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Published in:
Journal of Fitness Research

FitnessResearch.edu.au

CONFERENCE PAPER

Evolution of smart devices and human movement apps: recommendations for use in sports science education and practice

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ABSTRACT

Many smart phones and tablets possess high-speed cameras. An increasing number of human movement professionals (e.g. personal trainers, athletics coaches, strength and conditioning coaches and physiotherapists) are beginning to use human movement analysis apps with their smart phones/tablets to quantitatively assess their clients' performance and injury risk. However, an understanding of the validity and reliability of these tools is required. This narrative review seeks to list some relevant human movement apps; summarise the validity and reliability of selected apps and to provide recommendations for their use in education and practice.

Keywords: biomechanics; coaching; personal training; physical education; physiotherapy; smart phones; sports and exercise science.

INTRODUCTION

The accurate quantification of human movement is vital in many professions including the coaching, personal training, physical education, physiotherapy as well as sports and exercise science. A considerable portion of human movement analysis is performed qualitatively, with the professional using their own eyes and understanding of the movement to assess overall movement competency; with the aim to identify potential movement issues that may reduce performance and/or increase injury risk.

POTENTIAL BENEFITS OF HUMAN MOVEMENT APPS

Newer devices e.g. iPad Pro and iPhone 6 have high-speed (240 fps) video camera, 3-D accelerometers and gyroscopes that provide a cost-effective method of quantitative performance analysis.[1] As a result of these technological innovations, a relative explosion in the number of human movement analysis apps is now occurring. Some of these apps are somewhat generic and have multiple applications e.g. the *TiltMeter* app which has been used to assess shin angle in the weight bearing lunge test.[2] Other apps have been developed for specific tasks including range of motion (e.g. *Simple*

ISSN 2201-5655

Table 1: Validity and/or reliability of selected iOS human movement apps.

Study	App	Validity	Intra-tester reliability	Inter-tester reliability
Balsalobre-Fernandez et al.[3]	My Jump	Against force plate R^2 = 0.99; ICC = 0.997 (CI = 0.996-0.998); BAB = 1.3 ± 0.5 cm	α = 0.99, CV = 3.4-3.6%	ICC = 0.999 (CL = 0.998–0.999); MD = 0.1 ± 0.4 cm
Jones et al.[4]	Simple Goniometer	Against Universal Goniometer r ≥ 0.96; ICC ≥ 0.93; BAB = +0.5°	Not reported	Not reported
Williams et al.[2]	Tiltmeter	Against digital inclinometer ICC = 0.83; MD = -0.15° (CI: –0.74° to 0.45°)	Straight ICC= 0.81 (CI 0.66-0.96 Bent ICC = 0.85 (CI 0.74-0.97)	Straight ICC = 0.80 (CI 0.57-0.92) Bent ICC = 0.96 (CI 0.90-0.98)

BAM = Bland Altman bias; CI = 95% confidence interval; MD = mean difference; SEM = standard error of the mean.

Goniometer), bike fitting (e.g. *Bike Fast Fit*), postural analysis (*e.g. Posture Aware*), weight training (e.g. *IronPath*), gait analysis (e.g. *RunMatic*), sprinting (*MySprint*) and vertical jumping (e.g. *MyJump*).

VALIDITY AND RELIABILITY OF HUMAN MOVEMENT APPS

While such data may prove invaluable data to the human movement professional and client, the validity and reliability of these apps needs to be demonstrated if they are to be used in practice and research. A summary of some validation and reliability studies of a cross-section of fitness industry relevant human movement apps is provided in Table 1.

As can be seen in Table 1, some apps have been demonstrated to have sufficient validity and reliability for measuring variables including segment angles, joint range of motion and jump height. While this list is not exhaustive, this suggests that a number of apps may provide feasible quantitative analysis options for the analysis of human movement. However, human movement students and professionals need to be aware of the potential pitfalls of these apps. We therefore recommend that prior to using any human movement app, the peer-reviewed literature is consulted so to determine its validity and reliability; and that an attempt is made to understand the process in which the outcome measures are generated. We also recommend conducting some in-house reliability testing of the app so to gain an understanding of the likely error of measurement that may be observed with repeated measures. By following this advice, human movement students will be provided with greater real-world educational opportunities that will improve their graduate employability; while human movement professionals may be able to further improve the performance and reduce the injury risk of their clients.

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