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Research Article

Effect of mobile phone use on gait speed and stride length on an uneven surface in young healthy individuals: a comparative study

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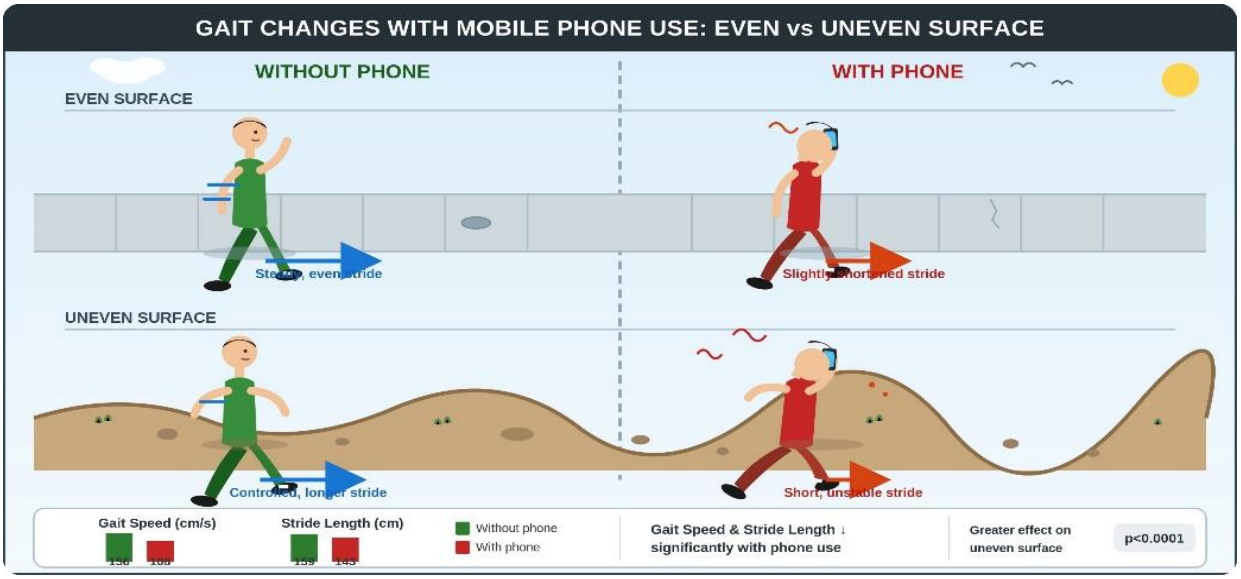
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ABSTRACT

Smartphone use while walking is common among young adults and may adversely affect gait, especially on uneven terrain. To compare gait speed and stride length with and without mobile phone use on an uneven surface in young healthy individuals. In this observational cross-sectional comparative study, 69 healthy young adults (18-23 years) walked a 20-metre uneven-surface path with and without using a mobile phone. Gait was video-recorded and analysed using Kinovea software; gait speed and stride length were compared using the paired t-test. Both gait speed and stride length were significantly reduced during mobile phone use compared to normal walking ($p<0.0001$ for both). Young adults who use mobile phones considerably change their gait speed and step length on uneven ground, suggesting a higher risk of falls and pedestrian injuries when walking while distracted.



Keywords: Gait speed, Stride length, Mobile phone, Dual-task, Uneven surface, Kinovea, Young adults.

INTRODUCTION

The use of mobile phones, which have developed from communication tools to essential tools for social interaction, entertainment and education, has increased further since the introduction of fifth-generation (5G) technology. Individuals aged 18–22 years have developed a strong attachment to their smartphones, which are now an integral part of nearly every aspect of daily life, including routine activities such as walking [1].

Walking is generally considered an automatic motor task, but it requires attention and executive function—both of which are needed for dual-tasking. Attention, the limited capacity to understand and prioritise stimuli, is closely related to executive function, which allows for goal-directed behaviour. Dual-task performance, most commonly assessed by walking while performing a secondary task, is widely used to investigate cognitive

function. Everyday life frequently requires processing multiple stimuli at the same time (divided attention). Distractions such as texting, talking or browsing while walking can considerably influence gait performance and increase the risk of accidents and injuries.

Many gait analysis techniques have been explored; Kinovea is a sports analysis video annotation tool. The tool allows motion recording, slow-motion inspection, comparison, annotation and measurement. Fernández-González et al. evaluated spatiotemporal gait parameters, such as step length, stride length and stride duration, with Kinovea and reported strong test-retest and inter-rater reliability (ICC>0.90), supporting its use as a reliable gait-assessment tool [2].

Smartphone use while walking is a common and dangerous habit, particularly among young people. It is connected with negative consequences such as bone fractures, damage to internal organs, cuts and bruises. Ministry of Road Transport (2022) [3] reported that in India, 1.4% of injuries, 2% of fatalities and 1.6% of accidents were due to the use of mobile phones while walking. The effects of factors other than cognitive function on gait have not yet been clarified, but Kim et al. showed that the use of a smartphone significantly affects the variability of gait and pedestrian walking speed by diffusing cognitive resources [4].

Several studies have investigated the effects of texting or mobile phone use on gait in healthy adults, older people and clinical populations, generally finding reduced gait velocity, cadence, and step/stride length, together with increased step width, step time, and double-support time during phone use [5]. The Kinovea software has also been validated against motion-capture systems such as AutoCAD and VICON, and has demonstrated excellent criterion validity and inter/intra-rater reliability for spatiotemporal gait analysis [6]. However, to our knowledge, no prior study has explicitly examined changes in gait speed and stride length with and without mobile phone use on an uneven surface in young individuals – a gap this study seeks to fill, considering that uneven terrain independently challenges balance and stability and may exacerbate cognitive-motor interference induced by phone use.

MATERIAL AND METHOD

Study design

It was an observational, cross-sectional comparative study conducted in the Physiotherapy School and Centre, Government Medical College, Nagpur.

Study population and sampling

The study population comprised normal, healthy young individuals. A sample of 69 participants was recruited using convenience/purposive sampling. Sample size was calculated using the formula $n = 2sp^2[z(1-\alpha/2) + z(1-\beta)]^2 / \mu d^2$, where sp^2 is the pooled variance, μd is the mean difference between samples, α is the significance level, and $1-\beta$ is the power; sample size calculation was performed using n-Master version 2.0 software.

Selection criteria

Inclusion criteria were healthy young adults of both sexes aged 18–23 years. Inclusion criteria were individuals with difficulty in normal walking due to fatigue, dizziness or musculoskeletal impairment of the lower limb (e.g., recent trauma, joint replacement); visual, auditory or musculoskeletal system abnormalities; or neurological, sensorimotor or circulatory system impairment.

Study material

uneven surface, marker cones, mobile phone, laptop with Kinovea software, pen, paper.

Ethical approval and consent

The study was approved by the institutional ethical committee and the head of the institution. The participants were informed about the study protocol and objectives in detail, and written informed consent was obtained from the volunteers before enrolment. Participants were free to withdraw at any time, and the confidentiality of data was maintained throughout.

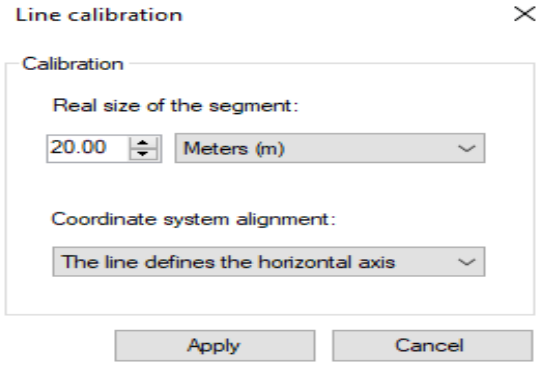
Method

Two points were marked 20 meters apart on a road of uneven surface. A camera on a mobile phone was set up to record gait. Each participant stood at the start point without using a mobile phone and walked to the end point. The same participant then walked the same distance using the mobile phone application they use most often.

Figure 1: Study set-up on the uneven surface



Figure 2: Kinovea software interface showing gait analysis



Videos were uploaded to Kinovea software on a laptop, and the walking distance was calibrated to 20 m. Two markers were placed at successive heel strikes of the same foot, and a line between the two points was used to calibrate and determine stride length. Gait speed was calculated as: Gait speed = total distance / total time.

Figure 3: Calibration and marking of heel-strike points for stride length measurement

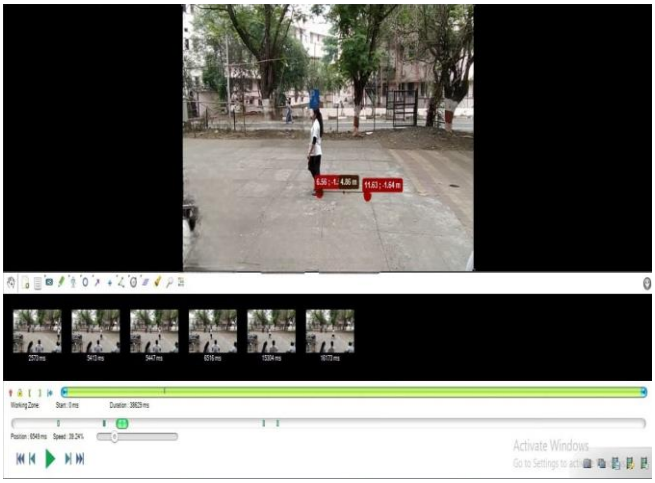
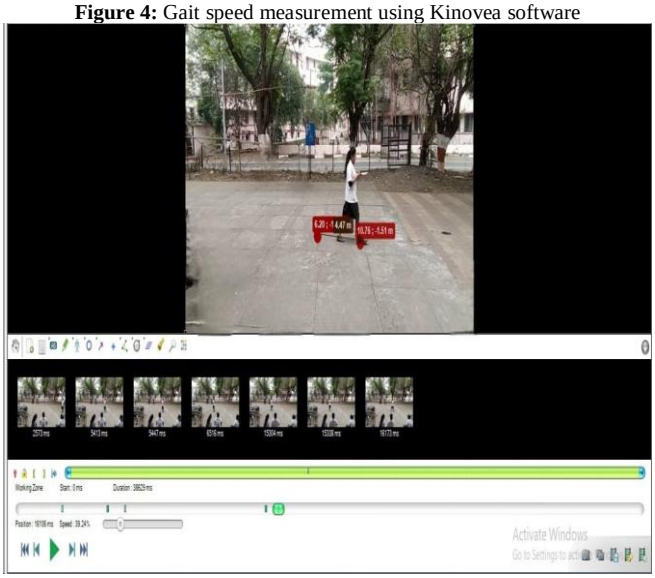


Figure 4: Gait speed measurement using Kinovea software



Outcome measure

Gait speed and stride length were recorded using Kinovea software.

Statistics

Data were entered into a Microsoft Excel spreadsheet.

Tables and graphs were prepared using Microsoft Word and Excel.

Continuous variables were presented as mean ± SD, and as median and range for non-normally distributed data.

Stride length and gait speed with and without mobile phone use were compared using the paired t-test.

$p<0.05$ was considered statistically significant.

Statistical analysis was performed using STATA version 14.0.

RESULTS

A total of 69 participants volunteered for this study.

Table 1: Comparison of mean stride length with and without mobile phone use

Parameter	With phone: Mean	With phone: SD	Without phone: Mean	Without phone: SD	t-value	p-value
Stride Length (cm)	142.95	22.78	158.95	26.04	19.89	<0.0001, HS

Table 2: Comparison of mean gait speed with and without mobile phone use

Parameter	With phone: Mean	With phone: SD	Without phone: Mean	Without phone: SD	t-value	p-value
Gait Speed (cm/s)	108.22	17.84	156.08	30.50	16.37	<0.0001, HS

On comparing stride length with and without mobile phone use on an uneven surface using the paired t-test, the difference was found to be highly statistically significant ($p<0.0001$). Similarly, gait speed with and without mobile phone use on an uneven surface was found to differ significantly ($p<0.0001$).

DISCUSSION

The aim of this study was to compare gait characteristics with and without mobile phone use, on an uneven surface. Statistically significant differences in stride length and gait speed with and without mobile phone use were observed in young people, indicating that phone use significantly affects gait on challenging terrain.

It is inherently difficult to maintain balance and stability when walking on uneven surfaces. Mobile phone use in conjunction with cognitive distraction may increase people's susceptibility to tripping, falling and injury, such as sprains, fractures and head trauma. Hence, it is important to understand the effects of mobile phone use on gait on uneven surfaces so that we can address these safety concerns and promote pedestrian safety.

Brennan and Breloff reported that gait kinematics are affected by dual-task walking due to the dual-task cost of cell phone use, and that the degree of impact increases with the cognitive difficulty of the secondary task; gait velocity and stride length both decreased, with the reduction becoming more pronounced as task difficulty increased [7].

Krasovsky et al. found that texting while walking was associated with larger decreases in gait speed, greater gait variability, higher mental workload, and lower text comprehension compared with reading while walking.

Bruyneel et al., in a systematic review and meta-analysis comparing texting-while-walking effects on spatiotemporal gait parameters across healthy adults, older people, and persons with motor or cognitive disorders, found significant impairment of gait speed, step and stride length, cadence, and double- and single-support time during combined texting-and-gait tasks.

In line with the present results, Kim et al. also found that participants walked with slower cadence and velocity, changed stride length and gait cycle, and spent more time in ground contact while using a smartphone compared to walking without a smartphone.

Our results on an uneven surface are generally in line with previous studies mostly conducted on flat surfaces and suggest that uneven surface plus phone-related cognitive-motor interference might further impair gait stability in young adults, which is an area that warrants further study [8].

CONCLUSION

The results showed significant differences in gait speed and stride length with and without mobile phone use on an uneven surface in young healthy individuals, which supports rejecting the null hypothesis. Identifying the specific gait characteristics that are most affected by mobile phone use on uneven surfaces can help researchers and clinicians develop specific interventions and educational campaigns to promote safer walking behaviour. This can include technological, environmental, or behavioural strategies to reduce the risk of accidents and injuries associated with distracted walking. The cross-sectional design, single institution setting, and convenience sample used in this study may limit the generalisability. Further studies should employ objective wearable sensors and larger and more heterogeneous samples.

ACKNOWLEDGEMENT

None.

Conflict of interest

There was no conflict of interest for this study.

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