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## Injury Occurrence and Mood States during a Desert Ultra Marathon

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<b>Abstract:</b>	<p><b>Objective:</b> To describe injuries and illnesses presented and profile mood states and sleep patterns during a desert environment ultra marathon.</p> <p><b>Design:</b> Prospective study gathering data on mood states and injury patterns.</p> <p><b>Setting:</b> Gobi Desert, Mongolia.</p> <p><b>Participants:</b> Eleven male competitors (mean Mass 83.7 ± 7.1 kg; BMI 24 ± 1.79, Age: 33 ± 11 yrs).</p> <p><b>Interventions:</b> Injuries were clinically assessed and recorded each day.</p> <p><b>Main Outcome Measures:</b> Mood state was assessed using the Brunel Mood Scale (BRUMS).</p> <p><b>Results:</b> All subjects presented with abrasion injuries, dehydration and heat stress. Vigour decreased over the first six days whilst fatigue increased (p&lt;0.05). Fatigue and vigour recovered on the final morning. The observed recovery was set against increasing levels of depression, tension and confusion, which peaked at days 5/6 but returned to day 1 levels on the 7th morning (p&lt;0.05). Mean sleep duration (6:17 ± 00:48 hr: min, lowest on day 6 4:43 ± 01:54 hr: min) did not vary significantly across the 7 days but did correlate with mood alterations (p&lt;0.05). Increased anger and fatigue correlated strongly with sleep disruption (r=0.736 and 0.768 respectively). Vigour and depression displayed a moderately strong correlation to sleep (r=0.564 and -0.530).</p> <p><b>Conclusion.</b> Injury patterns were similar to those reported in other adventure/ultra distance events. Consistent with previous work, data shows increased fatigue and reduced vigor in response to an arduous physical challenge.</p>

## **Injury Occurrence and Mood States during a Desert Ultra Marathon**

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## **ABSTRACT**

**Objective:** To describe injuries and illnesses presented and profile mood states and sleep patterns during a desert environment ultra marathon.

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**Participants:** Eleven male competitors (mean Mass  $83.7 \pm 7.1$  kg; BMI  $24 \pm 1.79$ , Age:  $33 \pm 11$  yrs).

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**Results:** All subjects presented with abrasion injuries, dehydration and heat stress. Vigour decreased over the first six days whilst fatigue increased ( $p < 0.05$ ). Fatigue and vigour recovered on the final morning. The observed recovery was set against increasing levels of depression, tension and confusion, which peaked at days 5/6 but returned to day 1 levels on the 7<sup>th</sup> morning ( $p < 0.05$ ). Mean sleep duration ( $6:17 \pm 00:48$  hr: min, lowest on day 6  $4:43 \pm 01:54$  hr: min) did not vary significantly across the 7 days but did correlate with mood alterations ( $p < 0.05$ ). Increased anger and fatigue correlated strongly with sleep disruption ( $r = 0.736$  and  $0.768$  respectively). Vigour and depression displayed a moderately strong correlation to sleep ( $r = 0.564$  and  $-0.530$ ).

**Conclusion.** Injury patterns were similar to those reported in other adventure/ultra distance events. Consistent with previous work, data shows increased fatigue and reduced vigor in response to an arduous physical challenge.

**Keywords:** sleep, mood, endurance exercise, ultra marathon, wilderness medicine, injury and illness pattern.

## **INTRODUCTION**

Adventure racing gained popularity during the 1980's in New Zealand with the emergence of the Raid Gauloise series and the Southern Traverse race which set the tone for later multinational, corporate sponsored and media supported events including the well known Eco Challenge events. Over recent decades many additional events have been created world-wide. Typically these events are held in wilderness environments and range in duration from 4-hour sprint races to expedition-length races lasting from 36 hours to 10 days.

A small cohort of studies have documented physiological and psychological states<sup>1,2,3</sup> in participants but there has been little research detailing injury rates or mood states during these races, particularly in extreme environments<sup>4,5</sup>.

The Gobi Challenge is an ultra marathon event held in the southwestern province of the Gobi Desert during July. Participants run in seven discrete consecutive stages accumulating a total of 150 miles in seven days. Temperatures exceed 38°C during daylight hours and drop to ~0°C during the twilight and nighttime hours. Athletes are required to carry all food, spare clothing, sleeping bag and mat, essential signaling and communication devices, and survival equipment throughout the duration of the event.

Runners have to negotiate undulating terrain including sun baked lava plains, 300m high soft sand dunes, rock and rubble strewn valley floors, ice gorges and sparse scrubland. Water was supplied at stage checkpoints, at overnight camps and was not rationed in any way.

Within such demanding environmental conditions and as a result of extreme physical exertion, one would expect some type of behavior or mood alteration. Mood states, in fact, have previously been shown to vary over 44 days of an expedition to the South Pole<sup>6</sup> and during a

100-hour adventure race<sup>2</sup>. Relative to the discomfort of the environment and the time limitation of the event, sleep duration in these athletes can be disrupted.

Mood disruption has been correlated with sleep time (positively with high vigour scores and inversely with low fatigue and depression scores)<sup>1</sup> and may be a contributing factor in susceptibility to overreaching or overtraining in athletes with minimal recovery opportunity during long duration events<sup>2</sup>. The purpose of this investigation was twofold: [1] identify common injury patterns and illness and [2] profile mood states and patterns of sleep of athletes participating in a desert environment ultra marathon.

## **METHODS**

Competitors participating in the 2009 Gobi Challenge were recruited as volunteers for the study. All subjects were medically assessed for physical injuries and symptoms of environmental stress morning and night by a qualified medical practitioner. Injuries were recorded as such if they required treatment. Assessments were performed each morning and night. Additional psychological measurements were recorded on rising each morning using an internally validated questionnaire. If a competitor was treated multiple times for the same injury or condition or presented more than once during the day (for blister treatment as an example), then each treatment was recorded as one injury. The medical team was small and there were frequent meetings to discuss injuries and athlete assessments contributing to standardization of assessment methods and injury reporting.

Mood was assessed daily as part of the morning assessments with the Brunel Mood Scale (BRUMS). The subscales of the BRUMS are: anger, confusion, depression, fatigue, tension, and vigor. The 24 items in the scale are rated on a 5 point scale from 0 (not at all) to 4 (extremely). Examples of items include: panicky; sleepy; depressed; lively; uncertain; energetic; angry; tired; alert; active and muddled.

## **Subjects**

Eleven male competitors (mean BMI:  $24 \pm 1.79$ , Age:  $33 \pm 11$  yrs) completed all 7 stages in the desert race. One individual (BMI: 25, Age: 43 yrs) was a below knee amputee and is documented separately.

## **Data Collection**

During the event, a medical team consisting of one Emergency Medical Technicians (Wilderness) (EMT-W) and one Registered General Nurse (RGN)/EMT-W provided assessment and emergency trauma care, soft tissue rehabilitation and recorded each medical event. This process was delivered at vehicle checkpoints along the event route and in the overnight staging area in tents. Foot clinics were particularly well utilized. A basic physical assessment was performed by an EMT-W on each presenting athlete with consultation with other EMT-W taking place as soon as possible after initial assessment. Injuries were documented on standardized injury reporting form. This information was subsequently used to document the injuries and illnesses presented. Any Gastrointestinal (GI) conditions, including vomiting and diarrhoea, that were related to hydration status were documented as dehydration. Psychological assessment was measured simultaneously with medical assessment at morning (pre-race stage) and evening (post race stage) sessions. Mood was assessed daily as part of the morning assessments with the Brunel Mood Scale (BRUMS), which is a shortened and validated version of the Profile of Mood States<sup>14</sup>. A full self-assessment sleep log was completed by nine of the eleven participants and submitted at the end of the event.

## **Statistics**

Data analysis was performed using SPSS (PASW Statistics 18.0, SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to describe the patterns of injury, illness and mood states of the participants. Friedman's nonparametric test was used to compare differences

(anger, confusion, depression, fatigue, tension, and vigor) between and within groups for each of the mood subscales (anger, confusion, depression, fatigue, tension and vigour). Daily mood and sleep relationship was re-investigated using the non parametric Kendal's Tau-b correlation. Only anger showed a significant negative relationship with sleep duration. Differences were considered statistically significant at the  $p < 0.05$  level.

### **Ethical Approval**

Ethical approval was given by University of the West of Scotland ethics committee prior to the event.

## **RESULTS**

### **Pathology**

All subjects presented with minor abrasion injuries, predominantly localized in the lower limbs, dehydration and heat stress. More than half of the subjects presented with heat illness, specifically heat exhaustion (athlete  $n=6$ ; 54%). The most frequent complaint requiring medical examination or care was skin or soft tissue damage (athlete  $n=11$ ; 100 %). Blisters (particularly feet) were the single most common injury (athlete  $n=11$ ; 100 %) (Fig 1a). Common complaints received from competitors were pain, lack of joint mobility (stiffness in knees), Achilles tendon pain and shin pain, occurred in a similar pattern to previous studies increasing as the race progressed<sup>4</sup>. One athlete presented daily with increasing severity of abrasion injury at the interface of the body with a prosthetic limb (Fig 1b).

INSERT FIGURE 1

### **Psychological states**

Perceived vigor as assessed by the BRUMS decreased over the period of the first six days

( $p < 0.05$ ) while perceived fatigue increased ( $p < 0.05$ ). Both measures improved somewhat on the final morning but not to pre-competition levels. These findings were set against increased levels of depression ( $p < 0.05$ ), tension ( $p < 0.05$ ) and confusion ( $p < 0.05$ ) peaking on days 5 and 6 but returning to day 1 levels on the 7<sup>th</sup> morning of the race. Mean sleep duration over the 7 nights was  $6:17 \pm 00:48$  hr: min. Sleep duration was at its lowest on day 6 ( $4:43 \pm 01:54$  hr: min) and did not vary significantly across the 7 days (Fig 2).

INSERT FIGURE 2

When mean daily sleep duration were examined for correlation with the daily mood scores there was only an inverse statistical relationship observed between sleep duration and anger ( $r = -0.683$ ). There was also a moderately strong correlation noted between sleep and vigour ( $r = 0.564$ ). A moderately strong relationship was found between sleep duration and depression ( $r = -0.530$ ). The findings for vigor, tension, depression and fatigue were not statistically significant (Table 1).

INSERT TABLE 1

INSERT TABLE 2

## **DISCUSSION**

There have been few studies, which have examined in detail the psychological demands of ultra runners in desert type environments. The purpose of this study was to document injury patterns and mood states experienced by competitors. Common complaints were pain or lack of movement (stiffness) in the knees, Achilles tendons and shins; findings similar to observations in other adventure races held in extreme environments<sup>7,8</sup>.

Skin and soft tissue injuries were the most frequent injury, with higher rates observed in this event when compared to other events<sup>9</sup> (100% on Gobi compared to 48% on Subaru) with blisters on the feet representing the most common (100% on Gobi compared to 32.8% on Subaru)<sup>9</sup>. Although most athletes wore sand gaiters during the event, dirt and grit was present in all competitors' socks and footwear and this may have exacerbated friction. In addition, a number of competitors crossed water, without drying their feet post event, this probably contributed to the feet blister rates. The competing amputee athlete suffered dehydration, abrasions and heat exhaustion. In addition, extensive abrasions/ blistering were present on the stump (Fig 1b) due to excessive sweating and friction.

During the Subaru Primal Quest Expedition Length Adventure Races (PQ 2002 and PQ 2003) sixty-two teams of 4 individuals competed, resulting in per participant was ~1.1 (PQ2003)<sup>9</sup>. In both events, the most frequent reason to require medical care during the event was skin and soft tissue injury, accounting for 70.4% (PQ 2003) and 48.0% (PQ 2002) of medical encounters. Blisters were the single most common reason for medical care, accounting for 45.6% (PQ 2003) and 32.8% (PQ 2002) of medical encounters.

There has been a previous case study<sup>10</sup> that documented changes in respiratory function (a decline in FEV<sub>1</sub> and FVC) in an athlete participating in multi day wilderness adventure event. The findings appeared to be attributable to an evolving airflow obstruction suggesting contraction of a viral infection that may have contributed to the decline in respiratory function observed. Given the close nature of participant transport into the desert and communal living in the tent areas in this study it would not be improbable to suggest that respiratory changes may have contributed to changes in physical performance and sleeping pattern and psychological states.

However, respiratory function was not recorded on this occasion, and as such, this suggestion is purely speculative. Injury patterns from this event indicate common patterns of soft tissue damage and illness with particularly incidence of skin and soft tissue injuries. There were no cases of clinical heatstroke recorded, and this may be attributed to preventative planning and information provided from the medical team and the continual monitoring of hydration status throughout the race period.

While no attempt was made to determine mechanical or muscular imbalances or suitability of footwear, it may be acceptable to suggest that some of the lower limb complaints would be caused or exacerbated by extrinsic training errors (incorrect footwear type and sizing, unfamiliarity of terrain, overtraining, incorrect volume or specificity of training)<sup>11</sup>. Although this study did not document nor directly assess training regimens prior to participation, it is possible that some injuries can be associated with training overload prior to competition, poor adaptation to the workload demanded of these races, incorrect or deficient nutrition, or incorrect or inefficient exercise type.

Previous papers have reported that participants may experience a perceived increase in fatigue and reduced vigour scores in relation to elevated scores of confusion, depression and tension<sup>6</sup>. Although similar in duration and in physical demand, participants were studied in an environmentally different locale, the South Pole. The combined results and comparisons suggest that it is not the environmental conditions that drive alterations in mood during these prolonged events, rather the actual increased physical workload associated with the distances covered within the extreme conditions presented.

Although self reported sleep time is recognized as a crude measure (i.e. sleep quality was not examined) it is an easily assessed entity and there were interesting relationships identified

between the duration of sleep and the mood scores. The present data is similar to previous works in that negative mood scores were manifest in those participants who experienced reduced sleep duration<sup>3,6</sup>. The imbalance between the physiological demand for sleep and the desire to complete a race as quickly as possible resulted in the mood disturbances observed. One of the proposed physiological functions of sleep is to conserve energy<sup>11</sup>. A recent calculation of the energetic cost of a single night of sleep deprivation equates to the energy required for a 68 kg adult to walk 3 km<sup>12</sup>. This putative relationship between sleep and energetic cost may interfere with both endurance performances via limiting available metabolic resources and through inhibiting energetic recovery between sequential days of effort. Assuming this relationship, it is important for individuals who undertake these extreme and physically demanding events to ensure that they not only consider the energy cost of the activities undertaken, but also consider the increased energy demands that occur as a result of sleep disruption or deprivation. This is strongly suggestive of provision of a surplus of high density energy providing macronutrients in the rations carried by the competitors.

The lack of relationships shown between the injury data and the BRUMS score could have resulted from a lack of sensitivity in the injury data collection for this cohort. As such, future studies may need to consider using more sensitive tools of measurement to examine these relationships. Data collection during this type of research is difficult when we consider the extremely demanding race conditions. This may prove not to be feasible as the researcher's objective is to collect appropriate and reliable data, however this process must be balanced with the needs of the competitors and be minimally disruptive to the flow of competition and recovery.

## **CONCLUSION**

One previous study<sup>13</sup> has suggested the need for guidelines in relation to medical support for

adventure and endurance races. This is not an exact science due to differences in abilities, training preparations, athlete support during the event, and environmental factors. Additional information regarding injury rates, recovery and psychological demand may assist in anticipating and preparing for the potential negative effects that may occur over the course of a race.

The findings of this study support previous researchs that suggests medical personnel supporting adventure or ultra distance races, particularly in extreme environments, should plan and expect a wide variety of medical conditions particularly soft tissue and temperature related.

The behavioral disruptions reported here suggest that individual athletes should more adequately prepare sleep strategies in order to enhance their performance. Limiting the mood disturbances associated with reduced sleep requires attention with the experimental literature and may be a fertile area of future performance enhancement research. Furthermore, it might be suggested from these data that event planners need to consider the sites and conditions of sleep encampments in order to support peak athlete performance.

## References

1. Speedy DB, Rogers IR, Safih S, et al. Hyponatremia and seizures in an ultradistance triathlete. *J Emerg Med.* 2000;18:41-44.
2. Speedy DB, Noakes TD, Rogers IR, et al. Hyponatremia in ultra distance triathletes. *Med Sci Sports Exerc.* 1999;31:809-815.
3. Anglem N, Lucas S, Rose E, et al. Mood, illness injury responses and recovery with adventure racing. *Wilderness Environ Med.* 2008;19:30-38.
4. Fordham S, Garbutt G, Lopes P. Epidemiology of injuries in adventure racing athletes. *Br J Sports Med.* 2004;38:300-303.
5. Borland ML, Rogers IR. Injury and illness in a wilderness multisport endurance event. *Wilderness Environ Med.* 1997;8:82-88.
6. Pedlar C, Lane A, Lloyd J, et al. Sleep profiles and mood states during and expedition to the South Pole. *Wilderness Environ Med.* 2007;18:127-132.
7. Townes DA, Talbot TS, Wedmore IS, et al. Event medicine: injury and illness during an expedition length adventure race. *J Emerg Med.* 2004;27:161-165.
8. Cipriani DJ, Swartz JD, Hodgson CM. Triathlon and the multisport athlete. *Orthopaed Sports Phys Ther.* 1998;27:42-50.
9. McLaughlin KA, Townes DA, Wedmore IS, et al. Pattern of injury and illness during expedition-length adventure races. *Wilderness Environ Med.* 2006;3:158-162.
10. Rogers IR, Speedy D, Hillman D, et al. Respiratory function changes in a wilderness multisport endurance competition: a prospective case study. *Wild Environ Med.* 2002;13:135-139.
11. Berger R, Philips N. Energy conservation and sleep. *Behavioural Brain Res.* 1995;69:65-73.

12. Jung C, Melanson E, Frydendall E, et al. Energy expenditure during sleep, sleep deprivation and sleep following sleep deprivation in adult humans. *J Physiol.* 2011; 589:235–244.
13. Greenland K. Medical support for adventure racing. *Emerg Med Australas.* 2004;16:465–468.
14. McNair, D.M., Lorr, M. and Droppleman, L.F. *Manual for the Profile of Mood States.* 1971. San Diego, CA: Educational and Industrial Testing Service.

### **Figure Captions**

Figure 1. Example of injuries over the course of the event.

Figure 2. Mood states and self-reported sleep over the 7 days of the race.

Figure

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Figure

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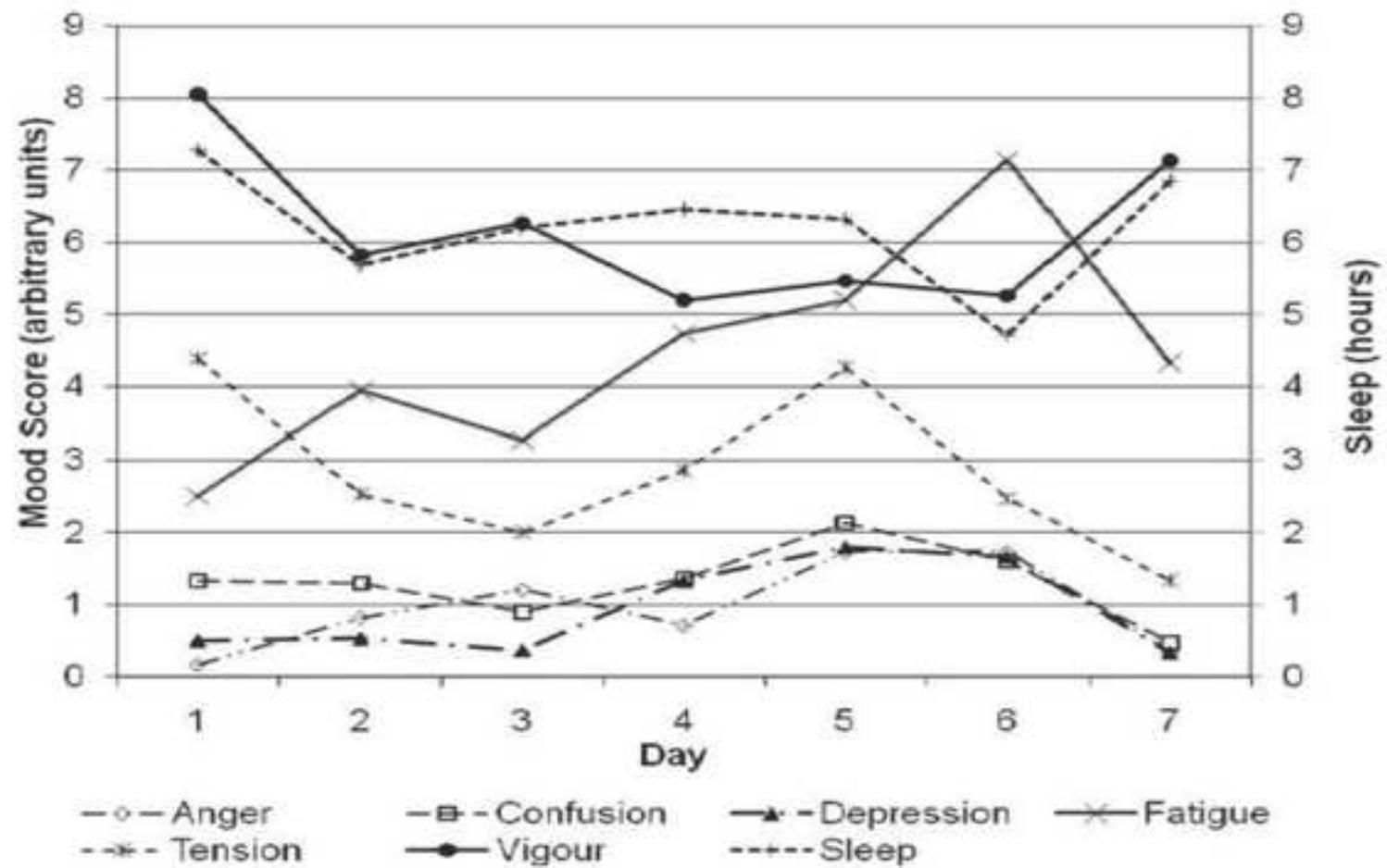


Table 1. Statistical correlations between daily mood scores and reported sleep duration over the 7 days of the race (n=9).

	Anger	Confusion	Depression	Fatigue	Tension	Vigor
Confusion	0.39					
Depression	0.49	0.90**				
Fatigue	0.49	0.43	0.52			
Tension	-0.01	0.52	0.43	-0.05		
Vigor	-0.49	-0.43	-0.33	-0.62	0.14	
Sleep time	-0.68*	-0.24	-0.33	-0.43	0.28	0.43

\*\* $P = 0.01$ .

\* $P < 0.05$ .

Severity of injury was investigated along with BRUMS subscales ( $P > 0.05$ ).

Table 2. Scores (Mean  $\pm$ SE) of Mood Recorded Over the Course of the 7 Days of the Race.

Day	Anger	Confusion	Depression	Fatigue	Tension	Vigour	Sleep
1	0.17 (0.17)	1.33 (0.38)	0.50 (0.31)	2.50 (0.60)	4.39 (0.84)	8.06 (0.91)	7.28 (0.38)
2	0.82 (0.27)	1.29 (0.41)	0.53 (0.29)	3.94 (0.56)	2.53 (0.67)	5.82 (0.67)	5.69 (0.43)
3	1.21 (0.63)	0.89 (0.34)	0.37 (0.19)	3.26 (0.51)	2.00 (0.47)	6.26 (0.85)	6.19 (0.39)
4	0.71 (0.41)	1.36 (0.5)	1.33 (0.55)	4.73 (1.02)	2.87 (0.7)	5.20 (1.04)	6.46 (0.57)
5	1.73 (1.10)	2.13 (1.07)	1.80 (1.09)	5.20 (1.07)	4.27 (1.26)	5.47 (0.97)	6.32 (0.37)
6	1.73 (1.02)	1.60 (0.62)	1.67 (0.84)	7.13 (0.95)	2.47 (0.58)	5.27 (0.84)	4.71 (0.51)
7	0.33 (0.23)	0.47 (0.29)	0.33 (0.19)	4.33 (1.07)	1.33 (0.52)	7.13 (0.96)	6.86 (0.40)