Sleep and Activity Measurement in Search and Rescue Aircraft Crews Using Novel Sensing Technologies.

Gregory C. May, John Burke, Sarah Colclough, Brendan Maloney, Ciaran O' Cathain, Shauna O'Connor, Stephen Ryan, Giles D. Warrington FACSM

Dublin City University, Ireland

Abstract

Helicopter search and rescue crews (SARC) remain on constant 24 hour alert. This requires the SARC to remain in a state of readiness and maximise sleep opportunities when available. When on duty, depending on their proximity to the SAR base, crew members may either sleep on-base or at home. These factors may lead to possible variations in the level of physical activity (PA), duration of sleep (S_{dur}) and sleep efficiency (S_{eff}). **Purpose:** To investigate the levels of PA, S_{dur}, and S_{eff} of members of the SARC during a typical 24 hour on-call shift using several novel sensing technologies. **Method:** Ten members of the Dublin SARC (mean ± SD: age 40 ± 5 years; height 1.76 ± 0.06m; mass 89.2 ± 14 kg; 5 on-base, 5 off-base) were instrumented with two tri-axial accelerometers (GT3X+) and a Sensewear armband (SW) which also contained an internal accelerometer (SW_{acc}). The GT3X+ were placed on the right ankle and right hip with the SW placed on the left triceps. Data was recorded for a 26 hour period during which the subjects kept a written activity log. The first and last hour of data was not used for analysis. Total estimated energy expenditure (tEEE), S_{eff} and S_{dur} were calculated for each subject during the 24 hour period. Sleep periods were verified for each subject using a written activity log. **Results**: *Within Group*: Based on the placement of the sensors on each subject (ankle; waist; triceps) significant differences were observed for tEEE (1093.9kcal ± 329.8kcal; 502kcal ± 211.5 kcal; 2371.1kcal ± 838.2kcal , p<0.01). Sleep indices calculated from the SW were seen to be significantly different to the GT3X+ data, but not between the GT3X+ units themselves (triceps vs. ankle; waist): S_{eff} (72.8% ± 18.5% vs. 96.3% ± 2.6%; 97.3% ± 1.9%, p<0.01) and S_{dur} (257.9mins ± 80.1mins vs. 371.3mins ± 49.0mins; 379.6mins ± 53.9mins, p<0.01). *Between Home and Base*: Significant differences were seen for tEEE for the SW (1907.0kcal ± 397.3kcal vs. 2835.2kcal ± 940.4kcal, p<0.01) and SW_{acc} (193.8kcal ± 63.2kcal vs. 893.2kcal ± 564.2kcal, p<0.01). Similarly there was a significant difference observed for S_{dur} (231.4mins ± 82.1mins; vs. 284.4mins ± 77mins, p<0.01) recorded on the SW. **Conclusion:** The location of the sensor being utilised to measure activity and sleep indices in SARC members appears to play a vital role in determining the accuracy of measurement. The SW recorded significant differences in PA levels and S_{eff} between SARC on-base and off-base. Further research is required to determine if this holds true for a larger sample size.

Aim

The aim of this study was to investigate if differences exists in the amount of physical activity undertaken, sleep quality and sleep duration between members of the SARC who sleep on-base or off-base under normal working conditions.

Environment:

During working hours all subjects were located at the SARC facility at Dublin airport operating on a 15 minute call out response time. During the stand-by readiness period (2100 – 0730) subjects were located either on-base or off-base and subject to a 25 minute call out response time. Only subjects living with a 20 minute radius, based on driving time, are allowed sleep off-base.

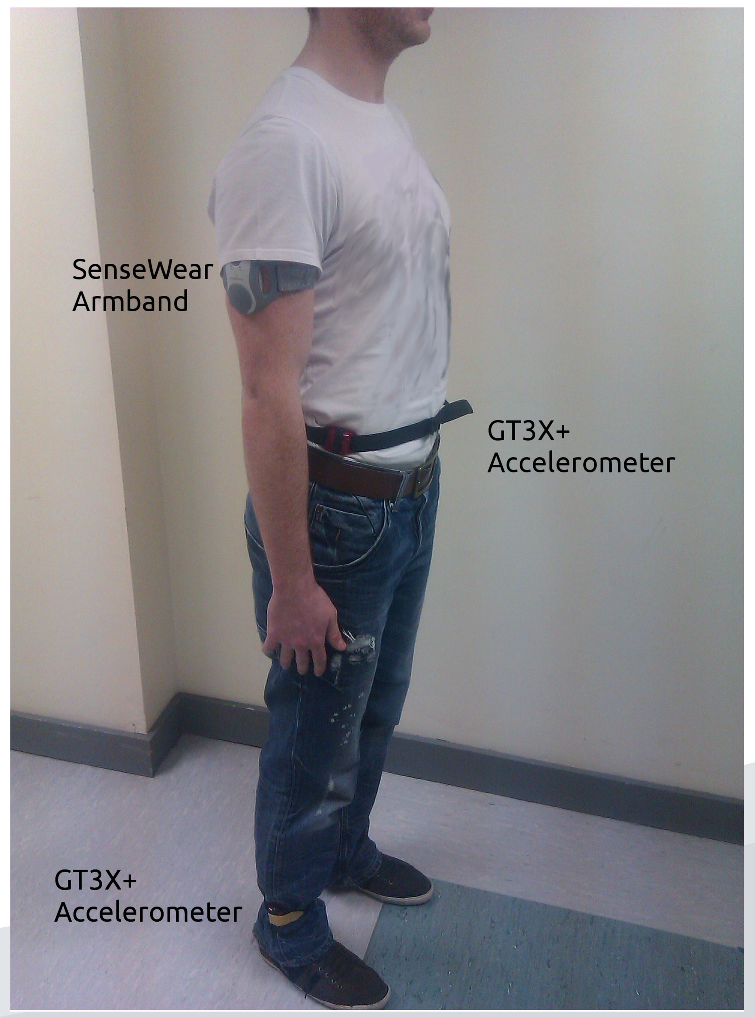
Methods:

Subjects separated into 3 distinct groups:

- G1 – Habitual on-base sleepers, (n = 4)
- G2 – Habitual off-base sleepers, (n = 6)
- G3 – Habitual off-base sleepers on-base, (n = 6)

Subjects instrumented with:

- Sensewear Armband – left arm.
- Actilife GTX3+ - right ankle.
- Actilife GTX3+ - right hip.
- 24 hour self report diary.



Protocol:

- Subjects went about normal daily activities for a 24 hour on-call shift.
- Subjects recorded all physical activity and sleep periods in self report diary,

Results:

Table 1. Subject Characteristics (n=10);

Variable	Subjects
Age (yrs)	40 (5)
Mass (kg)	89 (14)
Height (m)	1.76 (0.06)
BMI (kg/m²)	25.24 (1.95)

Data presented as means (SD)

Table 2. On-Base Sleepers (G1);

Variable	Subjects
Age (yrs)	36 (6)
Mass (kg)	86.4 (8)
Height (m)	1.79 (0.03)
tEEE (kcal)	2,835 (940)
PA (kcal)	893 (504)
S_{eff} (%)	74 (11)
S_{dur} (mins)	284 (77)

Data presented as means (SD)

Table 3. On-Base Sleepers (G2);

Variable	Subjects
Age (yrs)	42 (6)
Mass (kg)	99.2 (20)
Height (m)	1.74 (0.09)
tEEE (kcal)	1,907 (397)
PA (kcal)	455 (94)
S_{eff} (%)	71 (25)
S_{dur} (mins)	231 (82)

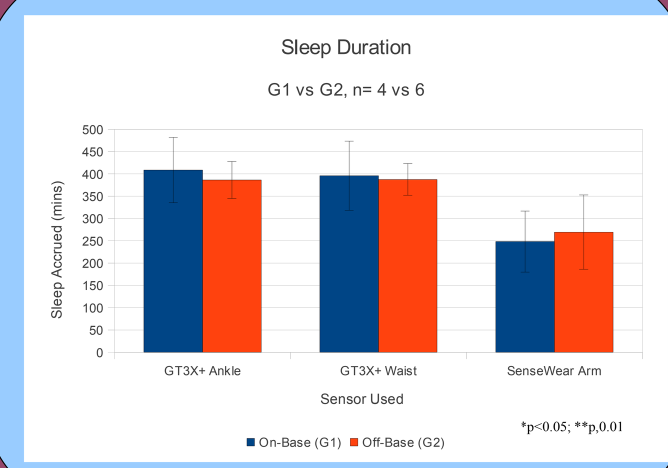
Data presented as means (SD)

Table 4. Off-Base Sleepers as On-Base (G3);

Variable	Subjects
Age (yrs)	42 (6)
Mass (kg)	99.2 (20)
Height (m)	1.74 (0.09)
tEEE (kcal)	2,689 (296)
PA (kcal)	642 (295)
S_{eff} (%)	85 (5)
S_{dur} (mins)	353 (38)

Data presented as means (SD)

Results From Sleep Measures



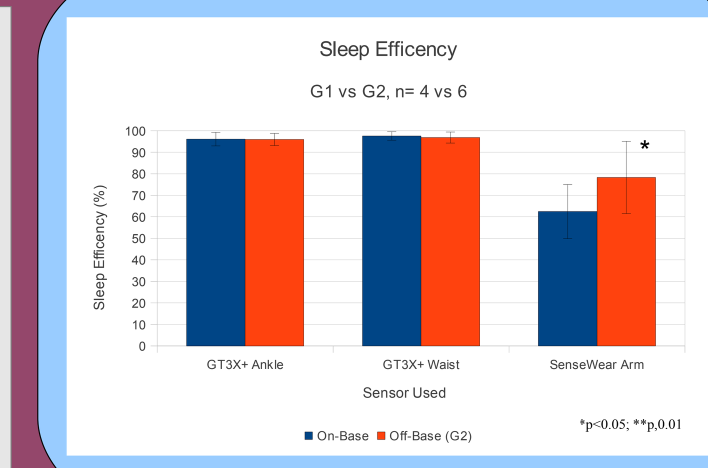
Significant differences exist between:

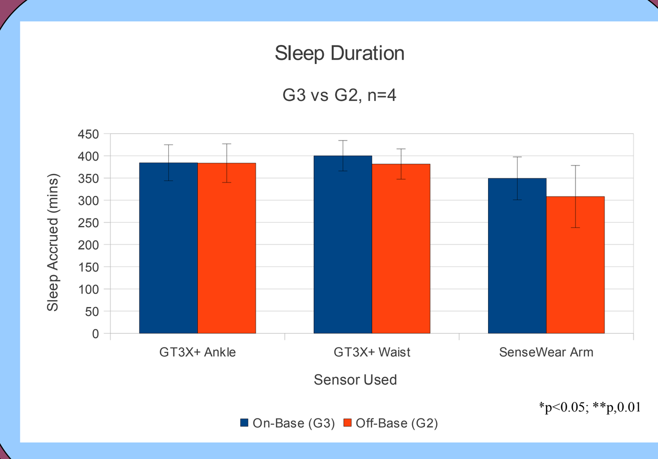
S_{eff} and S_{dur} depending on the sensor utilised.

G1 vs. G2 for S_{eff} depending on sleep location with the SW.

No significant differences exist between:

G1 vs G2 for S_{eff} and S_{dur} when the same sensor is utilised.



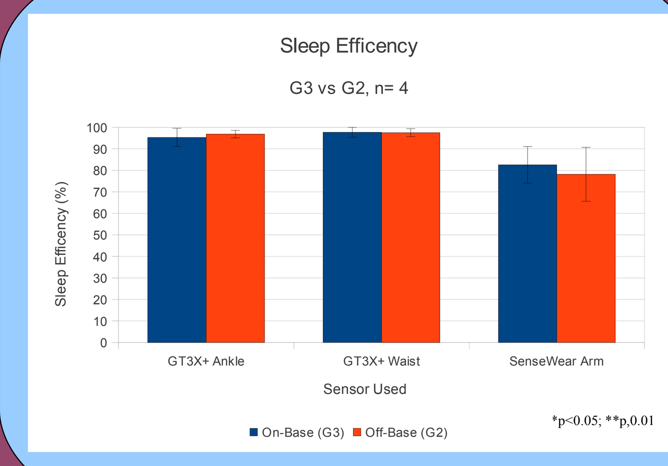


Significant differences exist between:

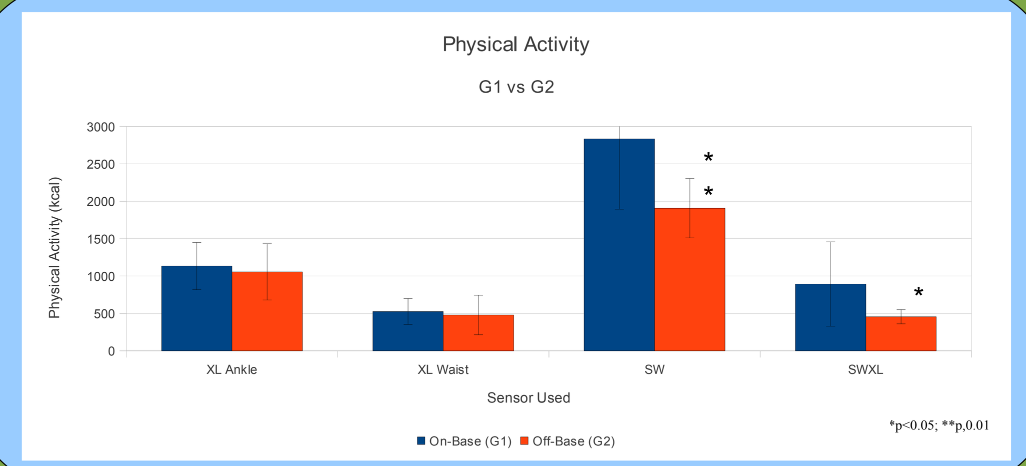
S_{eff} and S_{dur} depending on the sensor utilised.

No significant differences exist between:

G2 vs. G3 for S_{eff} and S_{dur} when the same sensor is utilised.



Results From Activity Measures



Significant differences were observed between:

PA measures between the SW and all XL sensors.

G1 vs. G2 PA measures on the SW and SW_{XL}.

No significant differences were observed between:

PA measures G1 vs. G2 on the ankle or waist XL sensors.

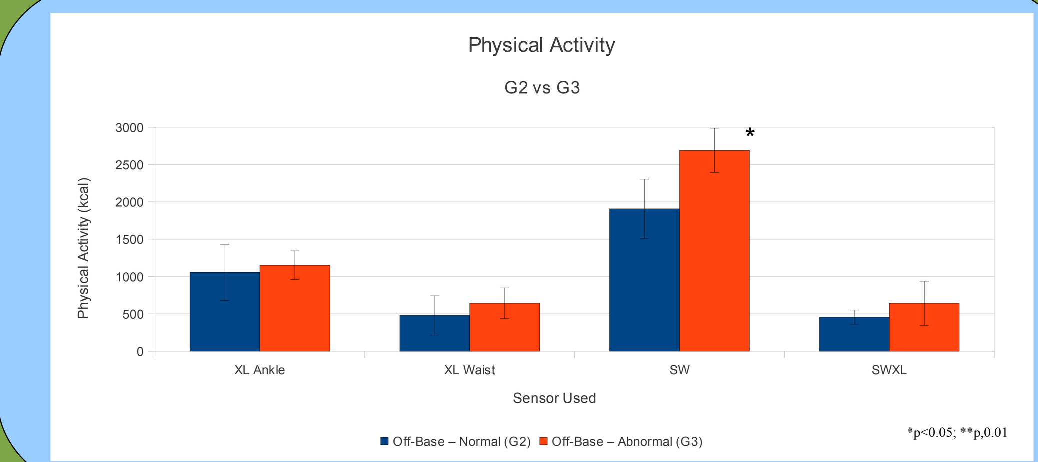
Significant differences were observed between:

PA measures between the SW and all XL sensors.

PA measures between G2 vs. G3 based on the SW.

No significant differences were observed between:

PA measures G2 vs. G3 on all XL sensors.



Conclusions:

The location and sensor utilised to measure PA and sleep indices in SARC members appears to play a vital role in determining the accuracy of measurement.

The SW recorded significant differences in PA levels and S_{eff} between SARC on-base and off-base implying that members who sleep at home may undertake less physical activity and sleep more efficiently.

However, when off-base sleepers remained on-base, PA levels increased in-line with on-base subjects and their sleep efficiency remained the same.

Acknowledgements: This material is based upon works supported by the Science Foundation Ireland under Grant No. 07/CE/I1147. We would also like to extend our gratitude to the members of the Dublin Search and Rescue Crew.