Original Article

The Effects of Testosterone Gender-Affirming Hormonal Therapy on Body Composition and Psychosocial Well-being in Transmen

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Abstract

Introduction: The aim is to assess the effects of testosterone therapy on changes in the body composition and psychosocial well-being among treatment-naïve transmen. **Methods:** This is a prospective interventional study conducted over two years in a transgender clinic. The parameters measured were body mass index (BMI), waist-hip ratio (WHR), grip strength, in addition to serum levels of testosterone and estradiol. The body composition indices that include fat mass, lean body mass, android and gynoid regional fat distribution were measured and compared by dual energy x-ray absorptiometry (DXA). The psychosocial aspects of gender dysphoria were assessed with the GPSQ (gender dysphoria and stability questionnaire) scale, and quality of life was evaluated by the RAND SF-36 at baseline and one year of Gender-affirming hormone therapy (GAHT). **Results:** Sixty-eight transgender males were included in the study. The one year of GAHT had significant increase in BMI, grip strength, lean body mass (29.25 ± 6.63 to 35.82 ± 4.46 kg, $P = 0.001$), WHR ($P = 0.025$) and android fat (1.22 ± 1.36 into 1.74 ± 1.46 kg, $P = 0.001$), whereas significant reduction in total fat mass (17.07 ± 12.70 into 12.00 ± 10.51 kg, $P = 0.001$) and gynoid fat (3.59 ± 1.86 into 1.74 ± 1.46 kg, $P = 0.001$) was observed. There was a positive correlation between WHR and android fat distribution ($r = 0.5$). GPSQ scales and quality-of-life scores significantly improved at the end of the study. **Conclusion:** Testosterone GAHT helps in alleviating gender dysphoria as well as significant improvement in the desired body composition. The WHR may be used as a simple clinical tool to assess the android fat redistribution following testosterone therapy.

Keywords: Body composition, gender-affirming hormonal therapy, gender dysphoria questionnaire, testosterone, transgender, transmen

Introduction

Transgender and gender diverse (TGD) individuals are those whose gender identity is different from the gender that was assigned at birth.[1] Transgender males/female-to-male (FtM)/ transgender males are individuals who are assigned female sex at birth (AFAB), but they identify as male. In transgender individuals, puberty often brings significant incongruence between gender identity and body morphology. Gender-affirming hormone therapy (GAHT) helps align body composition with the affirmed gender.

Transgender health care is making rapid strides in India due to the availability of a greater number of multi-disciplinary transgender clinics, increased awareness about the benefits of GAHT and gender-affirming surgical (GAS) procedures. Testosterone therapy is the primary therapy in gender-affirming hormonal therapy (GAHT) for transmen for alleviating gender dysphoria. It aids in masculinisation and defeminisation, helping align the physical characteristics with their desired gender among trans males. The various formulations of testosterone preparations as recommended by the Endocrine Society, including transdermal (gel), parenteral and oral, are

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available to maintain serum testosterone levels in the cis-male range and to achieve the desired physical characteristics.[2]

The expected physical changes following testosterone administration include cessation of menstrual cycles, development of facial and body hair, masculinisation of voice, and clitoral enlargement.[3] The testosterone therapy also helps in improving muscle strength and desired body composition changes, which have a significant impact on their physical, psychosocial well-being and quality of life. Testosterone therapy induces android fat redistribution resembling typical male pattern, usually noticeable after six months, which further improves body image. Currently, very limited prospective studies are available regarding the assessment of body composition changes and the quality-of-life following testosterone therapy in transgender males.[4-8] In the present prospective study, we aimed to evaluate the effect of testosterone therapy as GAHT on these parameters among transgender males.

Materials and Methods

This interventional study was conducted in a transgender multi-speciality clinic of a 4000-bedded tertiary care referral centre in South Tamil Nadu between March 2023 and February 2025. The inclusion criteria were treatment-naïve transgender males of more than 18 years of age, in whom gender incongruence was confirmed by Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria.[9] Those with a previous history of testosterone use, uncontrolled diabetes mellitus, and obesity with a BMI of more than 35 kg/m^2 were excluded. Testosterone therapy was initiated and titrated in accordance with the Standards of Care for the Health of Transgender and Gender Diverse People, Version 8 of the World Professional Association for Transgender Health (WPATH). The sample size was estimated using Epi Info™ (version 7.2, CDC, Atlanta, USA), assuming a medium effect size (Cohen's $d = 0.5$) for changes in lean body mass (kg) measured by DXA, with 80% power and $\alpha = 0.05$, yielding a minimum required sample of 58 participants (29 per group). A total of 68 participants met the inclusion criteria and were randomised in a 1:1 ratio ($n = 34$ per group), and outcome data at 1 year were available for 62 participants (31 per group) who completed the study. Forty-one Participants received injectable testosterone enanthate starting at 50–100 mg and titrated up to 250 mg based on clinical response and serum testosterone levels, and continued thereafter at once in 3-week intervals. Twenty-seven participants received testosterone undecanoate 1000 mg, with the second dose being administered at 6 weeks, followed by 12 weekly intervals. Formulation choice was individualised based on availability and patient preference. According to the Declaration of Helsinki, medical research involving human subjects and the well-being of individual research subjects have taken precedence over all other interests.

The anthropometric parameters assessed were body mass index (BMI), waist-hip ratio (WHR), and muscle strength at the initial visit, followed by assessments every three months for one year. The muscle strength was assessed by the Camry digital handgrip dynamometer,[10] which measured the handgrip strength in kg, and an average of three readings was taken as the measured value. The hormonal parameters estimated were total testosterone and estradiol levels before starting testosterone therapy. Hormonal parameters were measured again at 3, 6, and 12 months. Testosterone levels were measured midway between injections for testosterone enanthate and at the end of the dosing interval for testosterone undecanoate, just before the next dose. All the hormonal parameters were measured by the electrochemiluminescence immunoassay (ECLIA) method by Roche Cobas e411.

The body composition analysis was done at baseline and the end of one year by the Lunar DPX DXA system (analysis version 13.40 manufactured by GE Healthcare). The parameters assessed by DXA were total body fat percentage (%), lean body mass (kg), and region-specific fat mass that includes arm, leg, trunk, android, and gynoid regions. The fat mass ratios, which include trunk/total fat mass, legs/total fat mass and arms + legs/trunk fat mass, were also analysed. The appendicular lean mass was calculated by adding the arms and leg lean mass.

The gender dysphoria was assessed by the Gender Preoccupation and Stability Questionnaire (GPSQ)[11] and quality of life (QoL) by the RAND SF 36 questionnaire at baseline and one year of GAHT. GPSQ consists of 14 questions with five responses (1–5) for each question. The total score for all 14 questions is 70, and the higher the score, the more severe the gender dysphoria. These questions were designed primarily to assess the effectiveness of medical, surgical, social, and psychological interventions that alleviate gender dysphoria.

RAND SF 36, which is an inexpensive tool for assessing the quality of life, consists of a set of 36 questions about eight domains. The scores of eight domains are about physical functioning (relating to the extent of physical limitations), social functioning (relating to one's ability to participate in social activities), role limitations due to physical health (relating to the extent individuals were limited in work/activities due to physical health), role limitations due to emotional health (relating to the extent individuals were limited in work/activities due to mental health), pain (relating to physical pain), energy/fatigue (relating to one's energy levels/vitality), general health (relating to one's perceived physical well-being), and emotional well-being (relating to perceived mental well-being).[12] Each domain is denoted by a value from 0 to 100 with a total score of 800, and the higher the score, the better the quality of life of that individual for that particular domain.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). The normality of data distribution was assessed using the Shapiro–Wilk test and visual inspection of histograms and Q–Q plots. As several variables did not follow a normal distribution, appropriate non-parametric tests were applied. The Wilcoxon

signed-rank test was used to compare pre- and post-intervention values of body composition and fat distribution parameters. For the analysis of hormonal levels (testosterone, estradiol) and grip strength measured at baseline, six months, and one year, the Friedman test with Bonferroni-adjusted *post hoc* comparisons was utilised. Spearman's rank analysis was done to assess the correlation between testosterone levels, lean mass, and grip strength at different time points. Statistical significance was set at $P < 0.05$.

Ethical aspects

Approval was obtained from the Institutional Ethical Committee of Madurai Medical College and Government Rajaji Hospital, Madurai vide letter approval dated 7.10.2022. The procedures used in this study adhere to the principles outlined in the Declaration of Helsinki (1964) and its subsequent revisions. Written informed consent was obtained from the patient for participation in the study and for the use of clinical data for research and educational purposes. Clinical Trial Registration No. CTRI/2023/05/052920.

Results

A total of 340 transgender males had visited the clinic over 2 years, of which 68 were included for the study based on the inclusion criteria. The study algorithm is summarised in Figure 1. The outcome data were available for 62 patients who had completed 1 year of GAHT. The mean age of the study population was 23.26 ± 4 years, and the age at onset of gender incongruence was 11.5 ± 2.5 years.

The mean duration of onset, i.e., clinically observable change in facial and body hair onset, was at 2.5 ± 1 months and clitoromegaly at 1.8 ± 0.6 months following testosterone therapy. The baseline haematological and hormonal parameters are detailed in Table 1, which shows a statistically significant increase in haemoglobin, haematocrit and testosterone levels and a decrease in estradiol levels at 6 months and 1 year of testosterone therapy as compared to baseline.

The body composition changes, following testosterone therapy, showed a significant increase in BMI ($P = 0.015$), WHR ($P = 0.025$) and a decrease in fat mass (both absolute and percentage) ($P = 0.001$), and an increase in lean mass ($P = 0.001$). The detailed changes are summarised in Table 2. The regional fat distribution (%) also changed following testosterone therapy, with the trunk/total fat ratio increased ($P = 0.001$). In contrast, the legs/total fat ratio decreased ($P = 0.001$), with the gynoid to android distribution confirming this trend. There was a significant positive correlation between WHR and android fat distribution as depicted in Figure 2.

The grip strength was improved significantly ($P = 0.001$), from 10.00 kg baseline to 17.00 kg at six months and 28 kg at one year, suggestive of substantial improvement in muscle function [Table 2]. The *post hoc* pairwise comparisons also confirmed that there was a progressive improvement in muscle strength at different time points, with significant differences. Despite a progressive increase in muscle strength and testosterone levels at six months, there was no correlation between them at 6 months ($r = 0.22$, $P = 0.119$) and 1 year ($r = -0.16$, $P = 0.476$). Similarly, lean mass also showed no correlation with grip strength at one year ($r = 0.12$, $P = 0.405$).

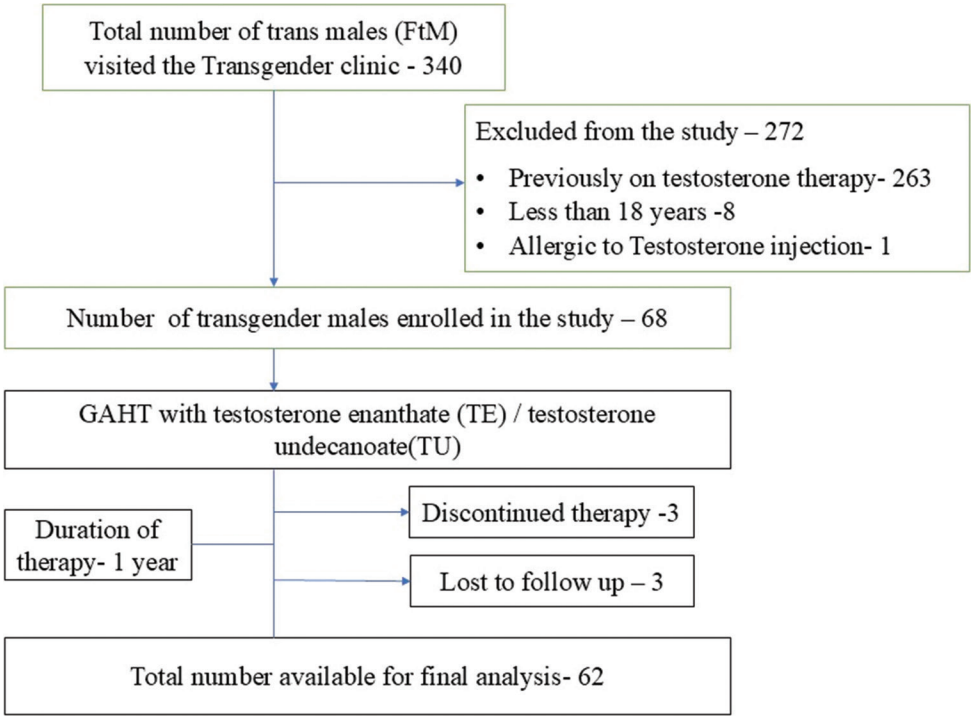

Figure 1: Study algorithm showing enrolment, follow-up, and final cohort

Table 1: Comparison of biochemical and hormonal parameters from baseline, 6 months and at 1 year of testosterone therapy

	Baseline (median±IQR)	At 6 months (median±IQR)	At 12 months (median±IQR)	*P* (baseline vs 12 months)	*P* vs *post hoc* comparison
Biochemical parameters					
Haemoglobin (g/dL)	11.7±3.3	12.3±3.4	12.5±3.0	0.001*	b*, c*
Haematocrit (%)	35.0±8.0	37.5±9.0	38.0±7.8	0.001*	a*, b*, c*
Hormonal parameters					
Testosterone (ng/dL)	34.8±32.5	506.4±325.7	865.0±228.0	0.001*	a*, b*, c*
Estradiol (pg/mL)	87.6±126.1	50.7±23.1	42.5±22.0	0.002*	b*

*(*P*<0.05) Friedman test with *post hoc* Bonferroni adjustment for multiple comparisons for aBaseline vs 6 months; bBaseline vs 12 months; c6 months vs 12 months

Table 2: Body composition- comparison at baseline and after one year of testosterone therapy

Variable	Baseline Median±IQR	Post intervention Median±IQ	*P*
Clinical parameters			
Body mass index (kg/m²)	20.27±5.28	21.02±4.59	0.015*
Waist circumference (cm)	72.0±9.5	79.0±8.7	0.001*
Hip circumference (cm)	90.0±10.2	92.0±9.80	0.038*
Waist–hip ratio	0.80±0.12	0.86±0.09	0.025*
Grip strength (kg)	10.00±2	17.00±5	0.001*
Body fat			
Fat mass (kg)	17.07±12.70	12.00±10.51	0.001*
Fat mass (%)	35.95±16.52	28.00±12.75	0.001*
Gynoid fat (kg)	3.59±1.86	2.89±1.79	0.001*
Android fat (kg)	1.22±1.36	1.74±1.46	0.001*
Fat mass ratios			
Trunk/total fat ratio	0.52±0.05	0.56±0.04	0.001*
Legs/total fat ratio	0.38±0.05	0.32±0.04	0.001*
Arms + legs/trunk ratio	0.88±0.15	0.75±0.11	0.001*
Total body fat/H² (kg/m²)	6.62±5.17	4.73±5.66	0.001*
Lean body mass			
Lean mass (kg)	29.25±6.63	35.82±4.46	0.001*
Appendicular lean mass/H² (kg/m²)	5.66±0.81	7.06±1.51	0.001*
Total lean body mass/H² (kg/m²)	12.04±1.14	14.11±1.41	0.001*

IQR=Interquartile Range. **P*<0.05; Wilcoxon signed-rank test; Effect size±Rank Biserial Correlation measures the strength of the difference±ranges from −1 to +1. Negative values indicate an increase in post-test values. Positive values indicate a decrease in post-test values

Table 3 analyses gender dysphoria and quality of life before and after the intervention. Psychological distress was significantly reduced after one year of GAHT, as measured by the General Psychological Stress Questionnaire (GPSQ) ($P = 0.001$). Additionally, notable improvements were seen across various domains, including emotional well-being ($P = 0.001$), social functioning ($P = 0.001$), and general health ($P = 0.001$).

Discussion

This prospective study among 68 transgender male individuals receiving testosterone therapy demonstrated significant improvements in body composition and psychosocial well-being over one year. There was a notable 23% increase in lean body mass, along with increases in grip strength and WHR, and an around 43% increase in android fat, with a concurrent reduction of nearly 30% in total fat mass and 50% in gynoid fat mass. These changes are consistent with the sexual dimorphism of body composition, reflecting a shift toward a typical male android fat distribution pattern.[13] The findings are in agreement with previous prospective literature, though such studies remain limited. Additionally, GPSQ and quality-of-life scores improved significantly, emphasising the beneficial physical and psychosocial effects of gender-affirming hormone therapy.

The body composition analysis was conducted using DXA, which offers several advantages, including the ability to delineate bone, fat, and lean mass (which includes muscle, connective tissue, water, and organs) separately, reduced radiation exposure, ease of use, shorter analysis time, and cost-effectiveness. The additional advantages of DXA include assessing lean mass and regional fat distribution, which encompasses appendicular, trunk, android, and gynoid areas. Even though magnetic resonance imaging (MRI) is the gold standard quantitative method for assessing body fat, it requires individual site imaging, such as the abdomen, right and left arms, and right and left thighs, to determine the individual fat percentage. In addition, the cost of the test, prolonged imaging time, and the need for expertise to interpret and analyse the data, preclude the use of MRI.[14]

The GAHT with testosterone was associated with prominent musculature of the upper and lower limbs with a male pattern of body fat distribution. The WHR and BMI were increased significantly following one year of testosterone therapy. The change in WHR is considered a surrogate marker of android to gynoid adiposity, and only very few studies have reported these effects; the remaining showed inconsistent effects on waist and hip circumference.[15] The overall body fat percentage decreased following testosterone, and fat redistribution was more of android fat (1.74 ± 1.46 kg vs 1.22 ± 1.36 kg, *P* value = 0.001) and less of gynoid fat (3.59 ± 1.86 kg vs 2.89 ± 1.79 kg, *P* value = 0.001). These effects were consistent with a male pattern of body fat distribution as evidenced by altered fat mass ratios with increased trunk/total fat and decreased legs/total fat.

Table 3: Comparison of GPSQ and quality of life at baseline and after one year of testosterone

Variable Name	Baseline Median±IQR	12 Months Median±IQR	*P*
General Psychological Stress Questionnaire (GPSQ)	47.0±13.3	28.0±7.3	0.001*
RAND-SF 36			
Physical functioning	92.5±20.0	100.0±6.3	0.004*
Role limitations due to physical health	100.0±50.0	100.0±25.0	0.025*
Role limitations due to emotional problems	100±52.7	100±0	0.005*
Energy/Fatigue	75.0±35.0	90.0±25.0	0.001*
Emotional Well-being	68.0±24.0	87.0±25.0	0.001*
Social Functioning	62.5±75.0	100.0±25.0	0.001*
Body Pain Score	90.0±22.5	100.0±10.0	0.026*
General Health Score	79.7±27.5	100.0±20.0	0.001*

IQR=Interquartile Range. RAND SF 36- RAND developed the 36-Item Short Form Health Survey (SF-36); wilcoxon signed-rank test; * (P<0.05)

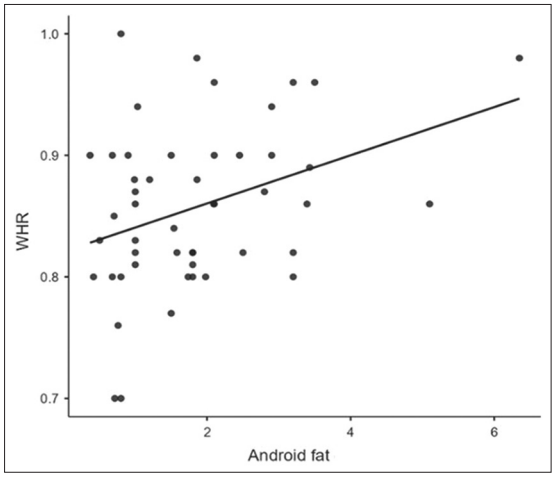

Figure 2: Scatter plot diagram depicting the positive correlation between Waist-Hip-Ratio and Android fat after testosterone therapy

Similarly, Ceolin *et al*.,[16] in their prospective study evaluating the effects of testosterone therapy in trans men, observed a significant decline in adiposity after 1 year. The mean body fat percentage decreased from 29.6 ± 8.4% to 27.7 ± 7.2%, and the fat mass index (FMI) showed a modest reduction from 7.57 ± 3.51 kg/m² to 7.48 ± 3.47 kg/m². Moreover, in their study, the tibial fat area measured by peripheral quantitative computed tomography (pQCT) decreased from 3203 ± 1130 cm² to 2746 ± 1018 cm², reflecting a testosterone-associated reduction in both total and regional fat mass. Correspondingly, Klaver *et al*.[15] assessed 162 transmen after one year of testosterone therapy (esters, gel, or undecanoate). Marked reductions occurred in leg (−16%) and gynoid (−14%) fat, while android fat remained unchanged (+1%). Lean mass increased across all regions (+9% trunk to +19% arm). Hip circumference declined (−1.9 cm) and WHR rose slightly (+0.01), reflecting a distinctly masculinised body composition pattern.

The mechanisms of more android fat development following testosterone are due to the binding of testosterone to androgen receptors that inhibit lipoprotein lipase activity and increase adipose tissue lipolysis, leading to an overall decrease in fat storage in the gynoid region.[17] Since there was a significant positive correlation between WHR and android fat [Figure 2], WHR can be used as a simple clinical tool to assess desired android fat distribution in trans males without doing DXA in resource-limited settings.

The present study reported a significant increase in lean muscle mass at the end of one year (21.02 ± 4.59 kg vs 29.25 ± 6.63 kg, P value = 0.001), which was consistent with the retrospective study by Tominaga *et al*. who analysed the effect of various doses of testosterone in trans males.[6] The calculated appendicular lean mass/(height)^2 and the total lean body mass/(height)^2 ratios also were increased following testosterone therapy at 1 year in alignment with previously published literature. Similarly, Ceolin *et al*.,[16] in their prospective study on trans men, observed a significant anabolic response after one year of testosterone therapy, with Appendicular Skeletal Muscle mass index (ASMMI) increasing from 7.17 ± 0.75 to 7.39 ± 1.32 kg/m². Van Caenegem *et al*.,[18] in a cross-sectional study (mean 10.1 years of therapy), reported higher lean body mass increasing from 29.2 ± 6.6 kg at baseline to 35.8 ± 4.5 kg, confirming sustained androgen-driven muscular enhancement, significantly higher than age-matched cis-female counterparts.

Handgrip strength is a surrogate marker of muscle strength. The hand grip strength increased following testosterone therapy. It was noted as early as six months. A further increase was reported at one year of treatment, which was similar to the study by the European Network for the Investigation of Gender Incongruence (ENIGI).[5] Hand grip strength shows a strong relationship with maximum upper-body strength and is partially related to lean body mass.[19] Ceolin *et al*.,[16] in their prospective study on trans men, observed an increase in handgrip strength of similar magnitude from 32.2 ± 5.3 to 34.9 ± 6.4 kgf after one year of testosterone therapy. Van Caenegem *et al*.[18] reported higher grip strength in long-term treated trans men (31.0 ± 5.6 kg vs 41.4 ± 7.2 kg), reflecting sustained androgen-mediated muscular improvement. Likewise, Wiik *et al*. studied 12 transgender men receiving testosterone undecanoate 1000 mg intramuscularly every 10 weeks for 12 months. Using magnetic resonance imaging (MRI) and computed tomography (CT), they demonstrated a 15% rise in thigh muscle volume and cross-sectional area, 6% increase

in radiological density, and improved knee extensor/flexor strength measured by isokinetic dynamometry.[20] The various mechanisms that lead to improvement in the muscle strength are an increase in appendicular lean mass, the anabolic effects of testosterone on muscle fibres, an increase in muscle protein synthesis, hypertrophy of Type 1 and 2 muscle fibres, and promotion of myocyte differentiation and inhibition of differentiation into adipogenic cells by androgens.[21] In our study, the possible reason for the weak correlation of hand grip despite rising testosterone levels is due to the plateauing effects of grip strength.

The GAHT plays a significant role in alleviating gender dysphoria and improving the quality of life in terms of emotional well-being, social functioning, and reducing role limitations due to emotional problems. The beneficial effects of GAHT in alleviating gender dysphoria and enhancing the quality of life have been studied previously[22-25] by using various scores. Some of the scores used in these studies are WHO Quality of life (WHOQOL-100),[23] Body uneasiness (BUT), psychopathology (SCL-90-R)[24], Body image (BIS), Utrecht Gender Dysphoria Scale (UGDS).[25] However, a multi-dimensional analysis of different aspects of quality of life has been assessed prospectively in very few studies.

Transgender individuals have lower body satisfaction indices before starting GAHT, which is associated with poor quality of life. The quality-of-life changes are an indirect effect of the alleviation of gender dysphoria, which motivates the individuals to have better social functioning and emotional well-being. An early intervention with GAHT has been shown to have a positive impact on the psychological aspects of transgender individuals.[24]

In the present study, we used the GPSQ and RAND SF-36 questionnaires. The alleviation of gender dysphoria is achieved by continuous testosterone therapy, which leads to the desired physical changes like cessation of menstrual cycles, facial and body hair, clitoromegaly, and alters body composition, thereby leading to greater satisfaction with body image with an overall improvement in the quality of life.[26] The emotional well-being and social functioning domains were also shown to have significant improvement among all after testosterone therapy. The study by Engel *et al*.[8] in TGD children and adolescents, it was found that gender dysphoria was associated with poor quality of life.

The strengths of the present study include its prospective design and single-centre setting. To the best of our knowledge, this is the first South Asian study to assess changes in body composition following testosterone therapy. Another strength is that morbidly obese individuals were excluded from the DXA assessment to avoid confounding factors. The limitations of the study include its short duration and small sample size, which prevented evaluation of the long-term effects of testosterone on body composition and bone mineral density.

Conclusion

GAHT with testosterone in transgender males helps in improving body composition as well as alleviating gender dysphoria. These desired changes were associated with improved quality of life. WHR can be used as a surrogate marker for android fat distribution following GAHT.

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Author's contribution

- SS was involved in the concept, design, and final approval of the manuscript.
- SS was involved in the collection of data and preparation of the manuscript for submission.
- Anuradha was involved in performing bilateral mastectomies for the patients
- RC was involved in the statistical analysis of the data
- PS was involved in managing patients and collecting data.
- GV was involved in the management of patients.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence

No use of artificial intelligence was involved in the study.

Data availability statement

Data available on request.

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