VALIDATION OF THE ACTIVPAL™ IN THE HEALTH PROMOTION CONTEXT

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Abstract

Background: The health value of an active lifestyle is well recognized. However, the behavioral and psychological correlates of physical activity need further investigation.
Purpose: We hypothesized that physiotherapists are significantly different from non-health related professionals in a) Health Locus of Control and b) physical activity levels as measured by activPALTM (PAL Technologies Ltd) and that physical activity levels are significantly correlated with Health Locus of Control.
Material and Methods: A convenience sample of 10 physiotherapists and 10 non-health related professionals completed the Health Locus of Control scale and then was monitored by the activPALTM for 24hours. The activPALTM's accuracy, test-retest and inter-instrument reliability was tested in a single participant study. Study design, Cross-sectional study.
Results: Physiotherapists were statistically significant more active ($p<0,01$) than non-health related professionals. Further the odds of having an external Health Locus of Control were 11.6 times as high among non-health related professionals as among physiotherapists. Internals were significantly more active ($p<0,05$) than externals. The validity of the activPALTM was strongly supported.
Conclusion: Physiotherapists were found more active and more often internals than non-health related professionals. A strong influence of Health Locus of Control in daily activities was observed. The results also support the use of the activPALTM as a physical activity measure.

Keywords: Physical activity, behavioral and psychological correlates, Health Locus of Control, health related professionals, accelerometer

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Introduction

The value of a physically active lifestyle as a means of protecting and promoting health is well recognized. It has been shown that physical activity (PA) decreases cardiovascular disease[1-3], averts or delays the development of high blood pressure[4,5], controls and prevents diabetes[6,7], normalizes weight[8], reduces the risk of osteoporosis[9,10] and forms of cancer[11], increases functional capability, improves depression and anxiety and contributes to a positive sense of well being[12,13]. In general a physically active way of life decreases the risk of mortality and increases longevity[14]. Unfortunately, people have not succeeded to understand the concept and health value of an active lifestyle[15].

A number of models and concepts that can possibly aid the understanding of PA participation have been discussed. The Locus of Control (LOC) model is one of them[16]. The first LOC scale was presented by Rotter (1966)[17] and was a measure of 'individual differences in a generalized belief for internal or external control of reinforcement'. Since this scale was developed as a generalized measure, it was inevitable that researchers would develop more situation-specific measures of LOC to allow for better prediction of specific behaviors. One of the most widely used such measure is the Health Locus of Control (HLC) scale[18] designed for predicting health behaviors.

Dishman (1981)[19] used the HLC scale to predict exercise adherence and drop-out in a 20-week prospective study of young adult men. They found that adherers had higher internal scores than drop-outs. Furthermore, subjects with external HLC were less likely to adhere to the programme than subjects with internal HLC. Moreover, Dishman and Steinhardt (1990)[20] studied the validity of HLC for predicting free-living PA among college students. They concluded that although HLC was unrelated to supervised PA, it could efficiently discriminate between high active and low active subjects. However, these studies did not use standardized assessments of PA. Therefore, their results cannot be easily generalized.

Another factor associated with PA participation is the knowledge of the benefits of PA[21]. However, studies implied inadequate counseling by health professionals[22,23]. Recommendations to improve physician counseling incorporate improving their personal PA habits, so that their guidance to patients can be more practical and effective[24]. These recommendations are reinforced by evidence that health professionals who are physically active themselves are more likely to counsel their patients about exercise[21].

Physiotherapists are among the health professionals that prescribe PA to their patients and a great proportion of their education consists of exercise training. However, little evidence exists with regard to the physiotherapist exercise counseling and its association with their activity levels and beliefs.

Research that wishes to address problems related to PA must be able to accurately quantify PA behavior[25]. Although a variety of techniques have been used to assess PA, none of these have been found to be both objective and practical[26].

The activPALTM, which combines the motion sensing approach with accelerometry, is a very small (35mm x 53mm x 7mm) and lightweight (20gr including battery) electronic device, designed to be worn on the mid-thigh. The activPALTM seems promising for use in PA research because it combines the advantages of accelerometry with the ability to register three classes of activity (sitting/lying, standing, stepping) second by second[27].

The present study aimed to provide evidence for the validity and reliability of the activPALTM and use it a) to identify any differences in the daily activity levels of physiotherapists and non-health related professionals and b) to test the validity of HLC scale as a predictor of PA levels.

MATERIAL AND METHODS

Validation of the activPALTM

To evaluate the validity and test-retest reliability of the activPALTM a 28 years old female student repeated the same protocol

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of activities fifteen times. The protocol included two sessions. In session one the activities included 600 seconds sitting, 600 seconds standing and 600 seconds stepping [The activPALTM presents the recorded time in the format hours, minutes, seconds to proceed in further analysis the time of each activity was transformed in seconds]. In session two she performed seven sets of 300 steps each on a treadmill (total of 2100 steps). Each set had different stepping characteristics (Table 1). The activPALTM was placed on the participant's right mid-thigh – midway between hip and knee. The percentage of the true value recorded for each output was calculated as 100 x device count / actual count. A value over 100 indicated over counting and a value under 100 indicated undercounting.

Table 1. Stepping characteristics of each set of 300 steps

Set	Stepping characteristics
1	1km/h
2	2.5km/h
3	3.5km/h
4	5.5km/h
5	2.5km/h + 250 inclination (ascent)
6	2.5km/h + 250 inclination (descent)
7	2.5km/h stepping backwards

The activPALTM gave almost identical measures with the true values and the measures obtained showed little variation within the fifteen recordings (Table 2).

Table 2. Mean, Mean %, Standard Deviation (SD) and Range for sitting, standing, stepping time (in seconds) and number of steps

	N	Units	Mean	Mean %	SD	Minimum	Maximum
Sitting/Lying	14	Sec	601	100.1	18	545	635
Standing	15	Sec	606	101	20	585	667
Stepping	15	Sec	605	100.8	36	498	651
No of Steps	15	No	2061	98.1	48	1993	2125

The inter-instrument reliability between the validated unit and a second that would be employed for further data collection was evaluated on the same participant. She had to wear both devices simultaneously on her right mid-thigh and be monitored for 24 hours. The 24 hours monitoring was repeated five times. Since the recording period was extensive, the time outputs were analysed in minutes. The mean difference in the output between the two devices 1 and 2 was calculated as 100 – (100 x mean Device 2 output/mean Device 1 output). Negative values indicated higher values in Device's 1 output.

Device 2 measured .08% more sitting time, 3% less standing time, 2.5% more steps than Device 1(Table 3).

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Table 3. Total minutes spent sitting/lying, standing, stepping and total number of steps registered for each of the five trials

Trial	Sitting/Lying* (min)		Standing* (min)		Stepping* (min)		Total time* (min)		Steps	
	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2
1	1267	1267	82	79	91	94	1440	1440	4979	4639
2	1229	1230	53	49	86	89	1368	1368	6068	6069
3	1200	1198	119	118	95	98	1414	1414	5378	5252
4	1327	1321	30	27	62	62	1419	1420	4161	4060
5	1324	1324	48	47	68	69	1440	1440	4063	4013
Mean	1269	1270	66	64	80	82	1416	1416	4930	5007
SD	56	58	35	35	15	16	29.5	29.5	843	745
Dif %	.08		-3		2.5		0		1.6	

*seconds were approximated to minutes

Operational definitions

Daily PA was defined as 'the sum of the total standing time plus the total stepping time as measured by the activPALTM in a 24 hours interval'.

Design

An independent samples experimental design with two groups (physiotherapists and non-health related professionals) was used to examine how occupation affected HLC and daily PA.

Participants

A convenience sample of ten (10) physiotherapists and ten (10) non-health related professionals was used. All participants were recruited on voluntary basis. The participants were eligible to participate if they were between 22 and 32 and master's level students pursuing a degree relevant to their occupation.

Ethics

Ethical approval was granted from the Queen Margaret University College's, Edinburg, UK Ethics Sub-committee for the study's procedure and the access to all participants.

Materials

The HLC Scale was used to measure HLC (Appendix I)[18]. The scale has been broadly employed in health behaviour studies[28] and evidence of reliability and validity is summarized elsewhere[29].

The two validated activPALTM devices measured the daily PA of the participants.

Procedure

Eligible volunteers who consented to participate in the study completed the HLC Scale in a quiet room. Subsequently, the activPALTM, secured on the mid-thigh with Medipore tape, monitored their activities for 24 hours. Earlier the participants had been taught how to position it on their thigh, because they had to remove it during shower or bath. Each activPALTM was reprogrammed and a fresh battery was inserted in the device before each participant's PA monitoring. The device was switched on and off by the researcher. Just after the participant had returned the activPALTM to the investigator, a few minutes semi-structure interview focusing on the participants' views on the activPALTM was conducted (Appendix II). The interviews were taken and transcribed by the researcher in a quiet room.

Data Analysis

The HLC Scale was scored according to Wallston et al's (1976)[18] instructions and was

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analyzed as a dichotomous variable (internal/external).

Since the activPALTM's software displays only one day's recording at a time, if a participant's recording covered more than 24 hours (one day), the first recorded day was selected for further processing. The recorded time was analyzed in minutes.

The interview data were analyzed using the grounded theory[30]. Recurrent themes and emergent concepts were identified enabling the researcher to produce a framework that clarified the participants' views on the activPALTM as a measurement of daily PA.

RESULTS

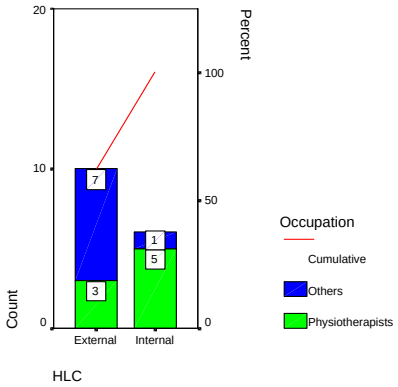
Twenty participants were tested. The activPALTM failed to give results in four occasions due to technical failure. Therefore, usable data were obtained for sixteen participants, eight physiotherapists and eight non-health related professionals (Table 4).

Table 4. Individual characteristics (occupation, age, gender)

		Age	
	No	Physiotherapists	Others
Male	1	24	30
	2	24	28
	3	23	21
	4	25	33
Female	1	24	34
	2	25	28
	3	25	29
	4	28	30
Both	Mean	24.7	28.4

Figure 1 presents how the participants were assigned to external and internal HLC.

Fig 1. Internal and external HLC assignment of the participants.



In order to identify the strength of association between the two dichotomous variables (occupation and internal/external HLC) the odds and the odds ratio were used. The odds is a measurement typically used for binary data, equal to the ratio of the probability of a event occurring divided by the probability of an event not occurring. The odds ratio is a ratio between two odds, used to summarize the strength of the relationship between two usually dichotomous variables. The odds and the odds ratio take values from 0 to infinity with 1 indicating indifference or lack of relationship[31]. The odds ratio suggested that the odds of having an external HLC were 11.6

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times as high among non-health related professionals as among physiotherapists (Table 5).

Table 5. Strength of association between external/internal HLC and occupation

		HLC		
		External	Internal	**Odds**
Occupation	Physiotherapist	3	5	3/5=0.6
	Other professionals	7	1	7/1=7

Odds ratio= 7/0.6= **11.6**

Raw data and summary statistics for the time spent in each activity by the two groups are given in the Table 6. The recorded time for the two groups was the same. Stepping and standing time were added together to give total activity time (defined as daily PA).

Table 6. Raw activPALTM data for sitting/lying, standing, stepping and total activity time (in minutes)

	Sit/lying		Standing		Stepping		Total activity		Total time	
No	Physio	Other	Physio	Other	Physio	Other	Physio	Other	Physio	Other
1	1025	1020	196	144	219	273	415	417	1440	1439
2	802	1147	184	146	438	147	622	293	1424	1437
3	929	1017	274	62	236	293	510	423	1439	1440
4	959	1257	104	71	196	423	300	182	1259	1440
5	1027	1208	193	112	220	182	413	231	1440	1439
6	911	1218	199	56	330	231	529	153	1440	1371
7	1018	1312	215	55	207	153	422	127	1440	1439
8	941	1253	301	47	197	127	498	185	1440	1438
Mean	951.5	1179	208.2	86.8	255.4	167.4	460.6	251.4	1415.1	1430
SD	75.8	109.6	59.6	41.1	85.5	99.6	97.2	115.5	63.3	24

An independent-samples t-test was conducted to compare the total activity times for physiotherapists and non-health related professionals since the data satisfied the parametric assumptions. The results indicated significant difference in total activity time between physiotherapists (M=463.6, SD=97.1) and non-health related professionals [M=251.4, SD=115.5, t (14) =3.97, p=0,001] (Table 7). The magnitude of the differences in the means was large (eta squared=0.53) (Cohen 1988).

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Table 7. Statistical differences in total activity time between groups

	Levene's test		t-test for Equality of Means						
	F	Sig.	t	f	Sig.(2-tailed)	Mean Difference	Std Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Total activity	.468	.505	3 3.97	14	.001	212.25	53.37	97.77	326.72

An independent samples t-test was used to compare the total activity times for internals and externals. The results with equal variance assumed indicated that the participants with external HLC (M=291.4, SD=134) had statistically significant lower total activity time compared with participants with internal HLC [M=467.66, SD=110.9c, t (14) =-2.70, p<0,05] (Table 8). The magnitude of the difference in the means was large (eta squared=.34).

Table 8. Statistical difference in total activity time between participants with internal and participants with external HLC

Levene's test		t-test for Equality of Means						
F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
1.042	.325	--2.70	` 14	.017	-176.3	65.20	-316.1	-36.4

Interview data

The participants regarded the activPALTM a valid and practical measurement of PA because it provides minute-to-minute monitoring of the main expression of PA and at the same time it is manageable, unobtrusive and fits easily under clothing. However, they mentioned that it would not reflect accurately the activity levels of populations that perform water activities or are in a wheelchair because it is not waterproof and does not detect activities of the upper body.

DISCUSSION

The results support that physiotherapists are significantly more active than the non-health related professionals. Physiotherapists are comprehensively educated about PA benefits. Hence, the present study supports the findings of Clever and Arsham (1984)[24] who associated the knowledge of PA health benefits with the PA levels.

The examination of the physiotherapists PA behavior was prompted by evidence that health professionals can have a positive effect in their patient's health behavior through counseling[32]. Effective PA counseling depends on health professionals' personal activity habits[33] because health professionals who are physically active themselves are more likely to counsel their patients about exercise and give more effective PA guidance[21]. Our results imply that physiotherapists have recognized the importance of PA. However, the hypothesis that physiotherapists with high PA levels tend to counsel more about PA is yet to be examined.

The results also indicated that participants with internal HLC were statistically significant more active than participants with external HLC. Between the two groups tested, the most active group (physiotherapists) presented mostly internal HLC. The less active group (non-health related professionals) presented mostly external HLC.

Previous studies on the association of HLC with PA have resulted in contradictory evidence. O'Connel and Price (1982)[34] suggested that participants that adhere to

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exercise programmes are slightly more internal than drop-outs. In contrast, Laffrey and Isenberg (1983)[35,36] found no relationship between internal HLC and PA practices. Finally, Dishman and Steinhardt (1990)[20] supported the validity of HLC in predicting free-living PA among college students.

The results of the present study cannot be easily generalized. Firstly, the PA of the participants was monitored only for 24 hours. The results might be indicative but it is not certain that habitual PA activity is represented. Secondly, physiotherapists in general are familiar with the HLC theory and the value of PA to health. This fact may have influenced the findings that address the association of PA levels with HLC scores. However, the strong relationship between internal/external HLC and free-living PA that was identified justify experimental studies to examine the associations of HLC with PA in different populations.

Activity monitors have been extensively used in PA research because they are generally easy to administer and score and are acceptable to participants. Moreover, by continuous minute-to-minute monitoring of daily physical activity, they offer an objective alternative to self-report instruments typically used in this area of work. However, it has been shown that they underestimate activity time and number of steps up to 20%[37,38], overestimate time spent in sedentary activities[39] and have large variability within their recordings[40].

The activPALTM seems a promising alternative to previously used activity monitors. It gave almost identical measured and true values for sitting/lying, standing and stepping time and number of steps. The repeatability of the values obtained was high and recordings from two different activPALTM devices were highly correlated with each other. Speed, a factor that influences the recordings of most activity monitors[26,39] does not seem to affect the activPALTM recordings. Finally, the participants' regarded the activPALTM as a practical and valid measurement of PA. This preliminary evidence suggest that the activPALTM is a useful PA measurement and justifies further research to establish its validity in different settings and populations and to test the accuracy of the step frequency and energy expenditure outputs.

CONCLUSION

The present study suggested that physiotherapists are more active and have a more internal Health Locus of Control than non-health related professionals, probably due to their education. The strong association of HLC with PA levels found implies that HLC model may have large potential in explaining free-living PA. However, studies are needed to confirm these results in different populations.

The PA of our participants was measured with the activPALTM activity monitor which was found valid and reliable in evaluating PA in populations that the majority of PA consists of ambulation. It could be valuable not only in measuring degree of physical activity of healthy individuals, but also in estimating activity of individuals undergoing rehabilitation interventions to improve ambulation and physical activity.

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