CANADIAN AVALANCHE FATALITIES – AN AGE DEMOGRAPHIC TREND ANALYSIS

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ABSTRACT: Across the world avalanche services report around 140 fatalities on average each winter, mainly involving backcountry recreationists. These events deeply impact local mountain communities. Examining patterns in accident data can provide valuable insights into trends in fatal accidents and highlight challenges that need to be addressed with future avalanche safety initiatives.

Avalanche Canada recently consolidated the available information about all known fatal avalanche accidents in Canada into a new database which can be accessed at https://incidents.avalanche.ca/. This searchable public database documents 1,077 fatalities from 577 accidents dating back to 1782.

In this study, we examine trends in avalanche fatality age demographics over the past 42 seasons. We used quantile regression modelling to gain more insight into trends across the entire age distribution. We conducted this analysis across the entire dataset as well as for the main user-activity groups: backcountry skiing/snowboarding, snowmobiling, and mechanized skiing/snowboarding.

We observe that for the overall dataset the age of avalanche fatality victims is getting older, but there are distinct trends in the age distributions of each activity. Snowmobiler fatalities are getting older and the age range is widening; backcountry skier and snowboarder fatalities are getting older at the median, but the oldest fatalities are getting younger; and mechanized skier and snowboarder fatalities are getting older with the greatest increase occurring among younger fatalities. This clearly highlights that avalanche fatality age demographics are changing in Canada. While the current lack of participation data prevents us from providing insights into fatality rates for different age groups, our results provide a comprehensive baseline to compare with in the future and can help to inform future awareness initiatives and safety services that aim to target specific at-risk groups.

KEYWORDS: Fatalities, accidents, trends, demographics.

1. INTRODUCTION

Snow avalanches represent a considerable hazard for people travelling in mountainous areas with sufficient snow cover during the winter months. Every winter, avalanche warning services around the world report around 140 fatalities on average (SFU Avalanche Research Program, 2026), and we suspect that many more avalanche fatalities in more remote regions around the world go unreported.

To help prevent future fatalities, the avalanche community has a long history of documenting fatal avalanche accidents and close calls and describing the conditions and circumstances that have led to these incidents in detail. Almost every western avalanche warning service maintains an avalanche accident database (e.g., Colorado: Colorado Avalanche Information Center (2026); Canada: Avalanche Canada (2026); Switzerland: WSL Institute for Snow and Avalanche Research SLF (2026); European Avalanche Warning Services: European Avalanche Warning Services (2026)). While data on avalanche fatalities is typically very reliable, information on close calls is much sparser.

In Canada, fatal avalanche accidents have predominantly been recorded in the Avalanche Accidents in Canada book series: Vol. 1: Stethem and Schaerer (1979); Vol. 2: Stethem and Schaerer (1980); Vol. 3: Schaerer (1987); Vol. 4: Jamieson and Geldsetzer (1996); Vol. 5: Jamieson et al. (2010). These books were initially published by Natural Resources Canada (NRCan) and later by the Canadian Avalanche Association. While Volumes 1 to 3 documented selections of fatal avalanche accidents, starting with Volume 4, all Canadian fatal avalanche accidents have been documented systematically. However, Volume 5, published in 2010 and documenting avalanche accidents from 1996 to 2007, has been the last publication in this series.

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Research on avalanche fatalities can provide important insights for incident prevention, rescue and medical treatment. To date, there have been several studies that have explored aspects of Canadian fatality records such as Boyd et al. (2009) studying patterns of death among avalanche fatalities, Haegeli et al. (2011) exploring Canadian survival curves, and Haegeli et al. (2014) examining the effectiveness of avalanche airbag usage. In addition, Avalanche Accidents in Canada Volumes 4 and 5 included overview chapters that examined trends and patterns in fatal avalanche accidents for the time periods covered by these books. Complementary studies like Jamieson and Stethem (2002) documented that the nature of avalanche fatality victims in Canada shifted from being heavily represented by worker-related incidents prior to 1970 to predominantly recreation-based since then. Examples of similar studies in other countries include Jekich et al. (2016), Berlin et al. (2019), and Peitzsch et al. (2020), which have all provided interesting insights into the demographics of avalanche victims in their respective countries.

Despite this long history of documenting avalanche accident in Canada, there has not been a trend summary or analysis of avalanche fatalities like this since the publication of Avalanche Accidents in Canada Vol. 5 in 2010. Building on the data collected in Avalanche Canada's newly published Canadian fatal avalanche incidents database (Avalanche Canada, 2026), the objective of this study is to provide an up-to-date analysis of how the age of recreational avalanche fatality victims has changed since 1984, and whether this change differs across activity groups.

2. MATERIALS AND METHODS

2.1 Data sources

Avalanche Canada's newly published fatal avalanche incidents database (https://incidents.avalanche.ca/) documents 1,077 fatalities from 577 incidents dating back to 1782. This database includes records for every known avalanche fatality that has occurred in Canada since then. The fatality database was compiled with data from the Avalanche Accidents in Canada book series, additional information from the Land of Thundering Snow database compiled and maintained by John Woods (https://www.landofthunderingsnow.ca/index-eng.php), and new documentations and analyses of fatal avalanche incidents since 2007. The fields from Avalanche Canada's database used for this analysis include season of incident, group activity, and age of victims.

Our analysis focuses on all guided and non-guided recreational avalanche fatalities that occurred between the winter seasons of 1984 (Oct 1, 1983 – Sept 30, 1984) to 2025 (Oct 1, 2024 – Sept 30, 2025). We chose to limit our analysis to the past 42 seasons as fatal avalanche accidents in Canada have been documented more systematically since Avalanche Accidents in Canada Vol. 4, which started with the winter season of 1983/84.

2.2 Statistical analysis

The objective of our analysis was to gain insight into how the age distribution of avalanche victims has changed over time. In this analysis, each data point represents the recorded age of an avalanche fatality. We chose to keep our data unaggregated (uncombined and ungrouped), rather than using the seasonal mean or median age of fatality victims or performing regression analyses based on grouped incidents as done by Peitzsch et al. (2020). This approach can give us a more comprehensive understanding of how the entire age distribution evolves over time.

To examine the age trends of the entire population, we first conducted this analysis for the entire dataset of recreational fatality incidents, where season was the only predictor variable. Subsequently, we included group activity as a covariate to the model to examine how age distributions differed between our main activity groups. Including an interaction between our two predictor variables allowed us to identify demographic distinctions between recreational user groups over the 42-year study period. Our analysis focused on three group activities where we have sufficient records for a meaningful analysis: snowmobilers, backcountry skiers and snowboarders, and mechanized skiers and snowboarders (composed of all heliskiing and snowcat related incidents). All other activities were combined into an "Other" group to keep them in the overall analysis, but we did not further examine the age trends in this group.

We chose to use quantile regression (QR) modelling for this analysis rather than ordinary least squares (OLS), the more traditional regression model. The main reason for this choice was because QR gives us a more detailed understanding of the distribution by offering modelling opportunities beyond the mean, which is the objective of OLS (Koenker & Bassett, 1978; Koenker, 2005; Hao & Naiman, 2007). In our analysis, we estimate separate QR for the 10th, 25th, 50th, 75th and 90th age quantiles. By modelling these quantiles, QR captures changes in the relationship between our predictor variables and the age of fatality victims across the entire distribution (from the youngest 10% of fatality victims to the oldest 90%). In addition, QR is more robust to

outliers and to various violations of OLS assumptions (e.g., normality of residuals, homoscedasticity).

We conducted our entire analysis in R statistical environment (R Code Team, 2026) and used the R package quantreg by Koenker (2025) to perform the QR analysis. Note that our analysis is descriptive, and we therefore do not use p-values in our interpretation.

2.3 Presentation of results

We use two different visualizations to present the output of our QR analysis. The first visualization shows the trend lines for the five quantiles in a single chart. A quantile represents a chosen proportion of the data. QR fits each quantile so that it shows where that proportion of observations falls below the line and the remainder falls above it, adjusting the fitted line's position as you move through each season so that the specified proportion of observations remains below the line as the relationship changes. For example, the 25th quantile regression line is positioned so that approximately 25% of the data points are below the line and 75% are above. This visualization highlights how the median age (50th quantile) and other quantiles evolve over time, but it is still somewhat difficult to relate this presentation to concrete age distributions.

To make our results more accessible, we expressed our outputs through histograms with 10-year age bins. This secondary visualization slices the quantile distribution at a given season and models the proportion of 10-year age categories for that season. Comparing these histograms across years allows us to examine changes in age structure over the 42-year study period. We highlight these changes by overlaying the histograms for the seasons of 1984 and 2024.

3. RESULTS

Of the 494 fatalities that have occurred in Canada since the beginning of the study period, 470 of them were recreational incidents. Only 440 of these recreational fatalities had recorded age information, decreasing the analysis dataset by thirty. In this dataset, snowmobilers represent 32% of fatalities, backcountry skiers and snowboarders 28%, and mechanized skiers and snowboarders 15%. The age distribution for the overall dataset ranged from 11 to 67 years old with a median age of 34 and interquartile range from 27 to 43.

3.1 Overall trends

The modelled outputs from our analysis for the complete dataset show that the age of recreational avalanche fatalities is increasing in Canada. The 50th quantile exhibits a consistent upward trend in the age of fatality victims across the study period, increasing by approximately 8.7 years between 1984 and 2025 (Fig. 1 left panel). All other analyzed quantiles exhibit a comparable upward shift, indicating that the entire distribution of victims' ages increases at a similar rate. These observations indicate that avalanche fatalities are occurring among older individuals than they previously were. These trends are also evident in the overlaid age group histogram (Fig. 1 right panel), which shows that, although the shape of the distribution remains largely consistent between 1984 (bars with dashed lines) and 2024 (bars with solid lines), the peak of the histogram shifts from individuals aged 20-30 to those aged 30-40. The percentage breakdown between 10-year age groups allows us to identify which age groups are more heavily represented among fatality victims. We observe that by the end of the study period, the proportion of fatality victims under the age of 30 is considerably smaller (54% in 1984 versus 20% in 2024), and that the greatest proportion of fatalities is now occurring among individuals between the ages of 30-50 years old.

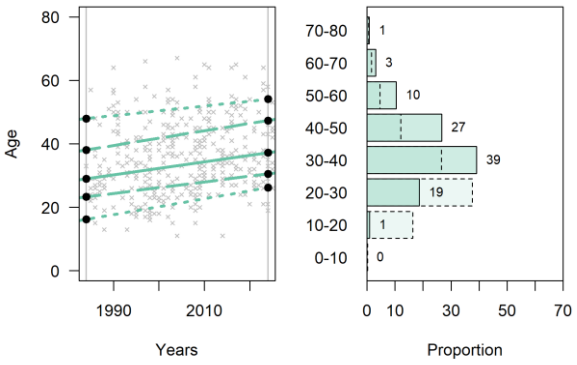

Figure 1: Left panel shows the 10th, 25th, 50th, 75th, and 90th age quantile trends for overall dataset. The 50th quantile (median) is identified by the solid line. Right panel shows the modelled age distributions of fatalities for the overall dataset grouped by ten-year bins for 1984 (dashed) and 2024 (solid).

3.2 Activity-specific trends

Our activity specific trends for snowmobiler fatalities are consistent with the overall trend that fatality ages are getting older. However, snowmobiler-specific trends differ from the overall age trends in that we observe the age distribution widening by the end of the study period (Fig. 2 left panel). The steeper increase in the older ages of

the distribution (75th and 90th quantiles) indicates that the proportion of fatality victims ages 40 and above has grown more rapidly within the past 42 seasons. This trend is evident in the proportional changes across age groups, with the proportion of victims aged 20-30 declining substantially from 56% in 1984 to 18% in 2024, while the proportion of victims in age groups above 40 years increased over the same period (Fig. 2 right panel).

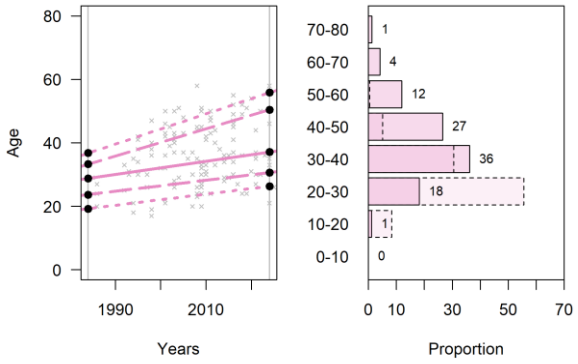

Figure 2: Left panel shows the 10th, 25th, 50th, 75th, and 90th age quantile trends for snowmobiling, and right panel shows the associated modelled age distributions of fatalities for 1984 (dashed) and 2024 (solid).

The age trend for backcountry skier and snowboarder fatalities also shows variation from the general trend we observed. Among these fatality victims, the younger end of the distribution is aging while the oldest segment of the distribution is decreasing in age (Fig. 3 left panel). These observed trends indicate that the age profile for backcountry skier and snowboarder fatality victims is tightening, with fatalities increasingly concentrated among individuals between the ages of 30-40 years old (Fig. 3 right panel).

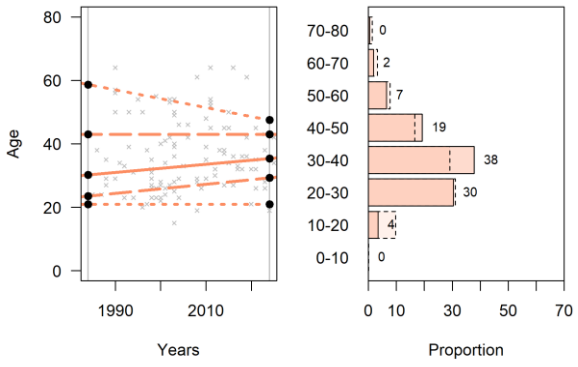

Figure 3: Left panel shows the 10th, 25th, 50th, 75th, and 90th age quantile trends for backcountry skiing and snowboarding, and right panel shows the associated modelled age distributions of fatalities grouped by ten-year bins for 1984 (dashed) and 2024 (solid).

Lastly, mechanized skier and snowboarder fatality victims, which exhibit the oldest age distribution overall, follow a similar increasing age trend to snowmobiler fatalities and the overall dataset (Fig. 4 left panel). What stands out the most about the age distribution trends in this activity is that we are seeing the greatest shift in age occurring most rapidly among the youngest 50% of the distribution. This is evidenced in the substantial decline in the proportion of younger age groups over the study period, where 70% of fatality victims were between the ages of 10-40 at the beginning of the study period, and by the end of the study period only 22% are under the age of 40, and 2% are under the age of 30 (Fig. 4 right panel).

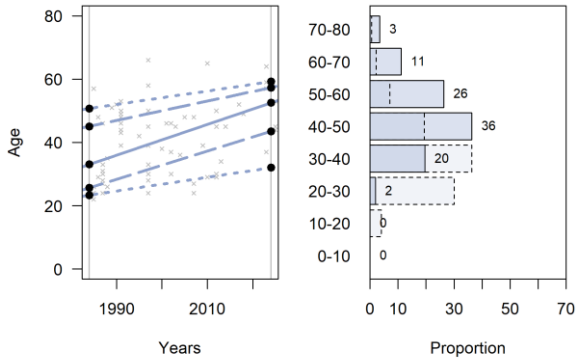

Figure 4: Left panel shows the 10th, 25th, 50th, 75th, and 90th age quantile trends for mechanized skiing and snowboarding, and right panel shows the associated modelled age distributions of fatalities grouped by ten-year bins for 1984 (dashed) and 2024 (solid).

4. DISCUSSION

Our findings indicate a clear overarching trend: avalanche fatality victims in Canada are getting older across the dataset. However, each activity exhibits their own distinct age profiles and trends. For snowmobilers, fatality victims now represent a more diverse spread of ages with the most notable shift taking place in the proportion of fatality victims ages 40 and above. For backcountry skier and snowboarder fatalities, we are noticing the oldest fatality ages are getting younger, with an increasing concentration among 30–40-year-olds. And for mechanized skier and snowboarder fatalities, the most notable shift is occurring among the youngest fatality victims, with very few fatalities under the age of 30 by the end of the study period.

We entertain several hypotheses to explain the observed trends. First, the increasingly high costs

associated with mechanized skiing and snowboarding trips is well known, and as such the increasing age of mechanized skier and snowboarder fatality victims could be a result of participation trends that are driven by younger recreationalists not having the means to participate in this sport as much as they previously could.

Second, experience in the backcountry and various proxy datasets suggest that backcountry recreation participation rates have increased substantially in recent years. Our results for snowmobiler fatalities identify a widening age range in fatalities, which could be driven by a broadening of the snowmobiling community during the study period. The dominance of 20-30-year-old fatality victims at the beginning of our study period could indicate that this sport was initially pursued primarily by younger people. Since then, the age range in snowmobiling has widened as many of the initially younger riders have aged but are still participating in the sport, and younger riders are entering the sport at the same time.

Lastly, the trend we see in the age distribution of backcountry skier and snowboarder fatalities might be a combination of the general aging trend but limited at the upper end by the physical demands of the sport. The physical fitness required to participate in backcountry skiing and snowboarding with serious exposure to avalanche hazard may deter older individuals from participating.

The outcome from our study on the entire dataset is consistent with results from the United States (Peitzsch et al., 2020; Jekich et al., 2016) and Switzerland (Berlin et al., 2019), which both identify that the age of avalanche fatality victims is getting older. The study conducted by Peitzsch et al. (2020) revealed that between 1990 and 2018 30-39-year-olds and 40-49-year-olds show an increasing trend in the number of avalanche fatalities, indicating a growing demographic of fatality victims among 30-49-year-olds. In Switzerland, through use of a Hazard Index analysis, Berlin et al. (2019) identify that the median age of fatalities increases from 31 years in the first decade of their study (1995-2004) to 42 years in the second decade (2005-2014), and that the rate of dying in an avalanche was significantly lower for individuals under the age of 40 in the second decade. Our results are similar to these trends as we identify an increasing trend across the entire distribution, with age groups between 30-50 years old representing the greatest proportion of fatalities by the end of the study period.

The study by Peitzsch et al. (2020) also analyzed changes in median age for specific activities, finding that the median age for backcountry tourer fatalities (31 years) trended positive between 1990 and 2018, whereas the median age for snowmobiling fatalities (35 years) had no significant trend. Our results for backcountry skiers and snowboarders are similar to those observed by Peitzsch et al. at the 50th quantile, where we observe an increasing trend, however our analysis reveals that the median trend is not representative of the entire distribution for this activity. For snowmobiling fatalities our results differ as we observe an increasing trend not only at the 50th quantile but across the entire distribution. With that said, the median age of backcountry skier and snowboarder, and snowmobiler fatalities in our study are similar to those observed in the United States, underscoring that while temporal trends may differ certain aspects of age demographics are alike. However, it is important to note that in comparison to other age analyses that look at which age groups are most represented among fatalities, or trends across the median age, we examine how the entire distribution of ages for fatality victims changes over time and what distinctions exist between activities. This difference in analysis approach makes it challenging to directly compare results.

4.1 Limitations

Our study provides a detailed analysis on up-to-date Canadian fatality age demographics which can help contextualize and support the development of effective and relevant avalanche education programs and awareness messaging. However, without Canadian backcountry recreation participation data to compare this fatality analysis with, we are unable to draw conclusions about how the risk of individual age groups has changed throughout the study period. In other words, we are unable to separate whether the increase in the proportion of an age group is related to the increase in participation in this age group or an age-group specific increase in fatality risk. Addressing this limitation is challenging. While countries like Switzerland have long-term population surveys on sport participation that allow detailed insight into the age structure of participants (Bürgi et al., 2021), Canada does not yet have systems in place to collect this data. However, Avalanche Canada has recently teamed up with Statistics Canada to gather initial information on Canadian's engagement in winter backcountry activities in avalanche terrain, which will facilitate more detailed analyses in the future.

5. CONCLUSION

Our study analyzed recreational avalanche fatality data from Avalanche Canada's Canadian fatal avalanche incidents database between the seasons of 1984 to 2025. We explored overall and

activity specific trends in the age of avalanche fatalities. Through our analysis we observed that avalanche fatality victims are getting older across all activity types, although there are distinct activity-specific age profiles: Snowmobiler fatalities are getting older but their age distribution is also widening considerably; the median age of backcountry skiing and snowboarding fatalities is also increasing (although at a lower rate), but the oldest backcountry skier and snowboarder fatalities are actually getting younger; and among mechanized skiers and snowboarders, the age of the younger fatalities is increasing the quickest.

Our analysis reveals that the age demographics of Canadian avalanche fatalities are changing. These results can help to provide a comprehensive baseline for the future as well as to help inform future awareness initiatives and safety services. Avalanche risk management education, tools, and services that aim to reduce fatalities can only be as effective as our understanding of their target audiences. This analysis provides an opportunity to explore which demographic groups are most represented among fatalities and highlights the variations experienced by distinct user groups. Once Canadian backcountry recreation participation data becomes available, future research should explore trends in avalanche fatality rates among the different age categories. Furthermore, trend explorations of other sociodemographic data (e.g., gender, nationality) will help to develop an even richer picture of Canadian avalanche fatalities. Further research in this area will provide a more complete baseline as well as more effectively support future awareness and safety initiatives.

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