Muscle groups located on upper body seem to be more responsive on testosterone levels compare to lower body muscles (17). However, there are only limited data available on the beneficial effects of TT on lower limb muscle strength (16, 17).

One of the possible drawback of the study was combination of patients treated with testosterone replacement therapy and untreated males. However, the relationship between parameters studied was very similar in both treated and untreated males, when analysed separately. Therefore, the data were merged for the purpose of the present study.

Conclusions

The main finding of this study was that testosterone levels had a strong inverse correlation with abdominal circumference and total body fat mass. On metabolic level, strong inverse correlation was also found between TT with insulin and TT with HOMA-IR. However, we did not find statistically significant correlation between total testosterone levels and lean mass, muscle strength or physical function in middle aged males. These results suggest strong role of testosterone on lipid profile, metabolic syndrome and other similar diseases with altered body composition towards higher proportion of fat tissue. Further studies need to be done for better understanding of the mechanisms how testosterone levels affect overall and regional lean mass, muscle strength, physical function and metabolic parameters in middle age males.

Trial registration: ClinicalTrials.gov: NCT03282682. The study was funded by the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and of the Slovak Academy of Sciences (VEGA) no. 1/0714/16.

REFERENCES

1. Bhasin S, et al. Testosterone therapy in adult men with androgen deficiency syndromes: an endocrine society clinical practice guideline. J Clin Endocrinol Metab 2006; 91: 1995–2010.
2. Bianchi VE, Locatelli V. Testosterone a key factor in gender related metabolic syndrome. Obes Rev 2018; 19: 557–575.
3. Hsu B, Cumming RG, Handelsman DJ. Testosterone, frailty and physical function in older men. Expert Rev Endocrinol Metab 2018; 13: 159–165.
4. Borst SE, Mulligan T. Testosterone replacement therapy for older men. Clinical Interventions in Aging 2007; 2: 561–566.
5. Wang C, et al. REVIEW ISA, ISSAM, EAU, EAA and ASA recommendations: Investigation, treatment and monitoring of late-onset hypogonadism in males. International Journal of Impotence Research 2009; 21: 1–8.
6. Jaworski PED, Ramos A, Nicoleit AR, et al. Importance of abdominal circumference and body mass index values in predicting male hypogonadism; A practical approach. Archives of Endocrinology and Metabolism 2017; 61: 76–80.
7. Corona G, Bianchini S, Sforza A, et al. Hypogonadism as a possible link between metabolic diseases and erectile dysfunction in aging men. Hormones (Athens) 2015; 14: 569–578.
8. Santosa S, Jensen MD Effects of male hypogonadism on regional adipose tissue fatty acid storage and lipogenic proteins. PLoS One 2012; 7: e31473.
9. Kelly DM, Jones TH. Testosterone and obesity. Obes Rev 2015; 16: 581–606.
10. Reynolds JM Prediction of one repetition maximum strength from multiple repetition maximum testing and anthropometry. Journal of Strength and Conditioning Research 2006; 20: 584–592.
11. Ebbeling CB, Ward A, Puleo EM, et al. Development of a single-stage submaximal treadmill walking test. Med Sci Sports Exerc 1991; 23: 966–973.
12. Akishita M, Fukai S, Hashimoto M, et al. Association of low testosterone with metabolic syndrome and its components in middle aged Japanese men. Hypertension Res 2010; 33: 587-591.
13. Grossmann M et al. Low Testosterone Levels Are Common and Associated with Insulin Resistance in Men with Diabetes. The Journal of Clinical Endocrinology & Metabolism 2008; 93: 1834–1840.
14. Dandona P, Rosenberg MT. A practical guide to male hypogonadism in the primary care setting. International Journal of Clinical Practice 2010; 64: 682–696.
15. Shamim MO, Khan FMA, Arshad R. Association between serum total testosterone and Body Mass Index in middle aged healthy men. Pak J Med Sci 2015; 31: 355–359.
16. Huhtaniemi I Late-onset hypogonadism: Current concepts and controversies of pathogenesis, diagnosis and treatment. Asian J Androl 2014; 16: 192–202.
17. Hildreth KL, Barry DW, Moreau KL, et al. Effects of testosterone and progressive resistance exercise in healthy, highly functioning older men with low-normal testosterone levels. The Journal of Clinical Endocrinology and Metabolism 2013; 98: 1891–1900.