Early detection methods to assess the risk of pressure ulcers in individuals with mental illness

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Introduction

Pressure ulcers (PUs) can develop if an individual spends too long **sitting or lying in one position**. They are common in those with both physical and mental health conditions. Indeed, a relatively high PUs prevalence has been reported in individuals with dementia, associated with their inherent **immobility** [1].

Research Aims:

This proof of concept study addressed the research questions:

1. Can methods for detecting inflammatory biomarkers to identify PUs risk be employed for individuals with early dementia?
2. Are there any associations between the biomarkers and the activity levels of able-bodies individuals?
3. Can accelerometers detect activity levels in the elderly early dementia population?
4. Does actimetry devices evoke skin irritation?

Materials and Methods

Table 1 summarises the three cohorts of young adults (YA), older adults (OA) and individuals with early dementia (DEM) recruited to the proof of concept study (UoS Local Ethics approval 40260).

Table 1. Participant demographics

	Group	Age (years)	Sex	Height (m)	Weight (kg)	BMI (kg/m^2)	Specifications
YA1	Young adult	53	F	1.6	90	35.15625	
YA2	Young adult	29	F	1.56	63.5	26.0930309	
YA3	Young adult	40	F	1.71	65	22.22906193	
YA4	Young adult	29	M	1.68	74.5	26.39597506	
YA5	Young adult	44	F	1.76	79	25.5036157	
OA1	Older adult	60	F	1.51	62.45	27.3891496	
OA2	Older adult	60	F	1.61	65	25.07619305	
OA3	Older adult	72	M	1.85	70.45	20.58436815	
OA4	Older adult	69	M	1.76	87.6	28.27995868	
OA5	Older adult	61	F	1.64	62.95	23.40496728	
OA6	Older adult	66	F	1.64	62.1	23.08893516	
OA7	Older adult	77	M	1.95	106	27.87639711	
OA8	Older adult	73	F	1.85	70	20.45288532	
DEM1	Dementia cohort	92	F	1.37	49.73	26.49581757	Walking frame
DEM2	Dementia cohort	85	F	1.74	92.72	30.62491743	Walking stick
DEM3	Dementia cohort	71	F	1.7	51.65	17.87197232	Very active (walking the dog everyday)
DEM4	Dementia cohort	93	F	1.62	78.11	29.76299345	Walking stick
DEM5	Dementia cohort	98	F	1.24	54.62	35.52289282	Walking stick
DEM6	Dementia cohort	88	F	1.4	55.7	28.41836735	Imobile
DEM7	Dementia cohort	93	M	1.27	60.96	37.79527559	Imobile

Inflammatory biomarkers were sampled non-invasively using Sebutape® (Cuderm, US) from the sacrum (Fig. 1A). Activity was monitored using accelerometers (Model AX3, Axivity Ltd, UK) mounted on the wrist and ankle (Fig. 1B).

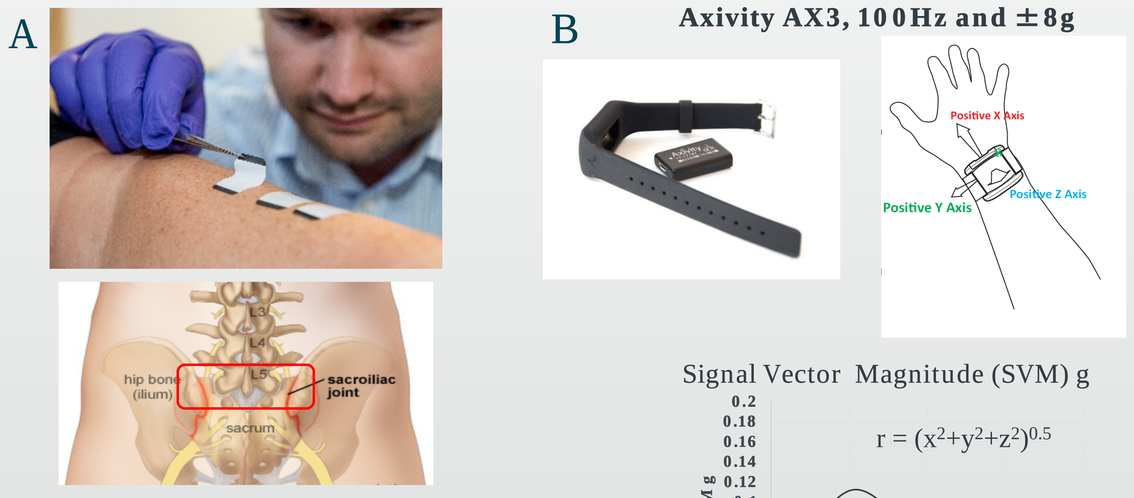

Figure 1. *A) Non-invasive Sebutape® sampling from the sacral skin; B) Axivity accelerometer and signal vector magnitude estimation.*

The test protocol was conducted over two days involving periods of static postures, lying for YA and OA groups and sitting for DEM (Fig. 2A). In addition, all participants were monitored before and after a period of activity (ambulation) (Fig. 2B).

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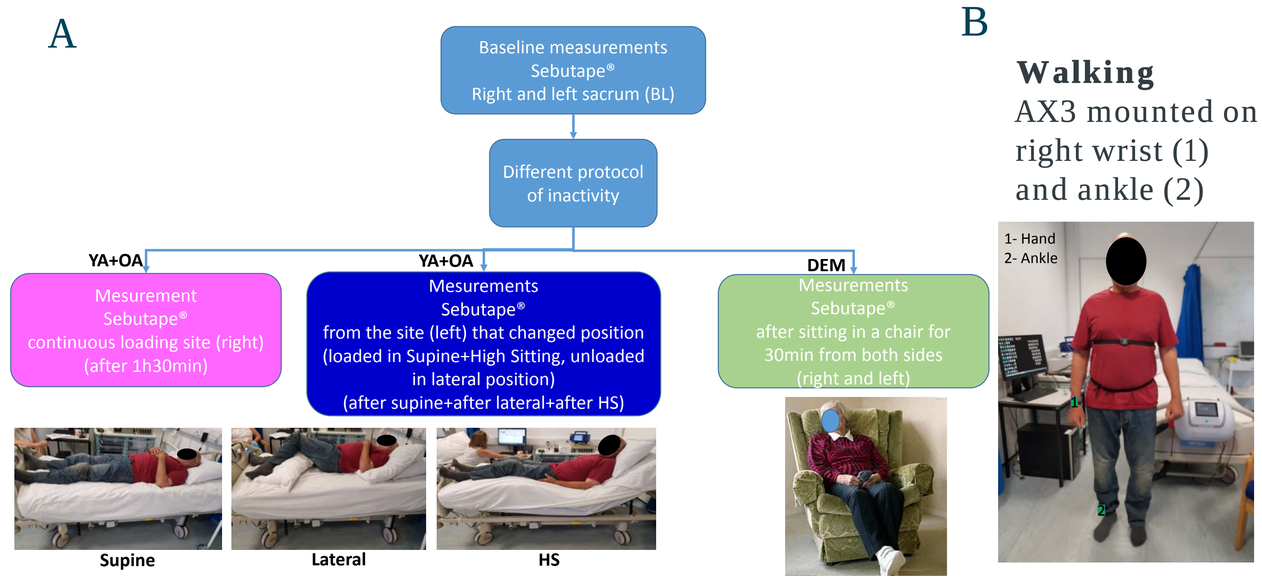

Figure 2. *A) Session 1 involving lying (YA and OA) and sitting postures (DEM); B) Session 2 involving periods of monitored ambulation.*

Results

Concentrations of inflammatory biomarkers were within the limits of detection (8-1000 pg/ml) for the early dementia cohort both in unloaded and loaded conditions (Fig. 3A). There was considerable variance in the inflammatory cytokine concentrations in each cohort (Fig. 3B and C). Some individuals exhibited differences in right and left sacral sites, suggesting potential asymmetry in loading (Fig. 3B and C).

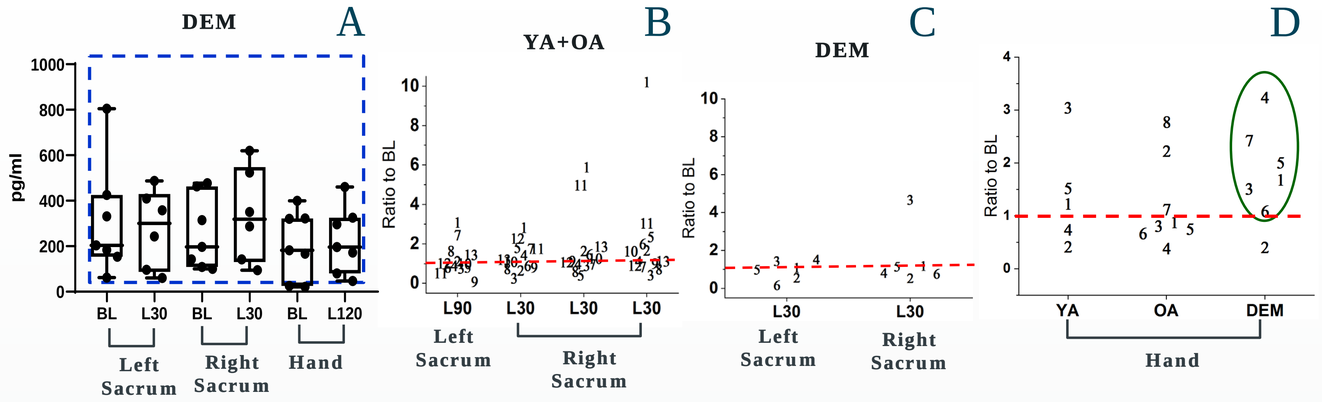

Figure 3. *(A) Concentrations of inflammatory biomarkers for dementia cohort collected from different sites; Cluster data of inflammatory biomarker ratios to baseline collected from left and right sacrum (B and C) and hand (D).*

Results indicated increased ratios of inflammatory biomarker after extended wearing (120min) of the accelerometer at the wrists, particularly for the DEM cohort (6/7) (Fig. 3D). Accelerometer mounted at the ankle produced a more accurate representation of the activity levels, distinguishing the DEM cohort from the other two groups (Fig 4).

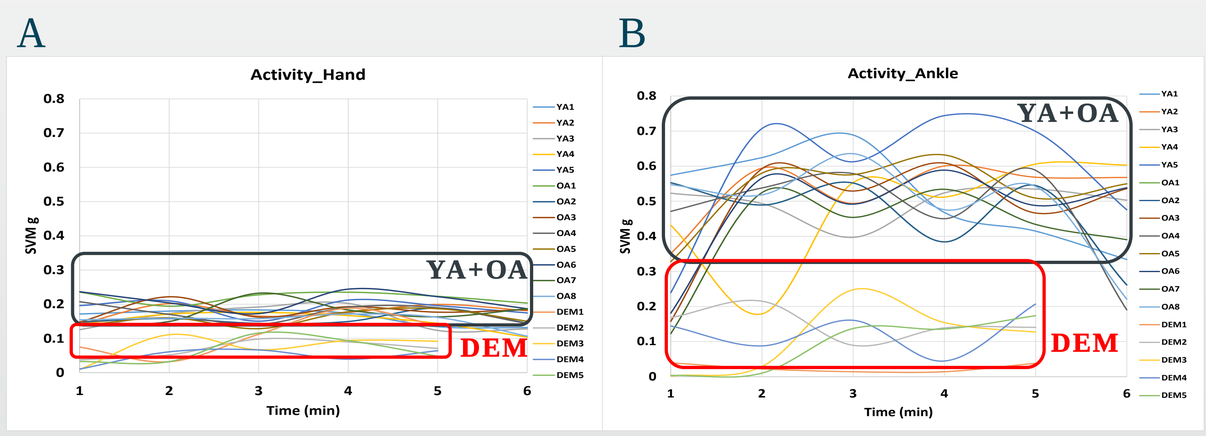

Figure 4. *SVM data processed after ambulatory session from the different position of the accelerometer: wrist (A) and ankle (B).*

Discussion

Inflammatory biomarkers indicative of PUs risk were successfully sampled from a small cohort of individuals with early dementia. Modification to test protocol was required to accommodate the features of the dementia cohort. The location of actimetry devices was critical for accurate assessment of activity, although the devices did cause some skin irritation after prolonged application.

References
[1] *Jaul E., et al. (2017) J Wound Care 26(7):400-403.*
[2] *Perkins MA, et al. (2001) Skin Res Technol 7(4):227-37.*