Physical activity and exercise performance in symptomatic Cambodia veterans

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Summary

Background: Dutch (ex-)servicemen who encounter health problems since return from the 1992–3 peace operation UNTAC, commonly complain of reduced activity levels, decreases in physical fitness and aggravation of symptoms after strenuous exercise.

Aim: To evaluate these symptoms.

Design: A prospective study of 26 symptomatic Cambodia veterans and 26 matched controls (healthy Cambodia veterans).

Methods: Using an actometer and diaries, both groups were followed for a 12-day baseline period prior to an incremental maximal exercise test on a bicycle ergometer, followed by 7 days of post-ergometer data.

Results: During baseline, symptomatic Cambodia veterans reported more symptoms, had lower levels of physical activity and took longer periods of rest after high activity periods. Symptomatic veterans did not perceive the exercise test needing more exertion than healthy veterans did, although their physical fitness was decreased. Post-ergometer, daily observed symptoms did not aggravate in symptomatic veterans. Four days post-ergometer, actometer and daily observed activity scores were lowered in both groups. As compared to baseline, one day post-ergometer, levels of physical activity were changed in healthy veterans, but not in controls.

Discussion: Complaints about reduced activity levels and decreases in physical fitness in symptomatic Cambodia veterans were confirmed. Post-exertion malaise was not found. The observed post-exertion effects were traced back to weekday patterns.

Introduction

After return from the 1992–3 peace operation UNTAC (United Nations Transitional Authority for Cambodia), Dutch Cambodia veterans have reported health symptoms, such as forgetfulness, difficulty concentrating and severe fatigue. In 1997, these symptoms became the subject of a number of studies. An operational case definition for symptoms in Cambodia veterans was constructed using a validated fatigue severity questionnaire.1 Cambodia veterans who yielded elevated fatigue severity scores on both an initial and a follow-up postal survey, were subsequently invited for extensive somatic and psychological assessment.

Clinical observations revealed that symptomatic Cambodia veterans commonly express complaints about reduced activity levels, decreases in physical fitness and aggravation of symptoms after strenuous exercise. Therefore, a controlled study on physical activity and exercise performance was performed. To our knowledge, such studies have not been done so far, but seem of interest for at least two reasons. First, to evaluate to what degree active-duty
symptomatic veterans are able to meet military demands in terms of physical fitness, activity and ability to be prepared on request. Second, to contribute to the development of effective, evidence-based treatment of symptoms in veterans. In the US, specialized treatment programs for Gulf War veterans have been developed that incorporate gradual, paced physical activation.²–⁴

The aims of the present study were to evaluate physical activity, physical fitness and post-exertion malaise in symptomatic Cambodia veterans. To prevent inconsistencies stemming from the use of inappropriate control groups, great care was taken in the selection of well-matched military controls. To prevent bias from ideas about illness and disability, physical activity was measured using both an actometer and self-report instruments.⁵

The study consisted of three parts. Firstly, self-reported complaints and physical activity in symptomatic and ‘healthy control’ Cambodia veterans were compared for a baseline period of 12 days (part 1). Secondly, a maximal incremental bicycle ergometer test was performed (part 2). We investigated whether symptomatic veterans had lower physical fitness and/or higher rates of perceived exertion during the exercise test. Thirdly, the exercise test was followed by 7 days of post-ergometer data (part 3). Self-report measurements and levels of physical activity were compared to baseline. We evaluated whether symptomatic veterans reported an increase in malaise and a decrease in physical activity following the exercise test. Furthermore, the impact of the exercise test in symptomatic veterans was compared with the impact in healthy veterans.

**Methods**

**Subjects**

Twenty-six symptomatic and 26 matched healthy control Cambodia veterans participated in the present study. Symptomatic veterans were randomly selected from a group of symptomatic veterans (n=82) who participated in our somatic and psychological assessment program. No significant differences were found in age, educational level, marital status, service branch during the mission, fatigue severity (CIS) and functional impairment (SIP) between the symptomatic veterans who participated in the present study (n=26) and those who did not (n=56), (Student's t-test, p<0.05 and χ² test, p<0.05).

Healthy veterans were selected on the basis of low levels of fatigue (CIS-fatigue severity score <21) and low symptom reporting (<4 health symptoms) in the initial postal survey mentioned in the introduction.¹ Furthermore, they were matched for age, service branch, rank during the mission in Cambodia and, as far as possible, geographical area, with the symptomatic veterans.

For reasons of homogeneity, only men were included. At the time of the study, symptomatic and healthy veterans were aged 42.1 ± 7.6 and 41.3 ± 6.5 years. It was not possible to match exactly for the variables ‘service branch’ and ‘rank’. During the mission, 58% of the symptomatic veterans were in the Marine Corps, 27% in the Navy and 15% in the Army. In healthy veterans, these percentages were 65%, 19% and 15%, respectively. Eighty percent of symptomatic veterans and 89% of healthy veterans hold a lower rank (below officer). No significant differences were found in marital status, educational level and active duty status between symptomatic and healthy veterans (Table 1). At the time of the study, CIS fatigue severity scores were 45.0 ± 6.2 in symptomatic veterans and 12.3 ± 5.5 in healthy veterans. The ethics committee of our hospital approved the study.

**Tests**

**Fatigue severity and activity**

The Checklist Individual Strength (CIS, subscales fatigue severity and activity) measures different aspects of fatigue over the last 14 days.⁶–⁸ Scores on the eight-item fatigue severity scale range from 8 to 56, scores on the three-item activity scale from 3–21. Higher scores indicate more fatigue and less activity experienced.

**Table 1** Biographical data of symptomatic and healthy Cambodia veterans

<table>
<thead>
<tr>
<th></th>
<th>Symptomatic veterans (n=26)</th>
<th>Healthy veterans (n=26)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Educational level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>96%</td>
<td>92%</td>
<td>1.000</td>
</tr>
<tr>
<td>Higher</td>
<td>4%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>65%</td>
<td>62%</td>
<td>1.000</td>
</tr>
<tr>
<td>Unmarried</td>
<td>35%</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td><strong>Active duty status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active duty</td>
<td>81%</td>
<td>89%</td>
<td>0.688</td>
</tr>
<tr>
<td>Left service</td>
<td>19%</td>
<td>11%</td>
<td></td>
</tr>
</tbody>
</table>

McNemar test, p<0.05. Lower educational level: elementary school, lower vocational and secondary education, intermediates. Higher educational level: school of higher general secondary education, higher vocational education, Royal Marine Academy, University.
**Functional impairment**

The total score of eight subscales of the Sickness Impact Profile (SIP) (subscales recreation and pastimes, home management, mobility, alertness behaviour, sleep/rest, ambulation, social interactions and work), was used to measure functional impairment.\(^9,10\)

**Actometer**

An actometer is a motion-sensing device that can register and quantify the level of actual physical activity. The apparatus consists of a computerized piezo-electric sensor, which is sensitive in three directions, and is attached to the ankle (size 55×25×15 mm; weight 26 g). Accelerations of the sensor larger than a pre-defined threshold are considered as activity, and are stored in an internal memory. Each second, the counter of the actometer is read and reset by a micro-controller. This adds the value to an integration counter, which is set at five minutes. Thus, every five minutes, an activity-score is produced. The actometer scores can be read out by a personal computer.\(^5,11\) In the present study, subjects were instructed to wear the actometer day and night for 20 consecutive days, except for activities involving water (e.g. taking a bath) and rowdy sports (e.g. rugby, judo).

**Activity patterns**

Activity patterns were analysed using the following parameters. Baseline physical activity was quantified as the mean actometer score over the 12-day baseline period. In order to distinguish between relatively high (peak) and low (rest) activity periods, the mean baseline physical activity score of the control group (Table 2, mean score 92) was used as a cut-off. The later (5-min) time periods above this cut-off were labelled as peaks, and the periods below this cut-off, as rest periods. The program identified the ten largest activity peaks by calculating the total energy of each peak (duration peak × Δ number of accelerations in each succeeding 5 minute period). Subsequently, both the average peak duration and average peak amplitude of these ten largest peaks were calculated.\(^11\) Furthermore, the average duration of rest after peaks and the percentage activity reduction after peak were calculated.

**Diaries**

During the 20-day period that the actometer was worn, subjects completed a self-observation list\(^5\) and the daily Profile of Mood States depression subscale (POMS).\(^12,13\) On the self-observation list, daily observed fatigue, daily observed pain and daily observed activity were rated four times a day on a five-point Likert scale (0–4; range 0–16). On the daily POMS depression subscale, subjects indicated once a day, on a five-point Likert scale (range 0–4), how they had felt during the day.

**Incremental maximal exercise test**

Subjects performed a bicycle ergometer test with incremental load. Estimated maximal workload was calculated according to Folgering.\(^14\) The steps varied from 10 to 30 W/min, aiming at completing the test in about 10 min. Subjects were strongly encouraged to carry on cycling, until they were too exhausted to continue.

**Perceived rate of exertion**

The modified Borg scale\(^15\) was administered during the exercise test. Subjects were asked every 3 min and at the point of maximum effort to indicate on a scale from 1 to 10 how much exertion the pedalling was requiring.

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**Table 2** Baseline measurements of symptomatic and healthy Cambodia veterans

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symptomatic veterans</th>
<th>Healthy veterans</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily observed fatigue*</td>
<td>4.1 (1.9)</td>
<td>1.1 (1.1)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Daily observed pain*</td>
<td>2.2 (2.1)</td>
<td>0.4 (0.5)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Daily observed activity*</td>
<td>4.6 (1.8)</td>
<td>5.8 (2.4)</td>
<td>0.085</td>
</tr>
<tr>
<td>Daily POMS-depression*</td>
<td>0.1 (0.4)</td>
<td>0.02 (0.1)</td>
<td>0.100</td>
</tr>
<tr>
<td>SIP 8 total</td>
<td>860.2 (493.9)</td>
<td>74.0 (210.9)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>CIS activity</td>
<td>14.2 (4.6)</td>
<td>4.7 (2.9)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>General physical activity**</td>
<td>81.6 (16.8)</td>
<td>92.0 (18.0)</td>
<td>0.016</td>
</tr>
<tr>
<td>Peak amplitude**</td>
<td>194.1 (21.4)</td>
<td>199.7 (20.9)</td>
<td>0.222</td>
</tr>
<tr>
<td>Peak duration (min)</td>
<td>129.6 (35.1)</td>
<td>135.4 (35.6)</td>
<td>0.560</td>
</tr>
<tr>
<td>Duration rest period after peak (min)</td>
<td>74.2 (31.6)</td>
<td>56.5 (19.3)</td>
<td>0.016</td>
</tr>
<tr>
<td>Activity reduction after peak (%)</td>
<td>56.4 (14.0)</td>
<td>54.6 (13.3)</td>
<td>0.614</td>
</tr>
</tbody>
</table>

Paired samples t-test, p<0.05. *Mean score baseline 12-day period. **Expressed as no. of accelerations per 5-min period.
Physical fitness

Fitness (W/bpm) was quantified as the slope of the heart-rate vs. external workload, calculated from the ratio of the observed maximal workload and the observed increase in heart rate, minus the ratio of the reference maximal workload and the reference increase in heart rate (220 – age in years). The reference maximal workload is based on age, sex and height. Negative values indicate that fitness is worse than predicted, positive values indicate that fitness is better than predicted. In formula:

\[
\text{Fitness (W/bpm)} = \frac{\text{Wmax}/(\text{HRmax} - \text{HRrest})}{-\frac{\text{Wmax\_pred}/(\text{HRmax\_pred} - \text{HRrest})}{10.29\text{ml/min}/W}
\]

Predicted maximal workload:\(^{16}\)

\[
\text{Wmax\_pred(W)} = \frac{(\text{VO}_2\text{max\_pred} - \text{VO}_2\text{rest\_pred})}{10.29\text{ml/min}/W}
\]

Predicted maximal \(O_2\) uptake:\(^{17}\)

\[
\text{VO}_2\text{max\_pred(male: l/min)} = (0.046 \times \text{height in metres}) - (0.021 \times \text{age in years}) - 4.31.
\]

Statistics

Data analysis was performed using SPSS 8.0. Skewed variables were log-transformed.

In the matched case-control design, biographical data and baseline measurements (part 1) were analysed by means of the paired-samples t-test for continuous variables and the McNemar test for categorical variables. For these analyses, the alpha level was set at \(p = 0.05\).

Repeated measures data concerning the exercise test (parts 2 and 3) were analysed as follows. Firstly, to evaluate interaction effects (group × time), difference scores were calculated for physical activity and self-report measures at time points after the exercise test as compared to baseline, and difference scores were calculated for successive BORG scores. The difference scores of symptomatic and healthy veterans were compared using paired-samples t-tests. Secondly, to evaluate main effects (time), time points were examined using paired-samples t-tests. To prevent error resulting from multiple testing, in part 2 the alpha level was set at \(p = 0.01\).

Results

Part 1: Baseline measurements

Self-reporting

At baseline, significant differences were found on most self-report measures between symptomatic and healthy Cambodia veterans (Table 2). Symptomatic Cambodia veterans reported significantly more fatigue and pain on the self-observation list. They were generally more impaired (higher SIP total scores). They perceived themselves as less active than healthy Cambodia veterans did, as measured by CIS activity. No significant differences were found in POMS depression scores and daily observed activity scores.

Figure 1. Flowchart of the study.
General physical activity and activity patterns
Symptomatic veterans had significantly lower actometer scores and thus a significantly lower baseline level of physical activity than healthy veterans (Table 2). Furthermore, their rest periods after a peak took significantly longer. No significant differences were either found in peak amplitude, peak duration and percentage activity reduction after peak (Table 2).

Part 2: Exercise test
All subjects and controls completed the maximal exercise test. A total of 23 symptomatic (88.5%) and 25 healthy Cambodia veterans (96.2%) achieved their maximal predicted workload (McNemar test, \( p = 0.625 \)). Symptomatic veterans had significantly lower fitness than their matched healthy controls (Figure 2, Table 3).

Since only 27\% (\( n=7 \)) of symptomatic and 69\% (\( n=18 \)) of healthy veterans performed the exercise test for 9 min (McNemar test, \( p = 0.007 \)), data on perceived rate of exertion were analysed for 3 and 6 min and point of maximum effort. No significant interaction effects (group * time) were found. Paired-samples t-tests revealed significant main effects of time (t = -12.5, \( p < 0.0001 \) and t = -13.7, \( p < 0.0001 \)), indicating that both symptomatic and healthy veterans perceived pedalling as significantly more tiring over time.

Part 3: Post-ergometer data
On the first day after the exercise test, a significant group * time interaction effect in actometer score was found (t = 3.9, \( p = 0.001 \)), indicating that, compared to baseline, levels of physical activity were elevated one day post-ergometer in healthy veterans, but not in symptomatic veterans (Figure 3a).

As compared to baseline, on the fourth day after the exercise test, a significant decrease in physical activity was found in both groups. Paired samples t-test revealed a significant main effect of time (t = -3.2, \( p = 0.002 \)).

As compared to baseline, on the fourth day after the exercise test, a significant decrease in daily observed activity was found in both groups. Paired samples t-test revealed a significant main effect of time (t = 4.8, \( p < 0.0001 \)) (Figure 3b).

The maximal exercise test did not induce any changes in daily observed fatigue, daily observed pain or depressive mood on the seven days after the exercise test as compared to baseline. No interactions or main effects were found.

Discussion
To our knowledge, this is the first controlled study on physical activity and exercise performance in (ex-)servicemen who encounter health problems after deployment. Symptomatic and healthy Dutch Cambodia veterans (of whom 85\% were active-duty military personnel) were followed for a baseline period of 12 days prior to taking an incremental maximal exercise test on a bicycle ergometer, followed by seven days of post-ergometer data. During baseline, symptomatic Cambodia veterans reported higher levels of daily observed fatigue, pain and impairment. Self-reported and actual levels of physical activity were reduced in symptomatic Cambodia veterans, and duration of rest taken after peaks was consistently longer.

All participants were able to complete the strenuous exercise test: 92\% of all participants reached their predicted physiological maximum. Symptomatic veterans did not perceive pedalling as more tiring than healthy veterans did, although their physical fitness was lower.

After the maximal exercise test, we found no increase in daily observed complaints in

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Table 3 Physical fitness of symptomatic and healthy Cambodia veterans

<table>
<thead>
<tr>
<th></th>
<th>Symptomatic veterans</th>
<th>Healthy veterans</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical fitness (W/bpm)</td>
<td>(-0.1 (0.7))</td>
<td>(0.3 (0.5))</td>
<td>0.028</td>
</tr>
<tr>
<td>Wmax reached (W)</td>
<td>(229.6 (38.9))</td>
<td>(268.8 (32.4))</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>VO(<em>2)(</em>{\text{max}}) (l/min)</td>
<td>(2.7 (0.5))</td>
<td>(3.1 (0.5))</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Paired samples t-test, \( p < 0.05 \).
symptomatic veterans. On the fourth day after the exercise test, a Sunday by definition, levels of physical activity and daily observed activity scores were decreased in both groups. However statistically significant, we question the relevance of this finding, since a baseline week-pattern was observed: at baseline, on Saturdays and Sundays, levels of physical activity were lower in both symptomatic and healthy veterans. Furthermore, in both symptomatic and healthy veterans, actometer and daily activity scores on the fourth post-ergometer day (Sunday) did not differ significantly from actometer and daily activity scores on the Sundays before the exercise test (10 and 3 days before the exercise test) (paired-samples t-test, all tests \( p = \text{NS} \)). Likewise, in our opinion, the observed increase in actometer score in healthy veterans on the first day after the exercise test (Thursday) can also be traced back to weekday patterns. Again, no significant difference was found with the scores on the Thursday before the exercise test (paired samples t-test, all tests \( p = \text{NS} \)).

Two points can be brought up for discussion. Firstly, the level of physical activity was evaluated in both symptomatic and healthy veterans. Unexpectedly, the level of general physical activity in healthy control Cambodia veterans, of whom 85% hold an active duty status, was not significantly different from levels found in healthy male civilians (\( M = 97 \pm 30 \)).\(^{11}\) This finding may cast doubt on the usefulness of an actometer for measuring physical activity in military personnel. Since in the present study physical fitness and physical activity were positively correlated \( (r = 0.370, p < 0.01) \) and previous studies have found better physical fitness in military personnel than in civilians,\(^{18,19}\) we had expected higher levels of physical activity in healthy Cambodia veterans as compared to healthy male civilians. It may be we did not find this difference because healthy veterans had performed many rowdy sports and thus had, according to the instructions, more often removed the actometer from their ankles, leading to an underestimate of their actual level of physical activity. A total of 85% of healthy veterans performed sports on a regular basis, with an average of 6.4 \( \pm \) 8.4 h/week (in symptomatic veterans, 48% performed sports, with an average of 2.4 \( \pm \) 3.5 h/week). But unfortunately, we do not possess detailed self-report data on the periods for which the actometer was removed. Nevertheless, the actometer was sensitive enough to demonstrate a difference in the level of physical activity in symptomatic versus healthy Cambodia veterans.

Figure 3. a Actometer scores. b Daily observed activity.

\[ a \]

\[ b \]
Secondly, we did not monitor on the day of the exercise test, since most participants in the maximal exercise test had taken a day off from work and had to travel quite a distance to get to our hospital. Therefore, the day of the exercise test was not considered representative. Whether post-exertion effects have taken place on the day of the exercise test remains unanswered.

From the present study, it can be seen that symptomatic veterans may encounter serious problems in exercising their duty. In our view, it should be questioned whether servicemen who report health concerns and who are physically less active and less fit, are prepared for future deployment. Veterans who suffer from chronic symptoms should be given an opportunity to recover, both by temporarily adjusting their tasks and by effective treatment. In previous studies we have elaborated on the role of fatigue, self-efficacy, causal attributions and other illness-related cognitions. Physical activity and physical fitness could also form an essential part of therapy that integrates behavioural and cognitive aspects.

Acknowledgements

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