ORIGINAL PAPER

Physiotherapy Quarterly (ISSN 2544-4395)
2024, 32(1), 100–104

Impact of smartphone use on posture control in healthy adolescents

DOI: https://doi.org/10.5114/pq.2024.135429

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Abstract

Introduction. Smartphone (SP) use among adolescents is constantly increasing, and it has been reported that SP usage is detrimental to a number of health-related factors. This study was conducted to determine whether the use of SPs has an immediate impact on posture control in healthy adolescents and whether different time limits have different effects.
Methods. This single-group experiment was conducted on 75 adolescents aged between 13 and 18. Subjects' static balance was evaluated using the Humac balance system before using an SP and after 10 min, 15 min, 20 min SP use, and 20 min using the SP with a headpiece. The stabilometric measures, including stability and path length scores, were obtained.
Results. By comparing stability scores and path length scores between baseline static assessment, after 10 min, after 15 min, after 20 min, and after 20 min of using an SP with a headpiece, we found that there was a significant difference between baseline static assessment and reassessment after all time limits. Following the use of an SP, the stability scores decreased, and path length scores increased. We also found no significant difference in stabilometric scores between different time limits of SP use. Furthermore, there were no substantial differences regarding posture control between the use of SP with and without headpieces.
Conclusions. Based on our study's findings, SP use has an immediate effect on posture control with different time limits in healthy adolescents. Therefore, it is better to avoid SP use before or during activities requiring good postural stability.
Key words: adolescent, balance, postural control, smartphone

Introduction

SPs are prevalent in our lives and can even perform, if not entirely replace, mental operations as they perform several cognitive functions, using phonebooks, calendars, web browsers, calculators, games, and maps, among other uses [1].

Despite these advantages, a growing body of research indicates that SPs may have adverse effects and pose threats [2–4], which include excessive use [2], more uncontrollable behaviours such as constantly checking for messages [5], mental health issues such as anxiety and depression [2, 6], and physical issues [7].

Due to the rapid physiological, psychological, and social development during adolescence, this age group is particularly susceptible to the negative impacts of SP usage [8, 9].

Postural control is fundamental to maintaining posture and performing functional activities from childhood to adulthood. It is essential for a child's normal motor development. Postural control necessitates postural mechanisms to preserve stability through the use of muscular force to govern body positions and mental functions, such as attention and motivation [10], which may be adversely impacted by the early use of technology [11].

Posture control necessities visual, vestibular inputs, tactile as well as proprioceptive somatosensory inputs in order to control the body's posture-regulating muscles, particularly those of the lower limbs and trunk [12]. A deficiency in any of these vital systems can significantly impact an individual's ability to survive in their environment.

Dual activities performed on a daily basis while using an SP might be a risk factor for postural instability and poor posture, particularly in a standing posture [13]. Therefore, it is critical to consider these factors when overcoming health issues in youngsters.

By reviewing the literature, numerous prior studies have investigated the impacts of SP usage on gait, cervical posture, neck pain, and other postural-related changes [14–16], but limited research has demonstrated the effect of SPs on posture control, especially in adolescents. Therefore, we conducted this study to determine if SP use immediately affects posture control in healthy adolescents and if the effects of different lengths of usage vary.

Subjects and methods

Study design

This non-randomised, single-group clinical trial was conducted between April 2021 and November 2021.

Subjects

Seventy-five (51 girls and 24 boys) healthy adolescents were enrolled in the present study. Subjects were recruited from Egyptian governmental schools/universities using bulletin boards and WhatsApp groups to advertise the study's objectives and methodology. Healthy adolescents between ages 13 and 18 of both genders were interested in volunteering (Figure 1). We excluded obese adolescents, and adolescents with vestibular or visual impairments, neurological disorders, congenital anomalies or musculoskeletal disorders, or cognitive impairment.

Sample size

The sample size was calculated by the G*POWER statistical software (version 3.1.9.2; Franz Faul, Universität Kiel, Germany) based on stability scores from a pilot study conducted on five subjects; it was determined to be approximately 75. Calculations were performed with $\alpha = 0.05$, power = 80% and effect size = 0.13.

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Received: 10.06.2022
Accepted: 19.09.2022

Citation: Anter E, Al-Tohamy A. Impact of smartphone use on posture control in healthy adolescents. Physiother Quart. 2024;32(1):100–104; doi: https://doi.org/10.5114/pq.2024.135429.

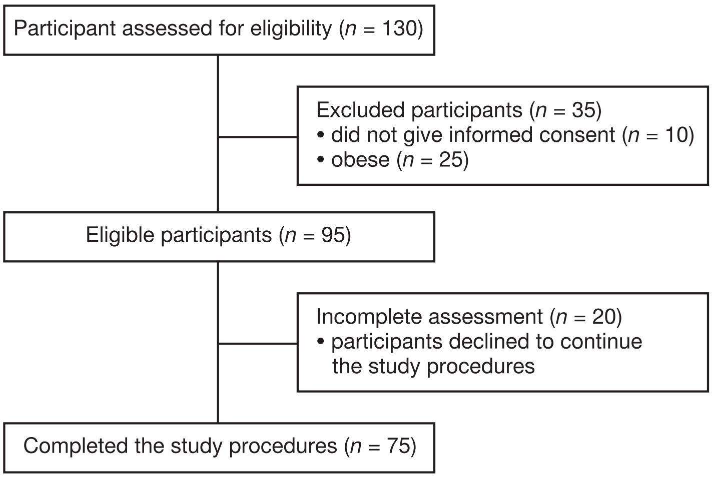

Figure 1. Participants' enrolment flow chart

Procedures

The study procedures were conducted in a quiet and spacious room. We informed the participants about the purpose of the study and its procedures. After providing consent, the participants' demographic characteristics, such as weight, gender, height, age, as well as body mass index (BMI), were recorded. The SP used in the study was the iPhone 7 (model A1778, from Apple Inc.), with dimensions of 138.3 × 67.1 × 7.1 mm (5.44 × 2.64 × 0.28 in) and a weight of 138 g.

First, the participants' data (name, age, gender, weight, and height) were collected, followed by baseline static balance measurements (control group). We then asked the participants to use the SP to play a game while seated in a comfortable position. After playing the game for the set duration, we asked the participants to immediately stand on the Humac platform to measure their static balance (Figure 2).

Static balance was assessed at different time limits; after 10 min of SP use, after 15 min, after 20 min, and finally, after 20 min of SP use with a headpiece, with the sequence of SP-use times for each participant being determined using a sealed envelope. Each participant performed three 1-min balance trials, and the mean was calculated and recorded. Five minutes of rest (non-SP use time) were allowed between SP use tests.

Figure 2. Assessment of posture control with the participant standing on the Humac platform

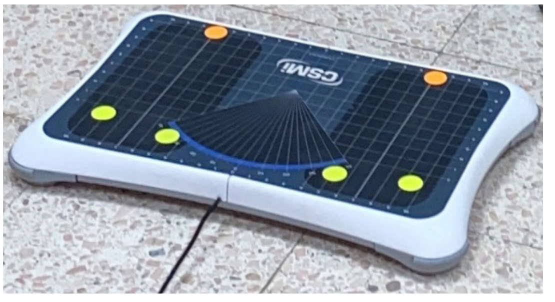

Figure 3. Humac platform with adhesive dots for the same foot position to be maintained for the same participant during the reassessment

We measured static balance using the Humac balance system (computer sports medicine, Inc (CSMisss4a). Since a learning curve must be considered when testing with Humac, practice trials were performed before testing. Each participant was asked to stand on the Humac platform barefoot and place their feet in the most comfortable position with their arms by their sides. The participant's foot position was determined by coloured adhesive dots to maintain the same foot position during measurement repetitions (Figure 3). Subsequently, Humac recorded the centre of pressure (COP) metrics, including stability scores (%) and path length scores (centimetres) (Figure 4). We used the Humac balance system with a sampling rate of 100 HZ, and the data were filtered and analysed utilising the system software.

Statistical analysis

The subject's demographic data were presented using descriptive statistics (Table 1). ANOVA with repeated measures was performed to determine the difference in stability

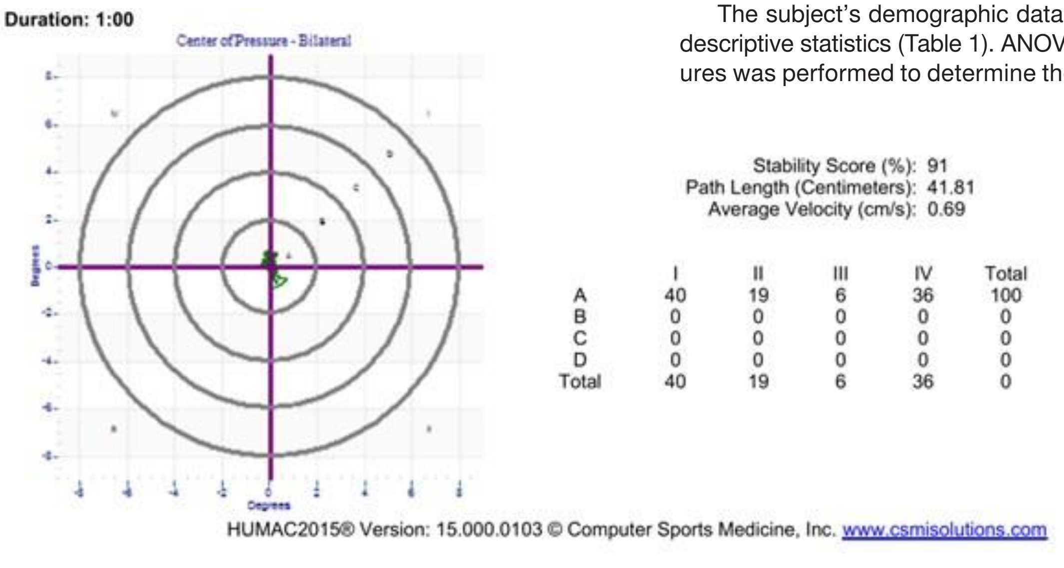

Figure 4. Humac report of COP parameters

scores and path length scores between baseline static assessment, after 10 min SP use, after 15 min SP use, after 20 min, and after 20 min using the SP with the headpiece. The significance level for statistical testing was set at a *p*-value of 0.05. All statistical tests were conducted utilising the statistical package for social studies (SPSS) version 22 for windows (IBM SPSS, Chicago, IL, USA).

Table 1. Participant characteristics

Variables	Mean ± *SD*
Age (years)	14.92 ± 1.54
Weight (kg)	52.42 ± 9.05
Height (cm)	159.4 ± 8.73
BMI (kg/m²)	20.49 ± 2.22
Sex distribution, *n* (%)	
Girls	51 (68%)
Boys	24 (32%)

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Institutional Review Board of the Faculty of Physical Therapy, Cairo University (approval No.: P.T.REC/012/003065). The registration number for the clinical trial is (NCT04775342).

Informed consent

Informed consent was obtained from the school participants' parents and from the university participants themselves.

Results

By comparing stabilometric parameters between baseline static assessment and after 10 min, after 15 min, after 20 min, and after 20 min of using the SP with the headpiece (Table 2), there was a significant difference in stability scores and path length scores between baseline static assessment, after 10 min SP use, after 15 min SP use, after 20 min using the SP, and static after 20 min SP use with the headpiece ($F = 25.53$, $p < 0.001$).

After 10 min, 15 min, 20 min SP use, and 20 min of SP use with the headpiece, the stability scores significantly decreased ($p < 0.001$), and the path length scores significantly increased ($p < 0.001$) when compared to the baseline assessments.

There were no substantial differences in stability and path length scores when comparing SP for 10 min, 15 min, 20 min, and 20 min with the headpiece ($p > 0.05$).

There were also no substantial differences in stability scores and path length scores after 20 min using the SP and after 20 min using the SP with the headpiece ($p > 0.05$).

Discussion

This study aimed to determine whether SP use immediately affects postural control in healthy adolescents and if different time limits have varying effects. It also aimed to compare the impact of SP use with and without a headpiece on postural control after 20 min of SP use.

After all time limits, we observed a negative effect of SP use on the postural control parameters. Following the use of the SP, the stability scores decreased, and the path length scores increased. We hypothesise that this significant immediate change in stability and path length scores following SP use may be attributable to the impact of smartphones' electromagnetic waves on visual data. Since the afferent information necessary for maintaining proper body balance is dependent on superficial sensory perception and proprioception, any condition affecting these systems reduces postural stability [16, 17]. Furthermore, these changes may be due to disturbed cervical afferent function in SP users. Prolonged muscular tension alters the sensitivity of neck proprioception, affecting balance and resulting in postural instability [18].

This study's findings align with the findings of Shafeek et al. [19], who investigated the impact of SP usage on dynamic balance in healthy adolescents, and their work revealed

Table 2. Comparison of stability scores and path length scores between baseline static assessment, assessment after 10 min, after 15 min, after 20 min smartphone use, and after 20 min smartphone use with the headpiece

Parameters	Baseline static assessment mean ± *SD*	After 10 min smartphone use mean ± *SD*	After 15 min smartphone use mean ± *SD*	After 20 min smartphone use mean ± *SD*	After 20 min smartphone use with the headpiece mean ± *SD*
Stability score	91.8 ± 2.81	87.08 ± 9.42	86.57 ± 5.26	85.2 ± 7.87	85.36 ± 5.46
Path length	48.82 ± 14.35	66.49 ± 24.4	68.79 ± 25.66	70.74 ± 27.98	70.93 ± 27.29

Multiple comparisons (Bonferroni test)				
Comparison sides	Stability score		Path length	
	MD (% of change)	*p*	MD (% of change)	*p*
Baseline static assessment vs. after 10 min smartphone use	4.72 (5.14%)	0.001*	–17.67 (36.19%)	0.001*
Baseline static assessment vs. after 15 min smartphone use	5.23 (5.69%)	0.001*	–19.97 (40.91%)	0.001*
Baseline static assessment vs. after 20 using a smartphone	6.6 (7.19%)	0.001*	–21.92 (44.9%)	0.001*
Baseline static assessment vs. after 20 min using smartphone with headpiece	6.44 (7.01%)	0.001*	–22.11 (45.29%)	0.001*
After 20 min using the smartphone vs. after 20 min without the headpiece	0.16 (0.18%)	1	0.19 (0.27%)	1

MD – mean difference, * significant values a significant immediate influence of SP use on balance. Moreover, our findings are comparable to those of Lee et al. [20], who found that using an SP changes the degree to which healthy adults can control their posture.

The findings of Weyk et al. [21] are compatible with the current study, as their analysis of children's postural control in three different conditions (open, closed eyes, and SP use) indicated that the children's postural adjustments were similar in the eyes-closed and SP-use conditions, unlike when the children were in an orthostatic position with their eyes open.

In addition, our findings regarding the deterioration of postural control metrics are consistent with those of Hyong [22] and Cho et al. [23], who illustrated that using an SP while engaging in physical activity impaired cognitive capacity and dynamic balance. Furthermore, Laatar et al. [24] found that using an SP increased CoP displacement and diminished the standing postural stability of old and young individuals.

Similarly, Schabrun et al. [25] showed that the dynamic analysis of the gait pattern altered while using an SP. One of the causes of these changes was decreased visual attention to the surroundings and an emphasis on head posture adjustments [25].

In contrast to Lee et al. [20], who reported that different SP use time limits have variable effects on postural control in healthy adults, our study revealed that there was no statistically significant difference in stability and path length scores between different time limits of SP use in healthy adolescents. However, as their study was applied to the adult population, it is not easy to compare the results directly.

In addition, our findings revealed no significant difference on posture control between using an SP with and without a headpiece for 20 min. This insignificant change may be because posture stability primarily depends on vestibular, somatosensory, and visual information, not auditory information [26].

Palluel et al. [27] illustrated that despite the difficulty of postural challenges, the CoP displacements of adolescents were greater than those of adults. In addition, their findings confirmed the existence of a turning point when multitasking. Due to physical changes during adolescence, adolescents had to devote more cognitive resources to a postural task [27]. The temporary neglect of proprioceptive stimuli causes a decline in postural orientation and body stabilisation during adolescence, indicating that adolescence is a period of profound physiological and psychological change [28].

Researchers investigating the relationship between SP use, physical activity, and posture stability have revealed an association between increased phone use and decreased physical activity and posture stability [29, 30]. The ability to maintain an upright standing position is the most fundamental skill required for gait and other dynamic behaviours [31]. Dual tasking while using an SP is typical in social situations, and it reduces the cognitive ability and thus affects postural control [32]. Our findings suggest that adolescents should avoid engaging in activities requiring good postural stability while using an SP or immediately afterwards. In addition, sportive adolescents should be advised not to use their SP before any sports participation.

Limitations

This study is limited to investigating only immediate effects of SP usage; their duration is therefore still unknown. Second, the current study only investigated one specific age range (13–18 years).

Therefore, future studies are required to determine whether SP usage has long-lasting effects and if there is an immediate effect on postural control in different age groups.

Conclusions

Based on the results of our study, we conclude that posture control decreases immediately after using an SP for 10 min or more. Consequently, it is advisable to avoid SP use prior to daily activities that necessitate good balance, walking, and before engaging in sports.

Acknowledgments

The authors would like to thank all the participants, their parents, schools, and Cairo University for participating in this study.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors declare no conflict of interest.

Funding

This research received no external funding.

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