Investigation of Gait Parameters between Sexes

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Abstract

Aim: Gait is a complex neuromuscular process that provides valuable insight into an individual's health status and functional capacity. The parameters of gait can be influenced by a number of factors, including gender, age, height, weight and the level of physical activity. An understanding of the influence of gender on gait has significant implications for the prevention and treatment of various musculoskeletal disorders. The objective of this study was to investigate the impact of gender on gait parameters in a cohort of healthy adults.

Method: The study was conducted on a total of 64 healthy adult subjects, comprising 32 female and 32 male volunteers, with an age range of 18 to 45 years. Gait analysis was conducted utilising the TecnoBody Walker View device. The participants were instructed to walk for five minutes at a speed of 4.0 km/h with the device. The gait analysis encompassed the assessment of several biomechanical parameters, including trunk flexion range of motion, hip flexion range of motion, knee flexion range of motion, stride length, cadence, and step contact time. The findings obtained from both genders were compared.

Results: No statistically significant difference was observed between the sexes with regard to the gait parameters ($p>0.05$).

Conclusion: The findings show that gender has no significant effect on gait parameters such as step length, cadence, step duration and joint range of motion in healthy adults. Future studies conducted on larger sample groups will shed light on whether there are differences in gait parameters between genders.

Keywords: Gait, gender, gait analysis, ankle biomechanics.

Cinsiyetler Arası Yürüme Parametrelerinin İncelenmesi

Öz

Amaç: Yürüyüş, bireyin sağlık durumu ve fonksiyonel kapasitesi hakkında değerli bilgiler sağlayan karmaşık bir nöromüsküler süreçtir. Yürüyüş parametreleri cinsiyet, yaş, boy, kilo ve fiziksel aktivite düzeyi gibi bir dizi faktörden etkilenebilir. Cinsiyetin yürüyüş üzerindeki etkisinin anlaşılması, çeşitli kas-iskelet sistemi rahatsızlıklarının önlenmesi ve tedavisi açısından önemli sonuçlar doğurmaktadır. Bu çalışmanın amacı, sağlıklı yetişkinlerden oluşan bir kohortta cinsiyetin yürüyüş parametreleri üzerindeki etkisini incelemektir.

Yöntem: Çalışma, yaşları 18 ile 45 arasında değişen 32 kadın ve 32 erkek gönüllülerden oluşan toplam 64 sağlıklı yetişkin denek üzerinde gerçekleştirilmiştir. Yürüyüş analizi TecnoBody Walker View cihazı kullanılarak gerçekleştirilmiştir. Katılımcılardan bu cihaz ile 4.0 km/saat hızda 5 dakika boyunca yürümeleri istenmiştir. Yürüyüş analizi, gövde fleksiyon hareket aralığı, kalça fleksiyon hareket aralığı, diz fleksiyon hareket aralığı, adım uzunluğu, kadans ve adım temas süresi dahil olmak üzere çeşitli biyomekanik parametrelerin değerlendirilmesini kapsamıştır. Her iki cinsiyetten elde edilen bulgular karşılaştırılmıştır.

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Bulgular: Cinsiyetler arasında yürüyüş parametreleri açısından istatistiksel olarak anlamlı bir fark bulunamamıştır (p>0.05).

Sonuç: Elde edilen bulgular sağlıklı yetişkinlerde cinsiyetin adım uzunluğu, kadans, adım genişliği ve eklem hareket açıklığı gibi yürüyüş parametreleri üzerinde önemli bir etkisi olmadığını göstermektedir. Gelecekte daha geniş örneklem grupları üzerinde yapılacak araştırmalar, cinsiyetler arasında yürüyüş parametrelerinde farklılık olup olmadığına ışık tutacaktır.

Anahtar Sözcükler: Yürüyüş, cinsiyet, yürüme analizi, ayak bileği biyomekaniği.

Introduction

The analysis of human gait represents a valuable approach to assess an individual's health status, functional abilities and quality of life[1]. The process of gait is achieved through the harmonious movement of the lower extremity joints and muscle activity. However, this process is influenced by a number of factors, including gender, age, height, weight and physical activity level[2]. In particular, gender is a significant factor influencing gait biomechanics. Understanding these differences is of great importance in both research and clinical practice.

The biomechanical differences between males and females can have a significant impact on gait patterns. To illustrate, females typically exhibit narrower shoulder widths, a wider pelvis, and less muscle mass than males[3]. Anatomical features such as narrower shoulders, a wider pelvis and less muscle mass may result in gait characteristics including a shorter stride length, higher cadence and narrower stride width in women[4]. Furthermore, hormonal factors are believed to influence women's gait parameters[5].

The investigation of the effect of sex differences on gait parameters represents a critical aspect of scientific studies and clinical applications. For instance, gait analysis can be employed as a valuable diagnostic and therapeutic tool in the management of musculoskeletal conditions such as osteoarthritis, which is more prevalent in women[6]. Furthermore, it is essential to consider gender-specific gait parameters in the evaluation of sports performance, the planning of rehabilitation programs, and the design of personalized prostheses[7].

The TecnoBody Walker View device (Bergamo, Italy) is a treadmill system equipped with sensors that provide three-dimensional (3-D) images of the individual's posture, lower extremity load distribution, range of motion, and body tendencies[8]. The system is frequently employed in clinical settings, as it expedites and streamlines the process of gait analysis reporting. The objective data obtained with this device allows clinicians and physiotherapists to rapidly evaluate gait parameters and range of motion[9].

It is of great importance to understand the effects of gender on gait for the evaluation of sports performance and the development of rehabilitation programs. For example, certain movement patterns that may increase susceptibility to knee injuries may be more common among female athletes. Gait analyses can be used to identify such risks and develop preventive strategies.

The objective of this study was to examine the differences in gait parameters between male and female volunteers with the 3-D gait analysis system, with a view to integrating the findings into the existing body of literature on the subject. In addition, the study aimed to discuss the biomechanical and physiological mechanisms that underlie these

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differences. In this context, an examination of basic gait parameters, including stride length, cadence, stride width, and joint motion angles, will be undertaken. Furthermore, the implications of these differences for clinical and practical applications will be evaluated. It is anticipated that this study will contribute to a more nuanced understanding of the gait patterns exhibited by men and women, which in turn will inform the development of gender-specific health services.

Material and Methods

Participant

This study was conducted on 64 healthy adult individuals, 32 female and 32 male volunteers. The sample size of the study was calculated using the G*Power 3.1.9.7 program with a power of 80%, with a total of 64 people, 32 healthy people in each group[10]. Volunteers between the ages of 18-45 who had previous experience of walking on a treadmill were included in the study. Exclusion criterias for volunteers included in the study were having a difference of more than 2 cm between the two legs lengths, having pes planus, any orthopedic disorder or surgery history in the lower extremity, or neurological disease.

Ethics Committee

Ethical approval for the study was granted by a local ethical review board (Çankırı Karatekin University Health Sciences Ethics Committee, Decision Date: October 15, 2024 & Application number: e9be79d9ca4b4f69). The study adhered to the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from the participant, and all evaluations were conducted in person.

3-D Gait Analysis System

The TecnoBody Walker View 3.0 SCX treadmill system is equipped with a 3-D motion capture camera and eight load cells[9]. The system's sensors enable the performance of a comprehensive posture and gait analysis within a 30-second time frame. The expeditious and pragmatic reporting of gait analysis facilitates the utilization of this system in clinical settings for the observation of kinematic parameters during gait training. The 3-D gait analysis system allows clinicians and physiotherapists to easily analyze spatial gait parameters and objective data on the total range of motion (ROM) obtained from the system[11].

Furthermore, this system is employed in clinical practice for the analysis of asymmetries and alterations in range of motion. Such data are crucial for identifying aberrant kinematic parameters and for guiding further research utilizing gold-standard methodologies[12]. In this regard, the 3-D gait analysis system can be employed as a valuable analytical instrument in both clinical and research contexts.

Procedure

A five-minute barefoot gait analysis was conducted on healthy adult subjects at a speed of 4.0 km/h using the TecnoBody Walker View device (Figure 1). During the gait analysis, subjects were instructed to wear tight-fitting attire, excluding black or white garments. In the gait analysis, the following parameters were recorded: trunk flexion range of motion (ROM), right and left hip flexion ROM, right and left knee flexion ROM, right

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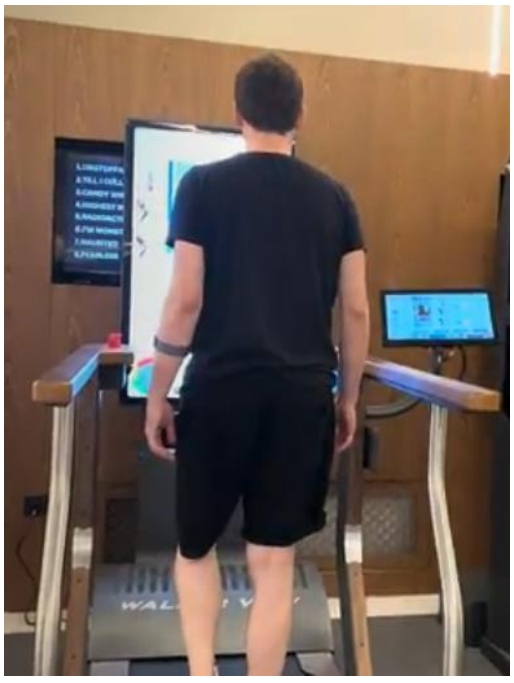
and left stride length (cm), cadence (min/step) and right and left contact time (sec). Furthermore, a sociodemographic form was completed by each subject, providing information on gender, age, height, weight and body mass index (BMI). Findings obtained from both genders were compared with statistical methods.

Figure 1. Gait analysis on the TecnoBody Walker view device



Statistical Method

The IBM Statistical Package for Social Sciences, Version 26 (SPSS Inc., Chicago, IL, USA) was employed as the statistical software. Qualitative variables were expressed as numbers and percentages. An Independent t-test was employed to assess the gender-based differences in gait parameters ($p<0.05$).

Results

The study included 32 female and 32 male volunteers. The mean age of the female volunteers was 30.81±5.331 years and the mean age of the male volunteers was 30.69±6.342 years. The BMI of the female volunteers was 21.90±1.277 kg/m^2 and that of the male volunteers was 24.08±2.282 kg/m^2. Detailed data are shown in Table 1.

Table 1. Sociodemographic data

	Female			**Male**		
	n	**Mean**	**SD**	**n**	**Mean**	**SD**
Age (year)	32	30.81	5.331	32	30.69	6.342
Height (cm)	32	163.81	5.910	32	178.50	3.654
Weight (kg)	32	51.19	6.679	32	76.78	7.542
BMI	32	21.90	1.277	32	24.08	2.282

cm; centimetre, kg; kilogram, BMI; body mass index, SD; standard deviation

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No statistically significant difference was identified between the gait parameters of the participants according to gender ($p > 0.05$). Further details can be found in Table 2.

Table 2. Comparison of gait parameters

	Female		Male				
	Mean	**SD**	**Mean**	**SD**	**t**	**p**	**Cohen's d**
Trunk Flexion ROM (°)	2.60	0.653	2.73	0.507	.854	.396	-0.22
Right Hip ROM (°)	45.35	8.047	48.06	9.430	1.235	.222	-0.30
Left Hip ROM (°)	43.27	8.378	46.62	8.864	1.552	.126	-0.38
Right Knee ROM (°)	50.89	6.963	52.30	10.940	.616	.540	-0.15
Left Knee ROM (°)	52.33	6.256	54.21	8.855	.978	.332	-0.24
Right Step Length (cm)	64.50	7.704	65.97	8.968	.703	.485	-0.17
Left Step Length (cm)	64.09	7.536	65.03	8.106	.479	.634	-0.12
Cadence (min/step)	.88	.105	.88	.101	-.036	.971	0.20
Right Step Duration (sec)	.73	.078	.76	.143	.820	.415	0.23
Left Step Duration (sec)	.74	.085	.77	.150	1.021	.312	0.29

(°); degrees, cm; centimetres, sec; seconds, SD; standard deviation, min; minute ($p<0.05$)

Discussion

The present study employed the 3-D gait analysis system to analyze the differences in gait parameters between men and women. The findings indicated no statistically significant differences in gait parameters between the sexes. This finding is at odds with the conclusions of some previous studies. For example, Cho et al. demonstrated that there were differences in gait parameters between genders in a sample of healthy Korean adults. The findings of this study indicate that women exhibited slower walking speeds than men, along with shorter stride lengths and narrower stride widths[13]. Similarly, Hughes-Oliver et al. had reported that gait patterns in patients with ankle osteoarthritis were influenced by gender. The findings of this study indicate that women exhibit a longer stride duration and higher variability than men[14].

Conversely, studies findings are aligned with those of certain other studies. For example, Oberg et al. had conducted an analysis of basic gait parameters in a cohort of healthy individuals aged between 10 and 79 years. Their findings revealed a statistically significant age-related variability in stride length and cadence during both normal and fast walking but not in stride frequency. Furthermore, this study identified a significant interaction effect of age and gender on step length parameters during normal and fast walking[15]. The discrepancies observed may be attributed to methodological discrepancies between studies, sample size, and participant characteristics. For instance, the gait analysis system employed in the present study may differ from the optoelectronic systems utilized in other studies.

There are notable differences between the gait patterns of men and women. It is established that women typically exhibit narrower shoulder width, a wider pelvis, and

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less muscle mass than men[16]. In general, women exhibit a higher cadence and a shorter stride length than men[17]. Furthermore, women exhibit reduced ankle plantar flexion moments compared to men during the majority of the support phase. Nevertheless, the extent to which these discrepancies contribute to an elevated risk of falls or injury remains unclear. Nigg et al. had indicated that women employ distinct strategies to control the ankle joint in comparison to men[18]. Rowe et al. had reported that women and men utilize disparate control strategies, yet these do not influence the risk of falls or injuries[10]. Furthermore, it is postulated that hormonal factors exert an influence on women's gait parameters[19].

The analysis of gait between genders has significant implications for clinical and practical applications in general. The consideration of gender differences in gait parameters is of critical importance in the diagnosis and treatment of musculoskeletal diseases, the analysis of sports performance and the planning of rehabilitation programs.

The absence of a statistically significant difference between male and female participants in terms of gait parameters may be attributed to a number of factors. Firstly, the limited sample size of 32 participants in each group may have reduced the statistical power and made it challenging to discern significant differences. Furthermore, the fact that the participants in the study were healthy young adults may have precluded the potential for gender differences in gait parameters to emerge. A review of the literature reveals that gender differences in gait parameters tend to become more pronounced with increasing age. Consequently, further research conducted with older age groups or individuals with specific health conditions may prove more fruitful in identifying significant differences.

Conclusion

The findings of this study offer significant insights for clinicians and physiotherapists. Future studies conducted on larger sample groups will shed light on whether there are differences in gait parameters between genders. It is imperative to assess gender-based disparities in gait parameters to understand their implications for clinical and practical applications. These differences must be taken into account in the diagnosis and treatment of musculoskeletal diseases, the evaluation of sports performance, and the design of rehabilitation programs.

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