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Survey of hot water temperatures in campgrounds: elevated scalding risk and energy wastage

The epidemiology of scalding injuries in New Zealanders (particularly children) and the need for prevention has been detailed by health professionals for over three decades. There have been articles published in the 1970s,[1] the 1980s,[2–5] the 1990s[6,7] and in the current century.[8–10]

A recent study identified a total of 1015 hospital admissions for 862 tap water burn events in New Zealand from 2000 to 2009.[11] Combined with these persisting health concerns are the growing need to use electricity more efficiently to reduce running costs and to lower the greenhouse gas emissions which contribute to climate change.

At present the *New Zealand Building Code 1992* specifies that stored hot water in residential dwellings should be held at temperatures greater than 60ºC (irrespective of whether a mixing device is installed) so as to kill the micro-organism, *Legionella*. The Code also specifies that this hot water should be delivered at not more than 55ºC (or 45ºC for retirement homes and early childhood education centres), so as to reduce the risk of scalding.

Given this background we aimed to expand the study of New Zealand hot water temperatures from the previous studies in domestic settings, to an unstudied public setting: i.e., public campgrounds. In particular, we aimed to: (i) assess the extent of hazardous water temperatures (i.e., scalding risk) in sanitary fixtures used for personal hygiene in a sample of New Zealand campgrounds; and (ii) to assess the potential for further energy savings in these settings.

Methods—Convenience sampling was performed involving 25 New Zealand campgrounds that three of the authors holidayed in over a 4-year period (i.e. while participating in cycle touring holidays). The public campgrounds were located in both main islands and in the following regions: Southland/Otago/Canterbury (n=8, February 2008), Otago (n=5, December 2008), Northland (n=4, December 2009), Waikato (n=4, December 2010), and Otago/Southland (n=4, December 2011). Sampling was mainly performed by one author (NW) but also by another (JJ).

We measured the temperature of hot water: (i) that was running into a basin in the men's toilet block (maximum temperature reached within 5 minutes); and (ii) in the men's shower with just the hot tap flowing (recording maximum temperature). We aimed to measure the temperature as close to 1600h on day of arrival at the campground and as close as possible to 0700h on the following day of departure. A thermometer with range of up to 150 degrees Celsius (°C) and accurate to within 0.1°C was used (a LCD digital pen type stem thermometer [ST-9282], Winning Technology Ltd, China). This thermometer showed no indication of any performance problems (based on regular comparisons with an identical thermometer). Other data collected included: if wood (wet-back) water heating was used; and if the taps were labelled hot/cold (words or colour-coding).

Results and Discussion—The key findings from this study were the relatively high mean and median temperatures for both taps and showers, with 74% of these temperatures exceeding 55°C, the maximum level specified in the Building Code (Table 1). The American Academy of Pediatrics recommend a maximum level of 120°F, equivalent to 48.9°C,[12] which was exceeded by 90% of samples. This lower level (49°C maximum) is also set in certain legislation (e.g. Washington State, USA) and various codes (the Ontario Building Code, and the International Plumbing Code).

Although mean hot tap temperatures were slightly higher than shower temperatures (hot setting), the differences were not statistically significant. Similarly, there were no statistically significant differences between morning and evening temperatures for all devices (62.3 vs 62.4°C respectively) and when analysed by device.

The campgrounds that used wood-fuelled heating systems (n=3), tended to have hotter water temperatures (means for all devices = 65.1 vs 61.8°C, but with this difference was not statistically significant). Two of the campgrounds using wood fuel had warning signs in the toilet/shower block regarding the potentially high water temperatures.

Of note is that reducing hot water storage temperatures is one of cheapest and most cost-effective energy saving opportunities for hot water systems. Standing losses (the heat loss to maintain storage temperatures) in many hot water systems amounts to 30–40% of total hot water energy consumption. Each 1°C reduction in hot water storage temperature reduces standing losses by approximately 3%.

For the basin taps, colour-coding (e.g. red for hot, blue for cold) or word labels were present in 60.7%, partially present (e.g., just one of two taps coloured or labelled) in 32.1% and completely absent for 7.1%. For showers, the equivalent figures were: 60.7%, 3.6% and 35.7% respectively.

These results have various limitations, particularly the non-random sampling of campgrounds, the modest number of campgrounds sampled (n=25), and the limited number of samples per campground. Furthermore, sampling was generally in early December and so was outside the peak season for campground use. When campground use is high, average hot water temperatures will probably be lowered as water may be not fully heated to the set temperature. Nevertheless, it is plausible that some campground operators may respond by setting temperatures even higher at peak use times. Vulnerable people, such as children, may use these facilities more often outside the times of peak use, and therefore be exposed to greater scalding risk.

Ideally further studies would clarify the hot water situation in New Zealand campgrounds, and better identify the societal optimum for hot water temperature levels in a range of domestic and public settings. That is, such work should ideally determine the optimal trade-off between striving for lower water temperatures (to prevent scalds, save costs and lower greenhouse gas emissions), with the potential benefits of higher temperatures (possibly extra convenience and possibly legionellosis prevention[13]).

Of note is the uncertain role of hot water systems in buildings causing legionellosis in New Zealand,[14] and the absence of analytical evidence for any such relationship in the international literature.[11] Therefore, we suspect that the current 55°C level in the

Building Code is probably too high from health, economic and societal perspectives. This point has also been articulated by others in the New Zealand setting.[11,15]

Furthermore, there are two regulatory approaches which could be used to ensure that campgrounds reduce the scalding risk (at least to below the current level in the Building Code):

- Safe water temperature and proper tap labelling could become part of the Compliance Schedule and annual Warrant-of-Fitness which are required by Territorial Local Authorities under the *Building Act 2004* (a change that would probably occur without any new legislation).
- Safe water temperature and proper tap labelling could be built into a revision the *Camping-Grounds Regulations 1985*.[16]

In summary, the excessive temperatures identified in this study probably warrant further action by government agencies on the grounds of reducing the risk of scalding. Reducing hot water storage temperatures will also contribute to more efficient use of energy and save fuel costs for campground operators.

Table 1. Sanitary fixture (basin hot tap and shower) temperatures in 25 New Zealand campgrounds (summer months, 2008 to 2011)*

Device sampled and period of the day	No. of samples	Sampling time of day – median (range)	Maximum temperature (°C)			Percentage of samples >55°C**	Percentage of samples >48.9°C**
			Mean	Median	Range		
Hot tap							
– morning	20	0714h (0616–0850)	64.8	65.4	46.2–86.4	85.0%	95.0%
– evening	21	1700h (1530–2043)	63.4	64.8	45.1–80.1	71.4%	90.5%
– both times	41	–	64.1	65.0	45.1–86.4	78.0%	92.7%
Shower (on hot)							
– morning	19	0705h (0610–0810)	59.7	62.1	43.3–69.5	68.4%	84.2%
– evening	22	1652h (1438–2047)	61.5	62.3	47.1–74.1	72.7%	90.9%
– both times	41	–	60.6	62.1	43.3–74.1	70.7%	87.8%
All taps/showers	82	–	62.4	64.2	43.3–86.4	74.4%	90.2%

* Two campgrounds did not have hot taps in the toilet/shower block facilities. In one campground the basin/shower at a lodge were also sampled in addition to the communal facilities block. In one other site a stay of two nights allowed for repeat evening samples. See Methods section above for other details.

** The 55°C level is the maximum at the tap as in the current NZ Building Code (1992). The 48.9°C level is that recommended by the American Academy of Pediatrics (equivalent to 120°F).

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