



High Speed Craft: Review of INM Studies

- INM studies mainly restricted to RIBs ('rigid inflatable boats')
- Musculoskeletal pain in FPS ('Fisheries Protection Squadron seaboard users')
- Back belt trial
- UK Royal Marines project



Musculoskeletal Pain in FPS Seaboat Users

- INM tasked by Fleet Medical Division to investigate musculoskeletal pain amongst RIB users in the FPS
- 242 questionnaires sent to vessels in the FPS
- NORDIC questionnaire format used for musculoskeletal pain reporting
- Response rate of 63% was low, but enough to warrant further analysis of the returns



Context of Investigation

- Fisheries protection vessels of the RN patrol UK waters on behalf of MAFF
- Fishing vessels are boarded on the open sea to check permits and inspect catches and nets
- 4-man boarding parties travel to fishing vessels in rigid inflatable boats
- May carry out 'surprise' boardings at night or over the horizon



Twelve Month Prevalence of Pain by Body Region

Body Region	Percentage Pain	95 th ile CI
Low back	58%	50-66
One/both knees	41%	33-49
Neck	33%	25-41
Shoulders	26%	18-33
Wrists/hands	18%	12-25
Ankles/feet	13%	7-19
Upper back	9%	4-15
Hips/thighs	8%	4-14%
Elbows	7%	4-13



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Focus on Musculoskeletal Problems

- Over 40% of medical downgrading to PUNS is accounted for by back and knee disorders
- Background prevalence is high anyway
- However, 13% of FPS seaboat users report prior hospitalisation for low back problems
- 66% of seaboat users reported back problems at some stage



Consequences of Back Pain

Reduced leisure activity	43%
Reduced work in last 12 months	37%
Back pain in last 7 days	29%
Lasted >30 days	25%
Need to change job	19%
Hospitalisation	13%
Seen by doctor/physio	14%



Musculoskeletal Pain by Job Category

- Back and knee pain significantly more prevalent in coxswain/bowmen than boarding officers
- Shoulder problems more prevalent in Ex Boarding Officers



Risk Factors identified by Respondents

Musculoskeletal problems attributed to seaboat ops by 42% of respondents. Of these:

- Pounding/slamming in heavy seas 47%
- Twisted sitting posture 21%
- No back support 16%
- Transfer problems 12%
- Too many boardings 3%
- Boat trips too long 3%



Problems Identified



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Problems Identified



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Conclusions of Study

- Although the prevalence of musculoskeletal pain is high in FPS seaboard users, the survey design is not powerful enough to enable the problem to be attributed to seaboard use
- Background prevalence in the RN is also high
- Need proper age/rank matched controls



Back Belt Trial

- INM approached by RN Fisheries Protection Squadron
- Requested to 'establish a requirement for the use of back support belts by RIB crews'



Why Back Belts?

- No changes to the design of the seaboats can be made in the short term, although the design is not optimal. Could belts be palliative?
- Practically no evidence that these belts protect the backs of workers engaged in manual handling operations in industry
- Some evidence that they do more harm than good



On the other Hand...

- Possible mechanisms of belt action that *might* be of benefit to seaboat crews:
 - Stiffening of trunk of wearer and reduction in the amplitude of trunk rotations during RIB journey
 - Reduction of forward flexion in sitting through the 'hydraulic lift' effect
 - Compressed abdomen acts as an alternative pathway for the transmission of compressive forces from the upper body to the pelvis
 - Better insulation for lumbar spine in cold weather



Method

- Crossover trial design with 6 week baseline measures
- Belt group and exercise (control) group
- Crossover after 6 weeks
- Subjects kept back pain diaries for each day spent on boardings
- Seaboat journeys (distance and time) recorded by the bridge



Vibration Measurements

- Vibration measured on seat and backrest of RIB during travel at 45 knots over 'rough' water
- Low pass filtered at 100 Hz, sampling rate 526 samples/sec for 60 sec samples
- Data were frequency weighted and assessed wrt BS 6841 to calculate rms accelerations and vibration dose values



Results

- Trial disrupted due to technical problems on some of the FPS vessels
- Poor weather in winter 2002 prevented fishing
- Crossover trial compromised due to failure of some subjects to complete control condition



Results

Boardings/Day

Percentage of Days in Which 1 or More Vessels
Were Boarded

	1	2	3	4+
No Belt (203 man days)	47	35	12	6
Belt (106 man days)	54	30	15	1



Results

RIB Journeys

- Average RIB journey without the belts was 3.9 nautical miles and lasted 25.4 mins
- Average journey with the belt was 2.9 nautical miles and lasted 23.4 mins
- RIBs were launched in a variety of sea states under both conditions
- No evidence, overall, for risk compensation affecting journey length or speed



Results

LBT*

Frequency of LBT During Journeys With and without Back Belts (252 man-boardings without and 156 with a belt)

	With Belt	Without Belt
Mean % journeys with LBT	24	47
Min % journeys with LBT	0	0
Max % journeys with LBT	57	88
No subjects with no LBT	4	1

*based on 10 subjects who used a belt for at least 1 journey/day on at least 5 occasions P<0.01



Results

Vibration

- Very high vertical vibrations were measured associated with 'slamming' of the boat
- Highest VDV was $11.75\text{ms}^{-1.75}$ in a 60 sec period
- Exposures could reach VDV of $15\text{ms}^{-1.75}$ in about 3 minutes
- High crest factors (up to 13.7) occurred for vertical motion



Results

User's Comments on Belts

- Most frequent comments were 'feeling of support' and 'less back pain'
- Comments about minor discomfort after long periods of wearing belt (up to 6 hours)
- No comments about possible side effects such as increased gastric reflux, dizziness, nausea etc.



Discussion

- RIB crews exposed to extreme vertical accelerations
- Belts are unlikely to provide much protection from such extreme exposures
- Belts are reported to reduce LBT - research needed to investigate the possible mechanisms by which they might have an effect
- No evidence for risk compensation



Recommendations to RN

Firm Guidelines for Design of Boats

- Boat design exacerbates the problem
- No proper seating or handholds for 2 crew
- Twisted postures common
- Problems at night due to unexpected slamming of boat
- Proper seating with 'sit stand' forward-facing seats is recommended.



Recommendations to RN Tentative Guidelines for Belts

- Should be available on request only to individual LBT suffers in the Fisheries Protection Squadron RIB crews
- Not to be regarded as PPE
- Users to be advised that the *only* known benefit is less LBT when used on RIBS
- Not to be used for other tasks
- Feeling of support is to be regarded as a side effect.



Conclusions

- Although it is likely that boat operation is a causal factor in musculoskeletal injury of seaboat personnel, it is difficult to prove:
 - High background prevalence of injury
 - Difficult to obtain accurate data on injuries
 - Low response rates may indicate response bias
 - Self-report data needs to be supplemented by good quality data on vibration, shock and tissue response to vibration and shock

