New Zealand coronial data analysis of avalanche fatalities 200-2015

What was done?
I accessed the publicly available records 2007-2015 of closed coronial cases. I was kindly supplied with the records 1979-2003 but these were incomplete because unfortunately the cause/circumstances column wasn’t available from 1991-1999. Thus I decided to just concentrate on the period 200-2105.
I was also given access to Mountain Safety council Info Ex data, where snow industry and private individuals report avalanche involvement. This is totally voluntary and there is a significant under-reporting.
I was also assisted by Dr Brandon de Graaf at University of Otago Injuries prevention Unit who searched District Health Board databases on number of patients admitted to hospital following avalanche involvement, either survivors or fatalities.
For some parameters, i.e. not cause of death, but activity and overall numbers of fatalities I have used the period 2000-2018 by using publically available information from the local media.

Why was this done?
There are different avalanche survival curves for different locations, i.e. Canada has a worse survival curve due to more trauma and a wetter snowpack and longer rescuer response times than France and Switzerland where the terrain and activities cause less trauma, the snowpack is drier and there is generally speaking more rapid organized rescue response.
By analyzing causes of death and correlating that with activities undertaken by decedents at time of death I was hoping that there might be some useful information which could be used to guide rescue efforts and medical input.

What is already known on this subject?
The references include all the published work pertaining to New Zealand avalanche fatalities that I have been able to find.
The fatality rates for the period 1980-2003 were 2.18/ year.
The fatality rate 200-2013 was 1.2 / year
The cohort I have analysed 200-2018 the rate is 1.5/ year.
The small data set is very sensitive to annual fluctuations, however with the advent of increased recreational participation numbers, increased avalanche forecasting and increased uptake of avalanche training courses one has to decide that historical data going back to 1980 or 1990 is actually not of highest relevance.

What does this study add to the existing knowledge base?
Although incidences of avalanche fatalities in New Zealand have been studied previously, I am not aware of any work that has specifically looked at cause of death and activity of decedents. In view of the very small data set, I doubt any of my findings are statistically significant.
• The fatality rate is similar to that overseas 6% if we use the InfoEX data of avalanche involvements
• Alpine climbers are highly over represented amongst the decedents compared to skiers
• Trauma is the leading cause of death amongst climbers (61%) which is higher than amongst Canadian climbers
• Because of this asphyxia as the cause of death appears to be less than in some overseas cohorts
• Hypothermia as cause of death at 4% is higher that elsewhere reported rates but unlikely to be statistically relevant

Overall, my findings lead me to speculate:
• Alpine climbers may not have adequate avalanche avoidance knowledge
• Heli skiers might be able to avoid asphyxia if they were wearing and able to correctly deploy avalanche air bags. This device is not yet widely used amongst New Zealand heli skiers and back country skiers.
Results:

Annual avalanche fatalities in New Zealand 2000-2018:
Total 27
(average 1.5/year)
This figure 1.1 is sourced from “Avalanche awareness and decision making in backcountry terrain, Craigieburn Valley Ski Area, New Zealand”, Master of Science in Geography at the University of Otago, Dunedin, New Zealand Jeremy L. Bell, November, 2015 which can be accessed online.

https://ourarchive.otago.ac.nz/bitstream/handle/10523/6355/BellJeremyL2016MSc.pdf?sequence=1

reserves, which makes them easily accessible, promoting a high level of recreation and exploration of these areas. As a result Irwin and Owens (2004) indicate that there has been an increase in avalanche fatalities from 0.2 per annum (pa) in the 1930’s to 2.0 pa in the 1990’s. It is believed that this is both the result of an increase in user numbers of alpine terrain and the population increase of alpine towns. Between 1981 and 2003 there were 48 avalanche related fatalities in New Zealand. Sixty percent of these were from people involved in alpine climbing and 15% were from people completing training courses. Combined skiing related fatalities make up 16% of total fatalities over this period. These include ski area work (4%), ski touring (4%), heli-skiing (2%), skiing in area (2%), skiing out of bounds (2%) and snow sports operations (2%) (Irwin and Owens, 2004). Over the last two decades there has been a noticeable reduction of avalanche fatalities, which may be the result of an increase in avalanche education and control measures (Figure 1.1).

![Avalanche fatalities per decade in New Zealand 1860-present](image)

**Figure 1.1:** Avalanche fatalities per decade in New Zealand 1860-present. Data sourced from Irwin and MacQueen, (1999), Irwin and Owens, (2004), Logan, (2014) and supplemented with data from Mountain Safety Council publications.
This graphic is sourced from Mountain Safety Council, Crystal Ball 2013 which can be accessed online
https://issuu.com/nzavalanche/docs/crystal_ball_volume_22_winter_2013
Annual involvement (nonfatal, not necessarily totally buried) in avalanches in NZ: Average 22 /year

No data available for 2011
Cause of death of the 23 decedents 2000-2015 by activity at time of death

Asphyxia & Trauma combined 22%

Trauma 39%
- 8 climbers
- 1 snowboarder

Asphyxia 26 %
- 4 climbers
- 1 snowboarder
- 1 climber
- 2 trampers
- 3 heli-skiers

Hypothermia 4%
- 1 skier

Undetermined/unknown cause 9 %
- 2 unknown activity
New Zealand 2004-2017:
377 recorded avalanche persons involved by activity
Reported avalanche involvement 2000-2010
New Zealand (total 275 individuals)

- Partial burial: 10%
- Total burial: 2%
- Fatal outcome: 6%
- Not buried: 82%

- 3/6 total burials were shallow and self rescued
- Buried at 1.5 metres, time to face 12 minutes, time fully dug out 22 min, skied rest of day (!)
- Buried at 2 metres, time to face 10 minutes, breathing, rescue helicopter evacuation
- Buried at 2.5 metres, time to face 25 minutes, breathing, cyanosed & unconscious, flown out to medical centre with his heliski group

Only 9 injuries reported: fractures, knee injuries, concussions, cuts & grazes
(consider possible under reporting)
Activity at time of avalanche burial of the 27 decedents in NZ avalanches 2000-2018

- Climbing: 63%
- Skiing: 15%
- Snowboarding: 7%
- Tramping: 7%
- Unknown activity: 7%
Climbers:
make up 4.2% of avalanche involvements
but make up 63% of fatalities

Trampers
make up 0.5% of avalanche involvements
but make up 7% of fatalities

Snowboarders
make up 13% of avalanche involvements
but make up 7% of fatalities

Skiers
make up 40% of avalanche involvements
but make up 15% of fatalities

Please note:
Time period for fatalities is 2000-2018
Time period for activity when involved in nonfatal avalanche
is 2004-2017
Avalanche involvement has the potential to be a Multi Casualty Incident

In each of the years 2004-2017 there
7 groups of 4
4 groups of 5
2 groups of 6
2 groups of 7
involved in avalanches

(No serious injuries or deaths occurred, luckily)

Multiple burials searches:
reverse triage

Once they have been dug out:
ICAR checklist patient triage
Seasonality of NZ avalanche fatalities 2000-2018
All activities (n=25)

- Winter = June, July & August
- Spring = September, October & November
- Summer = December, January & February
- Autumn = March, April & May
That concludes my analysis of the NZ coronail data on avalanche fatalities.
The data obtained from the Injuries Prevention Unit of University of Otago was scant. I quote Dr Brandon de Graaf:

“I added keyword criteria for 'snow' or 'ice' in addition to the ICD10 code 'X36' criteria and found

- 6 non-fatal cases between 2000 and 2017,
- and 5 fatal cases between 2000 and 2015.
The numbers are too small to report any more detail on.”

As we have seen above, there were at least 11 hospital admissions between 2000-2010 so obviously the X36 code does not get applied consistently for avalanche casualties.

Not all fatally injured patients get admitted to hospital so the discrepancy there is totally understandable.

For higher quality research to be able to be carried out in the future, improved coding would be highly desirable.
References:

1 & 2) The two graphs inserted on pages 4 and 5 and the documents they were shared from

3) A history of avalanche accidents in Aotearoa, New Zealand by David Irwin and Ian Owens

can be accessed online here (this is my website)

https://drmwildernessemc.files.wordpress.com/2019/02/a_history_of_avalanche_accidents_in_aotearoa_new_z.pdf

4) A review of the New Zealand Avalanche Hazard Advisory and Information Service by Dr Hugh Logan, HFM Logan Consulting Ltd, 15 October 2014

can be accessed online here (this is my website)


5) Comparison of avalanche survival patterns in Canada and Switzerland by Haegli, Brugger & Falk, 2011


6) Pre hospital resuscitation of the buried avalanche victim by Brugger, Paal & Boyd

doi.1089/ham.2011.1025 (not open access)

This quotes cases of death in Canada, USA & Austrai in 2007 and 2009.
Chain of survival for Avalanche rescue:
Not all links are equal in hypothermic cardiac arrest

Companion rescue  Alpine rescue & Avalanche dogs  EMS/HEMS  Hospital

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for more details
Is it really worth the effort to teach & train & implement ICAR Avalanche patient resuscitation checklist in New Zealand?

- On average 1.5 avalanche fatalities a year
- Only a small % (currently 4%) of those may be hypothermia related (coronial data)
- Survival in avalanche induced accidental hypothermic cardiac arrest after ECLS rewarming is 10% (H. Brugger 2018)
- It could take approximately 150 years before one life is saved form avalanche induced hypothermia but everything about avalanches has a degree of unpredictability
- The overall rescue efforts will be evidence based and may save lives, just possibly not from hypothermic cardiac arrest

The other side of the coin is this:

- Non avalanche hypothermic cardiac arrest has a very good chance of neurologically intact survival (70% or more, T. Darocha et al)
- It is not viewed as an exciting or relevant topic & currently false assumptions due to little known New Zealand specific data (younger patients with less co-morbidities amongst decedents than overseas, thus more potentially salvageable abound. (M. Zachau, 2018))
- The "Avalanche rescue" topic might interest people sufficiently to implement management changes which will benefit a wider patient cohort

Yes, I believe it is worth it.
Per capita, in New Zealand (nearly) as many people die of avalanches as in France.

<table>
<thead>
<tr>
<th>France</th>
<th>New Zealand</th>
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<tbody>
<tr>
<td>65 million</td>
<td>4.8 million</td>
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<tr>
<td>29/year on average</td>
<td>1.5/year on average</td>
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<tr>
<td>0.4/million</td>
<td>0.3/million</td>
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<tr>
<td>also take into account large tourist population of France</td>
<td>&quot;small data set&quot;, very sensitive to annual fluctuations</td>
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Canada: 10-14 deaths/year, population 35 million 0.28-0.4 deaths/million

if NZ were France it would become 2 fatalities/year

Austria
2.4 deaths/year
8.7 million
0.27 deaths/million

Switzerland
25/year
8.6 million 2.9/million