364. Physical activity monitors: from toy to valid tool?

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Validity of 6 activity monitors during standard physical activities in COPD – Comparison with indirect calorimetry

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Background: Reduced physical activity is an important feature of COPD. A range of monitors are available, but the validity of their various output parameters is not well established for patients with chronic diseases. The IMI PROactive project evaluated 6 activity monitors: SenseWear (SW); RT3; Actiwatch (AW); Actigraph (AG); Dynaport Minimod (MM) and Lifecorder Kenz (KZ).
Methods: 40 patients (GOLD stage 1-4; Age 67±7, FEV1 56±18%pred, 6MWD 430±127) were recruited in 4 centres. Patients wore all activity monitors and a portable metabolic system and performed a 1 hour standard activity set (including walking, standing, stair climbing and upper limb tasks). Activity intensity (METs), assessed by indirect calorimetry, was compared to activity monitor outcomes. Average VO_2 during the protocol was also calculated (8.78±1.72 ml min^{-1} kg^{-1}) and compared to activity monitor outputs; METs (SW, MM); activity counts or Vector Magnitude Units, VMU (AW, AG, RT3); or a general activity outcome (KZ).

Table 1

	SW	MM	RT3	AG	AW	KZ
Min-by-min	0.72 (0.64–0.81)	0.82 (0.73–0.85)	0.74 (0.64–0.79)	0.73 (0.60–0.83)	0.53 (0.45–0.62)	0.57 (0.39–0.65)
Mean VO_2	0.72**	0.51**	0.19	–0.005	0.56**	0.40**

**p<0.01

Results: Table 1 gives median (IQR) for Pearson correlation between VO_2 and activity monitor outcomes and that between mean METS over the study and mean activity monitor output.
Conclusion: The MM, SW, RT3 and AG give acceptable estimates of minute-by-minute variation in metabolic activity during physical activity. SW, MM, AW and KZ show acceptable correlations between overall metabolic activity and monitor output. These findings could guide users in choosing valid activity monitors for research or clinical questions.

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User acceptability of 6 activity monitors in COPD; part of the PROactive project

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Background: Activity monitors (AM) are used to assess physical activity in patients with lung disease. To date the user (patients) acceptability of using these devices has been not well documented.
Aim: To monitor patients' experiences and preferences after wearing multiple monitors for a sustained period.
Method: As a part of the PROactive project 65 COPD patients (GOLD 1-4) wore 3-5 activity monitors simultaneously for two weeks. Monitors were the Actiwatch (AW); Kenz Lifecorder (KZ); RT3; SenseWear Monitor (SW); Actigraph (AG) or DynaPort Minimod (MM). Patients completed a questionnaire to assess technical difficulties in handling the devices, efficiency, acceptability and satisfaction. Answers were scored on a 5-point Likert scale with lower scores indicating a more positive experience. Patients were asked if outcomes from activity monitors seemed relevant to them.
Results: Ninety four% of patients agreed that AM contributes to understanding of the impact of their disease. The dominant response to the 13 user questions was 0, indicting no burden. Table 1 summarizes the key questions and the overall scores of the monitors.

Table 1

Monitor	Patients wearing monitor	Overall monitor score (0–100)	No technical problem (%)	No interference in daily life (%)	Willing to wear >1wk
AW	31	93*	94	84	84
KZ	33	90*#	97	85	82
RT3	28	90*#	93	79	74
SW	56	88*#	90	79	83
AG	31	86*#	97	84	81
MM	37	74$	81	54	73
p-value		0.05	NS	0.06	NS

*#$Group similar results ANOVA.

Conclusion: All monitors showed good overall acceptance ranging from 74% (MM) to 93% (AW). The lower overall score for the MM suggests that potentially the position on the back of patients is perceived less comfortable.
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Accuracy of three activity monitors in patients with COPD – Validation by video

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Introduction: COPD patients have a slowing of movements due to muscle disuse, muscle wasting and increased dyspnea. The use of walking aids such as rollators are common. Slow movements,low movement intensities and the use of rollators have been reported to potentially decrease the accuracy of activity monitors (AM) when used in patients with COPD.
Aims and objectives: To assess the accuracy regarding number of steps from three AM's. The objective was to test the hypothesis that differences between AM's might occur when used in patients with severe COPD.
Methods: 15 patients with severe COPD (FEV1 1.15 l) who desaturated ≥4% during a 6-minute walk test were included. Patients performed a 53 minutes structured protocol of different physical activities, while simultaneously wearing 3 AM's; (*McRobert's DynaPort ADL-monitor®*, *McRobert's DynaPort MiniMod®* both worn at waist level, and *BodyMedia SenseWear Armband Pro®* worn around

the upper arm). Activities included walking at different speeds, walking with a rollator, walking in stairs, sitting, lying, etcetera. As criterion validity, video recording and manual step count was used.
Preliminary results: Significant differences ($p<0.05$) in the number of steps detected by AM's compared to manual step count was found (Table 1).

	Detected by:			
	Video	ADL-monitor	MiniMod	SenseWear Armband
Number of steps (n)	2074 (225)	1904 (506)	1827 (315)	1311 (474)
Compared to video (%)	100	89	88	60

Mean (SD) and %.

Conclusions: Caution in interpreting results from activity monitoring seems warranted if the outcome is number of steps derived from different AM's. The SenseWear Armband seem unsuitable for detecting number of steps in severe COPD, especially if a rollator is used.

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Energy expenditure during daily activities as measured by two motion sensors in patients with COPD
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Background: In patients with chronic obstructive pulmonary disease (COPD), energy expenditure (EE) assessment during the performance of daily activities is not yet studied in depth. The aim of this study was to determine which daily activities are more demanding to patients with COPD and to compare the accuracy of EE estimation given by the pedometer Digiwalker SW701 (DW) and the multisensor SenseWear Armband (SAB).
Methods: Thirty-six patients with COPD (20 men; FEV_1 48±15%predicted; BMI 25.7±8 kg/m^2) were submitted to a modified version of the Glittre ADL-test, which included five activities performed for one minute each: walking on the level, walking on the level carrying a backpack, walking up/downstairs, rising/sitting in chairs and moving objects in and out of a shelf. During the protocol subjects wore both devices concomitantly, and indirect calorimetry (IC) was simultaneously performed as the criterion method to assess EE.
Results: The most demanding daily activity for individuals with COPD was walking up/downstairs (4.9±1.7Kcal *versus* 3.7±1.4 to 4.2±1.8Kcal for the other tasks; $p<0.05$). EE estimation by the SAB did not show difference in comparison to IC for the sum of the five activities (SAB=22.7±7Kcal *versus* IC=21±8Kcal; $p>0.05$), although overestimation was found in activities involving walking. DW showed significant EE underestimation in the sum of the activities (9.6±4.3Kcal; $p<0.05$ *versus* IC) and for each activity.
Conclusion: Walking up/downstairs was the most energy-demanding daily activity for patients with COPD. Furthermore, during daily activities, the multisensor showed adequate overall estimation of energy expenditure, as opposed to the pedometer.

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Dyspnoea and fat free mass are major determinants of reduced physical activity in COPD patients
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Background: Physical activity is reduced in patients with chronic obstructive pulmonary disease (COPD), and this has been associated with systemic inflammation and left cardiac disfunction (Magnussen et al, AJRCCM 2008)
Aim: To assess the predictors of physical activity, expressed as daily steps, in COPD patients.
Subject and methods: In a cross sectional study 45 COPD (FEV1%: 52±17.1, 34 male) underwent: physical activity evaluation by Armband (as a mean of a 7-day monitoring period), pulmonary function tests (PFT), cardiopulmonary exercise test (CPET) with assessment of dynamic hyperinflation, arterial blood analysis, Saint George's Respiratory Questionnaire (SGRQ), comorbidity index (CIRS), dyspnea scale (MRC), body composition by bioelectrical impedance analysis, Pro-BNP, inflammatory cells in blood and sputum.

	Beta coefficient	P	R square
MRC	–0.461	0.013	0.234
FFM %	0.448	0.015	0.434
FEV1%	0.261	NS	
IC %	0.165	NS	
TLCO %	0.006	NS	
VO2/Kg	0.032	NS	
Pro-BNP	–0.007	NS	
CIRS comorbility index	–0.005	NS	
blood neutrophils %	–0.13	NS	
SGRQ tot%	0.78	NS	

Results: Multivariate linear regression analysis stepwise method were performed using daily steps as dependent variable.
The severity of dyspnea (MRC) and the free fat mass (FFM%) explained 43% of the variance of the physical activity, while other physiologic and biologic markers did not have additive effects.
Conclusion: Dyspnea and nutritional status are extra-pulmonary parameters that play a relevant role in the limitation of the physical activity level in COPD patients.

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Smoking, exercise capacity and physical activity in daily life in physically independent elderly
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Background: Smoking results in cardiovascular changes that can lead to a gradual decrease in exercise capacity and, when associated with the physiological changes related to the aging process, can decrease the physical performance of the elderly.
Objective: To investigate the relationship between smoking, exercise capacity and physical activity in daily life (PADL) in physically independent elderly.
Methods: Two hundred and nine physically independent elderly with normal lung function were assessed. They were distributed into four groups: smokers (SG; n=12; 6 women, 66 [64-71] yrs, BMI 24 [21-28] kg/m^2), ex-smokers (ESG; n=63; 31 women, 69 [64-74] yrs, BMI 27 [25-31] kg/m^2), passive smokers (PSG; n=42, 36 women; 66 [63-70] yrs, BMI 28 [25-31] kg/m^2) and nonsmokers (NSG; n=92; 69 women, 67 [64-71] yrs, BMI 28 [24-32] kg/m^2). Subjects were submitted to assessment of exercise capacity (6 minute walking test (6MWT) and the incremental shuttle walk test (ISWT)), PADL using a questionnaire (Baecke) and a step counter, as well as smoking habits.
Results: There was no statistically significant difference among groups regarding functional and maximal exercise capacity and PADL as seen in table 1.

Table 1

	SG	ESG	PSG	NSG	Kruskal-Wallis
6MWT (% pred)	90 [79–104]	93 [85–102]	92 [84–98]	97 [90–107]	0.06
ISWT (m)	550 [385–663]	590 [450–780]	475 [350–658]	555 [420–688]	0.063
Baecke (points)	4.2 [1.8–6.0]	3.5 [2.1–5.8]	3.5 [2.4–6.2]	4.5 [2.8–8.5]	0.163
Step counter (n)	6090 [3807–7833]	6493 [4655–9351]	6287 [4776–8735]	6970 [4642–9310]	0.89

Conclusion: Physically independent elderly with preserved lung function, smokers or not, seem to present similar pattern of exercise capacity and PADL.

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Activity outcomes correlation of 6 monitors in COPD, a field study part of the PROactive project
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Background: Monitoring Physical activity (PA) in COPD patients is a new outcome to assess effects of interventions. It is unknown to what extent outcomes of different Physical activity monitors (PAM) interrelate when used in patients with low PA. A monitor will be part of the assessment platform created by PROactive project. We assessed the correlation between different outcomes of six PAM.
Methods: PA was measured for 2 weeks in 64 COPD patients (Age 68years (55-83), FEV_1 57% (16-95), 6MWD 429m (149-675)). Patients wore at least 3 PAM simultaneously: SenseWear Armband (SW n=57); RT3 (n=27); Actiwatch Spectrum (AW n=30); Actigraph GT3X (AG n=30); MiniMod Dynaport (MM n=37) or Lifecorder Plus Kenz (KZ n=27). Correlations are provided in Table 1.

	MM Avg EE	SW Avg Mets	SW steps	AG VMU	RT3 VMU	KZ	AW VMU
MM Walking time	0.55**	0.51**	0.77**	0.77**	-	0.41**	0.61**
MM Average EE		0.22**	0.43**	0.55**	-	0.87**	0.53**
SW Average METS			0.57**	0.48**	0.55**	0.22**	0.67**
SW Steps				0.57**	0.81**	0.51**	0.65**
AG Vector Magnitude Units					0.62**	-	0.72**
RT3 Vector Magnitude Units						0.64**	0.74**
KZ							0.68**

** p<0.01 Note that some of the combination are not available these are indicated with '-'

Results: PAM providing a general PA outcome (KZ, AG, RT3) correlate modestly (R=0.62-0.64). Walking specific outcomes (MM, SW) relate stronger (R=0.77) while energy expenditure (EE) estimates correlation is less (R=0.22).
Conclusion: Different outcomes measuring Physical activity of daily life in COPD patients, show significant correlations when compared in between activity monitors. Monitors, however, assess different aspects of PA reflecting specific or overall movement or EE. Selection of a device and validation in COPD population is mandatory.