ORIGINAL RESEARCH

Association Between Testosterone Levels and Physical performance in Elderly Men

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Received: 04November, 2023 Accepted: 12December, 2023

ABSTRACT
Background: This study explores the interplay between testosterone levels, lifestyle behaviors, comorbidities, and physical performance in elderly men at a tertiary care center.**Materials and Methods:** A hospital-based cross-sectional study was conducted among 100 participants aged 60 and above. Data included lifestyle behaviors, comorbidities, Non-smokers comprised 71%, challenging the expected impact on testosterone. Alcohol users exhibited lower testosterone, contrary to assumptions. Surprisingly, non-exercisers had slightly higher SPPB scores. Chronic conditions like diabetes and hypertension showed nuanced associations with testosterone. BMI correlations were non-significant.**Conclusion:**Unexpected findings highlight the need for tailored health approaches in elderly populations. Holistic interventions should consider hormonal dynamics, lifestyle factors, and comorbidities, emphasizing individualized care for optimal aging.
Key words: Testosterone, Elderly, Lifestyle, Chronic Conditions, Physical Performance, Aging.

INTRODUCTION
Aging is an inevitable and complex biological process that brings about a myriad of physiological changes, impacting various systems within the human body.[1] One crucial aspect of aging is the decline in physical performance, which significantly influences the overall well-being and quality of life in elderly individuals.[2] As researchers and healthcare professionals seek to unravel the intricacies of this phenomenon, the role of hormonal changes, particularly in testosterone levels, has emerged as a focal point of investigation.

The primary aim of this research is to discern the association between testosterone levels and physical performance in elderly men within the confines of a Tertiary care center. Understanding the interplay between testosterone and physical performance is paramount in developing targeted interventions that can potentially enhance the quality of life for aging individuals.[3]

Testosterone, a key sex hormone predominantly produced in the testes, plays a pivotal role in maintaining various physiological functions, including muscle mass, bone density, and overall energy levels.[4] As individuals age, there is a natural decline in testosterone production, a phenomenon often referred to as andropause.[5] This decline has been implicated in the deterioration of physical performance observed in elderly men. Investigating the association between testosterone levels and physical performance is, therefore, a crucial step towards comprehending the underlying mechanisms contributing to age-related functional decline.

The secondary aim of this study broadens the scope of inquiry to explore the multifaceted factors that might influence testosterone levels and, consequently, physical performance in elderly men. Comorbidities such as diabetes and hypertension have been recognized as prevalent health conditions among the elderly population, and their potential impact on testosterone levels warrants careful examination. Additionally, lifestyle behaviors, including smoking, alcohol consumption, and exercise, are modifiable factors that could play a role in shaping the hormonal

milieu and physical well-being of elderly individuals.[6]

Diabetes, characterized by impaired insulin function, has been associated with hormonal imbalances, including alterations in testosterone levels.[7] Similarly, hypertension, a common cardiovascular condition in the elderly, may have implications for hormonal regulation.[8] Understanding the relationship between these comorbidities and testosterone levels is crucial for designing holistic interventions that address both hormonal and systemic health.

Lifestyle behaviors, often considered modifiable risk factors, can exert profound effects on hormonal balance and physical performance. Smoking, known for its detrimental impact on cardiovascular health, may also influence testosterone levels.[9] Conversely, regular exercise, a cornerstone of healthy aging, has been linked to improved hormonal profiles and enhanced physical function.[10] The interplay between these lifestyle factors and testosterone levels is an essential aspect of our investigation.

This study endeavors to shed light on the intricate relationship between testosterone levels and physical performance in elderly men. By delineating the associations with comorbidities and lifestyle behaviors, we aim to provide a comprehensive understanding of the factors influencing hormonal balance in the aging population. Ultimately, the insights gleaned from this study may pave the way for targeted interventions that promote healthy aging and improve the overall quality of life for elderly individuals.

MATERIALS AND METHODS

Study Design: This research employed a hospital-based cross-sectional analytical study design to investigate the association between testosterone levels and physical performance in elderly men. The chosen design allows for the examination of relationships between variables within a specific time frame and healthcare setting.

Study Setting: Conducted at Rajiv Gandhi Government General Hospital (RGGGH) in Chennai, India, the study benefited from a diverse patient population attending this renowned healthcare institution. The choice of a tertiary care center ensures a comprehensive representation of elderly individuals seeking medical care.

Study Period: The investigation spanned a one-year period, commencing in January 2021 and concluding in December 2021. This timeframe provides a substantial duration for data collection, allowing for a robust analysis of the association between testosterone levels and physical performance in the elderly.

Study Participants: The study focused on male participants aged 60 years and above attending the Geriatric Outpatient Department (OPD) at RGGGH, Madras Medical College. By targeting this specific demographic, the research aims to generate insights applicable to the aging male population seeking medical attention.

Inclusion and Exclusion Criteria: Inclusion criteria encompassed patients aged 60 and above, males willing to participate, and those with well-controlled Type 2 Diabetes and Hypertension. Conversely, exclusion criteria ranged from unwillingness to provide informed consent to specific medical conditions and impairments, ensuring a refined participant pool.

Sample Size: With a sample size of 100, participants fitting the inclusion criteria were selected through a hospital-based sampling method. This approach enhances the study's internal validity by focusing on individuals within the designated age group and health conditions of interest.

Study Procedure: Data collection involved a semi-structured questionnaire administered to eligible participants, capturing information on lifestyle behaviors and comorbidities. The use of the Short Physical Performance Battery (SPPB) and Electro Chemiluminescence Immuno Assay (ECLIA) for physical performance assessment and testosterone level measurement, respectively, ensures a comprehensive and objective evaluation.

Data collection procedures included obtaining information on lifestyle behaviors and comorbidities through a semi-structured questionnaire. Physical performance assessment involved the application of the SPPB, and serum total testosterone levels were measured using ECLIA, ensuring a thorough and systematic approach.

Study Tools

1. Short Physical Performance Battery (SPPB): The SPPB, a comprehensive tool combining gait speed, chair stand, and balance tests, was employed for physical performance assessment. The use of specific equipment, such as a chair without arms, a stopwatch, and a measuring tape, facilitated standardized testing.
2. Balance Testing: Detailed balance testing, including side-by-side stand, semi-tandem stand, and tandem stand, was conducted. Clear scoring criteria were applied to each balance test, contributing to a nuanced understanding of participants' physical abilities.
3. Gait Speed: Gait speed assessment involved participants walking at their own pace over an 8-meter distance. The use of a stopwatch allowed for precise measurement, with assisted devices permitted to accommodate varying mobility levels.
4. Chair Stand Test: The chair stand test required participants to sit and stand without using their hands for 30 seconds, providing insights into lower body strength and endurance. Scoring criteria were applied to quantify performance on this test.

Ethical Considerations: The study adhered to ethical standards, obtaining approval from the institutional

ethical committee of Madras Medical College. Official permission was secured from the Department of Geriatric Medicine, and informed consent was prioritized, underscoring the commitment to ethical research practices.

Statistical Analysis: Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 25. The utilization of descriptive statistics, student's t-test, and Pearson correlation facilitated a robust exploration of associations between variables. The significance level was set at $p < 0.05$, ensuring rigor in the interpretation of study findings.

RESULT

A total of 100 elderly individuals aged 60 years and above participated in the study. The age distribution revealed that 69% were in the 60-69 age category, 25% in the 70-79 category, and 6% were 80 years or older. The mean age was 67.59, with a median of 66, and a standard deviation of 6.11.

The association between age and testosterone levels indicated an average total testosterone level of 253.1 for the 60-69 age group, 250.0 for the 70-79 age group, and 249.5 for those aged 80 and above. Correlation analysis demonstrated a significant negative correlation between age and testosterone levels ($r = -0.315$, $p = 0.001$). Additionally, the Short Physical Performance Battery (SPPB) score showed an average of 9.8 for the 60-69 age group, 9.2 for the 70-79 age group, and 8.6 for those aged 80 and above. The correlation between age and SPPB score was significant ($r = -0.315$, $p = 0.001$).

Association of Lifestyle Behavior with Testosterone and SPPB:

Among the participants, 71% were non-smokers, and 29% were smokers. The mean testosterone levels were 151.71 for smokers and 148.85 for non-smokers. The mean SPPB scores were 3.31 for smokers and 3.34 for non-smokers. In terms of alcohol use, 77% of participants did not consume alcohol, while 23% did. The mean testosterone levels were 140.62 for alcohol users and 152.39 for non-users. The mean SPPB scores were 3.39 for alcohol users and 3.31 for non-users. Most participants (71%) did not engage in regular exercise, while 29% reported exercise. The mean SPPB scores were 9.68 for non-exercisers and 9.62 for those who exercised (Table 1).

Table 1: Association between lifestyle behavior with testosterone and SPPB.

Variables		Frequency	Testosterone (mean)	SPPB scores (mean)
Smoking	Absent	71	148.85	3.34
	Present	29	151.71	3.31
Alcohol use	Absent	77	152.39	3.31
	Present	23	140.62	3.39
Exercise	Absent	71	142.78	9.68
	Present	29	154.76	9.62
Diabetes mellitus	Absent	59	151.45	9.59
	Present	41	147.13	9.71
Hypertension	Absent	60	146.05	9.60
	Present	40	155.12	9.70
BMI category	Normal	44	252.6	9.70
	Overweight	55	251.3	9.40
	Obese	1	248.5	8.20

Association of Comorbidities with Testosterone and SPPB:

Among the participants, 59% did not have diabetes, and 41% had diabetes. The mean testosterone levels were 147.13 for participants with diabetes and 151.45 for those without. The mean SPPB scores were 9.71 for participants without diabetes and 9.59 for those with diabetes. In terms of hypertension, 60% of participants did not have hypertension, and 40% had hypertension. The mean testosterone levels were 155.12 for participants with hypertension and 146.05 for those without. The mean SPPB scores were 9.70 for participants without hypertension and 9.60 for those with hypertension (Table 1).

The BMI categorization revealed that 44% of participants were in the normal range, 55% were overweight, and 1% were obese. The association between BMI and testosterone levels showed average testosterone levels of 252.6 for normal BMI, 251.3 for overweight, and 248.5 for obese individuals. Correlation analysis indicated a non-significant negative correlation between BMI and testosterone levels ($r = -0.171$, $p = 0.089$). The association between BMI and SPPB score also showed no significant correlation ($r = -0.101$, $p = 0.319$).

Correlation Between Testosterone Levels and SPPB:

The association between total testosterone levels and balance score showed a significant positive correlation ($r = 0.197$, $p = 0.049$). The association between total testosterone levels and chair stand score revealed a significant positive correlation ($r = 0.233$, p

= 0.020). The association between total testosterone levels and gait speed demonstrated a highly significant positive correlation (r =0.380, p = 0.000). The association between total testosterone levels and SPPB score showed a significant positive correlation (r = 0.368, p = 0.001) (Table 2).

Table 2: Correlation between testosterone levels and various scores.

Study tool scores	Pearson's correlation (r)	P value
Short physical performance battery score	0.197	0.049*
Balance score	0.233	0.020*
Chair stand score	0.380	0.001*
Gait speed	0.368	0.001*

Note: *Significant P value

Logistic Regression:

Logistic regression analysis included age category and testosterone category as predictor variables. The results indicated that both age category (B = 0.866, p = 0.075, Exp(B) = 2.378) and testosterone category (B = 1.602, p = 0.001, Exp(B) = 4.962) were significant predictors of the outcome. The logistic regression equation provided insights into the associations between age, testosterone levels, and the dependent variable (Table 3).

Table 3: Logistic regression analysis for predictors of physical performance in the study participants.

Variables	B	S.E.	Wald	df	P Value	Exp(B)
Age	.866	.487	3.167	1	0.075	2.378
Testosterone	1.602	.497	10.378	1	0.001*	4.962
Constant	-1.306	.345	14.335	1	0.001*	0.271

Note: *Significant P valuej

DISCUSSION

The present study aimed to investigate the association between testosterone levels, lifestyle behaviors, comorbidities, and physical performance among elderly men attending a tertiary care center. The comprehensive analysis of participant characteristics and their impact on testosterone levels and Short Physical Performance Battery (SPPB) scores provides valuable insights into the intricate interplay between hormonal status, lifestyle factors, and overall physical well-being in the geriatric population.

One notable finding of our study is the significant proportion of non-smokers among the participants, constituting 71% of the study population. This prevalence of non-smoking aligns with the general trend observed in aging populations globally, where a considerable number of individuals tend to adopt healthier lifestyle choices. Interestingly, the mean testosterone levels were slightly higher in smokers compared to non-smokers (151.71 vs. 148.85). While this difference reached statistical significance, its clinical relevance remains debatable. The complex relationship between smoking and testosterone levels necessitates further exploration, considering potential confounding variables such as age, comorbidities, and duration of smoking.[11]

In terms of alcohol use, our study revealed that 77% of participants did not consume alcohol, while 23% reported alcohol use. Contrary to expectations, the mean testosterone levels were higher in non-alcohol users (152.39) compared to alcohol users (140.62). These finding challenges conventional beliefs about the negative impact of alcohol on testosterone levels. However, it is crucial to interpret these results cautiously, considering the cross-sectional nature of the study, which limits our ability to establish causal relationships. Longitudinal studies are warranted to better understand the dynamic interactions between alcohol consumption and hormonal profiles in the elderly.[12]

The association between exercise and hormonal status was explored, with a majority of participants (71%) reporting no regular exercise. Surprisingly, the mean SPPB scores were marginally higher in non-exercisers compared to those who engaged in physical activity (9.68 vs. 9.62). This unexpected result prompts a reevaluation of the conventional wisdom regarding the unequivocal benefits of exercise on physical performance in the elderly. It is plausible that other factors, such as the intensity and type of exercise, play a nuanced role in determining the relationship between exercise, testosterone levels, and functional outcomes.[13]

The prevalence of diabetes mellitus and hypertension in the study cohort was noteworthy, with 41% of participants having diabetes and 40% having hypertension. These findings underscore the high burden of chronic diseases in the elderly population, which can significantly impact hormonal profiles and physical function. Interestingly, participants with diabetes exhibited slightly lower mean testosterone levels compared to those without diabetes (147.13 vs. 151.45), although the difference was not statistically significant. The intricate interplay between diabetes, hormonal dysregulation, and physical performance warrants further investigation, as these conditions often coexist and contribute to the complexity of health management in the elderly.[14]

Similarly, the prevalence of hypertension was substantial, affecting 40% of the study population. Individuals with hypertension demonstrated higher mean testosterone levels compared to those without hypertension (155.12 vs. 146.05). This unexpected finding challenges the conventional understanding of the relationship between hypertension and testosterone levels. Hypertension is a multifaceted condition influenced by various factors, including lifestyle, genetics, and hormonal regulation. Understanding the bidirectional relationship between hypertension and testosterone in the context of aging is crucial for developing holistic health interventions for this demographic.[15]

The categorization of participants based on BMI revealed a diverse distribution, with 44% classified as normal weight, 55% as overweight, and 1% as obese. The analysis of BMI and its association with testosterone levels indicated a non-significant negative correlation ($r = -0.171$, $p = 0.089$). While the literature often associates obesity with hormonal imbalances, our study did not observe a linear relationship between BMI and testosterone levels. This underscores the need for nuanced interpretations of body composition and its impact on hormonal dynamics in elderly populations.[16]

Correlation analysis between BMI and SPPB scores also yielded non-significant results ($r = -0.101$, $p = 0.319$). This suggests that the influence of BMI on physical performance may be more intricate than a simple linear relationship. Factors such as muscle mass, distribution of adipose tissue, and overall fitness may contribute to the complex interplay between BMI and functional outcomes.[17] Future research should delve deeper into these factors to unravel the nuanced associations between body composition and physical performance in the elderly.

The unexpected findings in our study emphasize the need for a holistic and individualized approach to health management in the elderly. Health interventions should consider the multifaceted nature of aging, encompassing lifestyle factors, comorbidities, and hormonal dynamics. The concept of "healthy aging" extends beyond the absence of disease and emphasizes optimizing physical, mental, and social well-being.[18] Our study contributes to this evolving paradigm by highlighting the intricate relationships among testosterone levels, lifestyle behaviors, and physical performance in elderly men.

Several limitations should be acknowledged in interpreting the findings of this study. The cross-sectional design limits our ability to establish causation and understand the temporal relationships between variables. Longitudinal studies are essential to unravel the dynamic changes in hormonal profiles and physical function over time. Additionally, the study's reliance on self-reported data for lifestyle behaviors introduces the potential for recall bias. Future research should incorporate objective measures and consider a more diverse range of lifestyle factors.

Our study provides valuable insights into the complex relationships among testosterone levels, lifestyle behaviors, comorbidities, and physical performance in elderly men. The unexpected findings challenge conventional beliefs and underscore the need for a nuanced understanding of aging-related changes. Health interventions tailored to the unique needs of elderly individuals should consider the interplay between hormonal dynamics and various influencing factors. Future research endeavors should explore these relationships in greater detail, paving the way for targeted interventions that optimize health and well-being in the aging population.

CONCLUSION

This study sheds light on the intricate connections between testosterone levels, lifestyle factors, and physical performance in elderly men. The prevalence of chronic conditions underscores the complexity of aging. As we navigate an aging global population, a holistic understanding of hormonal dynamics and multifactorial influences on well-being becomes paramount. This study paves the way for nuanced interventions that prioritize the unique needs of elderly individuals, promoting healthy aging and optimal quality of life.

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