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Effects of smartphone use on postural control and mobility: a dual-task study

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HIGHLIGHTS
- This study examined potential risks of using a smartphone while standing or walking.
- Using a smartphone had a negative impact on both postural control and mobility.
- Participants faced great challenge on postural stability when talking on the phone.
- Texting message or talking on the phone had a similar impact on mobility.
- Further studies should be conducted among different population groups.

ABBREVIATIONS
None

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BACKGROUND: Smartphones have become an integral part of our lives, providing a wide range of useful features. However, it is important to address the potential risks of using a smartphone while performing motor tasks.
AIM: To investigate the effects of smartphone use on postural control and mobility in young adults during standing or walking activities.
METHOD: Forty-five individuals, mean age of 22.1 ± 1.5 years, were enrolled in this study. The impact of using smartphone was assessed during a static (performed on a force platform) and a dynamic (timed up and go) test. The participants were instructed to text a message and talk on the phone while standing or walking. Multiple analyses of variance were applied to verify main effect of task. Effect sizes are reported. Significance was set at 5%.
RESULTS: Using a smartphone with a simultaneous motor task had a negative impact on both static and dynamic tests (effect size of 0.820 and 0.788, respectively). Participants were at similar risks when walking while texting messages or talking on the phone. Conversely, when standing, talking on the phone caused greater risks compared to the texting condition.
INTERPRETATION: In a sample of young adults, smartphone usage was found to affect the performance of motor tasks. The impact varied depending on whether the participants were walking or standing. Further studies should be conducted to investigate the risks associated with performing motor tasks with a smartphone among different population groups, including older individuals and subjects with physical disabilities.

KEYWORDS: Smartphone | Postural balance | Gait | Multitasking behavior

INTRODUCTION

Smartphones have become increasingly accessible over the years. The device, which at first was used for conversation, now have a variety of useful features. The popularity of smartphones is related to several factors. First, they tend to be more affordable than laptops and computers. Second, they are easy to carry and use. Third, they offer a wide range of entertainment options. Finally, they allow online access wherever the person is [1].

With the recent crisis caused by the COVID-19 pandemic, the use of smartphones gained prominence. Prior to the pandemic, smartphones were commonly used for online shopping, ordering food, listening to music, playing games, performing bank transactions, and chatting. Nowadays, they have become even more important, serving as a tool for monitoring one's health, receiving exercise instructions and performing academic and professional activities [2,3].

Today, people often find any excuse to check their phones during their free time. Wherever a person goes, there is always someone accessing internet or having fun with a smartphone [4]. However, dividing one's attention between multiple tasks can be harmful because the conflicts in prioritization may affect motor performance [5].

The ability to perform more than one activity at the same time is called dual task. Dual tasks activate the prefrontal cortex on a demand that should be automatic and with little activation of the cognitive areas of the brain. As consequence, executive processes are stimulated and the focus of attention is divided between the simultaneous tasks [5,6]. Several studies investigated the impact of dual tasks on motor and cognitive functions. However, there is still a limited body of research specifically investigating the impact of smartphones as a dual-tasking mechanism, particularly when individuals are engaged in activities like talking or texting while standing or walking [7,8]. This aspect warrants further discussion, as it contributes to our understanding of the potential consequences of smartphone use on individuals' balance and mobility.

In this study, we investigated the impact of texting messages and talking on the smartphone while individuals were walking or simply standing. We hypothesized that engaging in typing and talking tasks on smartphones would have a detrimental effect on participants' postural balance and mobility, resulting in both static and dynamic instabilities. We anticipate that individuals using a smartphone will exhibit an increased center of pressure sway area and imbalance speed while standing, as well as require more steps and time to complete the walking task. This hypothesis was based on the assumption that dividing attention between the motor task of walking or standing and the cognitive demands of using a smartphone would negatively impact their ability to maintain the static balance and move effectively.

METHODS

This is a cross-sectional study conducted with 45 participants, 25 women, mean age of 22.1 (standard deviation:1.5) years. The participants were recruited in the city of Campo Grande-MS, Brazil. All individuals provided written consent prior the assessments. Ethical approval was obtained from the institutional research ethics committee (# 3,584,933).

The recruitment was carried out through direct contact with potential participants and through social media. The inclusion criteria involved young adults aged between 18 and 25 years, of any sex, religion, race, or educational level, without any walking problems, and not using any continuous medication, such as for hypertension, diabetes, or depression. The exclusion criteria involved individuals who were unable to attend the data collection center, participants with cognitive scores below normative values on the Mini-Mental State Examination [9,10] and the Frontal Assessment Battery [11,12], and subjects who did not own or who had never used a smartphone.

A total of 60 individuals were initially assessed for eligibility. However, the final sample size was reduced to 45 participants due to difficulties encountered by some individuals in attending the research location. Table 1 provides information on individual characteristics, including sex, age, weight, height, body mass index, cognition, duration of smartphone usage, and daily hours of using the device.

Table 1. Anthropometry characteristics, cognition, and smartphone use by the participants.

Variables	Values	95% Confidence Interval
Sample size, n (men:women)	20:25	---
Age, yrs	22.1 (1.5)	21.7 ; 22.7
Weight, Kg	70.5 (14.9)	66.1 ; 75.0
Height, m	1.7 (0.1)	1.6 ; 1.7
Body Mass Index, Kg/m^2	24.4 (4.0)	23.2 ; 25.6
Mini-Mental State Examination, score	28.9 (1.2)	28.5 ; 29.3
Frontal Assessment Battery, score	17.3 (0.9)	17.0 ; 17.6
Time of using smartphone, yrs	10.4 (2.8)	9.6 ; 11.3
Hours per day using smartphone, h	5.2 (2.6)	4.4 ; 6.0

Data are expressed in absolute frequency value for sex and as mean (standard deviation) for other variables.

Methodological procedures

The methodological procedures are described following the STROBE Statement checklist. To evaluate static upright postural control, participants underwent a balance task using a force platform consisting of a 500 mm^2 plate and four load cells (BIOMEC 400_V4®, EMG System). The test was performed barefoot, with participants instructed to maintain their standing position on the platform for 60 seconds. The following variables were assessed: maximum sway in the anterior-posterior and medial-lateral directions (cm), center of pressure sway area (cm^2), and imbalance speed (cm/s). The data were processed using a sampling rate of 100 frames per second and a 2nd order digital low-pass Butterworth filter. Higher values in these variables indicate poorer postural control performance by the participants.

To investigate motor performance on a dynamic walking task, we used the Timed Get Up and Go test[13]. This test measures the time and number of steps necessary to get up from a chair, walk three meters, return and sit down in the same chair. Longer time to perform the task and greater number of steps indicate poorer mobility.

During the assessment, participants performed a series of tasks with and without a smartphone. The tasks included answering a phone call and texting the message: "Hello, I will be late for our appointment" ("*Olá, eu chegarei atrasado para nosso compromisso*", Portuguese version). Participants kept their smartphones in their front pockets prior to each assessment. The tasks were completed in a randomized order. To minimize any learning effect, participants performed only one trial per task. The focus of this study was to examine the impact of smartphone use on static and dynamic tasks. We did not investigate the cognitive costs associated with smartphone use, such as reduced accuracy in typing and talking tasks.

All assessments were conducted at the Laboratory of Biomechanics and Clinical Neurology of the Federal University of Mato Grosso do Sul. The laboratory ensured controlled conditions for the evaluations, including floor regularity, lighting (six 9W lights), temperature (20 to 25°C), and a low noise level (up to 40 dB). The data collection for this study took place between August and December 2022.

Statistical analysis

The statistical analysis was performed using the SPSS® software. The data are presented as mean and standard deviation. Before conducting the analyses, the authors evaluated parametric assumptions, which included assessing normality and homogeneity of variance. Then, to examine the main effect of the task (no smartphone × texting messages × talking on the smartphone), we used multivariate analyses of variance in association with Wilk's Lambda test. Additionally, univariate analyses were employed to complement the analyses for each specific factor of the static and dynamic tests. Post hoc tests with Bonferroni correction were conducted for pairwise comparisons.

Cognitive scores were not included as a covariate since all participants exhibited normal parameters. However, sex was included as a covariate to examine its potential significant effect. In cases where significant differences were observed, effect sizes and statistical power were reported. Significance was set at 5%.

RESULTS

Table 2 provides information on each variable measured on the force platform, along with their respective univariate analyses. The multivariate analysis of variance showed that using a smartphone while standing had a negative impact on the postural control of the participants (*P* = 0.001; Effect size: 0.820; Statistical power: 99.9%). Specifically, participants experienced greater challenges on postural stability when talking on the phone compared to texting messages or no smartphone use. There was no significant sex × task effect for frontal sway (*P* = 0.854), lateral sway (*P* = 0.715), center of pressure sway area (*P* = 0.931), frontal imbalance speed (*P* = 0.433), and lateral imbalance speed (*P* = 0.160).

Table 2. Impact of dual tasking with smartphone on postural balance.

Variables	Task			***P***	**Effect size**	**Statistical Power (%)**
	No Cell Phone	**Texting Message**	**Talking on Phone**			
Frontal sway, cm	1.9 (0.6)	2.7 (0.9)[ɿ]	3.9 (2.2)[ɿ,ʋ]	0.001	0.392	99.9
Lateral sway, cm	1.7 (0.5)	2.6 (0.9)[ɿ]	2.8 (1.0)[ɿ]	0.001	0.376	99.9
Center of pressure sway area, cm^2	2.3 (1.3)	3.7 (2.5)[ɿ]	5.9 (4.9)[ɿ,ʋ]	0.001	0.321	99.9
Frontal speed, cm/s	1.1 (0.2)	1.3 (0.1)[ɿ]	1.5 (0.2)[ɿ,ʋ]	0.001	0.424	99.9
Lateral speed, cm/s	1.1 (0.2)	1.2 (0.2)	1.3 (0.2)[ɿ]	0.001	0.453	99.9

Data are expressed in mean (standard deviation). P-value, effect size and statistical power of the univariate analyses of variance tests. [ɿ]Post hoc analyses indicated differences in each group compared to the "no smartphone" condition. [ʋ]Post hoc analyses indicated differences in each group compared to the "texting message" condition.

Table 3 details each variable measured on the Timed Get Up and Go test, along with their respective univariate analyses. The multivariate analysis of variance showed that using a smartphone while walking had a negative impact on the mobility of the participants (*P* = 0.001; Effect size: 0.788; Statistical power: 99.9%). Participants experienced similar challenges in mobility when texting message or talking on the phone, compared to the no smartphone condition. There was no significant sex × task effect for the time (*P* = 0.427) or number of tests (*P* = 0.580).

Table 3. Impact of dual tasking with smartphone on mobility

Variables	Task			*P*	Effect size	Statistical Power (%)
	No Cell Phone	Texting Message	Talking on Phone			
Time, secs	9.2 (1.3)	11.8 (2.1)[נ]	11.1 (1.7)[נ]	0.001	0.498	99.9
Number of steps, n	13.2 (1.2)	15.5 (1.6)[נ]	14.9 (1.7)[נ]	0.001	0.612	99.9

Data are expressed in mean (standard deviation). P-value, effect size and statistical power of the univariate analyses of variance tests. [נ]Post hoc analyses indicated differences in each group compared to the “no smartphone” condition. No statistical difference was seen between the “texting message” and the “talking on the phone” conditions.

DISCUSSION

The aim of this study was to examine the effects of texting messages and talking on the phone while individuals were performing a simultaneous motor task. The results suggest that postural stability suffered a negative effect especially when participants were talking on the phone. Conversely, both talking on the phone and texting messages had a similar negative effect on the mobility of the participants. Identifying situations where smartphone use leads to increased imbalance is important in ensuring the advantages of this technology without compromising the user's safety.

The dual task of using a smartphone was assessed during a standing and a walking activity. The authors choose these tasks because they are seen in ordinary situations, such as waiting for the bus, standing at a bank line or when individuals access their smartphone while walking. The findings of this study should serve as a warning about the risks of using smartphone on a secondary motor task.

The target population was young adults. The authors limited the recruitment of participants to those aged between 18 and 25 years for two reasons. First, this segment is known to use smartphones more often than other age groups. Second, during the COVID-19 pandemic, smartphones were used for academic purposes such as online classes and meetings, leading to an increased use of the device in the daily lives of young adults [14].

Normal cognitive scores were observed in all participants. This is an important factor since simultaneous activities, such as using a smartphone while performing a secondary motor task, demand a high degree of cognitive processing [15]. In situations where individuals have cognitive dysfunctions, the results could be negatively impacted.

In the static test, both texting messages and talking on the phone resulted in increased postural instability, which is consistent with previous studies [16,17]. However, talking on the phone affected more participants' postural balance than the texting task. The authors hypothesized that texting would result in greater postural instability than talking because texting messages requires constant ocular view on the text. The results, however, indicate otherwise. Possible reasons to justify this finding refers to a simultaneous activation of cerebellar-cortical pathways (necessary to stand safety) with the prefrontal and premotor neural pathways, stimulated during conversation. Additionally, it is possible that the talking activity, which involves the abilities of 1) listening (primary auditory area of the brain), 2) processing the information (secondary auditory area of the brain), 3) speech planning (secondary motor speech area of the brain), and 4) speech execution (primary motor speech area of the brain), resulted in a decrease in attentional focus on the activity of standing up, leading to imbalance18. Further studies are needed to confirm these findings.

In spite of talking while standing have caused greater imbalance to the participants, texting messages had a similar effect to talking while walking. From a biomechanical standpoint, these findings suggest that texting messages increases muscle tone in the hands, which, when combined with staring at the cell phone screen, may hinder the corrective sensory feedback mechanism of walking [19,20].

Significant differences were observed for the type of task (walking vs. standing) across different conditions (no smartphone, texting messages, talking). To enhance the analyses, we incorporated effect sizes and statistical power. While effect sizes were used to quantify the magnitude of the observed differences, the statistical power was employed to assess the likelihood of detecting true effects. The inclusion of these metrics aimed to provide a more comprehensive and meaningful analysis of the statistical differences observed.

Sex did not impact the walking ability of participants while using a smartphone. Although men and women typically have different motor reference values, the main effect of sex in relation to the task was not found to be statistically significant in this study.

Limitation

The authors recognize some limitations. First, our results are restricted to young adults. Second, this study did not take into account the potential differences among smartphone brands, apps, and models. Third, we did not assess grammar errors while participants were engaged in texting and talking activities. Fourth, we employed a general dynamic test to evaluate the walking task.

Incorporating kinematic analyses would offer additional data. Finally, the lack of cognitive performance measures and the limited number of trials may have constrained the analysis primarily to motor costs rather than cognitive costs. To gain a more comprehensive understanding of the impact of smartphone use during motor tasks, we encourage further studies addressing these aspects

CONCLUSION

Young adults exhibit increased instability on postural control and mobility when using a smartphone simultaneously with a motor task. The extent of the impact varied depending on whether the individuals were walking or standing. While participants faced comparable risks when texting messages or talking on the phone while walking, standing and talking on the phone posed greater risks compared to the texting and to the no smartphone condition.

These findings should not discourage individuals to use smartphones but should alert them about the risks involved if the device is used simultaneously with a walking or standing task. We encourage additional research to explore whether similar effects are observed in other population groups.

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