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Analytical Clinical Studies

Epidemiology of shivering (shivers) in horses

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Summary

Reasons for perfoming study: Investigating the epidemiology of shivering in horses.
Objectives: The purpose of this study was to characterise the signalment, clinical signs and management factors associated with shivering (also known as shivers), a relatively rare, poorly defined movement disorder in horses.
Study design: Web-based case series survey and case–control study.
Methods: A Web-based survey was used to obtain information from owners, worldwide, who suspected that their horse had shivering. Survey respondents were asked to answer standardised questions and to provide a video of the horse. Authors reviewed the surveys and videos, and horses were diagnosed with shivering if they displayed normal forward walking, with difficulty during manual lifting of the hoof and backward walking due to hyperflexion or hyperextension of the pelvic limbs. Cases confirmed by video were designated 'confirmed shivering', while those with compatible clinical signs but lacking video confirmation were designated 'suspected shivering'. Owners of confirmed shivering horses were asked to provide information on 2 horses without signs of shivering (control group).
Results: Three hundred and five surveys and 70 videos were received; 27 horses were confirmed shivering (50 controls), 67 were suspected shivering and the rest had a variety of other movement disorders. Suspected shivering horses resembled confirmed shivering cases, except that the suspected shivering group contained fewer draught breeds and fewer horses with exercise intolerance. Confirmed shivering signs often began at <5 years of age and progressed in 74% of cases. Owner-reported additional clinical signs in confirmed cases included muscle twitching (85%), muscle atrophy (44%), reduced strength (33%) and exercise intolerance (33%). Shivering horses were significantly taller (confirmed shivering, mean ~173 cm; control horses, ~163 cm) with a higher male:female ratio (confirmed shivering, 3.2:1 vs. control, 1.7:1). No potential triggering factors or effective treatments were reported.
Conclusions: Shivering is a chronic, often gradually progressive movement disorder that usually begins before 7 years of age and has a higher prevalence in tall male horses.

Keywords: horse; movement disorder; neurology; dyskinesia; myopathy

Introduction

Shivering (also known as shivers) is an age-old disease, which was described to be 'as common as dirt' by a comparative neuropathology text from 1962 [1]. After World War II, the disorder seems to have decreased in occurrence with the decline in the number of draught horses [1]. Individual case reports and reviews indicate that shivering commonly affects draught horse and Warmblood breeds, their crosses, carriage horses, Thoroughbreds and, less frequently, other lighter breeds [2]. Most modern neurology textbooks [3,4] refer to shivering only in passing, and there has been limited research performed regarding the disease [2,5–8]. Shivering is characterised by muscle tremors, abduction, hypertonic flexion or extension of the pelvic limbs induced by walking backwards and manual lifting of a hindlimb [2,4]. It can be unilateral or bilateral, consistent or intermittent. Shivering is often first noticed by farriers and is especially problematic when it progresses to a total inability to hold up the hind hooves for trimming.

Shivering has been proposed to have origins in the musculoskeletal system [7] as well as the nervous system [3], with trauma, osteoarthritis [5], infectious disease [2] and a genetic basis [9] being proposed as potential aetiologies. Although it has been suggested that shivering could be due to polysaccharide storage myopathy, one study found that two-thirds of shivering cases lacked evidence of amylase-resistant polysaccharide typical of *type 1* polysaccharide storage myopathy in muscle biopsies [6]. Only one histopathological study of the nervous system of shivering horses has been published, and this involved only 2 Belgian Draught horses using basic haematoxylin and eosin light microscopy techniques [7]. No histological lesions were identified in the nervous system and, thus, no clear cause for shivering is apparent.

Veterinarians have difficulty advising clients because there is no comprehensive information published regarding the cause or progression of shivering. An epidemiological study is needed to provide better characterisation of shivering and determine possible risk factors, as well as to provide information to guide diagnosis, prognosis and management decisions. Given that shivering cases are seen relatively infrequently by any one veterinary practice, the aim of this study was to use a Web-based survey to collect as many well-characterised cases as possible and report the signalment, age of onset of clinical signs and management of horses with shivering in comparison with non-affected control horses from a similar region.

Materials and methods

Case selection

Potential cases of shivering were solicited through advertisements in national (USA) and international horse magazines (English language), and owners were directed to a Web-based, closed-ended questionnaire on the University of Minnesota's Neuromuscular Diagnostic Laboratory Website (Supplementary Item 1). The authors were aiming for a worldwide distribution of cases. Owners were asked to post or upload a video of their horse being led in hand, walking forwards, walking backwards, circling (to the left and right) and with a handler manually lifting each limb for a minimum of 10 s. If questionnaires were incomplete or illegible, they were not included in the analysis.

Case definition

Shivering cases were divided into the following 2 groups: 1) confirmed shivering, where horses were examined by one of the authors (A.C.E.D. or S.J.V.) in person or by viewing the submitted video; and 2) suspected shivering, where a diagnosis was established based on owner-reported

clinical signs, without video analysis or veterinary examination. The clinical definition of shivering was established and has been described previously [10] and included horses with shivering hyperextension and with shivering hyperflexion. The horses with shivering hyperextension had prolonged hypertonic extension of the hindlimbs induced by backward walking and manual lifting of the hindlimbs. The horses with shivering hyperflexion had normal forward walking and intermittent hypertonic hindlimb flexion during backward walking and manually lifting the limb. Horses with signs of hyperflexion with forward walking were not included in the present study in order to avoid any confusion of shivering cases with stringhalt cases.

Control group

Control horses were selected by owners of confirmed shivering horses and were from the same widespread geographical area where confirmed shivering horses would be managed, in similar basal conditions. The owners of confirmed shivering horses completed additional questionnaires for up to 3 unaffected horses that were free of signs of shivering or other movement disorders, experienced no problems with farriery, were older than 4 years and lived in close geographical proximity to the confirmed shivering-affected horse. The control questionnaire (Supplementary Item 2) was Web based and consisted of the same closed-ended questions pertaining to signalment, diet, use, previous illnesses or trauma and supplements.

Epidemiological survey

The Web-based questionnaire included contact details and location, closed-ended questions for signalment (breed, date of birth, height, sex and body condition score) as well as specific clinical signs, precipitating factors, diet and management, including time spent in a stall. The use of the horse was recorded and grouped as pleasure (pleasure/trail or retired), competition (dressage, hunter/jumper, showing, eventing or racing) or draught work (farm labour or carriage pulling). The following 3 breed groupings were established; 1) draught; 2) combined Thoroughbred and Warmblood, including their crosses; and 3) other (Connemara, Welsh breeds, Quarter Horses, Standardbreds, Saddlebreds, Tennessee Walking horses, Missouri Fox Trotters, Paint, Morgan and 'mixed breed').

Clinical signs: The age when clinical signs of shivering were first observed was recorded. The perceived presence of reduced strength, exercise intolerance, unexplained lameness, abnormal forward and backward walking, difficulty with manual lifting of the hindlimbs, twitching of the face or muzzle, muscle atrophy and muscle quivering were documented using closed-ended questions and a comment box for additional information. Progression of clinical signs of shivering was classified as improving, worsening or remaining static.

Precipitating factors: Previously reported factors that could precipitate signs of shivering, such as aeroplane travel, major surgery, illness requiring hospitalisation or stall rest, abuse, neglect, trailer accident and long-distance road transportation (>6 h) were reported for the year preceding and subsequent to the development of signs of shivering. Neurological, gastrointestinal, endocrine and lameness diseases were also recorded.

Diet: Supplements added to the horse's diet were classed as no supplements, fat/oil, selenium, vitamin E, joint supplement, mineral block, salt block, vitamin and mineral, electrolytes, hoof care, putative calming compounds and probiotic.

Treatments: Owners were also asked to list which treatments or management factors they had used to alleviate signs of shivering and if they had any effect. The following list of treatments was provided: increased exercise/turnout, diet changes, acupuncture, chiropractics, herbs, flunixin meglumine, phenylbutazone, tranquilisers, muscle relaxers and phenytoin. A comments box was provided for additional treatments that were tried and any observed effects of these treatments.

TABLE 1: Comparison of age of onset, progression of shivering signs and additional owner-reported clinical signs within the confirmed shivering and suspected shivering horses

Parameter		Confirmed shivering	Suspected shivering
		n = 27	n = 67
Age of onset (years)	Median age group	2–4	5–7
Worsening of signs over time	n (%)	20 (74)	29 (43)*
Muscle twitching	n (%)	23 (85)	57 (85)
Muscle atrophy	n (%)	12 (44)	23 (34)
Reduced strength	n (%)	9 (33)	16 (24)
Exercise intolerance	n (%)	9 (33)	8 (12)*
Facial twitching	n (%)	5 (19)	11 (16)
Elevated tail head	n (%)	20 (74)	40 (60)
Farriery problems	n (%)	26 (96)	62 (92)

*Significant difference (P<0.05) between confirmed and suspected shivering.

Data analysis

Data were entered into a spreadsheet, and all analyses were performed using R-Project for Statistical Computing[a]. Confirmed and suspected groups were compared to determine whether there were differences in signalment and demographic factors. Only data from the confirmed shivering group were compared with the control group. Normally distributed, continuous variables were compared using Student's unpaired *t* test, or the Wilcoxon two-sample test if the data were not normally distributed. Categorical data that were normally distributed were compared using Pearson's Chi-square test or Fisher's exact test if fewer than 5 counts were in a given cell. Significance was set at P<0.05.

Results

Horses

Questionnaires were completed for 305 horses from the USA (n = 210), UK and Ireland (n = 44), Canada (n = 22), mainland Europe (n = 10), Australia and New Zealand (n = 9), Scandinavia (n = 6), South America (n = 2) and South Africa (n = 2). Seventy videos were received. Based on the case definition, 27 horses were diagnosed with confirmed shivering (USA [n = 21], Canada [n = 3], UK and Ireland [n = 2] and Australia and New Zealand [n = 1]) and 67 suspected shivering (USA [n = 49], UK and Ireland [n = 11], Canada [n = 3], mainland Europe [n = 3] and Australia and New Zealand [n = 1]). Horses were alive at the time the survey was completed. The majority of excluded horses showed an array of other gait abnormalities or difficulties solely involving holding up a limb, and these horse have been described previously [10]. The control group consisted of 50 horses from the USA (n = 39), Canada (n = 6) and UK and Ireland (n = 5).

Confirmed shivering

Clinical signs: Owner-reported, additional clinical signs of shivering in order of frequency included problems with the farrier trimming their hind hooves, muscle twitching, elevated tail head when backing, muscle atrophy, reduced strength and exercise intolerance (Table 1). Interestingly, owners reported that 19% of shivering horses showed twitching of their face, lips or eyes during backward walking (Table 1).

Frequency and progression of shivering: Clinical signs of shivering occurred most commonly on a daily basis as opposed to less frequently (daily signs: confirmed shivering, 93% [25 of 27]). Fewer than 12% of confirmed shivering horses had signs less frequent than weekly. Owners reported that most horses showed a progressive worsening of clinical signs over time (Table 1). Only 7% (2 of 27) of confirmed shivering horses had clinical signs that remained static over time. Eleven per cent (3 of 27) of confirmed shivering horses showed a temporary improvement in shivering signs. No horse was reported to have a total resolution of signs.

TABLE 2: Summary of signalment and management data of the suspected and confirmed shivering groups and the control group

		Groups						
Signalment	Units	Suspected shivering		Confirmed shivering		Control		P value
		n = 67		n = 27		n = 50		
		Mean ± s.d.		Mean ± s.d.		Mean ± s.d.		
Age	years	14.3 ± 5.4		11.5 ± 4.6		13.2 ± 6.5		0.2
Height	cm	170 ± 8.4		173 ± 6.2		163.4 ± 10.3		<0.001*
		n	(%)	n	(%)	n	(%)	
Gender	male:female	51:16		23:4		28:17[†]		0.04
Breed	Draught	18	(27)	10	(37)	9	(18)	0.002*
	TB/WB	33	(49)	16	(59)	19	(38)	
	Other	13	(19)	1	(4)	22	(44)	
BCS	Underweight	7	(10)	4	(15)	2	(4)	0.3
	Ideal	54	(81)	20	(74)	41	(82)	
	Overweight	6	(9)	3	(11)	7	(14)	
Management								
Use	Draught work	0	(0)	4	(15)	6	(12)	0.7
	Pleasure	34	(51)	10	(37)	24	(48)	
	Competition	33	(49)	13	(48)	20	(40)	
Time in stall	0–1 h/day	27	(40)	12	(44)	17	(34)	0.9
	1–4 h/day	7	(10)	1	(4)	1	(2)	
	4–8 h/day	7	(10)	4	(15)	5	(10)	
	8–12 h/day	14	(21)	4	(15)	11	(22)	
	12–16 h/day	6	(9)	5	(19)	3	(6)	
	16–20 h/day	3	(4)	1	(4)	11	(22)	
	≥20 h/day	3	(4)	0	(0)	0	(0)	
Imported		14	(21)	3	(11)	8	(16)	0.6

Statistical comparison was performed between the confirmed shivering and control groups (shaded area). Asterisks indicate values of P<0.05. [†]Gender not reported for 5 horses. TB/WB = Thoroughbred/Warmblood; BCS = body condition scoring.

Confirmed shivering horses compared with control horses

Signalment: Confirmed shivering horses were significantly taller and had a higher proportion of males than females compared with control horses (Table 2). There were significantly more draught and Thoroughbred/Warmblood breeds and fewer other breeds in the confirmed shivering group compared with the control group (Table 2).

Management: The stated use of the horse was not different between confirmed shivering horses and control horses, with pleasure and competition being the most common uses (Table 2). There was a similar bimodal distribution for stall time in both the confirmed shivering and the control horses of <1 h/day or 12–16 h/day.

Precipitating factors: The only significant differences in potential precipitating factors between confirmed shivering and control horses were abuse/neglect and lameness. Three shivering horses reportedly had suffered abuse/neglect in the past, whereas no control horses had (Table 3), and 30% of confirmed shivering horses experienced lameness compared with only 6% of the control horses (Table 3). There were no other statistical differences between the confirmed shivering and control groups in the reporting of diseases or other precipitating factors (Table 3).

Diet and supplements: There were a wide variety of hay and commercial rations fed to the horses in this study (Supplementary Item 3). Significantly more confirmed shivering horses received vitamin E (37%) supplementation and oats (26%) than control horses (vitamin E, 4%; oats, 8%; Supplementary Item 3).

Confirmed shivering compared with suspected shivering horses

As only 27 videos of confirmed shivering horses were received, we also evaluated the signalment, clinical signs, management, potential precipitating factors and dietary data from an additional 67 horses. These horses were diagnosed with shivering based on reported clinical signs (suspected shivering; Tables 1–3 and Supplementary Item 3). The suspected shivering horses, like the confirmed shivering horses, were tall (mean, 170 cm) and of a similar age. The suspected shivering group contained a significantly higher proportion of draught horses (P<0.05) than the confirmed shivering group. There was no significant difference in owner-reported clinical signs between confirmed shivering and suspected shivering, with the exception that fewer owners of suspected shivering horses reported exercise intolerance (Table 1). The frequency of clinical signs of shivering was similar in confirmed and suspected shivering horses (daily signs: suspected shivering, 82% [55 of 67]). Fewer suspected shivering than confirmed shivering horses showed a progressive worsening of clinical signs over time (Table 1).

Therapeutic strategies employed following diagnosis of shivering

Management and treatments: The wide variety of treatments given to small numbers of confirmed and suspected shivering horses precluded statistical evaluation. The most commonly reported changes implemented after shivering signs started were an increase in vitamin E and selenium. An increase in activity was instituted in 41% of shivering horses. Less than 10% in the 2 groups reported a worsening of signs when working under saddle or harness. Treatments included α_2-agonists (n = 11), nonsteroidal anti-inflammatory drugs (n = 29), muscle relaxants (n = 6), phenytoin (n = 1), carbamazepine (n = 1), gabapentin (n = 1) and fluphenazine (n = 1). Three horses also received herbs, 13 acupuncture and 38 chiropractic treatments in the confirmed and suspected shivering groups. There was no consistent improvement reported for any treatment, with the exception of the α_2-agonists, which appeared to provide temporary cessation of the signs to facilitate farrier work on the hind hooves.

TABLE 3: Summary of potential precipitating factors and disease data of the suspected and confirmed shivering groups and the control group

	Groups						
	Suspected shivering		Confirmed shivering		Control		P value
Precipitating factors	n = 67		n = 27		n = 50		
	n	(%)	n	(%)	n	(%)	
Major surgery	0	(0)	2	(7)	3	(6)	>0.9
Trailer accident	1	(1)	1	(4)	1	(2)	>0.9
Abuse/neglect	3	(4)	3	(11)	0	(0)	0.04
Hospitalisation	1	(1)	1	(4)	4	(8)	0.7
Aeroplane transportation	4	(6)	1	(4)	4	(8)	0.7
Illness requiring stall rest	4	(6)	2	(7)	7	(14)	0.5
Transport >6 h	9	(13)	4	(15)	14	(28)	0.3
Diseases							
Neurological	3	(4)	3	(11)	1	(2)	0.1
Gastrointestinal	1	(1)	3	(11)	7	(14)	0.09
Endocrine	1	(1)	0	(0)	7	(14)	0.09
Lameness	12	(18)	8	(30)	3	(6)	0.007

Statistical comparison was performed between the confirmed shivering and control groups (shaded area).

Discussion

Shivering is a relatively infrequent disorder that, up to this point, has been defined by century-old anecdotes and a few case descriptions [1,5–9,11]. The present study is important because it represents the only epidemiological characterisation of shivering performed to date. The results clearly indicate that shivering is often a slowly progressive movement disorder with a predilection for horses an average of ~17 hands high, and there appears to be a sex bias. Over 3 times more males than females were afflicted with shivering, which surpassed the more balanced sex ratio in our control group. Such a sex predilection has previously been reported for movement disorders such as hereditary spastic paraplegia in man, where the male to female ratio is 1.7:1 [12]. In hereditary spastic paraplegia, the sex predilection is believed to reflect a neuroprotective effect of oestrogen [13], which has been reported to augment retrograde neuronal transport [14]. If shivering is an autosomal genetic trait and oestrogen is protective, the male predilection could reflect the fact that the disease is more penetrant in males.

A genetic basis for shivering has been suggested previously [9] and is supported by the strong breed predilection, with largely draught, Warmblood and Thoroughbred breeds being affected. A genetic basis for shivering in tall breeds could explain the significantly taller height of the confirmed shivering horses compared with the control horses or, alternatively, the primary influence of height on developing signs of shivering could influence the breeds affected. The young age of onset of shivering could support a genetic basis for shivering. Over 40% of horses with confirmed shivering developed signs between 2 and 4 years of age, and the majority of suspected shivering cases had an age at onset of 5–7 years. At present, however, there are no firm data to support or disprove a genetic basis for shivering. The lack of a consistently reported infectious disease or trauma preceding shivering in the present study suggests that these are unlikely to be the sole cause of the disorder; however, larger sample sizes would be necessary to rule these out as contributory factors. Although polysaccharide storage myopathy has previously been suggested to cause shivering, in one study of 103 Belgians, 33% had polysaccharide storage myopathy and 18% had shivers, with only 6 horses having both polysaccharide storage myopathy and shivering, indicating that polysaccharide storage myopathy is not the sole cause of shivering [6]. Furthermore, there would not seem to be a logical reason why a metabolic muscle disorder such as polysaccharide storage myopathy would produce signs only with backward walking or would be associated with the horse's height.

Interestingly, there is a neurological disorder in horses that affects the same breeds, tall horses and is more prevalent in males. Recurrent laryngeal neuropathy is a peripheral mononeuropathy commonly affecting proportionately more male draught, Warmblood and Thoroughbred horses [15–19]. It results in a failure of abduction of the left arytenoid. Tall horses are believed to be particularly predisposed because of the extremely long length of the recurrent laryngeal nerve in these horses [20]. Thus, the high incidence of recurrent laryngeal neuropathy in males and tall breeds is speculated to be due to the longer length of the peripheral nerves in taller males and the associated additional metabolic demands for maintaining longer axonal transport mechanisms. Others have suggested, however, that a genetic basis exists for recurrent laryngeal neuropathy [21]. The similar signalment of both recurrent laryngeal neuropathy and shivering cases could indicate that they share a similar pathophysiology, i.e. long nerve axonopathy within the nervous system. While a peripheral neuropathy affecting long peripheral nerves is also possible for shivering cases, muscle biopsy findings and limited neuropathological studies of shivering cases have not identified neurogenic myofibre atrophy [11] or a peripheral neuropathy to support such a hypothesis [7,8].

Owners of shivering horses tried numerous treatment regimens in an attempt to improve signs of shivering, but the small numbers of horses receiving a variety of treatments precluded statistical evaluation. Supplementation with vitamin E was more common in the confirmed shivering than the control group, most probably because veterinarians prescribe vitamin E for its neuroprotective effects [22] rather than that vitamin E in itself is associated with the development of shivering signs. In spite of the best therapeutic attempts that owners could provide, overall, 43% of suspected shivering and 74% of confirmed shivering cases progressively worsened over time in the owners' possession. Bias might exist in the confirmed shivering group, with more severe shivering cases motivating their owners to seek veterinary advice and submit a video for analysis. Of note were the 17% (16 of 94) of shivering horses that showed signs of facial twitching while walking backwards. Such signs potentially indicate a more diffuse involvement of neuromuscular muscle pathways than only those affecting the hindlimbs.

Owners did comment that factors such as reduced turnout, excessive or limited exercise, abuse and illness temporarily precipitated more severe shivering signs in susceptible horses, which were followed eventually by stabilisation after removal of the precipitating factor. The finding that 11% of confirmed shivering horses showed clinical improvement was largely accounted for in owner comments as an improvement following abeyance of such factors. No owner reported a permanent improvement in signs over time, nor did anyone indicate that signs of shivering ever disappeared. The finding that precipitating events cause a temporary worsening of shivering signs is consistent with the authors' personal observation of 6 of the horses in the present study that were donated to the University of Minnesota Equine Centre. Upon arrival after >4 h of transport, these horses showed severe signs of shivering that improved within several days but did not disappear.

Given that shivering is seen relatively infrequently in practice, the equine network, via a Web-based survey, was used to ascertain as many potential cases as possible, and we requested that owners provide videos of their horse. We anticipated including a robust number of horses in the present study based on the initial receipt of >300 responses to questionnaires. Repeated attempts were made to encourage respondents to submit a video of their horse; however, only 70 videos were received. After careful review of videos, 27 horses were confirmed to have shivering based on clinical signs, yet a careful review of questionnaires revealed a much larger number of horses, 67, that appeared to have shivering based on described clinical signs. A comparison of confirmed and suspected shivering cases did not identify major differences in signalment, additional clinical signs (with the exception of exercise intolerance) or management and, thus, these 2 groups are likely to represent a comprehensive group of cases from which to characterise the disease. Thus, the diagnosis of shivering (by horse-owners) was likely to be accurate, given that the clinical signs of shivering are unique and can be differentiated largely from the closest diagnostic rule out stringhalt based on normal forward walking. The control group of horses was selected from the same widespread geographical area where confirmed shivering horses were managed and kept in similar basal conditions. The case–control study design has been used successfully in other equine studies of myopathies [6,11,23]. There are some major limitations and inherent biases with the type of control selection employed in this study, and caution is warranted in data interpretation. In retrospect, the power of the study could have been improved by including not only confirmed shivering case–controls but also suspected shivering case–controls. We did not anticipate, however, that so few owners would be able to submit videos for evaluation.

In conclusion, shivering often appears to be a gradually progressive chronic movement disorder that has a predilection for male horses of Warmblood, Thoroughbred and draught breeds that are on average 17 hands tall and over. The results of this study suggest that over time, shivering is progressive in over half of confirmed cases, and the treatments reported here do not appear to be effective. It remains a remarkable condition in that backward walking can be severely impaired, yet forward gaits are normal. This study has highlighted that shivering is a chronic, often gradually progressive movement disorder that usually begins by 7 years of age and has a greater prevalence in tall male horses.

Authors' declaration of interests

No competing interests have been declared.

Ethical animal research

The study was approved by the University of Minnesota Institutional Animal Care and Use Committee. Informed owner consent was obtained for each questionnaire submission.

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Authorship

A.C.E. Draper, S.J. Valberg, J.B. Bender and A.M. Firshman contributed equally to the study design, data analysis and interpretation. A.C.E. Draper, S.J. Valberg, J.B. Bender, A.M. Firshman, J.D. Baird, S. Reed and I.G. Mayhew contributed to the preparation of the manuscript and approval of the final manuscript.

Manufacturer's address

[a]http://www.r-project.org

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Supplementary Item 1: Shivers research survey.
Supplementary Item 2: Shivers control survey.
Supplementary Item 3: Summary of dietary data of the suspected and confirmed shivering groups and the control group.