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Validity of Mobile Based Technology Versus Direct Observation in Measuring Number of Steps and Distance Walked in Six Minutes

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To The Editor: Use of mobile technology and activity monitors are promising approaches to monitoring and improving physical activity (PA). It has been seen that in the US, one in five owners have a health app of whom 38% of 254 users have an app for exercise/fitness/pedometer/heart rate monitoring.[1, 2] In addition, fitness trackers (Fitbit) are also commonly used to monitor and promote PA. However, many of these apps and trackers appear to under-estimate steps walked and create a greater margin of error for most forms of PA. [3, 4] The Fitbit, has shown good agreement with other devices and between other models of Fitbit for steps walked.[5, 6] However, there is limited literature on the accuracy of assessing distance covered.[7] The current study therefore was designed to assess the accuracy in terms of steps walked and distance covered for the Runtastic mobile app and Fitbit Charge 2.

A prospective observational study was carried out between 2nd May to 31st July, 2017on 62 healthy participants, between the ages of 20-29 (n=31) and 30-39 (n=31). Institutional board approval and written informed consent was obtained from each subject prior to enrolment. Participants with recent musculoskeletal injuries of the lower limb limiting walking and those with pre-existing medical conditions were excluded. Sample size was estimated as described by Zou et al.[8]

Eligible participants performed the six-minute walk test (6MWT) with the Fitbit pedometer worn on the dominant hand and Runtastic application running on a smartphone. The number of steps and the distance covered were recorded from the device and app. Distance was obtained at the end of the 6MWT. Additionally, the test was video recorded to count the number of steps

walked. The number of steps walked from the video recordings were counted by two independent assessors, blinded to the outcomes recorded from the device and the app. Since the two assessors showed excellent inter-rater reliability (Cronbach's alpha=0.986; intraclass correlation of coefficient (ICC) = 0.972; P <.001), an average of both their readings were taken as the number of steps walked for each subject.

Data was analysed using SPSS version 20 and NCSS version 12 (trial version) using multivariate analysis of covariance to assess the difference between the means of steps walked and distance covered for the three measures after controlling for height and weight. Repeated measure analysis of variance was run with post-hoc Bonferroni adjustment to compare the differences between the three measurements. Bland Altman analysis was performed with standard error of means calculated. Statistical significance was considered when P<.05.

Table 1 summarizes demographic details, comparison and the 95% levels of agreement of steps walked and distance covered. Since there was no statistically significant difference (P=.89) between the mean age in both the age groups, no separate analysis was performed for both age groups. Multivariate analysis found statistically significant (P<.05) differences for the mean number of steps walked and mean distance covered after controlling for height and weight. Both the Fitbit and Runtastic demonstrated statistically significant differences for the mean difference of steps walked and mean difference of distance covered Mean percentage errors were lesser steps walked and distance covered with the Fitbit (-15.5% and -14.1%) than Runtastic (-42.6% and -46.5%). Univariate analysis revealed a statistically significant difference between the three methods for both steps walked and distance covered, which remained significant on post-hoc analysis.

A recent study found high accuracy with Fitbit monitors for steps walked on a treadmill.[7] However a previous model of the Fitbit, Fitbit One, was found to overestimate the number of steps walked for moderate-vigorous PA when compared to accelerometry.[9] However, since none of these were compared against direct visualization, it could be why most studies have reported overestimation rather than underestimation of steps walked and distance covered. The Runtastic has been reported to be an accurate approach to tracking PA.[10] However, our findings suggest that Runtastic grossly underestimates the steps walked and distance covered, similar to previous studies.[3, 4]. Therefore, better accuracy in measuring both steps taken, and distance covered for both the Fitbit and Runtastic, is required if they are to be used in PA research.

To conclude, significant discrepancies exist between methods of evaluation for both steps walked and distance covered. However, the Fitbit appears to have lesser deviation and percentage error from the direct measurement when compared to the Runtastic. Thus, the use of the Fitbit Charge 2 may be considered as a more valid device for promoting PA. If Runtastic is being used, it should be kept in mind that it may underestimate by ~45%.

Declaration of interest statement: None

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Table 1: Demographics, comparison of outcomes and accuracy between the three measurement methods

Variable	20-29 years (n=31)		30-39 years (n=31)		Total (n=62)			
[a] **Age in years**	23.5 ± 1.9		32.5 ± 2.6		27.9 ± 5.1			
[a] **Height in cms**	166.9 ± 7.5		170.2 ± 7.8		168.5 ± 7.7			
[a] **Weight in Kgs**	69.1 ± 17.0		69.7 ± 11.8		69.4 ± 14.5			
[a] **Body mass index in Kg/m^2**	24.6 ± 5.0		24.1 ± 4.1		24.3 ± 4.5			
	[b] **Steps walked**				[b] **Distance covered in meters**			
	Mean ± SD		**SEM**		**Mean ± SD**		**SEM**	
Fitbit	608.7 ± 91.6		11.6		451.4 ± 89.7		11.4	
Runtastic	413.9 ± 108.1		13.7		280.9 ± 83.9		10.6	
Direct visualization	720.9 ± 54.5		6.9		525.5 ± 54.9		6.9	
	[c] **Mean difference**	**Standard error**	**95% CI**	**95% limits of agreement**	[c] **Mean difference**	**Standard error**	**95% CI**	**95% limits of agreement**
Fitbit vs. direct visualization	112.1	12.9	86.2 – 138.1	-549.4±26.9, -64.4±26.9	-74.1	12.6	48.7 – 99.4	-269.7±21.7, 121.5±21.7
Runtastic vs. direct visualization	306.9	15.7	275.5 – 338.3	-312.2±22.2, 87.9±22.2	-244.5	13.1	218.1 – 270.8	-448±22.6, -40.9±22.6

a: $P>.05$; b: $P<.05$ after controlling for height and weight; c: $P<.05$