Title

The test-retest reliability of the Military Physical Loading Questionnaire (MPLQ).

Authors

Russell J. Coppack[1-3], James L. Bilzon[2-3], Andrew K. Wills[4], Theodora Papadopoulou[5], Robyn P. Cassidy[1,5], Alastair M. Nicol[5], Alexander N. Bennett[1,6]

[1]Academic Department of Military Rehabilitation, Defence Medical Rehabilitation Centre (DMRC), Stanford Hall, UK

[2] Department for Health, University of Bath, UK

[3] Centre for Sport, Exercise and Osteoarthritis Research Versus Arthritis, Department for Health, University of Bath, UK

[4] Faculty of Health Sciences, University of Bristol, UK

[5] Centre for Lower Limb Rehabilitation, Defence Medical Rehabilitation Centre (DMRC), Stanford Hall, UK

[6] National Heart & Lung Institute, Faculty of Medicine, Imperial College London, UK

Corresponding author contact details

E-Mail: russ.coppack100@mod.gov.uk

Tel: (+44)1509251500

Keywords

Hip; injury; occupational physical loading; risk factors; military; reliability.

Contributorship

RJC designed the study, conducted the initial analysis, drafted the initial manuscript and approved the final manuscript as submitted. All authors analysed and interpreted the findings. JLB, AKW and ANB supervised the conduct of the study, assisted with data analysis, reviewed and revised the manuscript, and approved the final manuscript as submitted. RPC assisted with data collection and participant recruitment, drafted the initial manuscript with RJC and critically reviewed the final

manuscript. TP and AMN, reviewed and revised the manuscript, and approved the final manuscript as submitted.

Funding

This study is funded by the Versus Arthritis Centre for Sport, Exercise & Osteoarthritis Research (Grant Reference 20194).

Competing Interests

The authors declare no competing interests in the conduct of this study.

Study approval

This study was approved by the UK Ministry of Defence Research Ethics Committee, approval code 651/MODREC/15 dated 18 Jul 2016.

ABSTRACT

Introduction. Despite the high prevalence of musculoskeletal injuries (MSKI) there is a shortage of data quantifying the risk factors attributable to cumulative occupational demands amongst UK Military personnel. We developed a new comprehensive questionnaire that examines occupational and operational physical loading during military service. The aim of this study was to examine the test-retest reliability of the Military Physical Loading Questionnaire (MPLQ).

Methods. Intraclass correlation coefficients (ICC) were used to evaluate the test-retest reliability (4-week interval) of the MPLQ on eighteen occupational and eighteen operational items in 50 male (mean age 36 yrs SD ± 7·9) UK military personnel. A stratified analysis based on duration of Service (0-10 yrs, 11-20 yrs, ≥ 21 yrs) was conducted to assess if stability of task items was dependent on participant length of recall. Internal consistency was assessed by Cronbach's alpha (α) coefficients.

Results. Reliability of individual operational items ranged from fair to almost perfect agreement (ICC range = 0·37-0·89; α range 0·53-0·94) with most items demonstrating moderate to substantial reliability. Overall scores related to occupational items showed substantial to almost perfect agreement between administrations (ICC range = 0·73-0·94; α range 0·84-0·96). Stratifying by duration of Service showed similar within group reliability to the entire sample and no pattern of decreasing or increasing reliability with length of recall period was observed.

Conclusions. It is essential that data used in planning UK military policy and health services are as accurate as possible. This study provides preliminary support for the MPLQ as a reliable self-report instrument for assessing the cumulative lifelong effects of occupational loading in UK military personnel. Further validation studies using larger and more demographically diverse military populations will support its interpretation in future epidemiological research.

INTRODUCTION

Musculoskeletal injuries (MSKI) are a major burden in military populations resulting in a reduction of operational strength and force readiness [1]. High incidence rates of MSKI are reported in the literature with military training cited as a common causative factor [2]. Two recent UK studies reported 58% of 1810 [3] and 49% of 6608 [4] Army recruits suffered at least one MSKI during training, with over-use lower-limb injury the most common diagnostic category. MSKI was the principle cause in the medical discharge of 4917 British Army personnel (61%) between 2012 to 2016 and accounted for 67% of all medical down gradings [5]. Overuse MSKI is also reported as a primary source of disability in non-UK military personnel in training and during combat operations [6].

Occupation is an important determinant of cumulative stress and workload and the military population is particularly at risk given the inherent occupational demands [7]. However, no studies have investigated cumulative exposure to occupational mechanical loading as a risk factor for developing hip pathology and OA in UK military personnel. Research is required to better understand the root causes of MSKI amongst UK Military cohorts thereby enabling the development of cost-effective, targeted prevention strategies.

The self-report questionnaire is the preferred instrument for measuring lifetime occupational physical loading of joints in epidemiological studies [8,9]. The cumulative, repetitive use and excessive loading of the hip over time has been linked to OA [10]. Therefore, it is important to identify the mechanical loads placed on the musculoskeletal system throughout life in order to accurately assess the occupational risk associated with hip OA. The Military Pre-Training Questionnaire (MPQ) is the only instrument specifically developed to offer a means of assessing important characteristics and injury risk of trainees entering British Army Training [10]. To our knowledge, no questionnaire specifically designed to monitor the relationship between lifetime occupational loading and hip injury in military populations is available.

We developed a new comprehensive questionnaire adapted from existing validated instruments used in population-based studies [8,9,11]. The Military Physical Loading Questionnaire (MPLQ) examines physical activity levels and occupational mechanical loading prior to and during military service. However, it is not known if UK

military personnel can reliably recall information about past occupational exposures. Therefore, the purpose of this study is to report the test-retest reliability of questions examining occupational and operational related mechanical loading in a representative sample of UK military personnel.

METHODS

Study Design

The study was planned and conducted in accordance with the UK Ministry of Defence (MOD) policy for research using human participants and the Helsinki declaration [12]. The study protocol was approved by the MOD research ethics committee (approval code 651/MODREC/15 dated 18 Jul 2016). A prospective test-retest study design was used to assess the reliability of the MPLQ, completed approximately 4-weeks apart.

Participants

All participants were serving members of the UK Armed Forces employed at the Defence Medical Rehabilitation Centre (DMRC), Headley Court, UK. Potential participants were notified using publicity posters and announcements on the DMRC organisational intranet webpage. Participants who expressed a willingness to participate were provided with a study information sheet detailing the aims and procedures of the study. The inclusion criteria were full-time serving UK military personnel, male, aged 18-50 years. A project investigator provided a verbal brief on questionnaire completion to all participants meeting the study eligibility criteria who provided their signed informed consent.

Sample

A sample of 50 male volunteers were recruited into this study between Jan 2017-Feb 2018. Our sample size was based on the COSMIN (Consensus-based standards for the selection of health Measurement Instruments) criteria which states a sample size of 30-49 participants is considered “fair” and 50-99 considered “good” for a validation study [13].

Questionnaire development

The MPLQ collects information on various categories of risk factors shown to be associated with MSKI in Military populations [14] and hip OA [10]. The instrument was designed to assess, in separate sections, pre-entry activity level and exercise, injury history, occupational loading, operational deployment loading, sport and recreation and lifestyle factors. Items were selected from existing questionnaires used in epidemiological research [8,9,11]. Questions in the sections pertaining to occupational physical loading and operational deployment loading were made specific to the target military population. The questions in sections surrounding pre-entry activity and exercise, injury history, sport and recreation and lifestyle factors have been shown to be reliable in military populations and young active adults [8,9,11]. Therefore, this reliability study focuses only on the questions surrounding occupational (job related) and operational deployment physical loading.

Measurement of occupational physical demands

History of cumulative exposure to occupational (job related) physical demands is measured from the point of enlistment. Participants are asked about each job/posting held for one year or longer up to a maximum of eight postings. Job number 1 describes the combined period of phase 1 (recruit) and phase 2 (trade) military training. Participants rate their involvement and exposure to each of 18 physical demand tasks (supplementary file, MPLQ, section 4). The 18 items comply with the nomclementure used routinely in the UK and NATO defence forces to categorise high, moderate and low intensity occupational military tasks [15].

The frequency of each physical task is rated on a 5-point scale with 0=’never’, 1=’not very often’, 2=’sometimes’, 3=’often’, 4=’very often’. This method of recording occupational physical demands has been used in community-based hip pain studies and its construct validity demonstrated [8].

Measurement of deployed operations physical demands

Participants are asked about performance during their time (total summed months) spent on deployed military operations. Information is provided on the average number of hours in a 12-hour day (none, 0-1, 2-4, 5-7, 8+hours) performing each of the 18 operational tasks (supplementary file, MPLQ, section 5). These tasks are a variation on the nomclementure used to construct and categorise the occupational

physical demand tasks in section 4 of the MPLQ. This section includes questions on tasks specific to the combat environment that may not be otherwise considered routine (e.g. flying rotary/fixed wing, armoured convoys etc). Participation in each specific task is calculated by taking the product of duration (total days on operations) x self-reported length of participation each day (average hours). Output data will yield information used to assess if exposure to physical loading on operational deployments presents an additional risk for developing hip pain compared to other periods during a military career.

A copy of the MPLQ is provided as an online supplementary file.

Study procedures

Participants were asked to complete the self-administered questionnaire (paper-version) on two occasions with an interval of approximately 4-weeks between administrations. The 4-week 'washout' period was chosen to minimise a "learned" (recall) response bias to the instrument whilst avoiding a potential change in the exposure construct being measured [16]. Participant feedback confirmed questionnaire completion usually took 25-35 mins. The MPLQ employed "skip-logic" allowing participants to avoid negative, irrelevant responses to questions thereby reducing participant burden [11]. If questionnaires were not returned within a 3-week delay, one e-mail and single telephone contact was attempted.

Statistical analysis

Statistical calculations were performed using IBM SPSS (version 25.0.0, SPSS Inc, Chicago, IL, USA). Descriptive statistics were performed to characterise the study sample. Differences in scores were calculated for the occupational and operational task questions comparing initial to follow-up scores. Because the number of jobs held for ≥ 1-year differed across participants, we measured the reliability of aggregated pooled scores for individual questions on each post held (1,2,3 etc) for occupational task questions. We also conducted a stratified analysis where participants were classified according to duration of military Service in 10-year intervals (0-10 yrs, 11-20 yrs, 21 yrs +) with the aim of assessing if stability of individual task responses was dependent on participant length of recall.

To examine the test-retest reliability between occupational and operational tasks at baseline and retest, we calculated the intraclass correlation coefficients ($ICC_{1,1}$) with 95% confidence intervals (CI) based on a one-way random-effects analysis of variance model. This $ICC_{1,1}$ uses test-retest measures to estimate single trial reliability rather than the average of repeated measures. As a guide, strength of agreement ratings between test-retest responses suggested by Landis and Koch [17] were used: poor = 0-0·2, fair = 0·2-0·4, moderate = 0·4-0·6, substantial = 0·6-0·8 and almost perfect = 0·8-1·0. Cronbach's alpha (α) coefficient was used to measure the internal consistency of the questionnaire. Internal consistency was deemed acceptable if α was >0·7 [13].

RESULTS

Participant characteristics

Baseline participant characteristics are summarised in table 1. Fifty male participants provided informed consent to participate in the study. All participants were serving UK Military personnel with a mean age of 35·8 years (SD ± 7·9). A complete response (i.e. MPLQ completed on two occasions) was obtained from 42 respondents (84%). Eight respondents did not complete and return a follow-up questionnaire within the allotted timeframe and could not be included in the data analysis. There was an average of 29 days (SD ± 3·6) between each administration of the questionnaire (range 26-42 days). Most participants were Caucasian (92%) and university educated (68%). The distribution of participants by military branch was 25 (50%) Army, 15 (30%) Royal Air Force (RAF), 5 (10%) Royal Navy (RN) and 5 (10%) Royal Marines (RM). The patient distribution by rank seniority was 12 (24%) junior ranks, and 19 (38%) for both the senior and officer rank categories. The most common job roles were physical training instructor (PTI) 12 (24%), physiotherapist 9 (18%), doctor 7 (14%) and logistics specialist 6 (12 %). The mean number of postings for ≥ 1-year was 4·8 (SD ± 2·0) with a cumulative mean 9·1 months (SD ± 4·5) served on deployed operations.

[insert table 1 here]

Test-retest reliability

Operational loading items

Table 2 summarises the results of the test-retest reliability for 18 operational loading items of the MPLQ. A significant number of missing items were recorded at baseline and re-test by 15 (38%) of participants. This reflected responses from participants with no operational exposure during their career. Including 'none' response options from this sub-group in the analysis could introduce a degree of bias that over-estimates the stability of these MPLQ items. Therefore, only data from participants with a minimum 6-months exposure on deployed/combat operations (N=27) was used for analysis purposes.

The highest reliability coefficients were obtained for the items flying (fixed-wing fast jet), $ICC_{1,1}$, 0·89 (95% CI 0·78 - 0·95), operating heavy tools and/or weapon systems $ICC_{1,1}$, 0·89 (95% CI 0·77 - 0·95) and driving over 'rough' terrain, $ICC_{1,1}$, 0·80 (95% CI 0·61 - 0·90) all demonstrating substantial to almost perfect agreement. The lowest reliability was found for items related to crawling, $ICC_{1,1}$, 0·37 (95% CI 0·01 - 0·65) and climbing/scaling walls, $ICC_{1,1}$, 0·38 (95% CI 0·78 - 0·95) showing fair strength of agreement. Reliability of all other occupational loading items ranged from moderate to substantial ($ICC_{1,1}$ range 0·44 - 0·74) with a majority of items showing moderate agreement between administrations. Internal consistency determined by Cronbach's alpha coefficient was ≥ 0·7 for 13 of the 18 occupational loading items (range 0·70 - 0·94); crawling had the lowest internal consistency (α = 0·53).

[insert table 2 here]

Occupational loading items

Within the entire sample the occupational loading items showed substantial to almost perfect agreement across all summary measures (table 3). Reliability co-efficients for questions relating to lifting and moving weights showed the highest $ICC_{1,1}$ values (range 0·91 - 0·94). The item on frequency of climbing ladders showed the lowest reliability coefficient in this section $ICC_{1,1,}$ 0·73 (95% CI 0·66 - 0·80). All occupational loading items showed Cronbach's alpha (α) values greater than 0·70 (range 0·84 - 0·96) suggesting high internal consistency and homogeneity for these items.

Stratifying by duration of Service 0-10 yrs (N=15), 11-20 yrs (N=16) and >21 yrs (N=11) showed similar within group reliability to the entire sample. The majority of items demonstrated substantial to almost perfect agreement in each sub-group (table

4). The item on road driving for at least 4-hours had the lowest reliability, $ICC_{1,1,}$ 0·53 (95% CI 0·33 - 0·69) in the > 21 yrs sub-group. However, a pattern of decreasing or increasing reliability with length of recall period was not observed and internal consistency (α) were comparable regardless of duration of Service. In general, better reliability was observed for occupational loading items than operational items.

[insert table 3 here]

[insert table 4 here]

DISCUSSION

This study reports the 4-week test-retest reliability and internal consistency of created occupational and operational exposure items of the MPLQ. Results showed moderate to almost perfect agreement for operational items ($ICC_{1,1,}$ range 0·37 - 0·89), and substantial to almost perfect agreement for all occupational items ($ICC_{1,1,}$ range 0·73 - 0·94). Length of recall period did not influence reliability scores and acceptable to good internal consistency was shown for the majority of all task items. The reliability of occupational task items was generally higher than operational task items. These results are important as they provide preliminary support for the MPLQ as a reliable measure of occupational physical workload and MSKI risk in UK military personnel.

Reliability responses

For items concerning operational tasks the highest repeatability was found for ‘operating heavy tools/weapon systems’, ‘flying (fixed wing fast-jet)’ and ‘driving over rough terrain causing your body to shake’. Higher reliability in response to questions concerning occupational ‘vibrations’ and working postures involving the whole body have previously been reported [18]. Furthermore, heavy load activity is consistently recalled more reliably than less intense activity [19]. Activities of mild activity are more common, less memorable and less likely to be accurately captured by self-report [20]. Lower test-retest reliability estimates were found for the operational tasks ‘crawling’ ($ICC_{1,1,}$ 0·38) and ‘climbing/scaling walls’ ($ICC_{1,1,}$ 0·37). It is possible the lower reliability for these tasks may be a result of reduced precision attributed to crawling and climbing activities occupying little time and therefore difficult to memorise in self-report [21].

For occupational task items the present results were consistent with previous studies reporting higher reliability responses for questions concerning repetitive lifting of manual loads [22]. The ICC values in our study (0·91 - 0·94) for 'lifting & moving weights' were generally higher than previously reported. Military personnel routinely plan and perform weight carriage activity with specified loads. Our finding that load lifting activity showed the highest test-retest reliability may reflect the routine nature of this activity and explain why military personnel display accurate recall of weight carriage task categories [23].

A main finding in the present study was the higher reliability and consistency found for occupational task items compared with operational task questions. Occupational histories are easier to recall than events occurring irregularly as they rely on generic knowledge rather than specific memories [24]. The 18 occupational items in the MPLQ centred around patterns of activity during specified time periods (job's / postings held) where generic memory may be more important than the specific, episodic recall of operational experiences. For military personnel working life comprises a significant span of time and posting's that potentially facilitates recall of occupational activities [24]. However, the smaller sample used for the operational tasks sub-group analyses may have resulted in recruitment bias and a misclassification of occupational exposure, thereby diluting a potential relationship between exposure and response compared with occupational task scores [18].

We did not find any significant group differences when reliability scores were stratified by duration of military service. Earlier research has shown self-report accuracy decreases with an increase in time from a given event [25]. Our findings suggest using individual jobs/postings of over 1-year was effective in increasing the reliability of recall for specific time periods during the respondents' military career [24]. The internal consistency of occupational task questions was very high with a Cronbach's alpha range of 0·84 - 0·97 across the 18 items. Whilst this could support the notion the MPLQ is a stable measure of military occupational exposure, a Cronbach's alpha score over 0·90 indicates redundancy rather than a desirable level of internal consistency [26].

Methodological considerations and study limitations

The study has some methodological limitations that should be noted. We aimed to assess the reliability of operational and occupational questions in the military population in which the MPLQ will be used. Study participants in sedentary or light-to-moderate activity occupations were over represented (e.g. administration, medical, logistics). This can lead to a disproportionate concentration of responses for low exposures on the numeric ordinal scale affecting resultant ICC scores [24]. Furthermore, the majority of participants in our sample were Caucasian, university educated & male only. Education level may influence the reliability of responses as higher educational attainment is associated with greater consistency of recall [18]. Therefore, the reliability of MPLQ items requires further evaluation using military participants from high, medium & low loading exposure occupations and a more representative mix of educational level, ethnic background and gender. Our test-retest sample for operational items was limited to 27 participants with exposure to deployed operations and some imprecision in ICC estimates is possible in this small sub-sample. Future studies need to validate the MPLQ in a larger sample of military personnel.

CONCLUSIONS

The availability of reliable physical loading data is essential for epidemiological investigations of MSKI's, particularly in military populations. We have developed a self-administered screening questionnaire designed to measure lifelong exposure to occupational physical loading as a risk factor for hip pain in military personnel. Results provide initial support for the test-retest reliability of the MPLQ occupational and operational items. With a re-design of existing questions, the MPLQ could potentially be used to measure the association between cumulative physical workload and injury risk for other musculoskeletal disorders. Further studies are encouraged with larger, demographically diverse military populations to further validate this tool.

KEY MESSAGES

- No questionnaire specifically designed to monitor the relationship between occupational physical loading and hip pain / musculoskeletal injury in military populations is available.

- We report the test-retest reliability of the Military Physical Loading Questionnaire (MPLQ) designed to measure exposure to lifelong occupational physical loading and hip pain risk in military personnel.

- The study provides evidence supporting the reliability and internal consistency of the MPLQ tested in a convenience sample of UK military personnel.

- Data used in planning UK military policy and health services must be accurate. The MPLQ may provide a reliable instrument to measure occupational physical workload in military cohorts.

ACKNOWLEDGEMENTS

The authors wish to thank those military members of permanent staff at DMRC Headley Court for their time and contribution to participation in this study.

REFERENCES

1. Belmont PJ, Owens BD, Schoenfeld AJ. Musculoskeletal injuries in Iraq and Afghanistan: Epidemiology and outcomes following a decade of war. *J Am Acad Orthop Surg,* 2016;**24**:341-348.

2. Andersen KA, Grimshaw PN, Kelso RM, et al. Musculoskeletal lower limb injury risk in Army populations.*Sports Med-Open,* 2016;**2:22**:DOI 10.1186/s40798-016-0046-z.

3. Robinson M, Siddall A, Bilzon J, Thompson D, *et al*. Low fitness, low body mass and prior injury predict injury risk during military recruit training: a prospective cohort study in the British Army. *BMJ Open Sport Exerc Med,* 2016;**2**:e000100. doi:10.1136/bjsem-2015-000100.

4. Sharma J, Greeves JP, Byers M, *et al.* Musculoskeletal injuries in British Army recruits: a prospective study of diagnosis-specific incidence and rehabilitation times. *BMC Musculoskeletal Disorders,* 2015;**16:106**:DOI 10.1186/s12891-015-0558-6.

5. UK Ministry of Defence internal report dated 14 Jul 16: Annual Medical Discharges in the UK Regular Armed Forces 1 April 2011-31 March 2016.

6. Halvarrson A, Hagman I, Tagern M, *et al*. Self-reported musculoskeletal complaints and injuries and exposure of physical workload in Swedish soldiers serving in Afghanistan. *PloS ONE,* 2018;**13(4)**:e01955. https://doi.org/10.1371/journal.prone.01955-48

7. Scher DL, Belmont PJ, Mountcastle, *et al*. The incidence of primary hip osteoarthritis in active duty US military service members. *Arthritis & Rheumatism*, 2009; **61(4)**: 468-475.

8. Pope DP, Hunt IM, Birrell FN, *et al*. Hip pain onset in relation to cumulative workplace and leisure time mechanical load: a population based case-control study. *Ann Rheum Dis*, 2003; **62**: 322-326.

9. Robinson M, Stokes K, Bilzon J, et al. Test-retest reliability of the military pre-training questionnaire. *Occupational Medicine*, 2010; **60**: 476-483.

10. Sulsky SI, Carlton L, Bochmann F, *et al*. Epidemiological evidence for work load as a risk factor for osteoarthritis of the hip: A systematic review. *PLoS ONE*, 2012; **7(2)**: e31521.doi:10.1371/journal.prone.0031521.

11. De Vera MA, Ratzlaff C, Doerfling P, *et al*. Reliability and validity of an internet-based questionnaire measuring lifetime physical activity. *Am J Epidemiol,*2010;**172(10)**:1190-1198.

12. World Medical Association Declaration of Helsinki [revised October 2013]. Recommendations Guiding Medical Doctors in Biomedical Research Involving Human Subjects. T64th WMA General Assembly, Fortaleza (Brazil).

13. Mokkink LB, Terwee CB, Patrick DL, *et al*. The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: an international Delphi study. *Qual Life Res,* 2010; **19(4):**539-549. doi: 10.1007/s11136-010-9606-8 PMID: 20169472.

14. Blacker SD, Wilkinson DM, Bilzon JL, *et al*. Risk factors for training injuries among British Army Recruits. *Military Medicine,* 2008;**173(3)**:278-286.

15. Gordon MD, Moshe S, Blanc PD, *et al*. The association between occupation and the incidence of knee disorders in young military recruits. *Military Medicine*, 2013;**178**:61-67.

16. Nieuwenhuijsen MJ. Design of exposure questionnaires for epidemiological studies. *Occup Environ Med*, 2005;**62**:272-280.

17. Landis JR, Koch GC. The measurement of observer agreement for categorical data. *Biometrics,* 1977; **33**: 159-174.

18. Wiktorin C, Wigaeus-Hjelm E, Winkel J *et al*. Reproducibility of a questionnaire for physical load assessment during work and leisure time. *J Occup Environ Med,* 1996; **38**: 190-201.

19. Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. *Res Q Exerc Sport,* 2000;**71**: S1-14.

20. Meyer AM, Evenson KR, Morimoto *et al*. Test-retest reliability of the women's health initiative physical activity questionnaire. *Med Sci Sports Exerc,* 2009; **41(3)**: 530-538.

21. Fernandes RCP, Wedge LP, Lima VMC et al. Measuring work-related physical demand: factorial structure and reliability of items on posture, handling of loads and repetitiveness. *Cad Staude Publica,* 2019; **35(1)**: e00123218. doi: 10.1590/0102-311x00123218.

22. Leijon O, Wiktorin C, Härenstam A *et al*. Validity of a self-administered questionnaire for assessing physical word loads in a general population. *J Occup Environ Med,* 2002; **44**: 724-735.

23. Martin Genis KA, Phang SH, Latimer AE *et al*. Reliability and validity of tests of the leisure time physical activity questionnaire for people with spinal cord injury. *Arch Phys Med Rehabil,* 2012; **93**: 677-682.

24. Friedenreich CM, Courneya KS, Bryant HE. The lifetime total physical activity questionnaire: development and reliability. *Med Sci Sports Exerc,* 1998; **30(2)**: 266-274.

25. Coughlin SS. Recall bias in epidemiologic studies. *J Clin Epidemiol,* 1990; **43**: 87-91.

26. Spekle EM, Hoozemans MJM, ven der Beek AJ *et al*. Internal consistency, test-retest reliability and concurrent validity of a questionnaire on work-related exposure related to arm, shoulder and neck symptoms in computer workers. *Ergonomics,* 2009; **53(9)**: 1087–1103.

Table 1. Baseline descriptive characteristics of study participants (N=50)

Baseline variable / physical characteristic	**Mean**	**SD**	**Median**	**Range**
Age (yr)	35.8	7.9	33.5	23 - 51
Height (cm)	180.4	17.0	179.5	172 - 187
Weight (kg)	84.4	11.9	81.2	62 - 110
Body mass index ($kg \cdot m^{-2}$)	26.3	2.9	25.9	21 - 36
Occupational history				
No of jobs ≥ 1-year	4.8	2.0	5.0	2 - 8
Total years military service	13.7	7.6	12.0	2 - 36
Total months on deployed operations	9.1	4.5	17.2	0 - 36
Rank seniority	**N**	**%**		
Junior rank (up to OR5 - Cpl)	12	24		
Senior rank (up to OR9 - WO/WO1)	19	38		
Officer rank (up to OF5 – Col/Gp Capt)	19	38		
Service branch				
Royal Navy (RN)	5	10		
Royal Marines (RM)	5	10		
Army	25	50		
Royal Air Force (RAF)	15	30		
Job role / trade				
Administration	5	10		
Logistics	6	12		
Medical – physiotherapist	9	18		
Doctor	7	14		
Nurse	5	10		
Physical training specialist	12	24		
Other	6	12		
Educational attainment				
University degree	34	68		
Further education college	13	26		
Secondary education	3	6		
Ethnic origin				
White British	46	92		
Black or Black British – African	2	4		
Mixed White & Black - Caribbean	2	4		

Abbreviations: SD, standard deviation; yr, years; cm, centimetres; kg, kilogram; Cpl, Corporal; WO, Warrant Officer; Col, Colonel; Gp Capt, Group Captain.

Table 2. Test-retest reliability of MPLQ operational loading task items

Item / Question	**Response options (all items)**				
How much time during a typical day did you spend performing the following tasks whilst on deployed operations?	None/ 0-to-1 hrs / 2-to-4 hrs / 5-to-7 hrs / 8+hrs	**n**	**ICC***	**α**	**95% CI**
1. Foot patrols at 1 to 2 km per hour carrying load		27	0·74	0·84	0·51 - 0·87
2. Sitting down		27	0·51	0·66	0·18 - 0·74
3. Standing still or moving slowly in a small space		27	0·53	0·70	0·23 - 0·77
4. Squatting / kneeling / crouching / 'getting up & down'		27	0·56	0·57	0·02 - 0·66
5. Crawling		27	0·38	0·53	0·01 - 0·65
6. Climbing / scaling walls & obstacles		27	0·37	0·54	0·01 - 0·66
7. Sprinting or 'dashing' short distances		27	0·74	0·85	0·51 - 0·87
8. Operating heavy tools and / or weapon systems		27	0·89	0·94	0·77 - 0·95
9. Running		27	0·70	0·81	0·45 - 0·85
10. Flying (fixed-wing fast jet)		27	0·89	0·94	0·78 - 0·95
11. Flying (rotary wing helicopter)		27	0·53	0·71	0·23 - 0·77
12. Vehicle movements (including armoured carriers, convoys etc)		27	0·61	0·75	0·31 - 0·80
13. Driving over 'rough' uneven terrain causing your body to shake		27	0·80	0·91	0·61 - 0·90
14. Jumping, 'leaping', bounding between different levels		27	0·60	0·75	0·28 - 0·79
15. Lifting, moving, holding, pushing objects greater than *22lbs (10·3kg)*		27	0·55	0·70	0·28 - 0·79
16. Lifting, moving, holding, pushing objects greater than *35lbs (25kg)*		27	0·59	0·73	0·28 - 0·79
17. Lifting, moving, holding, pushing objects greater than *88lbs (40kg)*		27	0·69	0·82	0·43 - 0·85
18. Lifting, moving, holding, pushing objects greater than *154lbs (70kg)*		27	0·44	0·60	0·30 - 0·84

n = number of participants with complete test-retest data; ICC = Intraclass correlation coefficient; α = Cronbach's alpha - assessment of internal consistency; CI = confidence interval; * = one-way random effects model.

Table 3. Test-retest reliability of MPLQ occupational loading task items

Item / Question	**Response options (all items)**				
What proportion of a typical working day in this job was spent performing the listed activities?	Never / Not very often / Sometimes / Often / Very often	**n**	**ICC***	**α**	**95% CI**
1. Sitting for at least 2-hours without a break		42 (213)	0·84	0·91	0·79 - 0·90
2. Standing for at least 2-hours without a break		42 (213)	0·76	0·87	0·70 - 0·82
3. Walking more than 2-miles (3·2 km)		42 (213)	0·84	0·91	0·79 - 0·90
4. Walking more than 2-miles (3·2 km) *over rough ground*		42 (213)	0·85	0·92	0·81 - 0·86
5. Running for at least 1-hour		42 (213)	0·89	0·94	0·86 - 0·92
6. Loaded marching / running (tabbing) for 30-minutes		42 (213)	0·89	0·94	0·86 - 0·92
7. Squatting down, crouching, bending at the hip/knee for 30-60 mins		42 (213)	0·87	0·93	0·82 - 0·90
8. Kneeling for more than 1-hour		42 (213)	0·80	0·89	0·75 - 0·85
9. Climbing ladders		42 (213)	0·73	0·84	0·66 - 0·80
10. Climbing at least 30-flights of stairs		42 (213)	0·78	0·87	0·72 - 0·83
11. Jumping between different levels (e.g. from the back of a 4-ton vehicle)		42 (213)	0·84	0·91	0·79 - 0·87
12. Operate heavy machinery and/or weapon systems		42 (213)	0·88	0·94	0·85 - 0·91
13. Road driving for at least 4-hours		42 (213)	0·81	0·89	0·76 - 0·85
14. Driving over 'rough terrain' causing your body to shake		42 (213)	0·82	0·90	0·77 - 0·90
15. Lifting or moving weights greater than *22lbs (10·3kg)* by hand at least 10-times)		42 (213)	0·93	0·96	0·91 - 0·95
16. Lifting or moving weights greater than 35*lbs (25kg)* by hand at least 10-times)		42 (213)	0·94	0·97	0·93 - 0·96
17. Lifting or moving weights greater than *88lbs (40kg)* by hand at least 10-times)		42 (213)	0·91	0·96	0·89 - 0·98
18. Lifting or moving weights greater than *154lbs (70kg)* by hand at least 10-times)		42 (213)	0·88	0·93	0·85 - 0·91

n = number of participants with complete test-retest data (pooled sample / aggregated responses); ICC = Intraclass correlation coefficient; α = Cronbach's alpha - assessment of internal consistency; CI = confidence interval; * = one-way random effects model.

Table 4. Test-retest reliability of MPLQ occupational loading task items by duration of Service (0-10 yrs, 11-20 yrs, > 21 yrs)

Item / Question (1 – 18 as for table 3)					**Response options (all items)**							
What proportion of a typical working day in this job was spent performing the listed activities?					Never / Not very often / Sometimes / Often / Very often							
	0-10 yrs				11-20 yrs				>21 yrs			
Item	**n**	**ICC***	**α**	**95% CI**	**n**	**ICC***	**α**	**95% CI**	**n**	**ICC***	**α**	**95% CI**
1	15 (58)	0·87	0·90	0·71 - 0·89	16 (88)	0·81	0·89	0·73 - 0·87	11 (64)	0·89	0·94	0·83 - 0·93
2	15 (58)	0·83	0·90	0·73 - 0·89	16 (88)	0·70	0·83	0·58 - 0·79	11 (64)	0·76	0·87	0·64 - 0·85
3	15 (58)	0·71	0·84	0·56 - 0·82	16 (88)	0·88	0·93	0·82 - 0·91	11 (64)	0·85	0·92	0·76 - 0·91
4	15 (58)	0·77	0·87	0·65 - 0·86	16 (88)	0·85	0·92	0·79 - 0·90	11 (64)	0·90	0·95	0·84 - 0·94
5	15 (58)	0·79	0·89	0·67 - 0·87	16 (88)	0·94	0·97	0·91 - 0·96	11 (64)	0·88	0·94	0·81 - 0·93
6	15 (58)	0·90	0·95	0·85 - 0·94	16 (88)	0·92	0·96	0·88 - 0·95	11 (64)	0·81	0·89	0·71 - 0·89
7	15 (58)	0·87	0·93	0·79 - 0·92	16 (88)	0·82	0·90	0·74 - 0·88	11 (64)	0·90	0·95	0·85 - 0·94
8	15 (58)	0·89	0·94	0·83 - 0·94	16 (88)	0·78	0·88	0·68 - 0·85	11 (64)	0·75	0·87	0·63 - 0·87
9	15 (58)	0·79	0·88	0·67 - 0·87	16 (88)	0·63	0·78	0·49 - 0·74	11 (64)	0·80	0·89	0·69 - 0·88
10	15 (58)	0·78	0·87	0·65 - 0·86	16 (88)	0·77	0·87	0·67 - 0·84	11 (64)	0·81	0·90	0·70 - 0·88
11	15 (58)	0·91	0·95	0·86 - 0·95	16 (88)	0·76	0·86	0·66 - 0·84	11 (64)	0·85	0·92	0·77 - 0·91
12	15 (58)	0·78	0·87	0·66 - 0·87	16 (88)	0·91	0·95	0·86 - 0·94	11 (64)	0·94	0·97	0·86 - 0·96
13	15 (58)	0·89	0·94	0·82 - 0·93	16 (88)	0·81	0·89	0·72 - 0·87	11 (64)	0·53	0·67	0·33 - 0·69
14	15 (58)	0·81	0·90	0·71 - 0·89	16 (88)	0·83	0·90	0·76 - 0·89	11 (64)	0·77	0·87	0·64 - 0·85
15	15 (58)	0·89	0·94	0·81 - 0·93	16 (88)	0·94	0·97	0·90 - 0·96	11 (64)	0·92	0·96	0·88 - 0·95
16	15 (58)	0·94	0·97	0·89 - 0·96	16 (88)	0·96	0·98	0·94 - 0·98	11 (64)	0·91	0·95	0·86 - 0·95
17	15 (58)	0·89	0·94	0·82 - 0·93	16 (88)	0·90	0·95	0·86 - 0·94	11 (64)	0·93	0·97	0·89 - 0·96
18	15 (58)	0·89	0·94	0·82 - 0·93	16 (88)	0·86	0·92	0·79 - 0·90	11 (64)	0·88	0·93	0·81 - 0·93

n = number of participants with complete test-retest data (pooled sub-sample / aggregated responses); yrs = years; ICC = Intraclass correlation coefficient; α = Cronbach's alpha - assessment of internal consistency; CI = confidence interval; * = one-way random effects model.