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**Title:** Impact of nocturnal calf cramping on quality of sleep and health-related quality of life

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## **Abstract**

**Purpose:** To evaluate the impact of nocturnal calf cramping (a condition that affects one in two people over 60 years of age) on quality of sleep and health-related quality of life.

**Methods:** 80 adults who experienced nocturnal calf cramp at least once per week and 80 age- and sex-matched controls who never experienced nocturnal cramp were recruited from the Greater Newcastle and Central Coast regions of New South Wales, Australia. All participants completed the SF-36v2 and the Medical Outcomes Study Sleep Survey (MOS-SS).

**Results:** People who experienced nocturnal muscle cramps reported more sleep disturbance ( $p < 0.001$ ), less adequate sleep ( $p = 0.001$ ), less quantity of sleep ( $p = 0.02$ ) and more snoring ( $p = 0.03$ ). Both sleep problem summary indices for the MOS-SS identified people who experienced nocturnal muscle cramp as having more sleep problems than the controls. People who experienced nocturnal muscle cramps had lower health-related quality of life for the SF-36 domains role physical ( $p = 0.007$ ), bodily pain ( $p = 0.003$ ) and general health ( $p = 0.02$ ). SF-36 domains that primarily relate to mental health were not significantly different between groups. The impact of nocturnal calf cramps on health-related quality of life was largely explained by their negative impact on quality of sleep.

**Conclusions:** Nocturnal calf muscle cramps are associated with substantially reduced quality of sleep and reduced physical aspects of health-related quality of life.

**Key words:** cramp; sleep quality; quality of life; sleep disturbance; gastrocnemius; aging

## Introduction

About half of people over 60 years of age experience nocturnal calf muscle cramps (1). Cramps can wake people from sleep and cause calf pain in the days following cramp (2). In one case study published in 1943, Gootnick reported on three patients whose sleep were so troubled by nocturnal cramps that they had been unable to sleep for months except in an armchair (3). Despite such anecdotal evidence, the impact of nocturnal muscle cramping on quality of sleep has not been measured using a validated and reliable tool.

Little research has been conducted to determine the impact of nocturnal calf muscle cramp on health-related quality of life (HrQoL). Results of studies suggest that other types of muscle cramp can have a profound impact on quality of life. Redmond and colleagues (2008) conducted a postal survey of 295 Australian adults with the inherited neurological disease Charcot-Marie-Tooth disease (CMT) and revealed that more frequent muscle cramps were associated with lower scores ( $p < 0.05$ ) for the SF-36 HrQoL domains of physical function, role physical, bodily pain, general health and vitality (4). In a separate cross-sectional study of 70 Australian children aged 5-16 years with CMT, leg cramps were the strongest identified independent correlate of reduced quality of life (5). Despite the high prevalence of nocturnal muscle cramps in people without neurological disease (6, 7), there has been no investigation of the impact of nocturnal muscle cramps on health-related quality of life. Knowledge of the impact of nocturnal muscle cramps is required to determine the most important treatment outcomes for patients and appropriately target resources for future research. The aim of this study was to explore the impact of nocturnal calf cramp on quality of sleep and on health-related quality of life in adults.

## Method

Eighty adults who experienced nocturnal calf cramp at least once per week in the preceding three months and eighty age- ( $\pm 3$  years)(8) and sex-matched adults who never experience muscle cramping volunteered to participate. All participants were proficient in English, ambulant and recruited from the Greater Newcastle and Central Coast regions, NSW, Australia. Muscle cramp was defined as '*a sudden, involuntary and painful contraction of muscle that gradually lessens. During cramp, the affected muscle hardens and joints can be forced into unusual positions. In some people, cramp can be brought on by certain movements and/or stopped by stretching the muscle*'. This definition was based on the literature (1, 7, 9) and from clinical experience of patients describing their cramping experience. In this study, muscle cramp was required to occur at night while at rest and not preceded by physical exercise. Exclusion criteria were: dementia; lower limb injury that prevented participation in activities of daily living; and known causes of cramps (e.g. neuromuscular or neurological disease, pregnancy and haemodialysis).

Participants were recruited from August 2010 to October 2011 through promotion on regional television news and radio; in four regional newspapers; at local general medicine, podiatry and University clinics; and by contacting local community groups (for example, Rotary and Lions clubs). Cases and controls were recruited from the same sources using the same promotion strategies. In addition, and to reduce the effect of potential confounders, cases were asked to show recruitment material to friends and family members who could participate as controls. Sample size was determined by the requirements of a broader study investigating physical and lifestyle factors associated with nocturnal calf muscle cramp. All participants consented to participate in accordance with approval of the University of Newcastle Human Research Ethics Committee (H-2010-1041).

All participants attended either The University of Newcastle Central Coast Campus, a University of Newcastle teaching clinic at Kanwal Medical Centre or Wyong hospital, Waratah Medical Centre (Morisset) or Cardiff Podiatry Clinic. Sleep quality was measured using the Medical Outcomes Study Sleep Survey (MOS-SS). MOS-SS has been used recently to measure sleep quality across a wide range of conditions (10-12) and is psychometrically validated for use in the general population (13) and in people with neuromuscular disturbances that manifest at night (14). MOS-SS is highly feasible (15) and includes a 'sleep disturbance' domain, which was anticipated to be of value to the present study. Participants were permitted to discuss the survey question regarding snoring habits with a family member. All MOS-SS domains are scored 0-100. For all domains except 'sleep adequacy', higher scores denote lesser quality sleep. Higher scores for 'sleep adequacy' denote more adequate sleep. Health-related quality of life was measured with the SF-36 v.2, a widely used, reliable and valid measure (16). All SF-36 domains are scored 0-100, where higher scores denote better quality of life.

*Statistical analyses* SF-36 data were entered twice into Quality Metric Health Outcomes™ Scoring Software 3.0®. Computed domain scores were transferred to SPSS v. 19.0 (Chicago, Illinois) for statistical analyses and checked for transcription error. To ensure accuracy, MOS-SS domain scores were calculated twice following scoring rules (17). Descriptive statistics were calculated to characterise the sample. Normality of distribution was determined using Kolmogorov Smirnov statistic and inspection of data distribution on histograms. Independent sample, two sided t tests were used to analyse normally distributed continuous data. Mann-Whitney U tests were used to analyse non-normally distributed continuous data. Amongst people who experienced nocturnal calf muscle cramps, the

relationships between health-related quality of life and quality of sleep with age and BMI were explored with Pearson's product-moment correlation coefficient ( $r$ ) for normally distributed data, and Spearman's rho ( $r_s$ ) for non-normally distributed data. Partial correlation was used to explore the relationship between health-related quality of life and quality of sleep while controlling for presence or absence of nocturnal calf cramps, and between nocturnal calf cramps and health-related quality of life while controlling for quality of sleep. The SF-36 and MOS-SS domains most strongly associated with each other were selected for analysis and transformed to normal distribution to allow assessment of partial correlation in SPSS. For all analyses, missing data were addressed by excluding cases pairwise and significance level was 0.05, two tailed.

## **Results**

### *Participant characteristics*

One hundred sixty four potential participants (83 potential cases, 81 potential controls) were sent an information sheet, consent form and surveys. Participants were directed to complete the surveys at home. One hundred sixty (80 cases, 80 controls) completed the surveys and attended a clinic appointment for measurement of physical characteristics. Of the four people who did not participate, one "decided against it", one could not find the time, one wanted payment and one did not respond to follow up phone calls and emails.

Age range of all participants was 34 to 95 years. Participant characteristics are presented in Table 1. There was no statistically significant difference ( $p \geq 0.05$ ) between cases and controls in self-reported alcohol consumption, exercise participation, number of different medications taken per day, or prevalence of smoking, diabetes, depression, anxiety disorders, alcohol or



other drug use disorders, knee or hip osteoarthritis, rheumatoid arthritis, kidney problems, lower back pain or sciatica. Full details of the association of nocturnal calf cramp with physical, health and lifestyle factors are published elsewhere (18).

### *Quality of sleep*

Between groups differences in summary scores for MOS-SS are presented in Tables 2 and 3. People who experienced nocturnal muscle cramping reported more sleep disturbance, more snoring, less adequate sleep and more daytime somnolence. Both sleep problem summary indices available for MOS-SS identified people who experienced nocturnal muscle cramp as having more sleep problems than that of age and sex matched controls. There was no significant difference between groups in reports of awaking short-of-breath or with a headache.

### *Health-related quality of life*

Between groups differences in scores on SF-36 are presented in Table 4. People who experienced nocturnal muscle cramping had lower health-related quality of life for the domains role physical, bodily pain and general health (Figure 1). Between groups differences in scores for other SF-36 domains were not statistically significant.

### *Relationship between quality of sleep and health-related quality of life*

MOS-SS Sleep Problems Index II and the SF-36 General Health domain were selected for use in partial correlation analyses. Sleep problems index II data were transformed to normal distribution using the square root technique (19). SF-36 General Health domain data were transformed to normal distribution using the reflect and square root technique (19). There was

a positive correlation between quality of sleep and health-related quality of life ( $r=0.452$ ,  $n=151$ ,  $p < 0.001$ ), which remained when controlling for nocturnal calf cramp ( $r=0.423$ ,  $n=151$ ,  $p < 0.001$ ). The small, positive correlation between presence of nocturnal calf cramps and health-related quality of life (using the SF-36 General Health domain) ( $r=0.176$ ,  $n=154$ ,  $p = 0.028$ ), was accounted for by controlling for quality of sleep (using the MOS-SS Sleep Problems Index II) ( $r=0.005$ ,  $n=150$ ,  $p = 0.948$ ).

#### *Other contributors to reduced quality of sleep and health-related quality of life*

In addition to the influence of nocturnal calf muscle cramping, some physical characteristics further contributed to reduced quality of sleep and health-related quality of life among people who experienced nocturnal cramp. Increasing BMI among cramping cases was associated with increasing sleep problems for summary index I ( $r_s=0.25$ ;  $p=0.02$ ) and summary index two II ( $r = 0.25$ ;  $p=0.36$ ), and with decreasing sleep adequacy ( $r_s=-0.25$ ;  $p=0.03$ ) and health-related quality of life for the domain bodily pain ( $r_s = -0.24$ ;  $p=0.03$ ). Males reported more snoring (Md: 40 vs. 20;  $p=0.02$ ) but did not differ significantly from females in any other domain of MOS-SS or SF-36. Increasing age among cramping cases was not associated with quality of sleep ( $p \geq 0.05$ ) but was associated with decreasing health-related quality of life for the domains physical function ( $r_s = -0.36$ ;  $p=0.001$ ), role physical ( $r_s=-0.43$ ;  $p < 0.001$ ) and social function ( $r_s=-0.23$ ;  $p=0.04$ ).

## **Discussion**

People who experienced nocturnal calf muscle cramps reported more disturbances of sleep, less adequate sleep, more daytime somnolence and more snoring than age- and sex-matched controls. There was no difference in BMI between cramping cases and controls. People who

experienced nocturnal calf muscle cramping also had lower health-related quality of life for the domains role physical, bodily pain and general health. That is, compared to controls, people who experienced nocturnal muscle cramps: had more problems with work or other daily activities as a result of physical health; had more severe pain and associated limitations; and rated their personal health more poorly and as more likely to get worse. There was no significant difference between cases and controls for the SF-36 domain physical function (a measure of limitation in performing all physical activities, including bathing or dressing) or for any of the domains that primarily relate to mental health: vitality, social function, role emotional and mental health. Of interest, the difference between cramp cases and control for the vitality domain did approach statistical significance (Md 63 vs. 69,  $p=0.06$ ). The vitality domain measures how often participants feel tired or worn out. In Redmond and colleagues' study of 295 Australian adults with CMT, vitality was the only SF-36 domain primarily related to mental health that was independently associated with leg cramps. This could be accounted for by an increased frequency of nocturnal and daytime cramps in adults with CMT. Due to the clinical importance quality of sleep and health-related quality of life, future trials of interventions for nocturnal muscle cramping should include measures of quality of sleep and health-related quality of life.

There was a positive correlation between quality of sleep and quality of life, which was maintained when controlling for the presence or absence of nocturnal calf cramp. The small, positive correlation between presence of nocturnal calf cramps and health-related quality of life was explained by quality of sleep. Therefore, while nocturnal calf cramps are associated with lesser health-related quality and lesser quality of life, the impact on health-related quality of life is largely through reduced quality of sleep.

Previous prospective research has shown that reduced quality of sleep in older adults can predict future depression (20), depression recurrence (21) and increased risk of dying beyond that associated with age, gender or known medical burden (22). In a small cross sectional survey of 51 'cognitively intact' nursing home residents, Gentili and colleagues (1997) found that sleep disturbances (including leg cramp, nocturia, noise and/or light and pain) were, as a group, independently associated with depressive symptoms (23). A larger, longitudinal study of 524 community-dwelling adults aged over 65 years in inner London reported that, over a period of 2 to 3 years, sleep disturbance was the strongest identified predictor of future depression (20). Our study found no significant difference in SF-36 domains that relate primarily to mental health. A longitudinal study design is required to determine long-term effects of reduced quality of sleep amongst people with nocturnal muscle cramps.

The findings of this study should be viewed in light of its limitations. As this study is cross-sectional, the findings do not demonstrate any cause-effect relationships between nocturnal calf cramp, quality of sleep and health-related quality of life. For example, while it is plausible that nocturnal cramp could reduce quality of sleep, it is also plausible that reduced quality of sleep could increase risk of nocturnal cramp. In addition, the quality of sleep and health-related quality of life surveys used in this study, while validated and reliable, are limited by participant recall. Laboratory-based sleep studies of nocturnal muscle cramps would help to reveal the nature of sleep disturbance associated with cramps, and would clarify those outcomes that are difficult to self-monitor, e.g. snoring. Finally, no data were collected on use of sleep medications that could mask sleep disturbance associated with cramping. Despite this limitation, nocturnal calf cramps were associated with markedly reduced quality of sleep.

In conclusion, nocturnal calf cramps are a common problem for which the cause is not well understood and no treatment has demonstrated consistent effectiveness and safety. This study demonstrates that nocturnal calf cramps are far more than a trivial nuisance and are associated with substantially reduced quality of sleep and reduced physical aspects of health-related quality of life. The impact of nocturnal calf cramps on health-related quality of life may largely be explained by their negative impact on quality of sleep. Future research should develop and evaluate safe and effective therapy for this important clinical problem.

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## **Tables**

Table 1. Participant characteristics

Table 2. Quality of sleep measured with MOS-SS for cramp cases and controls (non-parametric continuous data)

Table 3. Quality of sleep measured with MOS-SS for cramp cases and controls (parametric continuous data)

Table 4. Health-related quality of life measured with SF-36 for cramp cases and controls

## **Figures**

Figure 1. Health-related quality of life measured with SF-36 for cramp cases and controls

Table 1. Participant characteristics

Characteristic	Cramp participants	Control participants
Sex		
Female, <a href="#">number (%)</a>	47 (59%)	47 (59%)
Male, <a href="#">number (%)</a>	33 (41%)	33 (41%)
Age, mean years (SD)	71 (10)	71 (10)
Height, mean cm (SD)	167 (9)	166 (11)
Mass, mean kg (SD)	79 (16)	78 (18)
Body mass index, mean kg/m <sup>2</sup> (SD)	28 (5)	28 (5)
Socioeconomic index score, mean (SD)	970 (32)	982(42)

\*Calculated using The Australian Bureau of Statistics Socio-Economic

Indexes for Areas (SEIFA), Postal Areas (27).

Table 2. Quality of sleep measured with MOS-SS for cramp cases and controls (non-parametric continuous data)

Domain	N	Median (25 <sup>th</sup> 75 <sup>th</sup> centile)	N	Median (25 <sup>th</sup> 75 <sup>th</sup> centile)	Median difference	<i>p</i>
	cases	cases	controls	controls		
Sleep disturbance	80	36 (16-58)	78	16 (5-30)	20	<0.001*
Snoring	80	20 (0-60)	78	20 (0-40)	0	0.03*
Short of breath or headache	80	0 (0-15)	78	0 (0-0)	0	0.27
Sleep adequacy	79	50 (40-80)	78	70 (50-80)	-20	0.001*
Day-time somnolence	80	27 (13-40)	78	20 (7-27)	7	0.006*
Sleep problems index I	79	33 (20-50)	78	20 (10-30)	13	<0.001*

For all domains but ‘sleep adequacy’, higher scores denote lesser quality sleep. Higher scores for

‘sleep adequacy’ denote more adequate sleep. \*statistically significant difference between groups

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Table 3. Quality of sleep measured with MOS-SS for cramp cases and controls (parametric continuous data)

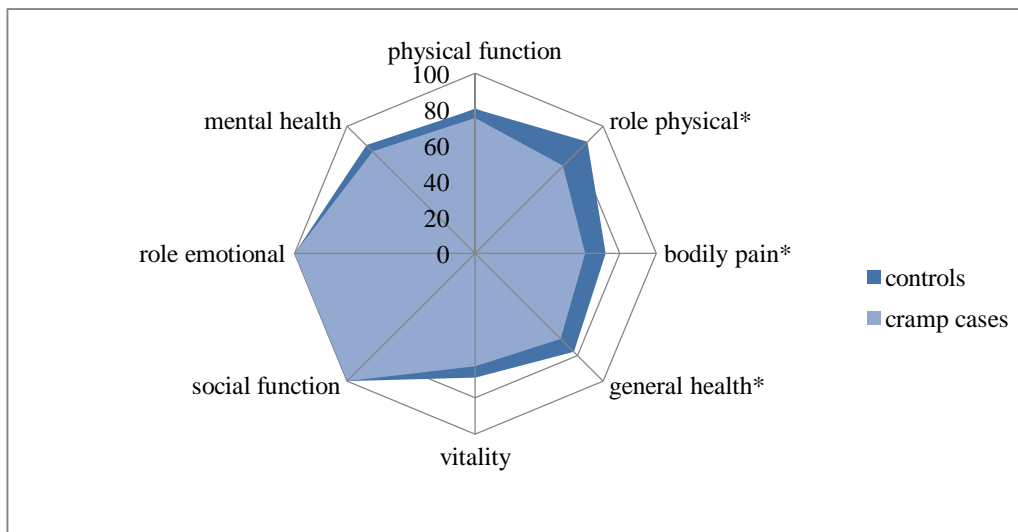
Domain	N	Mean (SD)	N controls	Mean (SD)	Mean dif.	t	df	p
	cases	cases		controls	(95% CI)			
Sleep problems Index II	79	35 (18)	78	22 (14)	-13.5 (-18 to -9)	-5.35	146	<0.001*

Higher scores denote lesser quality sleep. \*statistically significant difference between groups.

Table 4. Health-related quality of life measured with SF-36 for cramp cases and controls

<b>Domain</b>	<b>N</b>	<b>Median (25<sup>th</sup> 75<sup>th</sup> centile)</b>	<b>N</b>	<b>Median (25<sup>th</sup> 75<sup>th</sup> centile) score</b>	<b>Median difference</b>	<b><i>p</i></b>
	<b>cases</b>	<b>score cases</b>	<b>controls</b>	<b>controls</b>		
Physical function	79	75 (50-90)	79	80 (65-95)	-5	0.79
Role physical	77	69 (50-97)	80	88 (75-100)	-19	0.007*
Bodily pain	80	61 (41-74)	80	72 (54-74)	-11	0.003*
General health	76	67 (52-82)	80	77 (66-87)	-10	0.02*
Vitality	78	63 (44-75)	79	69 (56-75)	-6	0.06
Social function	79	100 (75-100)	80	100 (75-100)	0	0.61
Role emotional	79	100 (75-100)	80	100 (83-100)	0	0.33
Mental health	78	80 (70-90)	80	85 (75-90)	-5	0.72

\*statistically significant difference between group



**Figure 1.** Health-related quality of life measured with SF-36 for cramp cases and controls. Higher scores denote better health-related quality of life. \*denotes statistically significant difference