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# Increased admissions for musculoskeletal diseases after burns sustained during childhood and adolescence

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ABSTRACT

*Background:* Severe burn triggers systemic responses that result in reduced muscle mass and bone formation, with recent evidence also suggesting systemic effects on bone after minor burn. The aim of this study was to assess if children and adolescents who are hospitalised with a burn have increased long-term hospital service use for musculoskeletal conditions.
*Methods:* A population-based longitudinal study using linked hospital morbidity and death data from Western Australia was undertaken of those younger than 20 years when hospitalized for a first burn ($n = 13{,}244$) during the period 1980–2012 and a frequency matched non-injury comparison cohort, randomly selected from Western Australia's birth registrations and electoral roll ($n = 51{,}021$). Crude admission rates and cumulative length of stay for musculoskeletal diseases were calculated. Negative binomial and Cox proportional hazards regression modelling were used to generate incidence rate ratios (IRR) and hazard ratios (HR), respectively.
*Results:* After adjusting for demographic characteristics and pre-existing health status, those who were hospitalised for a burn had 1.87 times as many hospital admissions for a musculoskeletal disease (95%CI: 1.69–2.08) and spent 2.61 times as long in hospital with musculoskeletal disease (95%CI: 2.09–3.27), than the uninjured comparison cohort. The burn cohort had significantly higher rates of first time admissions over the study period for arthropathies (HR, 95%CI: 1.14, 1.00–1.29, $p = 0.047$), dorsopathies (HR, 95%CL: 1.64, 1.29–2.08) and for soft tissue disorders (HR, 95%CI: 1.33, 1.11–1.60); results were not statistically significant for incident admissions for osteopathies and chrondropathies (HR, 95%CI: 1.07, 0.71–1.59) or connective tissue disorders (HR, 95%CI: 0.54, 0.24–2.09).
*Conclusions:* These results identified elevated post-discharge hospital service use for diseases of the musculoskeletal system for a prolonged period after discharge for those with both severe and minor burns.



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## 1. Introduction

Burns, like other types of trauma, trigger systemic responses that include but are not limited to, chronic inflammation, hypermetabolism and elevated levels of catecholamines and cortisol, leading to the dysfunction of numerous organ and physiologic systems [1–3]. However, what makes a burn different is the additional deep wound to the skin, and the subsequent requirement for amino acids to facilitate wound healing [4]. In the acute phase after the burn, it appears that skeletal muscle acts as the body's depot of amino acids, redistributing protein from the muscle to provide substrates for other functions that include the synthesis of acute phase proteins and the deposition of new skin [4,5]. The resultant loss of weight and muscle mass is associated with poor outcomes in terms of metabolic health and functional capacity, with effects reported in children with severe burns at three years after the initial burn [1,6,7].

Following burn, in addition to the hypermetabolic response, significant and sustained suppression of bone formation occurs as a result of the systemic inflammatory and endocrine responses to the injury [2,8,9]. Muscle wasting and immobilisation after burn can also directly alter the balance of bone synthesis and degradation [2,8,10,11]. Vitamin D deficiency after burn may develop progressively as a result of a number of factors including prolonged sun avoidance during treatments [12], hypoparathyroidism [13,14] and low serum levels of cholesterol evident pots-burn [15,16], preventing the synthesis and activation of Vitamin D, also contributing to bone loss [17–20]. The loss of bone mass or a failure to gain bone mass during growth leads to reduced peak bone mass predisposing burn patients to an increased incidence of fractures and potentially, to lifelong issues associated with osteoporosis [8,11,19–22]. Clinical evidence suggests that severe burn can cause growth delays in children for up to three years [7], with decreased bone mineral density persisting for at least 5 years [11]. Recent evidence of decreased trabecular bone volume after minor burn in an animal model [23], demonstrated that systemic effects on bones are not limited to severe burns. While the clinical significance of these results is not clear, this finding is of particular interest as the majority of burn presentations in developed populations are for less severe injuries [24].

Children and adolescents represent vulnerable proportions of our communities who are at high risk of burn that places them at heightened risk of musculoskeletal disorders for years after the initial injury. To date an absence of prospective studies with long follow up has limited our understanding of the long-term health impacts of burn in children and adolescents. The aim of this study was to determine if individuals younger than 20 years of age when hospitalised for a burn have increased long-term musculoskeletal morbidity in terms of the number of burn admissions and length of hospital stay for musculoskeletal diseases [25], when compared with an age and gender frequency matched non-injured cohort.

## 2. Methods

This study forms part of a larger project, Western Australian Population-based Burn Injury Project (WAPBIP), a retrospective cohort investigation that uses linked health administrative data from the Western Australian Data Linkage System (WADLS). The WADLS is a validated linkage system that links several core datasets for the population of Western Australia [26]. The project was approved by the Human Research Ethics Committees of the University of Western Australia and the Western Australian Department of Health.

A de-identified extraction of hospital morbidity records for all individuals who were younger than 20 years when admitted to a hospital in Western Australia with a first burn between 1 January 1980 and 30 June 2012 were supplied to researchers by the WADLS. A first (index) burn was defined as the first hospital admission in a patient's medical record in which a burn was given as the principal diagnosis or an additional diagnosis International Classification of Diseases and Related Health (ICD) 9 CM 940–949 or ICD10 AM T20–T31. A population-based comparison cohort was randomly selected from Western Australia's birth registrations and electoral roll. Any person with an injury hospitalisation during the study period was excluded from this cohort by WADLS staff. The resultant comparison cohort was frequency matched (4:1) on birth year and gender of each burn case for each year from 1980 to 2012. Cohort selection and analytical methods have been reported previously [27,28].

Data from Western Australia's Hospital Morbidity Data System and Death Register were linked to the burn and non-injured cohorts for the period 1980–2012. Hospital admissions data included principal and additional diagnoses, age, gender, Aboriginal status, date of admission, date of discharge or other separation, mode of separation, percentage of total body surface area (TBSA%) burned and burn depth. Data supplied for the burn and non-injured cohorts included geocoded place of residence, indices of geographical remoteness [29] and of social disadvantage [30]. Geographical remoteness was classified into five categories: major cities, inner regional, outer regional, remote and very remote. The social disadvantage index was reclassified into quintiles. The mortality data included date of death and cause of death.

An individual listed as Aboriginal or Torres Strait Islander on any admission record was categorised as Aboriginal. Supplementary codes ICD9-CM 948 or ICD10-AM T31 were used to classify the patients into those with minor burns (less than 20% of TBSA), severe burns ($\geq$20% TBSA) and burns of unspecified TBSA. Comorbidity was assessed using the Charlson comorbidity index (CCI) [31] using the principal and additional diagnoses included in the hospital morbidity records (CCI = 0; CCI $\geq$ 1) with a five-year look-back period [32]. Record of congenital anomaly (yes/no) was identified using principal and additional diagnosis ICD codes 740–759 (ICD9-CM) and Q00-G99 (ICD10-AM). The final discharge date for the index burn admission was used as the study start for follow-up for the burn cases and the respective frequency matched non-injury controls.

Categorical and non-parametric continuous variables were compared using $\chi^2$ and Kruskal Wallis tests respectively. A $p$-value of 0.05 or lower was considered statistically significant. The total number of admissions for musculoskeletal disorders after burn discharge and the cumulative length of stay for principal diagnosis musculoskeletal disorders combined (M00-M99) and classified by sub-chapter headings