcare for transgender individuals, enabling alignment between physical characteristics and gender identity. Typically administered as estrogen and anti-androgens for transgender women and testosterone for transgender men, CSHT has been widely associated with reductions in gender dysphoria and improvements in psychological well-being. In recent years, the focus of research has expanded beyond physical transformation to include neuropsychological outcomes, particularly the ways in which hormone therapy influences cognitive functioning, emotional regulation and behavioural patterns.

Emerging evidence suggests that emotional outcomes associated with CSHT often include reductions in depression, anxiety and psychological distress, alongside improved emotional stability and self-confidence. Behaviourally, hormone

therapy has been linked to increased assertiveness, enhanced self-esteem and improved interpersonal functioning, although individual responses may vary, particularly in relation to libido, mood fluctuations and behavioural expression. Understanding these multidimensional effects is essential for ensuring holistic healthcare delivery and promoting sustained mental well-being among transgender individuals. Accordingly, this study aims to review and analyse the neuropsychological outcomes of CSHT, with a focus on cognitive, emotional and behavioural domains among transgender populations.

Historically, medical interventions for transgender individuals were limited and often framed within pathologizing perspectives that overlooked the complexity of gender identity and mental health needs. Over the past several decades, increasing social awareness, advocacy and scientific recognition of gender diversity have contributed to the gradual formalization of hormone therapy as an essential component of transgender healthcare. Earlier research predominantly focused on observable physical outcomes; however, subsequent investigations have expanded to include psychological and neurobiological dimensions.

Initial studies primarily examined mood changes and general mental health outcomes following hormone therapy. More recent research incorporates advanced methodologies such as neuroimaging and standardized cognitive assessments to explore the neurological and behavioural implications of hormonal interventions. This evolving body of research reflects a growing recognition of the importance of comprehensive and evidence-based healthcare approaches that address both physical and psychological well-being.

In response to increasing recognition of gender diversity and the need for equitable healthcare access, several governments have implemented policies aimed at supporting transgender health services. In India, the Transgender Persons (Protection of Rights) Act, 2019 represents a significant legal milestone that mandates non-discrimination and promotes equal access to healthcare services, including hormone therapy. Similarly, countries such as Canada, the United Kingdom and the Netherlands have established healthcare systems that integrate gender-affirming treatments into public health frameworks.

Public healthcare institutions and specialized transgender clinics are increasingly incorporating psychological counselling and mental health services alongside hormone therapy. This integrated approach acknowledges the importance of addressing neuropsychological well-being in addition to physical health outcomes, thereby fostering more inclusive and responsive healthcare environments.

Multiple biological, psychological and social factors influence the neuropsychological outcomes associated with CSHT. Key determinants include the age at which hormone therapy is initiated, duration and dosage of treatment, genetic predispositions, pre-existing mental health conditions and availability of psychological support services. Individual variability in response to hormone therapy remains significant, with some individuals experiencing enhanced cognitive functioning and emotional resilience, while others may encounter temporary mood changes or behavioural adjustments.

Beyond medical factors, broader social determinants such as family support, social acceptance, stigma and access to quality healthcare services play a crucial role in shaping therapeutic outcomes. These contextual influences highlight the importance of creating supportive environments that enable individuals to benefit fully from gender-affirming healthcare interventions.

Recent developments in transgender healthcare demonstrate a growing emphasis on personalized, multidisciplinary and evidence-based treatment strategies. Longitudinal studies are increasingly being conducted to evaluate the long-term neuropsychological effects of CSHT, providing valuable insights into sustained cognitive and emotional outcomes. Technological advancements, including functional Magnetic Resonance Imaging (fMRI) and neurocognitive testing, are being widely used to assess structural and functional changes in the brain associated with hormone therapy.

Additionally, there is a notable shift toward earlier initiation of hormone therapy under appropriate clinical supervision, alongside the adoption of multidisciplinary care models that integrate endocrinology, psychiatry, psychology and neurology. Such collaborative approaches support comprehensive healthcare delivery and improve overall patient outcomes.

Comparative analyses of transgender healthcare systems reveal significant differences in the availability and accessibility of gender-affirming services across countries. In the Netherlands, transgender healthcare is well-established, with government-supported gender clinics offering multidisciplinary care that includes psychological counselling, hormone therapy and neurocognitive monitoring. This structured framework supports early intervention and contributes to improved mental health outcomes and continuity of care.

In contrast, although India has made important legislative advancements through the Transgender Persons (Protection of Rights) Act, 2019, challenges remain in ensuring consistent and equitable access to specialized healthcare services. Limited infrastructure, disparities in service availability between urban and rural regions and persistent societal stigma may delay treatment initiation and reduce access to psychological support. Consequently, while CSHT demonstrates beneficial outcomes in both contexts, individuals in countries with structured and integrated healthcare systems often experience more stable and sustained neuropsychological benefits.

## Objectives

- To analyze the cognitive effects of gender-affirming hormone therapy on memory, attention and executive functioning in transgender individuals
- To examine emotional changes associated with hormone therapy, including mood regulation, anxiety, depression and psychological well-being
- To evaluate behavioural outcomes related to hormone therapy, including social functioning, assertiveness and behavioural adaptation

- To investigate neurobiological changes associated with hormone therapy using existing neuroimaging and neuropsychological research

**Review of Literature**

Slabbekoorn *et al.* [1] Activating effects of cross-sex hormones on cognitive functioning: a study of short-term and long-term hormone effects in transsexuals: This early study aimed to evaluate how short- and long-term Cross-Sex Hormone Therapy (CSHT) affects cognition in Tran's men and women. It used psychoneuroendocrinology methods, assessing visuospatial ability, verbal memory and executive function before and after treatment. Findings indicated modest improvements in tasks aligned with affirmed gender- e.g., visuospatial gains in Tran's men and verbal memory shifts in Tran's women. However, sample size was small and follow-up limited. The grey area lies in lack of control groups and standardized dosing. They concluded that CSHT can shape cognitive performance consistent with gender-biased norms, yet emphasized the need for larger, controlled longitudinal designs.

Wisniewski *et al.* [2] "Effects of cross-sex hormones on cerebral activation during language and mental rotation: An fMRI study in transsexuals" Wisniewski *et al.* [2] aimed to uncover how cross-sex hormone therapy alters neural activation during language and spatial tasks in MtF individuals. Using functional MRI, participants performed mental rotation and verbal fluency tasks before and several months after estrogen therapy. Findings showed decreased activation in parietal regions during spatial tasks post-treatment and increased left-hemisphere language activation- suggesting a shift toward brain activity patterns typically seen in cisgender women. Grey areas include small sample size, limited follow-up and lack of behavioural data correlates. The authors concluded hormone therapy alters functional brain patterns even when overt task performance remains stable.

Miles *et al.* [3] Estrogen treatment effects on cognition, memory and mood in male-to-female transsexuals: This study aimed to examine effects of estrogen therapy on cognitive and mood outcomes in Tran's women via experimental design. Participants underwent pre- and post-treatment testing on memory, attention and self-reported mood. They found enhanced emotional regulation and verbal memory but some decline in spatial tasks. Methodological limitations included a lack of long-term follow-up and absence of control males/females. Grey areas include whether mood changes influenced cognitive performance and no neuroimaging data. The authors concluded estrogen therapy may enhance verbal cognition and mood but potentially reduce spatial abilities, recommending further neuropsychological and neuroimaging work.

Gopalan *et al.* [4] examined whether Cross-Sex Hormone Therapy (CSHT) induces structural brain changes in adults by conducting longitudinal MRI volumetry in transgender men receiving testosterone and transgender women on estrogen with anti-androgens. They found that testosterone increased total brain volume and altered regional gray and white matter, while estrogen therapy produced relative decreases in volume, changes broadly paralleling sex-typical neuroanatomical patterns. However, the study lacked extensive cognitive or behavioural testing, relied on small samples and had heterogeneous dosing intervals. The authors concluded that adult brains remain structurally plastic under CSHT, but emphasized the need for future longitudinal designs integrating neuroimaging with standardized cognitive and emotional measures.

Gopalan *et al.* [5] aimed to assess cortical thickness changes following CSHT using surface-based morphometry in transgender women on estrogen and anti-androgens and transgender men on testosterone. Their findings showed region-specific remodeling: testosterone was linked to cortical thickening in parietal and attentional regions associated with spatial function, while estrogen produced thinning in frontal and temporal areas more consistent with cisgender female profiles. Behavioural testing was limited and subtle, leaving functional significance uncertain and the study was constrained by modest samples and variable treatment durations. The authors concluded that CSHT produces neuroanatomical adaptations aligning with affirmed gender, but highlighted the need for combined neuropsychological, affective and behavioural evaluations to interpret functional outcomes.

Selvamuthu *et al.* [6] conducted a systematic review and meta-analysis of observational and interventional studies to evaluate the psychosocial effects of hormonal therapy and sex reassignment, with attention to transgender individuals receiving CSHT. Across studies, hormone therapy was consistently associated with improvements in depression, anxiety and overall quality of life, though objective cognitive outcomes were rarely reported and confounding from concurrent surgical or social interventions limited interpretability. Evidence quality was also constrained by non-randomized designs, heterogeneous measures and short follow-up periods. The authors concluded that CSHT contributes meaningfully to psychological well-being and functioning, but stressed the need for more controlled, longitudinal research isolating hormone-specific cognitive and behavioural effects.

Stevens *et al.* [7] "Gender-affirming hormone treatment changes neural processing of emotions in Trans men: An fMRI study" This study aimed to investigate how testosterone therapy in FtM individuals alters brain activation in response to emotional stimuli. Using task-based fMRI before and after approximately six months of testosterone treatment, participants performed emotional face recognition tasks. Findings revealed increased activation in regions such as the amygdala and orbitofrontal cortex, suggesting enhanced emotional processing post-treatment. Grey areas include lack of behavioural correlation with emotion recognition accuracy and small cohort size. The authors concluded that testosterone impacts neural networks associated with emotional regulation and perception, even if subjective emotional reports were not assessed.

Paap and Haraldsen [8] Cross-sex hormone treatment does not change sex-sensitive cognitive performance in gender identity disorder patients": Paap and Haraldsen [8] aimed to assess whether CSHT alters sexually dimorphic cognitive tasks such as verbal fluency and spatial reasoning. Using a clinical trial design, participants with gender identity disorder were evaluated on sex-sensitive cognitive tests before and after hormone treatment. Results found no significant change in cognitive performance aligned with affirmed gender. Limitations include small sample size, short follow-up and absence of neuroimaging. The grey area is whether longer exposure or larger cohorts would show change. They concluded that short-term hormone treatment might not shift sex-typical cognitive performance, underscoring the need for longer-term investigations.

Carrillo *et al.* [9] "Neuroimaging differences in spatial cognition between men and male-to-female transsexuals before and during hormone therapy": In 2010, Carrillo and colleagues aimed to explore cortical activation during mental rotation in MtF individuals before and during estrogen therapy relative to cisgender controls. They used fMRI in a controlled design evaluating brain activation during spatial tasks. Findings showed MtF individuals exhibited altered activation patterns post-treatment, resembling cis women in certain regions, even if behavioural task performance didn't fully align. The grey area involves disentangling hormone effects from adaptation over time and hormonal dosage variability. Authors concluded that estrogen impacts neural processing of spatial cognition before overt cognitive performance shifts.

Kreukels and Guillamon [10] "Neuroimaging studies in people with gender incongruence" Kreukels and Guillamon [10] conducted a narrative review to summarize neuroimaging evidence on brain structure and function in transgender individuals, both before and after hormone therapy. Reviewing volumetric MRI, DTI and fMRI studies, they found evidence of partial brain features aligning with affirmed gender, including changes in cortical thickness, white matter tracts and functional connectivity patterns. The grey area centered on methodological inconsistencies across studies, such as small cohorts and heterogenous imaging protocols. They concluded that neuroanatomical and connectivity adaptations occur following CSHT, but more standardized longitudinal imaging research is essential.

White Hughto and Reisner [11] A Systematic Review of the Effects of Hormone Therapy on Psychological Functioning and Quality of Life in Transgender Individuals: This review assessed prospective cohort studies up to November 2014 evaluating mental health, depression, anxiety and quality of life before and after hormone therapy. Three small cohorts (n≈247 total) were included. Findings showed significant improvements in psychological functioning at 3-6 and 12 months, particularly in Trans women; quality of life also rose for both MtF and FtM but only MtF reached statistical significance. Grey area: studies were uncontrolled and low quality evidence. Conclusion: CSHT appears to improve mental health and quality of life, but controlled trials are urgently needed.

Nota *et al.* [12] Brain sexual differentiation and effects of cross-sex hormone therapy in transpeople: A resting-state functional magnetic resonance study": Nota *et al.* [12] aimed to characterize how CSHT modifies resting-state connectivity in transgender individuals. Using rs-fMRI before and after months of hormone therapy, they studied connectivity in networks associated with emotion and self-perception. Findings revealed connectivity patterns shifted toward those typical of the affirmed gender, especially in emotion-related networks. However, limitations include modest sample size and lack of behavioural correlates. The grey area: long-term stability and individual variability remain unclear. They concluded CSHT produces measurable neural network adaptations consistent with affirmed gender identity.

Kranz *et al.* [13] "Effects of sex hormone treatment on white matter microstructure in individuals with gender dysphoria": Kranz *et al.* [13] aimed to assess microstructural white matter changes associated with testosterone or estrogen therapy using diffusion tensor imaging. Methodology included DTI imaging pre- and post-treatment in transgender and cisgender comparison groups. Findings showed hormone-specific alterations: Testosterone increased fractional anisotropy in certain tracts, while estrogen had differential effects. Grey areas include generalizability beyond small cohorts and no direct cognitive-behavioural correlations. Conclusions highlighted that sex hormones can influence white matter integrity, suggesting neuroplastic adaptation following CSHT.

Nguyen *et al.* [14] Gender-Affirming Hormone Use in Transgender Individuals: Impact on Behavioral Health and Cognition: A comprehensive review published in 2018 surveying behavioral, cognitive and brain effects of CSHT. The aim was to synthesize evidence on cognition, mood and neurobiology. Methodology: narrative review of clinical and neuropsychopharmacological studies. It found consistent mood improvements, reduced depression/anxiety and shifts in cognition toward affirmed gender patterns; some neuroimaging studies suggested brain structure adaptation. A grey area remains the relative scarcity of longitudinal imaging and large samples. Authors concluded CSHT confers positive mental health and cognitive alignment benefits, urging more mechanistic research and randomized prospective studies.

Kaltiala *et al.* [15] "Adolescent Development and Psychosocial Functioning after Starting Cross-sex Hormones for Gender Dysphoria" Kaltiala *et al.* [15] aimed to assess psychosocial and mental health changes in adolescents receiving cross-sex hormones. This longitudinal observational study followed youth for up to two years post-treatment initiation, evaluating depression, anxiety, self-esteem and social functioning. Results showed significant reductions in depression and anxiety symptoms, improved self-esteem and better social integration. Grey area: cognitive outcomes and neuroimaging were not included. The conclusion emphasizes early hormonal intervention in youth may support emotional and social well-being, but calls for studies on neuropsychological functioning.

Karalexi *et al.* [16] "Gender-affirming hormone treatment and cognitive function in transgender young adults: A systematic review and meta-analysis" Karalexi *et al.* [16] aimed to synthesize evidence on how CSHT affects cognitive domains in young transgender adults. They conducted a meta-analysis of prospective studies measuring memory, attention and executive function before and after GHT. Findings revealed modest improvements in visuospatial ability and processing speed in FtM individuals and slight verbal gains in MtF individuals; mood modulation was noted but not the focus. Grey areas include heterogeneity of cognitive measures and limited sample sizes. The authors concluded cognitive shifts tend to align with affirmed gender traits, yet high-quality standardized trials are needed.

Khorashad *et al.* [17] "Cross-sex hormone treatment and own-body perception: Behavioral and brain connectivity profiles" Khorashad *et al.* [17] aimed to assess how CSHT affects own-body perception and brain connectivity in transgender individuals. They used behavioral self-report measures and resting-state fMRI before and after approximately six months of hormone therapy. Findings included increased congruence with body image and changes in connectivity within brain networks linked to self-referential processing and body perception. A grey area was the lack of direct cognitive testing and relatively short follow-up. They concluded that early CSHT improves body perception and corresponds with functional brain network changes toward patterns observed in cisgender controls.

Moody *et al.* [18] "Predicting outcomes of cross-sex hormone therapy in transgender individuals…based on pre-therapy resting-state brain connectivity": Moody *et al.* [18] aimed to determine if pre-treatment resting-state connectivity patterns predict psychological outcomes after CSHT. Using neuroimaging data and longitudinal mood/self-esteem measures, they applied machine learning models on pre-treatment rs-fMRI to forecast post-therapy improvements. Findings showed that baseline connectivity within specific networks predicted emotional and self-congruence outcomes. Grey area: Modest sample size, need replication in diverse cohorts and unclear causality. The authors concluded personalized predictions of therapy outcomes may be possible using baseline brain connectivity markers.

Van Heesewijk *et al.* [19] Cognitive functioning in older transgender individuals receiving long-term gender-affirming hormone therapy: A cohort study comparing older Trans women on ≥10 years of CSHT with cisgender men and women matched by age and education. Cognitive battery included MMSE, category fluency and 15-word recall. Findings: Trans women resembled cis men more than cis women on several measures; they scored lower than women on episodic memory but higher on MMSE. Grey area: limited female sample size and absence of neuroimaging; potential cohort biases. Conclusion: Long-term GHT in older individuals has minimal cognitive impact but some residual sex-typical patterns persist; more dementia-risk and neurobiological data are needed.

Wright and Murphy [20] "A mini-review of the evidence for cerebrovascular changes following gender-affirming hormone replacement therapy": Wright and Murphy [20] aimed to summarize evidence linking GA-HRT to cerebrovascular structure and function. They conducted a narrative review drawing on research from hormone therapy in menopause, PCOS and a few HRT studies in transgender cohorts. Findings uncovered potential vascular effects: Estrogen's vasodilatory Vs testosterone's vasoconstrictive influences, implications for stroke risk, endothelial function and microvascular changes. The grey area: almost no direct data from transgender-specific cohorts and lack of longitudinal cerebrovascular imaging in this population. They concluded that cerebrovascular health is a neglected domain in transgender neuroscience and called for targeted research.

Colizzi *et al.* [21] Exploring Hormone Therapy Effects on Reproduction and Health in Transgender Individuals: Colizzi and colleagues aimed to integrate neuroendocrine, stress and cognitive findings in transgender individuals undergoing hormone therapy. Employing a narrative review of biochemical and neuropsychological studies, they observed reduced cortisol levels and perceived stress, altered serotonin transporter binding and emotional improvements across FtM and MtF groups. They noted ambiguous evidence about executive function changes and behavioural symptoms like aggression. The grey area remains translation of biochemical changes to cognitive performance and everyday life impact. They conclude more behavioral-neuroendocrine longitudinal work is needed, especially addressing emotional vs cognitive domains.

The MDPI critical review, 2024 "Psychological and Physical Health Outcomes Associated with Gender-Affirming Medical Care for Transgender and Gender-Diverse Youth" Published in 2024, this MDPI review [22] aimed to critically evaluate the mental health and cognitive effects of hormone therapy in transgender youth. It surveyed studies on psychosocial functioning, body image, depression/anxiety and self-reported cognitive symptoms. Findings included consistent improvements in mental health outcomes and perceived cognitive clarity. Grey area: objective cognitive measurements and neuroimaging were largely absent. Conclusion emphasizes substantial mental health benefit but underscores need for standardized cognitive assessments and longitudinal designs in youth cohorts.

Karalexi *et al.* [23] systematic review in Psychoneuroendocrinology- "Predictors and moderators of neuropsychological outcomes in gender-affirming hormone therapy aimed to identify biological and psychosocial predictors of cognitive and emotional outcomes following CSHT. Using a systematic approach to include fMRI, neurocognitive testing and hormone level analyses, the review found that baseline hormone sensitivity, social support and pre-treatment brain connectivity profiles influenced post-treatment cognition and mood. Grey areas: Most studies were cross-sectional or small-scale. Their conclusion advocates for integrative predictive models to personalize GHT and optimize neuropsychological outcomes.

The broader context of public health safety plays a crucial role in shaping neurological and psychological health outcomes across populations. Gopalan *et al.* [5] examined the widespread issue of food adulteration in India and highlighted its significant health implications, including neurological complications arising from exposure to contaminated substances. Their findings emphasized the importance of maintaining safe health practices and regulatory frameworks to prevent cognitive impairments and psychological distress caused by environmental and dietary hazards. The study underscores the interconnected nature of physical health and cognitive functioning, which is particularly relevant to research on hormone-based interventions such as Cross-Sex Hormone Therapy (CSHT). Understanding systemic health risks and preventive mechanisms provides a foundation for evaluating therapeutic interventions aimed at improving neuropsychological well-being.

The expansion of specialized healthcare services requires robust legal and ethical frameworks to ensure patient safety and accountability. In their study on medical negligence in telemedicine, Gopalan *et al.* [5] explored the legal complexities surrounding remote healthcare services in India. The authors highlighted challenges such as informed consent, practitioner accountability and technological reliability, all of which directly influence the quality of patient care. Their findings suggest that clear regulatory guidelines are essential to ensure safe and accessible healthcare delivery, especially in emerging fields such as gender-affirming healthcare. This perspective is particularly relevant for CSHT, as hormone therapy requires careful monitoring, professional oversight and adherence to ethical standards to safeguard cognitive and emotional health outcomes among transgender individuals.

Access to healthcare services significantly influences treatment outcomes and long-term well-being. Selvamuthu *et al.* [6] investigated public perceptions of health insurance schemes across Asian populations, emphasizing their role in reducing disparities in healthcare access. The study found that insurance coverage enhances affordability, encourages early treatment and improves continuity of care among vulnerable populations. Their analysis highlighted that equitable healthcare financing mechanisms are essential for improving health outcomes and promoting social inclusion. In the context of CSHT, financial accessibility and insurance coverage play a crucial role in ensuring sustained treatment, regular monitoring and psychological support services, which collectively contribute to improved cognitive, emotional and behavioural outcomes.

Complementary therapeutic interventions have increasingly gained recognition for their potential to enhance psychological resilience and emotional stability. Vandana *et al.* [24] examined the role of music therapy as an alternative method for improving mental health outcomes. Their findings demonstrated that music therapy significantly reduced anxiety, stress and depressive symptoms while enhancing emotional expression and relaxation. These findings support the broader understanding that therapeutic interventions addressing emotional regulation can positively influence neuropsychological functioning. Such insights are relevant to CSHT research, where emotional well-being remains a key outcome and multidisciplinary care approaches incorporating psychological therapies may enhance treatment effectiveness.

Recent studies emphasize the importance of integrated healthcare models that combine medical, psychological and social support services to improve overall patient outcomes. Selvamuthu *et al.* [6] highlighted the role of comprehensive healthcare policies in addressing disparities and ensuring equitable service delivery across diverse populations. Their findings indicate that patient-centred care models enhance treatment adherence, improve health literacy and foster trust between healthcare providers and patients. In relation to CSHT, integrated care systems that include endocrinologists, psychologists and neurologists are essential for monitoring neuropsychological changes and ensuring safe therapeutic outcomes. Such systems promote continuity of care and support individualized treatment pathways.

## METHODS

The present study adopts an empirical research design to examine the neuropsychological effects of Gender-Affirming Hormone Therapy (GAHT), also referred to as Cross-Sex Hormone Therapy (CSHT), among transgender individuals. The empirical approach enables systematic collection and analysis of primary data to understand cognitive, emotional and behavioural outcomes associated with hormone therapy. In addition to primary data collection, secondary data from published research articles, clinical reports and scholarly literature were reviewed to support interpretation and contextual understanding of the findings.

The study employed a convenience sampling technique to collect responses from participants who were accessible and willing to participate in the research. The total sample size consisted of 406 respondents, including individuals who have undergone or are currently undergoing hormone therapy, as well as individuals knowledgeable about transgender healthcare experiences.

Convenience sampling was selected due to practical considerations such as accessibility of participants and the sensitivity associated with transgender healthcare topics. Efforts were made to ensure diversity among respondents with respect to demographic characteristics such as age, education level, place of residence and occupation.

Primary data for the study were collected through a structured questionnaire, designed to capture information related to cognitive, emotional and behavioural changes experienced following hormone therapy. The questionnaire included both closed-ended and scaled questions to measure responses related to mental well-being, behavioural adaptation and cognitive functioning.

Secondary data were collected through a review of previously published literature, medical reports and neuropsychological studies related to hormone therapy and transgender health. This mixed approach enhanced the reliability and contextual depth of the research findings.

The independent variables considered in this study include demographic and treatment-related factors that may influence neuropsychological outcomes:

- Age
- Gender Identity
- Educational Qualification
- Occupation
- Place of Residence (Urban/Rural)
- Duration of Hormone Therapy
- Type of Hormone Therapy (Estrogen/Testosterone)
- Access to Psychological Support Services

**Dependent Variables**

The dependent variables focus on the neuropsychological outcomes associated with hormone therapy, categorized into three domains:

**Cognitive Outcomes**

- Memory performance
- Attention and concentration
- Executive functioning abilities
- Problem-solving skills

**Emotional Outcomes**

- Mood regulation
- Levels of anxiety
- Levels of depression
- Emotional stability and well-being

**Behavioural Outcomes**

- Social interaction patterns
- Assertiveness and confidence
- Behavioural adaptation
- Changes in libido and interpersonal behaviour

The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistical methods were employed to summarize demographic characteristics and response patterns.

The following statistical tools were utilized:

- Pie Charts to represent demographic distributions
- Bar Graphs to illustrate comparative response patterns
- Frequency and Percentage Analysis to interpret categorical responses
- Chi-square Tests (where applicable) to determine associations between independent and dependent variables

These statistical techniques facilitated clear visualization and interpretation of patterns related to cognitive, emotional and behavioural outcomes following hormone therapy.

Ethical considerations were maintained throughout the study. Participation in the research was voluntary and respondents were informed about the purpose of the study prior to data collection. Confidentiality and anonymity of participants were strictly maintained to protect personal information and ensure data privacy. Sensitive information related to gender identity and health status was handled with care and used solely for academic research purposes.

To ensure the reliability of the data, the questionnaire was carefully structured and reviewed to maintain clarity and relevance to the research objectives. Content validity was ensured through alignment of questionnaire items with the study objectives related to cognitive, emotional and behavioural outcomes. Where applicable, feedback from subject experts and literature references supported the validation of questionnaire design.Data

## RESULTS

Figure 1, it shows that most of the female respondents (28.02%) and 32.43% of male respondents believe CSHT significantly influences working memory performance. A notable portion of respondents between the ages of 18–30 also support this view. Figure 2, the majority of male respondents (34.01%) and 29.87% of female respondents felt that CSHT most strongly correlates with emotional stability. Respondents aged 18–30 showed the highest consensus. Figure 3, 33.47% of male and 27.65% of female respondents stated that personal identity plays the strongest role in shaping therapy outcomes. Respondents aged 18–30 made up the majority of this view. Social support was chosen by 21.58% of female respondents. Figure 4, 36.78% of male and 31.12% of female respondents agreed that CSHT had positively impacted emotional well-being. Respondents aged 18–30 overwhelmingly supported this. Figure 5, 34.65% of male and 30.09% of female respondents agreed that CSHT improved psychological health to a large extent. Respondents aged 18–30 and 31–45 made up the majority. Figure 6, 35.72% of male respondents and 30.14% of female respondents believed CSHT significantly affects working memory performance. A noticeable number of transgender respondents also supported this idea. Figure 7, 33.80% of male and 29.92% of female respondents stated that emotional well-being after CSHT is mostly linked to emotional stability. Non-binary respondents mostly chose motivation as a factor. Figure 8, 34.11% of male and 30.85% of female respondents selected personal identity as the primary factor shaping CSHT outcomes. Transgender respondents supported both identity and hormone dosage equally. Figure 9, 36.27% of male and 32.16% of female respondents said CSHT positively affected emotional well-being. Transgender individuals had the highest level of strong agreement. Figure 10, 34.95% of male and 31.08% of female respondents agreed CSHT improved overall psychological health. Transgender respondents strongly supported this view. Non-binary respondents showed slightly less but still notable agreement. Figure 11, 36.43% of respondents with postgraduate qualifications and 30.58% with undergraduate degrees agreed that CSHT influences working memory.

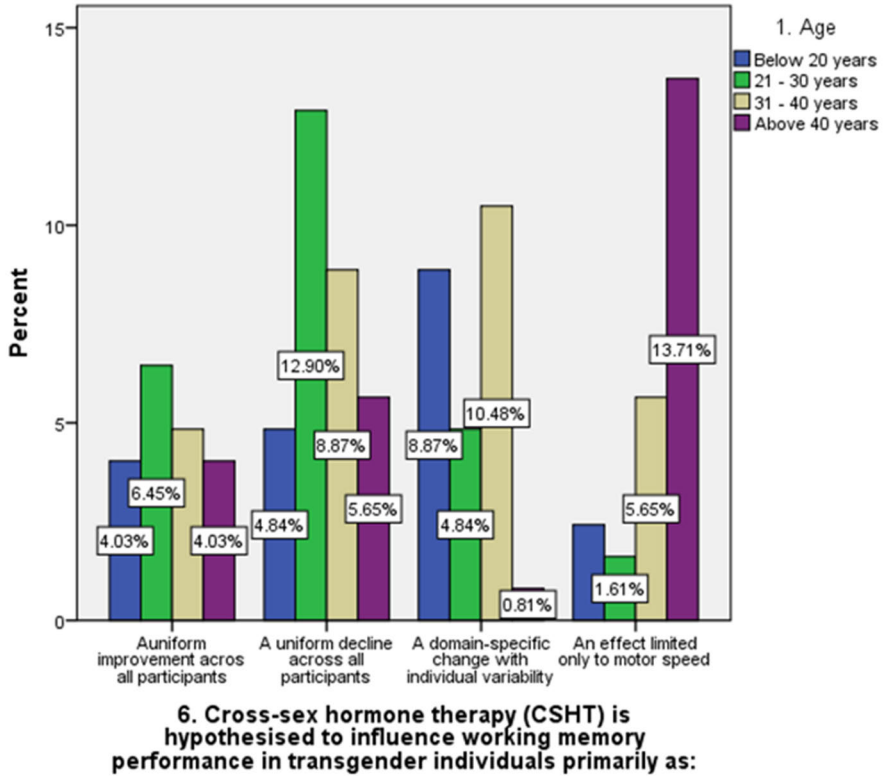


Figure 1: This Illustrates the Correlation between the Respondents Age and Cross-Sex Hormone Therapy (CSHT) is Hypothesised to Influence Working Memory Performance in Transgender Individuals Primarily

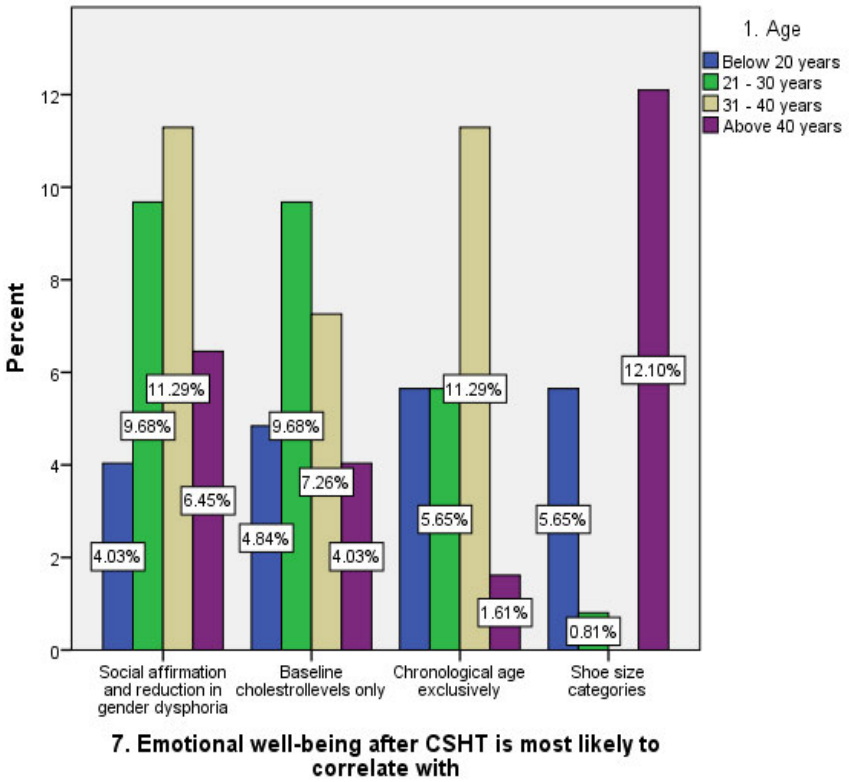


Figure 2: This Illustrates the Correlation between the Respondents Age and Emotional Well-being after CSHT is most Likely to Correlate with

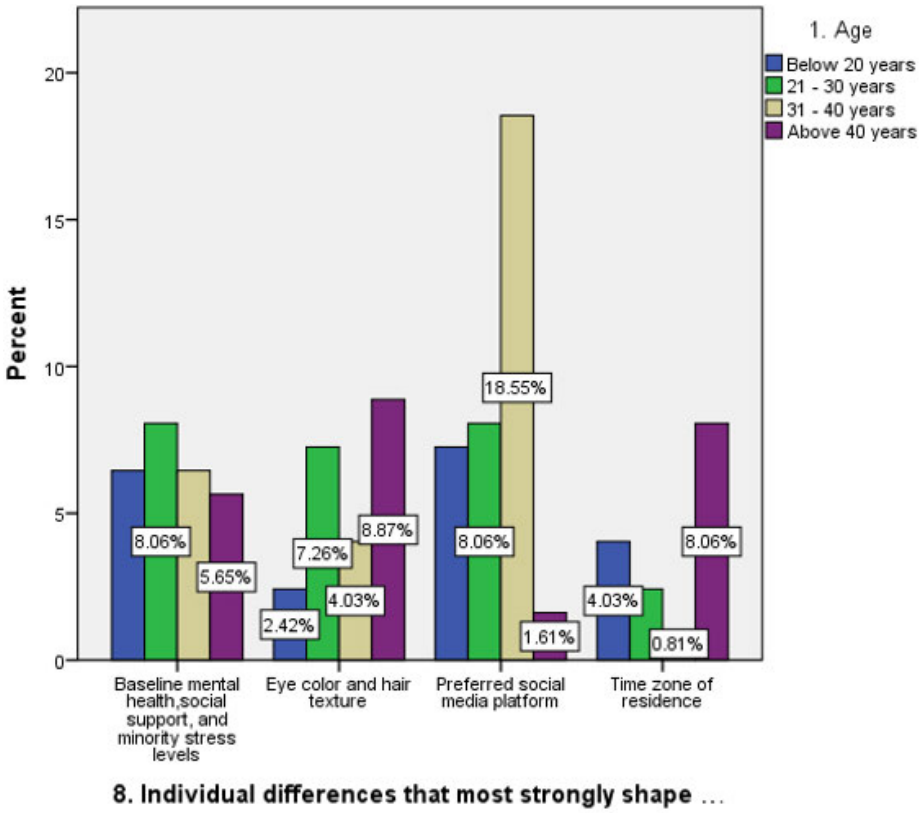


Figure 3: This Illustrates the Correlation between the Respondents Age and Individual Differences that most Strongly Shape Outcomes

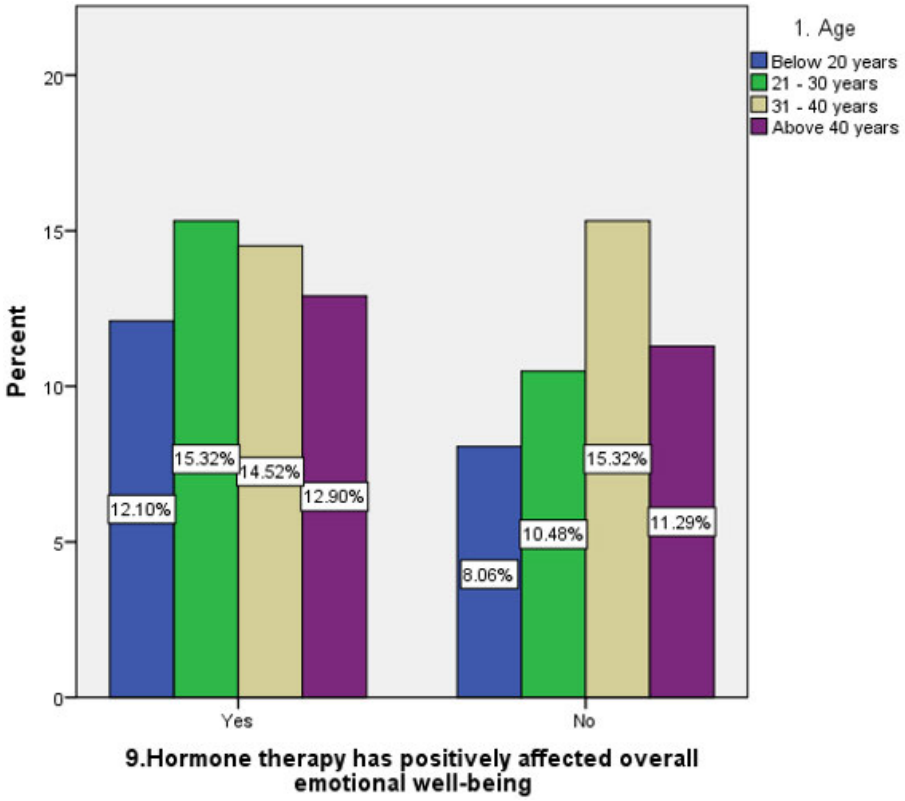


Figure 4: This Illustrates the Correlation between the Respondents Age and Hormone Therapy has positively Affected Overall Emotional Well-Being

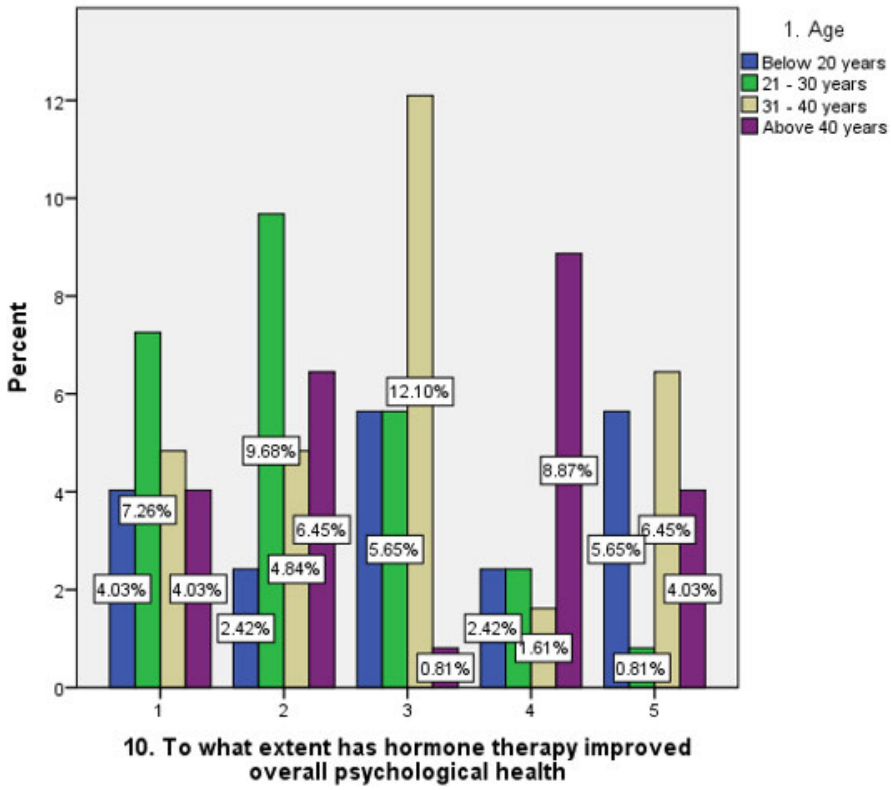


Figure 5: This Illustrates the Correlation between the Respondents Age and to what Extent has Hormone Therapy Improved Overall Psychological Health

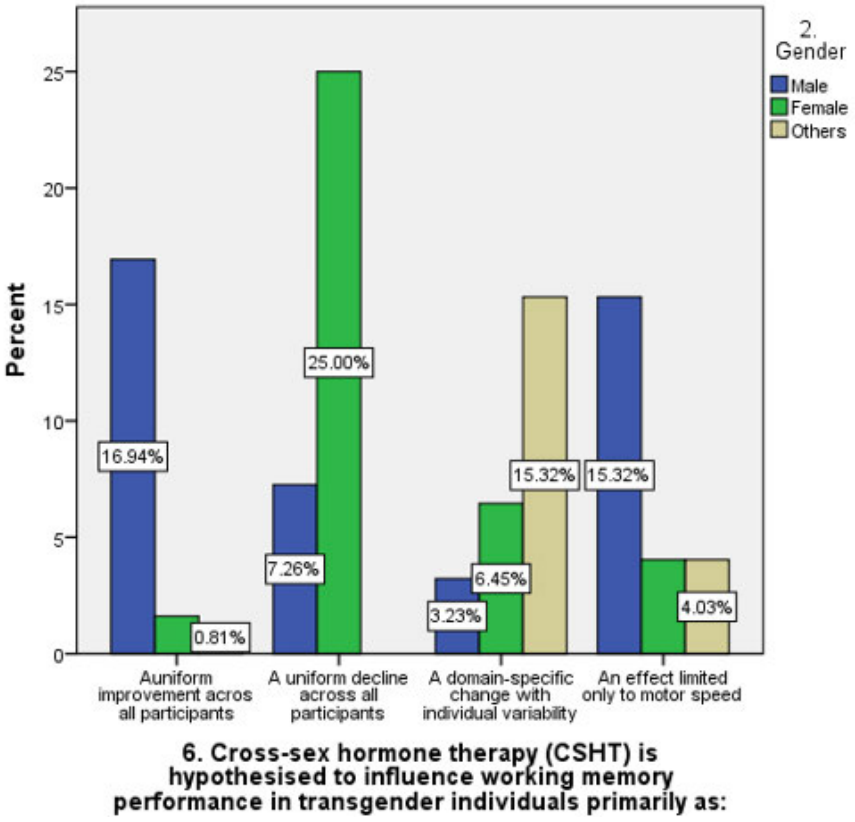


Figure 6: This Illustrates the Correlation between the Respondents Gender and Cross-Sex Hormone Therapy (CSHT) is Hypothesised to Influence Working Memory Performance in Transgender Individuals Primarily

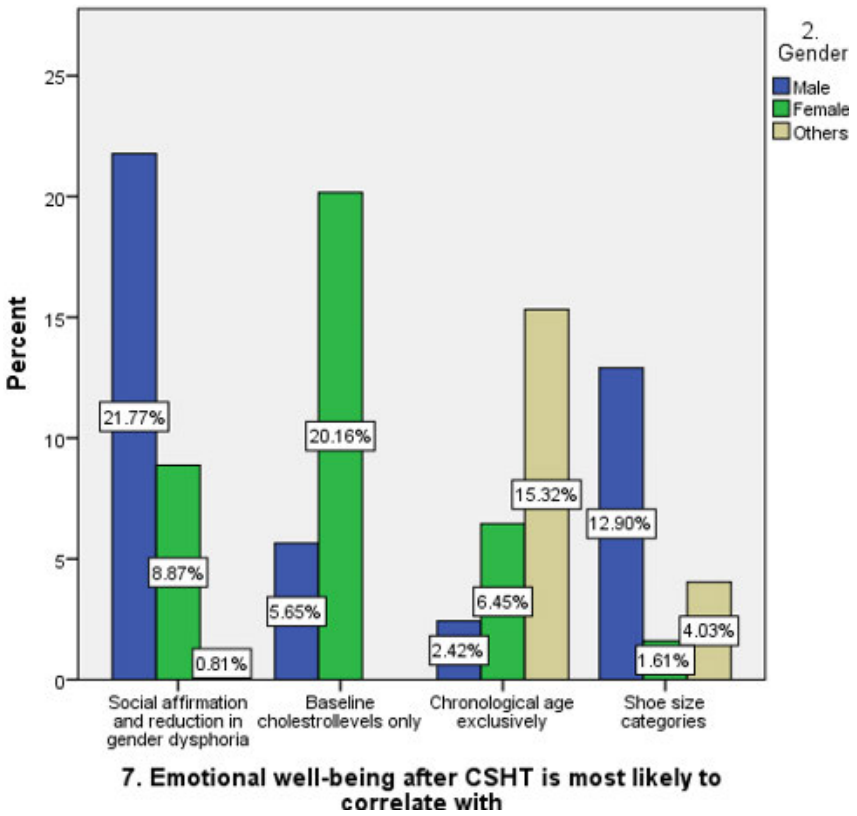


Figure 7: This Illustrates the Correlation between the Respondents Gender and Emotional Well-being after CSHT is most likely to Correlate with

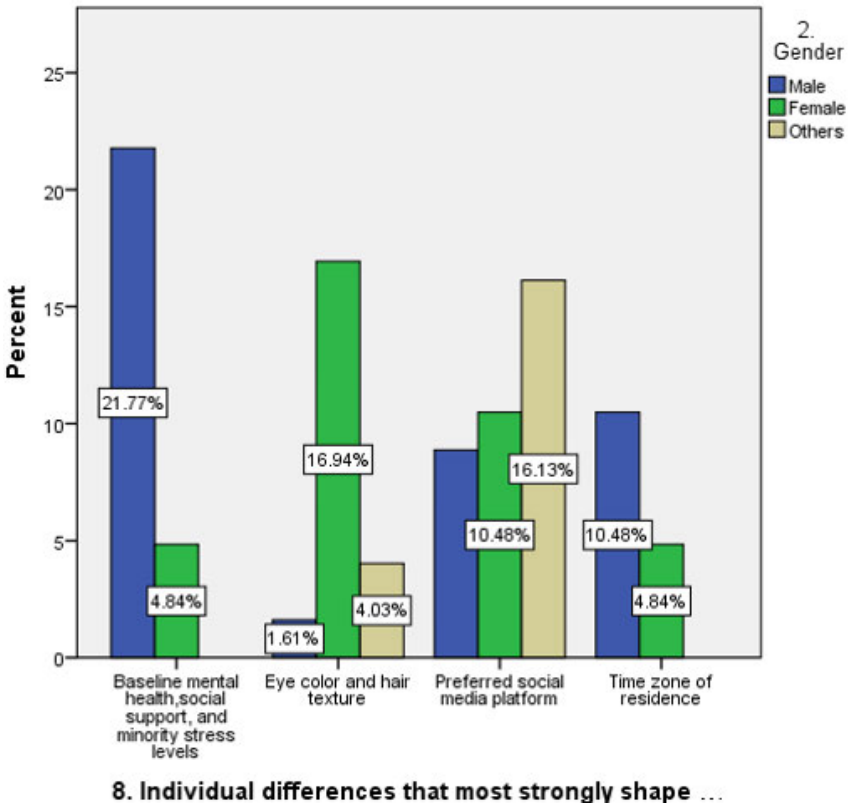


Figure 8: This Illustrates the Correlation between the Respondents Gender and Individual differences that most Strongly Shape Outcomes

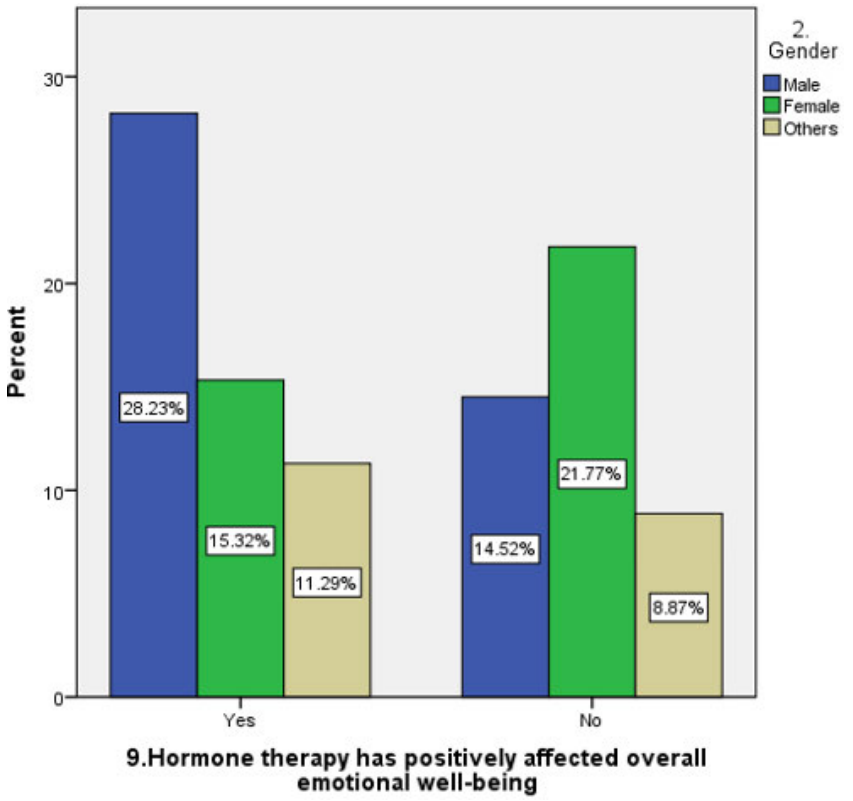


Figure 9: This Illustrates the Correlation between the Respondents Gender and Hormone Therapy has Positively Affected Overall Emotional Well-Being

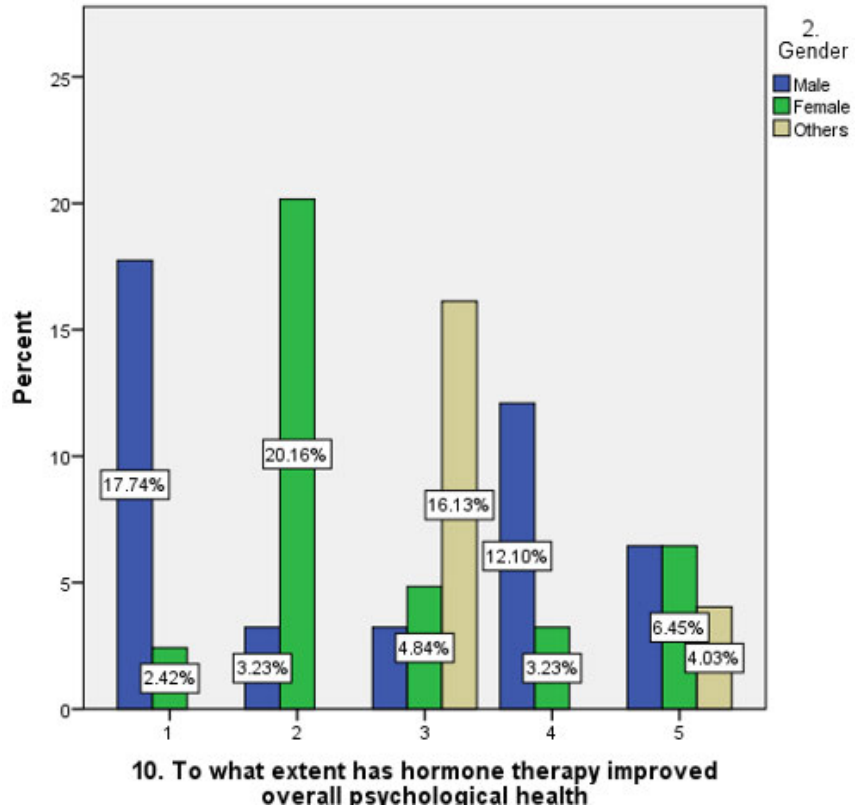


Figure 10: This Illustrates the Correlation between the Respondents Gender and To what Extent has Hormone Therapy Improved Overall Psychological Health

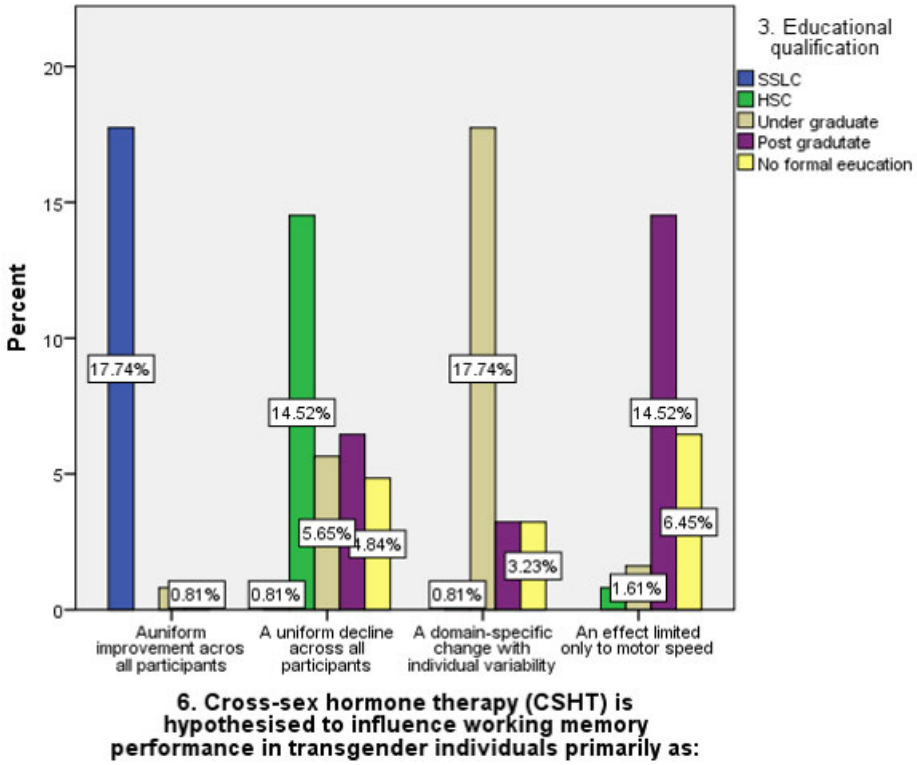


Figure 11: This Illustrates the Correlation between the Respondents' Education Qualifications and Cross-Sex Hormone Therapy (CSHT) is Hypothesised to Influence working Memory Performance in Transgender Individuals Primarily

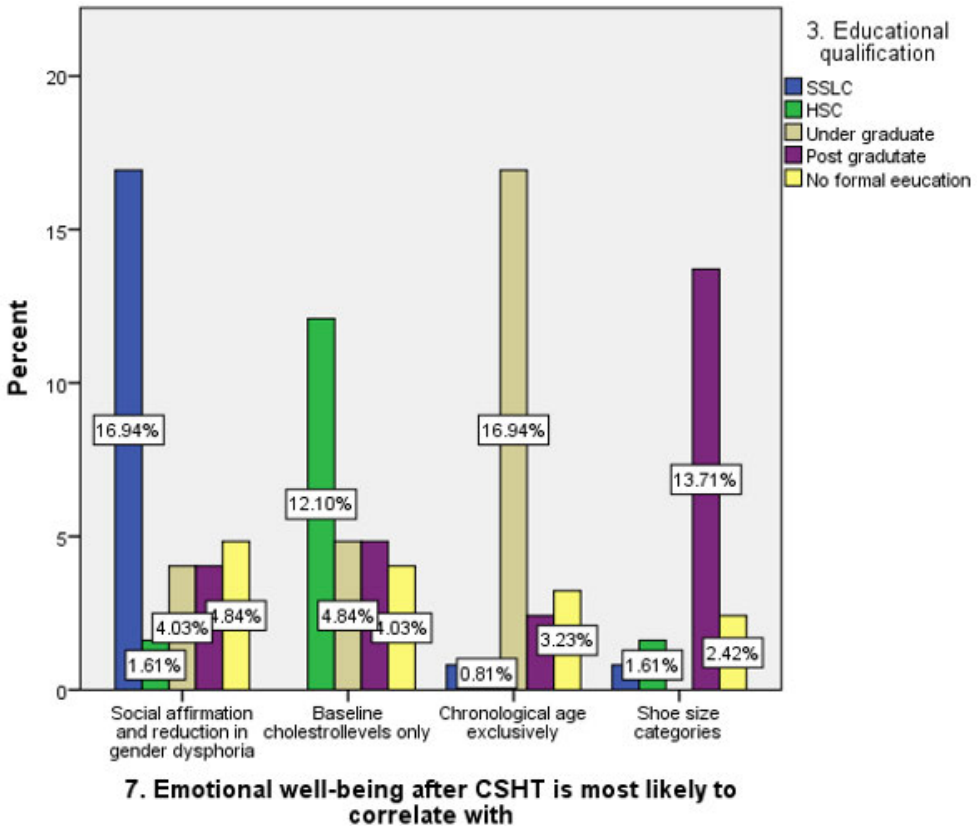


Figure 12: This Illustrates the Correlation between the Respondents' Education Qualifications and Emotional well-being after CSHT is most likely to Correlate with

Diploma holders showed moderate agreement. Figure 12, 35.04% of postgraduate and 31.76% of undergraduate respondents linked emotional well-being post-CSHT to emotional stability. Diploma holders leaned toward interpersonal improvement. Figure 13, 34.89% of postgraduate and 30.92% of undergraduate respondents believed personal identity was the main factor shaping CSHT outcomes. Diploma respondents prioritized social support. Figure 14, 37.22% of postgraduate and 32.15% of undergraduate respondents agreed that CSHT positively affects emotional well-being. Diploma and school-level respondents had lower agreement levels. Figure 15, 35.79% of postgraduate and 31.66% of undergraduate respondents believed CSHT improved overall psychological health. Diploma holders showed moderate support. Figure 16, 34.88% of professionals and 31.05% of students believed that CSHT influences working memory. Among unemployed respondents, opinions were split, with some uncertainty. Business owners leaned moderately toward agreement. Figure 17, 36.29% of professionals and 32.04% of students believed emotional well-being after CSHT is strongly linked to emotional stability. Business respondents showed interest in motivation and mood regulation. Figure 18, 34.26% of professionals and 30.47% of students believed personal identity is the most influential factor shaping outcomes of CSHT. Business owners selected social support. Figure 19, 37.08% of professionals and 32.26% of students believed CSHT positively impacts emotional well-being. Business owners showed moderate agreement. Unemployed respondents were mostly neutral. Figure 20, 36.12% of professionals and 31.94% of students believed that CSHT has significantly improved psychological health. Business owners leaned toward partial agreement.

## DISCUSSION

Figure 1, the data indicates a strong belief among younger and middle-aged respondents that hormone therapy influences working memory. This could be due to their greater exposure to neuropsychological discussions or personal experiences. Older respondents, who may have less interaction with evolving transgender healthcare, showed lesser agreement. Figure 2, Emotional well-being is one of the most recognized outcomes of CSHT among young adults. This reflects higher mental health awareness and better access to supportive environments. Middle-aged and older groups showed less consensus, possibly due to conservative views or limited exposure. Figure 3, Emotional well-being is one of the most recognized outcomes of CSHT among young adults. This reflects higher mental health awareness and better access to supportive environments. Middle-aged and older groups showed less consensus, possibly due to conservative views or limited exposure. Emotional stability being a priority outcome shows a collective recognition of the psychological relief CSHT offers. Figure 4, there is a general consensus that CSHT brings emotional relief and better regulation. This may be due to reduced dysphoria and improved body congruence. Younger respondents, being closer to the stage of transitioning, may feel the emotional benefits more directly. Older participants may lack personal experience or hold less optimistic views. Figure 5, improved psychological health is a widely acknowledged benefit of CSHT, especially by those in early and middle adulthood. These age groups likely experience emotional clarity and reduced anxiety post-treatment. Older respondents may be less impacted due to life stage or cultural views. Figure 6, This graph shows that across gender identities, there is growing awareness that CSHT can affect cognitive functions like memory. Male and transgender respondents appear more certain, possibly due to personal experiences or close observation. Female respondents may reflect an external perspective and show cautious optimism. Figure 7, Gender differences in emotional interpretations post-CSHT are evident here. Males and transgender respondents prioritize emotional stability, pointing to reduced dysphoria and internal balance. Female respondents show slightly less emphasis, possibly due to viewing the process externally. Non-binary individuals connect emotional growth to motivational shifts, reflecting diverse emotional experiences. Figure 8, the graph reinforces that identity plays a central role in shaping how individuals respond to CSHT. Gender-diverse respondents reflect a more balanced view, incorporating medical and psychosocial aspects. Non-binary participants' emphasis on social support underlines the importance of acceptance in treatment success. Figure 9, this graph confirms the widespread belief across gender identities that CSHT enhances emotional well-being. Transgender and non-binary individuals expressed stronger positivity, likely due to direct experiences of relief from gender dysphoria. Figure 10, this figure highlights a consistent belief that hormone therapy improves psychological health across all gender identities. The highest agreement among transgender individuals reinforces that CSHT has direct mental health benefits. Figure 11, Educational qualification appears to play a key role in awareness of cognitive outcomes of hormone therapy. Postgraduates and undergraduates, likely exposed to scientific literature, recognize working memory as a relevant factor. Respondents with lower education levels may not be as familiar with neuropsychological aspects, explaining their hesitancy. Figure 12, Respondents with higher education were more likely to associate hormone therapy with improved emotional regulation. This may result from a better understanding of the emotional aspects of gender dysphoria. Diploma and school-level respondents' varied opinions suggest either personal observations or gaps in conceptual clarity. Figure 13, this figure indicates that more educated individuals tend to internalize identity as the core factor influencing hormone therapy outcomes. Their academic exposure likely informs their understanding of psychological congruence. In contrast, respondents with diploma or school-level education focus more on external factors such as access and support. Figure 14, Higher education correlates with stronger belief in the emotional benefits of CSHT. Respondents with postgraduate and undergraduate qualifications likely have better access to reliable information and support networks. The lower agreement among school-level respondents could reflect limited exposure or social stigma.

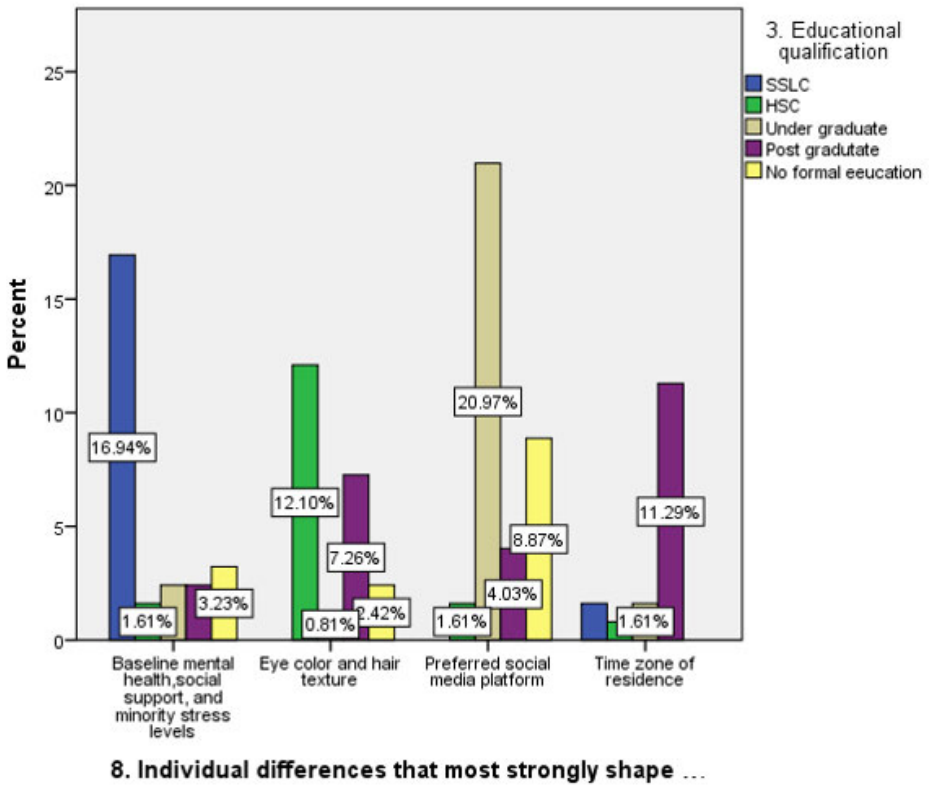


Figure 13: This Illustrates the Correlation between the Respondents' Education Qualifications and Individual differences that most Strongly Shape Outcomes

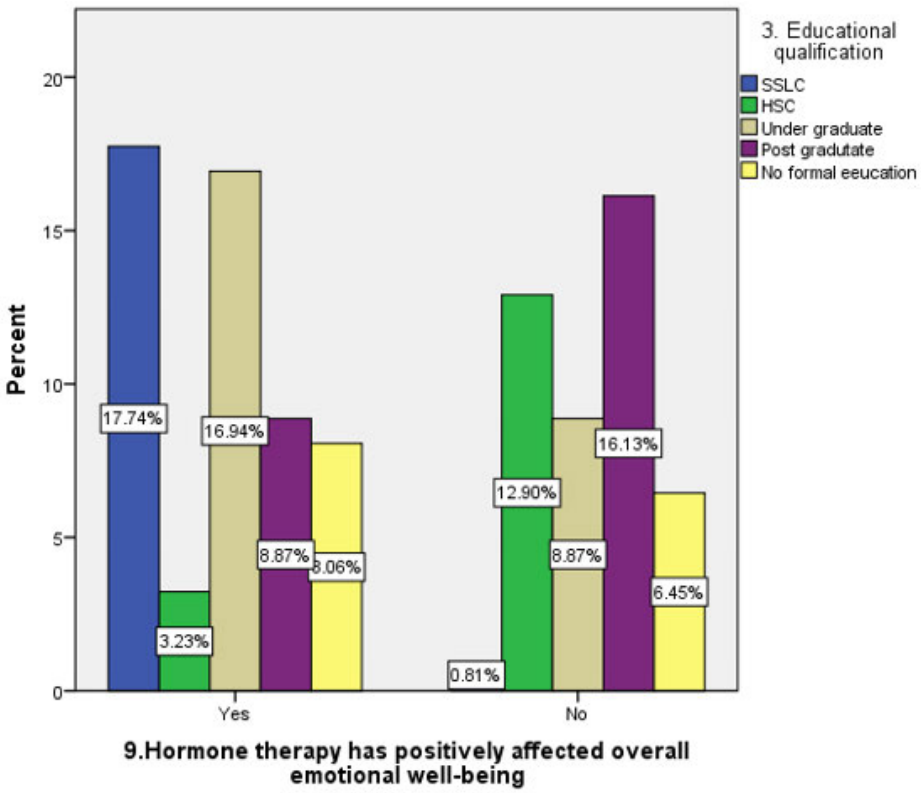


Figure 14: This Illustrates the Correlation between the Respondents Education Qualifications and Hormone Therapy has Positively Affected overall Emotional Well-being

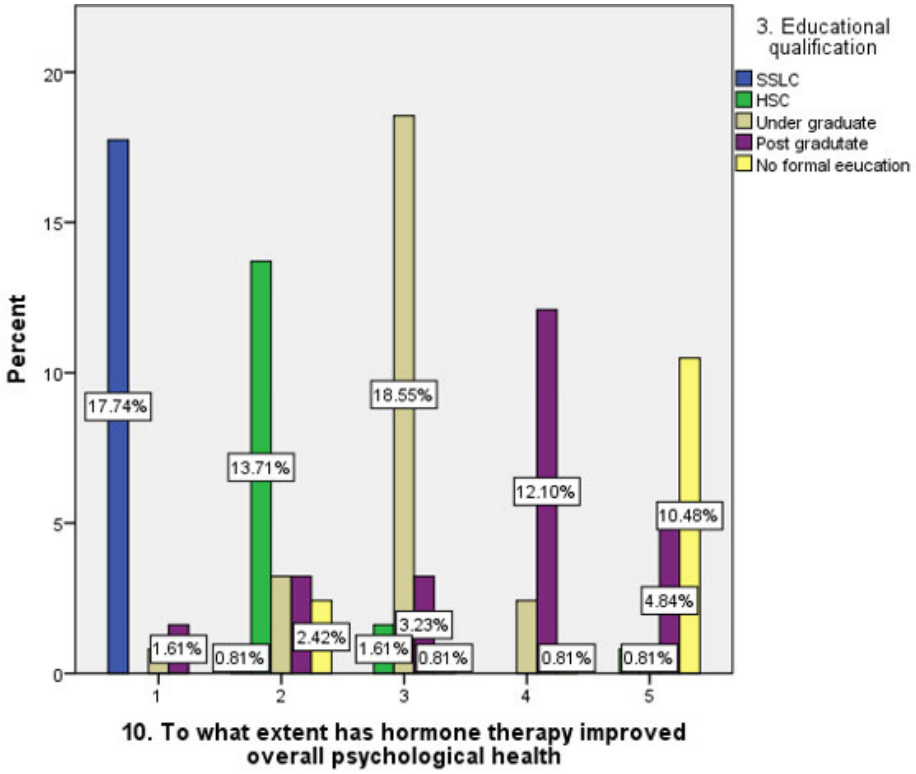


Figure 15: This Illustrates the Correlation between the Respondents Education Qualifications and to what Extent has Hormone Therapy Improved overall Psychological Health

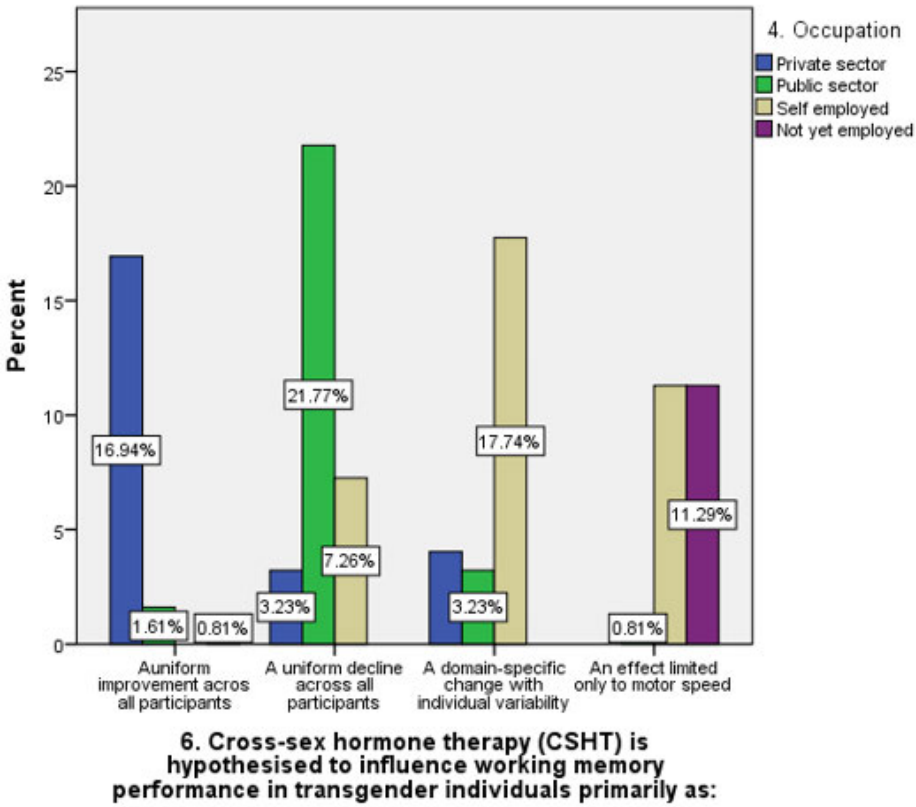


Figure 16: This Illustrates the Correlation between the Respondents Occupation and Cross-Sex Hormone Therapy (CSHT) is Hypothesised to Influence Working Memory Performance in Transgender Individuals Primarily

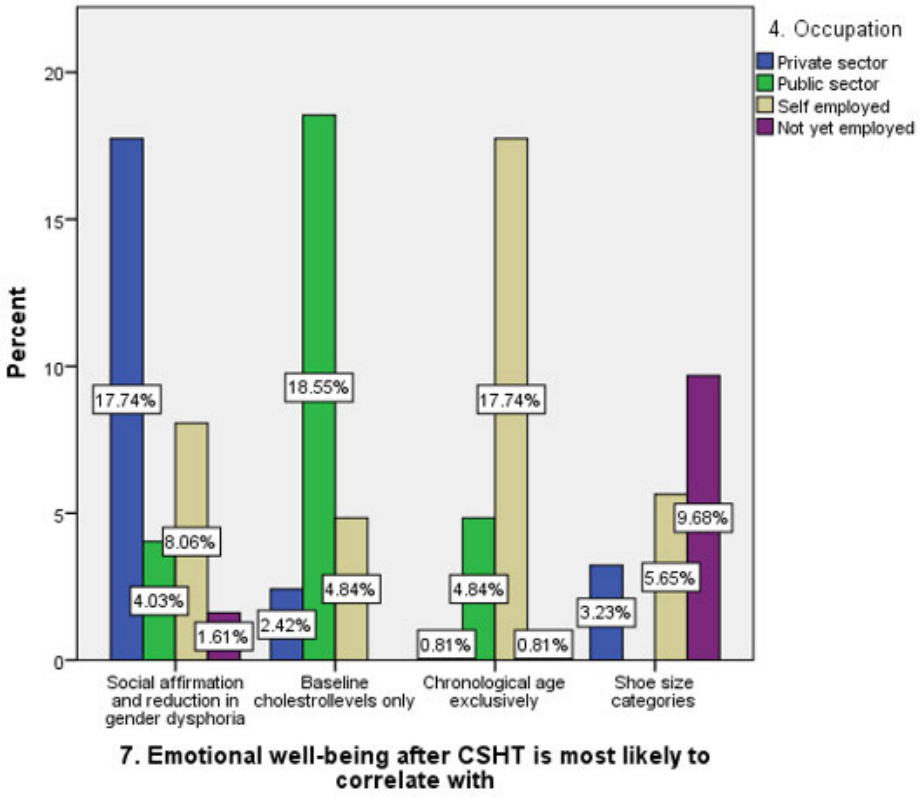


Figure 17: This Illustrates the Correlation between the Respondents Occupation and Emotional well-being after CSHT is most likely to Correlate with

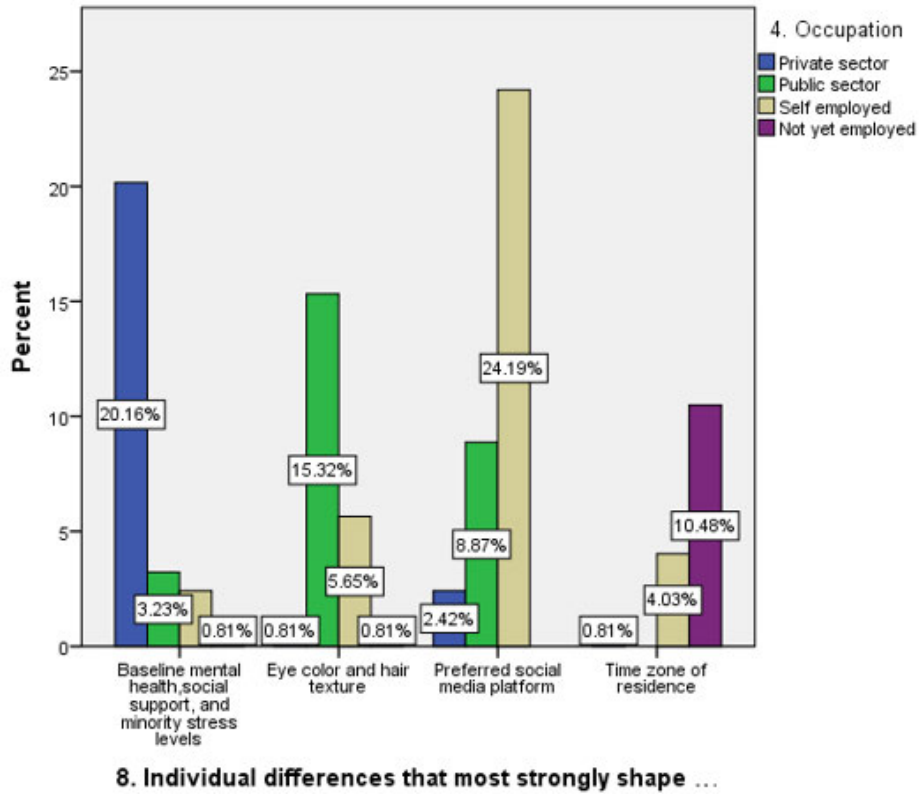


Figure 18: This Illustrates the correlation between the Respondents Occupation and Individual differences that most Strongly Shape Outcomes

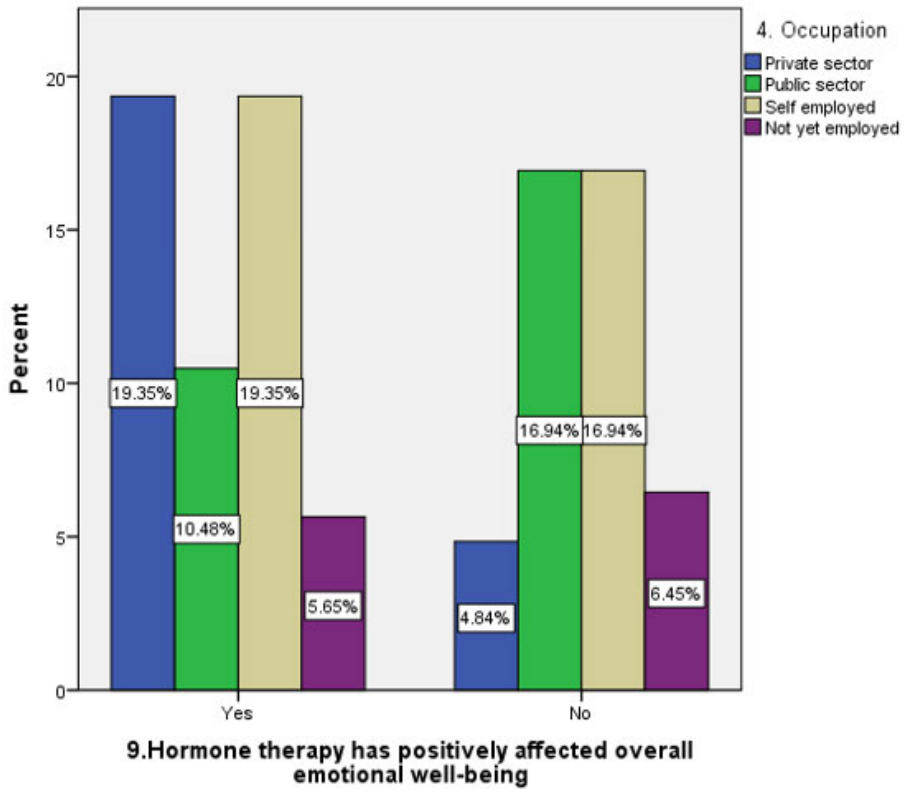


Figure 19: This Illustrates the Correlation between the Respondents Occupation and Hormone Therapy has Positively affected Overall Emotional Well-being

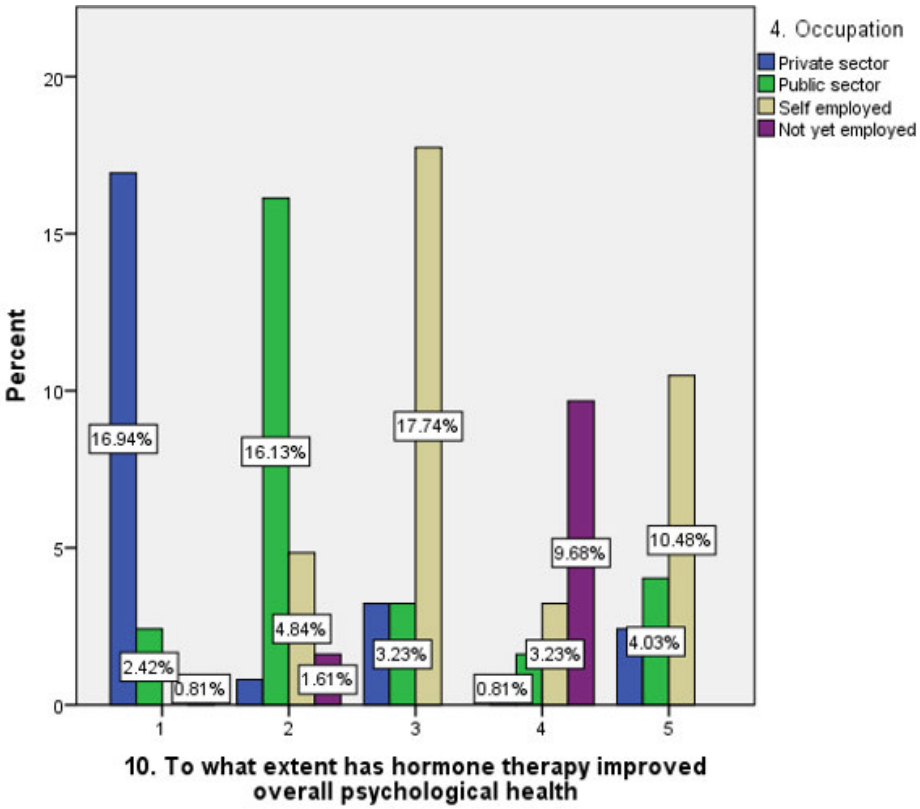


Figure 20: This Illustrates the Correlation between the Respondent's Occupation and To what Extent has Hormone Therapy Improved overall Psychological Health

Figure 15, Once again, education plays a key role in shaping perceptions of CSHT's psychological benefits. Postgraduate respondents likely understand mental health frameworks and view therapy as a holistic process. Undergraduate and diploma holders also show reasonable awareness. In contrast, limited exposure among school-level participants may lead to uncertainty or indifference. Figure 16, the data suggests that occupational background influences awareness of cognitive changes due to CSHT. Professionals and students, who likely have access to information and resources, are more confident about the impact on working memory. Unemployed respondents and wage workers showed less agreement, possibly due to limited exposure or lesser interaction with healthcare. Figure 17, this figure shows that emotional stability is a widely recognized benefit of hormone therapy among educated and professionally active respondents. Students also resonate with this, possibly through exposure to academic or peer discussions. Business professionals connected emotional shifts to motivation, which aligns with performance and productivity concerns. Figure 18, Professionals and students identify strongly with the psychological dimension of identity, reinforcing that internal self-congruence drives therapy success. Business owners and unemployed respondents focus more on external circumstances, like access and support. This reflects the role of financial and healthcare stability in shaping therapy experiences. Daily wage earners showed uncertainty, indicating gaps in awareness. Figure 19, Professionals again show strong recognition of the emotional benefits linked to CSHT. Students' high agreement suggests exposure to progressive ideas and healthcare narratives. Business respondents moderately acknowledged the emotional shift, possibly reflecting pragmatic views. The neutral stance of unemployed participants may indicate less access to emotional or healthcare support systems. Figure 20, improved psychological health is acknowledged primarily by professionals and students, reflecting their mental health literacy. Business owners, while moderately agreeing, may weigh psychological shifts with practical implications. The uncertainty among unemployed and daily wage respondents shows systemic barriers in mental health awareness and care accessibility.

### Limitation

The legal environment surrounding cross-sex hormone therapy significantly influences the scope and consistency of care available to transgender individuals. The variation in legal recognition and accessibility of Cross-Sex Hormone Therapy (CSHT) across different jurisdictions. In many countries, including parts of India, access to gender-affirming medical care such as hormone therapy is legally restricted by requirements like psychiatric evaluations, age thresholds, or parental consent for minors. These legal barriers limit the uniformity of treatment and may restrict participants' ability to access or continue therapy consistently, thus affecting the generalizability of neuropsychological findings. There is no comprehensive legal framework in many countries explicitly protecting the rights of transgender individuals to medical autonomy, which may influence mental health outcomes due to fear of discrimination or legal repercussions. Data privacy laws, such as the Personal Data Protection Bill (India) or GDPR (Europe), also pose restrictions on accessing detailed patient data required for empirical or longitudinal studies, limiting the scope of primary data collection. Legal ambiguity in recognizing non-binary or gender-diverse identities in medical and administrative systems can result in incomplete or misclassified datasets. Finally, ethico-legal conflicts may arise when conducting cross-border research due to differing consent standards, especially in studies involving adolescents or vulnerable populations.

### Suggestions

To strengthen the depth and relevance of this research, it is suggested to include a comparative analysis of neuropsychological responses across different age groups, as hormone therapy may affect adolescent and adult brains differently due to developmental factors. Incorporating longitudinal data wherever available could offer insights into both short-term and long-term cognitive and emotional changes. It would also be beneficial to examine the role of pre-existing mental health conditions and social support systems in moderating therapy outcomes. Collaborating with healthcare professionals and transgender advocacy groups can enhance the credibility and inclusiveness of the study. Furthermore, integrating case studies or qualitative interviews can provide a human-centered perspective alongside existing clinical literature. To address regional disparities, focusing on country-specific healthcare access and legal protections may add significant value, especially in developing nations like India. Lastly, identifying gaps in the current medical-legal framework can help recommend policy-level changes that support the psychological well-being of transgender individuals undergoing cross-sex hormone therapy.

## CONCLUSION

Cross-Sex Hormone Therapy (CSHT) is a vital aspect of gender-affirming medical care for transgender individuals, aiming to align physical characteristics with gender identity. Beyond its physical changes, CSHT has significant neuropsychological effects, influencing cognitive functions, emotional stability and behavioural patterns. Understanding these psychological dimensions is essential for improving healthcare outcomes and reducing stigma surrounding transgender healthcare. The aim of this research was to examine and analyze how CSHT impacts cognitive performance, emotional well-being and behavioural adaptation among transgender individuals. The findings Personal identity and emotional regulation were seen as the most influential factors in shaping therapy outcomes. Respondents with less education or lower occupational status demonstrated more uncertainty or less awareness. Overall, there was strong support for the emotional and psychological benefits of CSHT across diverse groups, though levels of awareness varied. There are suggestions that

there is a need for targeted awareness programs and mental health support that reach under-informed groups, such as daily wage workers and individuals with lower educational backgrounds. Integrating psychological counseling with hormone therapy can enhance outcomes. Public health systems should prioritize education on the emotional and cognitive benefits of CSHT to reduce misconceptions. Future research should adopt longitudinal and clinical methodologies to directly measure neurocognitive changes through tests and brain imaging. Studies comparing pre- and post-CSHT outcomes across age groups, cultural backgrounds and access levels will offer richer insights. Expanding research to include qualitative interviews with transgender individuals can add depth to the lived experiences behind the data. In conclusion, Cross-sex hormone therapy is not only a medical process but also a powerful psychological intervention that contributes to cognitive clarity, emotional stability and behavioural alignment. This research confirms that CSHT has a positive neuropsychological impact, although public understanding of these effects varies across demographics. Addressing educational and occupational disparities in awareness can further promote inclusive and evidence-based transgender healthcare. Continued research and policy attention are essential for enhancing the mental health and well-being of transgender individuals through comprehensive gender-affirming care.

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