CHECKING ME, CHECKING YOU... DO YOU? A BEACON-STUDY IN NORTHERN NORWAY

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ABSTRACT: Avalanche beacons are vital for winter backcountry activities. They provide a means for locating individuals buried by avalanches, allowing efficient companion rescue and survival in remote avalanche incidents. A comprehensive group check (double beacon group check) ensures that all beacons are operational and set to send mode, eliminating uncertainty, and saving precious time during a rescue. The know-how is easy to learn but less is known about the know-why and if backcountry recreationists understand why they should do the checks. Understanding would be seen by doing double group checks, not just single checks. This study investigates the practices surrounding beacon use, particularly the frequency and thoroughness of group checks in the Tromsø area. Awareness for avalanches was assumed to be high. During two seasons (2022/2023 and 2023/2024) popular starting points for backcountry skiing had a beacon checkpoint near the parking lot. Our main hypothesis was that backcountry skiers use these electronic signposts verifying their individual transceivers operating in send modes, but do not perform a double beacon group check. Data was collected either as survey (Kattfjordeidet study) post tour, or as hidden observation in the beginning of a backcountry trip. Many observed and some of the surveyed backcountry skiers were not checking their beacons at all even though the avalanche danger was moderate or considerable, and they immediately entered avalanche terrain (starting zones and/or run-out zones). Our results question whether backcountry skiers are aware of the efficacy of beacons. We do not know if these findings are a cultural and/or socio-ecological phenomena, e.g., lack of efficient avalanche education or psychological phenomena. This underscores the need for promoting continuous avalanche awareness especially for something as “simple” as the double beacon group check. Avalanche education needs to teach backcountry recreationists both the hard skills and safety behaviors they need to know, but also the soft skills necessary to implement these hard skills in their own touring practices in complex socio-ecological settings.

KEYWORDS: Avalanche Safety, Beacon Group Checks, Transceiver, Backcountry Skiing, Companion Rescue, Avalanche Survival

IMPLICATIONS FOR AVALANCHE EDUCATION

- Teach *know-why* (beacon tests are important) in addition to teaching the technical *know-how.*
- Teach skills of speaking up in socially ambiguous situations, in addition to teaching technical and procedural skills of doing beacon checks.
- Focus on creating a culture for safety behavior, making doing double beacon checks the default.

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1. INTRODUCTION

Avalanche beacons are essential for winter backcountry activities, providing a crucial tool for locating individuals buried by avalanches. When ski touring in the backcountry, organized rescue may be too far away if somebody gets buried by an avalanche. Adverse environmental conditions, such as low visibility and bad weather, may make air assisted rescue difficult and thus further increase rescue times by organized rescue operations. After about 15 minutes of being buried alive by an avalanche the chances of survival decrease dramatically (Falk et al., 1994; Haegeli et al., 2011; Procter et al., 2016). In the cases victims are not killed by trauma, but are in danger of dying from asphyxiation, survival after burial is time dependent and will be contingent on the effectiveness of the rescue. The most efficient way of saving the lives of those buried is through companion rescue (Wallner et al., 2019). Efficient companion rescue with the help of avalanche beacons can significantly decrease extrication times and increase survival odds in avalanche incidents, especially in remote areas where organized rescue operations are far away. Thus, it is important to have a working beacon. To ensure the beacon's functionality one must perform a function check, also called "group check". This should be performed at the beginning of every tour.

There are two kinds of group checks, the single group check and the double group check. The single group check tests only the SEND function of the participants and the SEARCH function of the group leader. In contrast, the double group check tests both the SEARCH and SEND functions for all participants and the group leader.

1.1 Importance of double group checks

There are both technical and procedural reasons for doing double group checks in the beginning of a tour as shown in Table 1 below.

While "single" group checks will ensure findability by others, that everyone's SEND function is checked, and that all group members are in SEND mode at the end of the check, doing a "double" group check has advantages. Checking both the SEND and SEARCH function ensures technical functionality of both operational modes. Doing these checks for everyone in the group also has the added benefit that everyone can inspect each other´s devices and everyone knows the devices work and are in send mode at the end of the check. This is important in case of a rescue situation. If no beacon signal is found, one must decide whether to keep on looking for a signal of the buried touring companion or change to other, usually slower means, such as manual search using a probe. Not knowing whether the buried person has a working device that sends signals adds unnecessary uncertainty to the situation and valuable time may be lost. Another, likely undervalued effect of doing beacon checks with the whole group is that it sends a message that on this tour, avalanche terrain and avalanches are a concern. This is a golden opportunity to turn on the group's "cognitive antennas" and get into a "mindset" of paying attention to the terrain and the conditions.

Pros and cons of double group checks

Pros	Cons
• Both SEND and SEARCH functions are checked and tested	• Only useful if group members are competent at companion rescue
• Training and routine in switching between SEND and SEARCH mode. It is easy to spot if people are not able to do this.	• Minimally more time needed
• Knowing that everyone's beacon is checked	• Need to be done in correct sequence to minimize drawbacks
• Knowing that everyone is in SEND mode at the end of the double group check	
• Self-sufficiency in case of rescue situation	
• Mindset shift to focus on terrain and avalamche conditions	

Table 1. Showing advantages and challenges of performing double group checks.

In summary, for situations where companion rescue is the most likely and most effective means of extrication it is strongly advised to employ a double group check by testing both the search and send function of all group members in the beginning of the trip. That ensures testing both SEND and SEARCH function of every beacon in the group, that everyone can find everyone and can be found by everyone. This, in turn, reduces uncertainty in case of a rescue situation.

1.2 Northern Norway as a case study

In Troms, a region in Northern Norway renowned for its backcountry skiing, the culture around beacon use and safety practices provides a unique case study into the adherence to safety protocols.

Around 40% of all deaths related to avalanches in Norway happen in this region (varsom.no, see Figure 1), which makes it especially interesting for studying people's safety behaviors. Teaching safety behaviors such as doing beacon checks can decrease avalanche deaths.

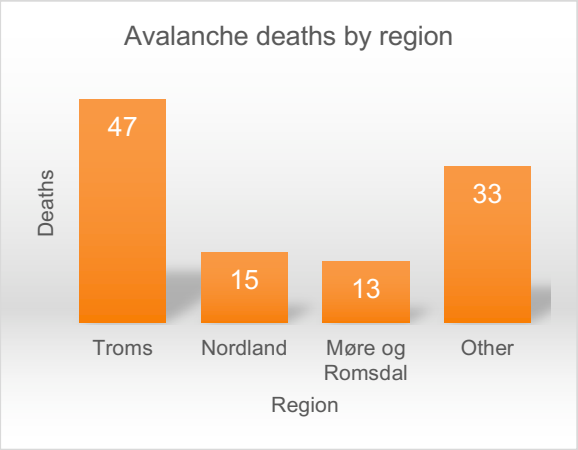

Figure 1. Avalanche deaths in Norway since 2008, decreasing, sorted by region. N = 108 people died in avalanches in Norway. 47 (43.5%) of these deaths happened in the Troms region in Northern Norway. 13.9% in Nordland, 12% in Møre and Romsdal, 7.4% in Svalbard, and 4.6% in Buskerud. For better viewability we have only included the top three out of the 17 regions with the highest number of avalanche deaths. Source: varsom.no

1.3 Beacon check-points

One fast and easy way of testing the SEND function of a beacon is through beacon check-points (BCPs) that can be installed at places where people enter the backcountry, such as parking lots and trail heads. As part of a study by Toft et al., (2024) to count how many people tour in the winter backcountry in the Troms region BCPs were installed at many popular ski touring destinations. A by-effect of the counting study is that recreationists can check that their beacons are turned on and that the SEND mode is functioning. However, the BCPs cannot be used to check the SEARCH function.

This study seeks to uncover the regularity and diligence of beacon checks, especially focusing on the practice of doing double group checks, among skiers in the Troms region, with a hypothesis that despite the availability of beacon check-points, many skiers forego this essential safety step, particularly in group settings. The overarching goal is to identify cultural and socio-ecological factors that may influence these behaviors, providing insights into areas where avalanche education could improve adherence to safety practices.

2. METHODS

The study was conducted over two seasons (2022/2023 and 2023/2024) at popular starting points for backcountry skiing near Tromsø. Data collection involved two methods: surveys administered post-tour at Kattfjordeidet (s1) and an observational study of skiers at the beginning of their trips, including a follow-up survey on the mountain (s2). The survey included questions on beacon use, group dynamics, and perceptions of avalanche risk. See Figure 2.

2.1 The KFC survey

The Kattfjordeidet study recruited recreational skiers who completed a self-selected back-country trip in the Kattfjordeidet area. For details, please see Ahonen et al. (ISSW 2024). In brief, participants answered a touring log (s1) assessing their group composition and management, planning information, snow condition assessment, trip details, avalanche likelihood estimation, and a visually sighted estimation of two slope angles (see Pfuhl et al., ISSW 2024) We used the following variables from the survey: a) Did your group perform a beacon check? Answer options were "yes - with my group members", "yes - on the checkpoint", "no", "Don't know"; b) How much has this group toured together in avalanche terrain before? Answer options were "completely new group – most people in the group had not toured together previously", "relatively new group – most people in the group had only toured together a few times", "established group – most people in the group had toured together several times previously"; we also asked whether the group had a leader (formal or informal), back country experience (years and days per season), avalanche education. However, not all participants completed the demographic section. In the season 2022/23 there were 112 responses, in the season 2023/24 there were 169 responses.

2.2 The observational pilot study

The observational pilot study consisted of two parts. (1) An observation of whether and what kind of beacon checks ski touring groups did when starting the trip, for example, at the parking lot. Furthermore, a (2) short survey (s2) asking

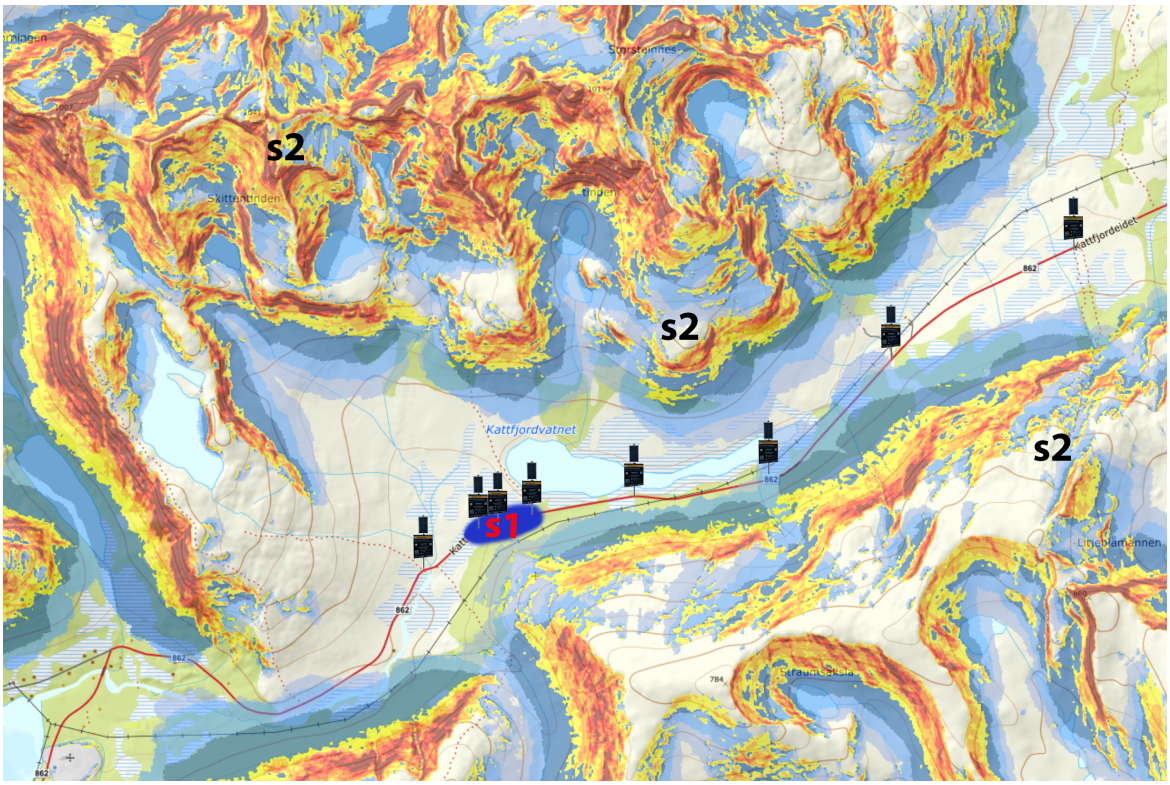

Figure 2. Overview over Kattfjordeidet area in Troms with beacon checkpoints, the survey area for the KFC survey (**s1**) and points where participants of the observational study were presented with the short survey (**s2**). Most trips pass avalanche release areas. All trips, including some parking lots and BCPs are in run out areas of avalanche paths. Runout distance and likelihood: Short runout (50% of avalanches stop within this boundary). Medium runout (25% of avalanches go further). Long runout (5% of avalanches go further). Some avalanches may have a runout that is not shown on the map. Colors of terrain steepness in degrees: 27-30, 30-35, 35-40, 40-45, 45-50, >50.

about the beacon check behavior of the group further up the mountain. For (1) a researcher was placed at the parking lot, observing the groups' safety behavior and communicating with a second researcher further up the mountain by radio or cell phone. The second researcher that presented the groups with the survey could check what kinds of checks the group did when starting the trip. This ensured that self-reported behavior could be checked against actual behavior.

Since reported and observed behavior corresponded for 100% of groups, minimal to no observation was done during the second season of data collection. Groups were only presented with the survey (s2) on the mountain.

2.3 *Integration of data sources*

Data from the KFC survey and the observational study were used for data triangulation and to check whether reported behavior did correspond with observed behavior. Both data sets were used to quantify how many groups that engaged in what kind of beacon check behavior. Furthermore, while the focus of analysis for the KFC survey (s1) was to identify underlying factors that may influence group check behavior, the main focus of the survey from the observational study

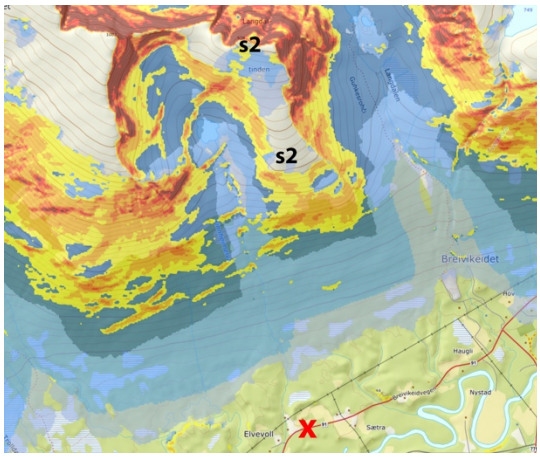

Figure 3. Langdaltinden, an example of another popular backcountry ski tour in Breivikeidet area in Troms without a BCP. The red **X** marks the start of the tour. Groups are presented with the short survey (**s2**) either immediately after traversing a release area or when reaching the peak. Note that there is no trip alternative to reach the peak avoiding release and run out zones.

(s2) was to corroborate reported behavior and explore the reasons groups gave as to why they did or did not engage in certain beacon check behavior.

This provided a holistic approach toward understanding of social dynamics and reasons why people refrain from doing beacon checks.

ior observed in the field. Finally, the study guarantees complete anonymity. No identifiable information about groups or individuals is recorded. The observations solely document whether beacon checks are performed, and the types of checks conducted.

In summary, the use of hidden observation, despite its divergence from informed consent, is justified by its contributions to the validation, contextual relevance, and ethical integrity of our research findings.

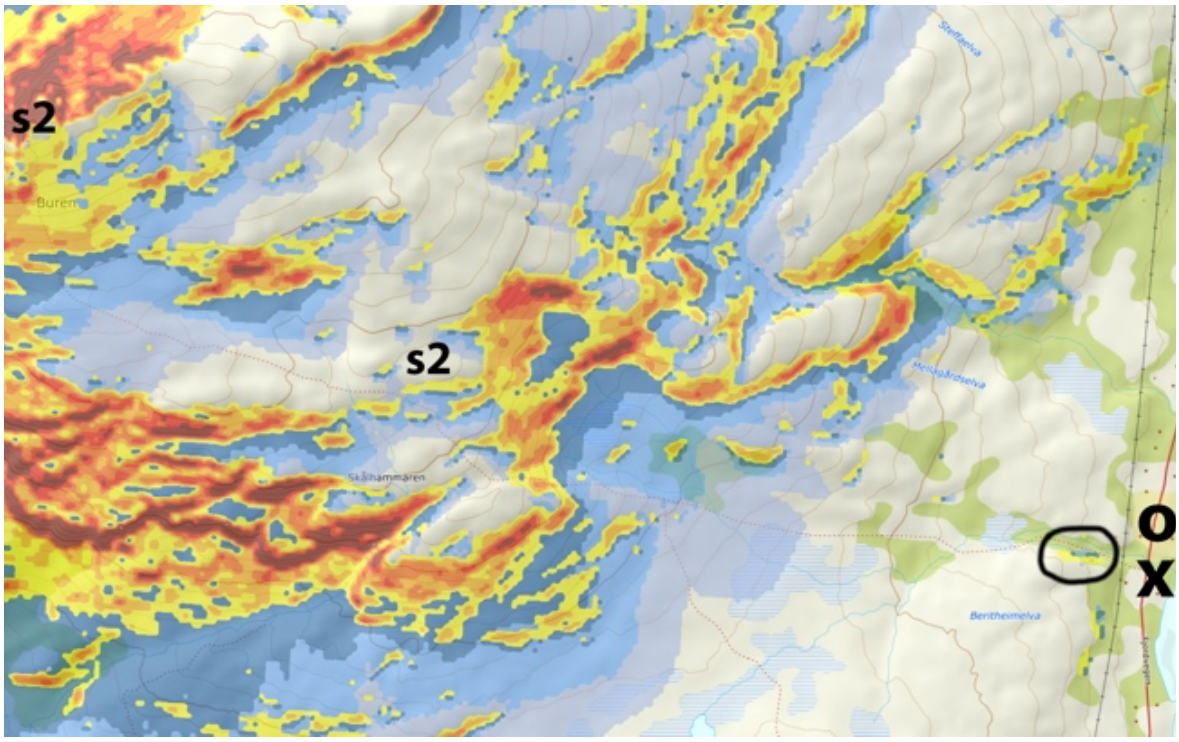

Figure 4. Example of a mountain with a starting point without a BCP (**X**). In this case Mt. Buren on Kvaløya in Troms, a popular ski tour. An observer (**O**) is placed at the parking lot where most tours start. The circled area is avalanche terrain ski tourers have to navigate immediately after the parking lot. Two more researchers presented the ski touring groups with the survey (**s2**) further up the mountain. Each ski touring group only answered the survey once.

2.4 Ethical assessment of hidden observations

To verify whether groups are conducting beacon checks and to identify the types of checks being performed, we employed hidden observation at the parking lots. Although hidden observation deviates from the principle of informed consent in qualitative research, we contend that it is essential for enhancing the robustness and trustworthiness of our study for several reasons.

First, the hidden observation method provides a means to validate the findings from the in-field questionnaire. Given that this research is conducted in real-world settings outside a controlled laboratory environment, validation is crucial for ensuring the reliability of the results. Second, the results of qualitative studies are highly context dependent. Since this study employs a mixed-methods approach, it is imperative to have an indication that the findings correspond to actual behav-

3. ANALYSIS AND INTEGRATION OF DATA SOURCES

KFC data (s1) from both seasons was pooled and quantitative survey data (s2) from the observational study was analyzed in R studio.

Groups also gave reasons why they did not do beacon checks when answering the survey (s2). We will provide some examples that give insights into the groups' reasonings.

4. FINDINGS

There were 281 responses in the KFC survey from the two seasons. 19% stated that they did not perform a beacon check. 42% stated that they performed the check at the BCP, 38% did a group

check and 1% did not know whether they did a beacon check.

Our data shows a high number of skiers neglecting beacon checks (see Figure 5). Observations and surveys indicated that many groups did not perform beacon checks, even when entering avalanche terrain.

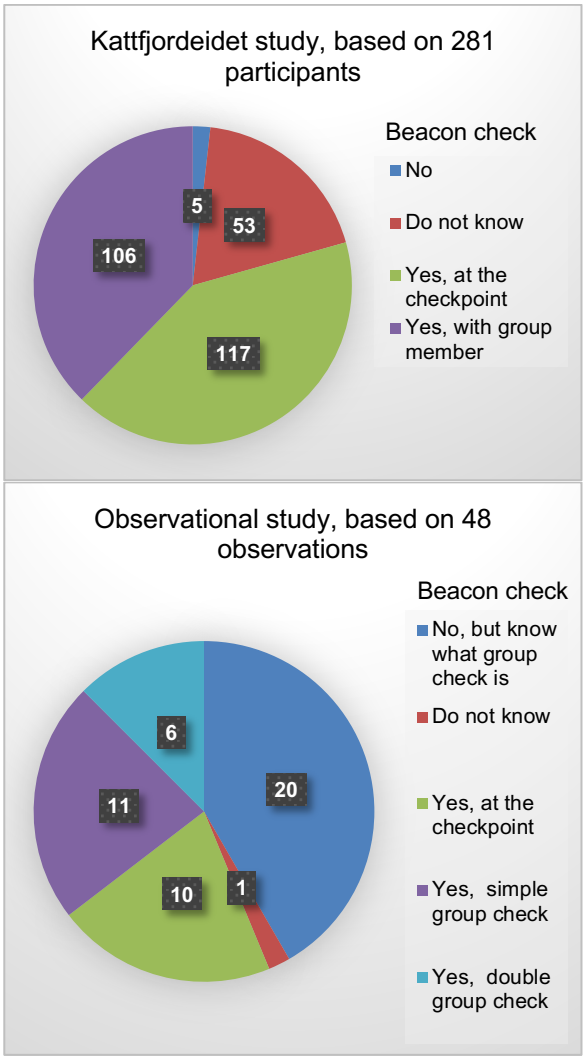

Figure 5. Proportions of practices in beacon check behavior. Kattfjordeidet study n=281 (persons) and observational study n=48 (observations). Note that 11 persons in the observational study went alone but were interviewed at BCPs.

We found no association between experienced or novel groups in the kind of beacon check performed, X^2 (df = 6) = 2.93, p = .81, Cramer's V = .08, and also no difference by trust, X^2 (df = 12) = 6.88, p = .87, Cramer's V = .1.

However, there was a significant difference by avalanche education. The higher the avalanche education the more likely that the group performed a group check instead of using the checkpoint, X^2 (df = 15) = 30.66, p = .01, Cramer's V = .25. Note, data is based on a small sample.

Comparing the two data sources, we find that significantly more participants in the observational study did not perform a beacon check (44%) compared to those surveyed at Kattfjordeidet (19%), X^2 (df = 3) = 14.64, p = .002, Cramer's V = .21. This is likely due to the presence of a) checkpoints and b) knowledge of the KFC study and seeing the tents set up influencing behavior. It may also suggest that the group answering as a whole, as well as observing and surveying ski tourers in different areas and on different days, where no visible study was going on (tents and researchers at parking lots), is maybe more representative. Performing group checks with group members was similar (38% and 36%).

Reasons cited for using checkpoints instead of doing group checks included laziness ("Because the check points are there.", "Because it is easier and faster.", "Faster.", "Because it is fast and cool.") and people being on a "solo trip".

Another finding from the observational study is that 95% (20 out of 21) of surveyed ski tourers who did not do beacon checks at all had knowledge of doing beacon checks.

Our preliminary analysis also shows that people might think of doing the checks, but then do not do it: "Jack did not have batteries"., "I have a beacon, but there is no avalanche danger."

5. DISCUSSION AND FURTHER DIRECTIONS

We hypothesized that despite the availability of beacon check-points, many skiers forego the essential safety step of doing beacon checks, particularly in group settings.

We found that 19% (KFC) and 44% (observational study) did not do beacon checks.

In the KFC study, where there always were BCPs available at the parking lots, 42% did beacon checks using BCPs. Since we do not have data for the same area without BCPs, we cannot say in which way BCPs influence beacon check behavior. It may be fruitfull, if possible, to incorporate control groups in future research looking into the effect beacon check points have on backcountry skiers performing group checks. The fact that there are more skiers doing beacon checks in the KFC sample, as compared to the observational study (which did not have BCPs at all locations) may be an indication that BCPs lead to more people checking their own beacons.

BCPs influencing peoples beacon check behavior in that way is supported by the reasons participants in the observational study cite, that they use BCPs "Because the check points are there.", and "Because it is easier and faster." If

BCPs are responsible, or partly responsible, for the higher number of people doing beacon checks in the KFC study, this is a positive effect of BCPs.

Nevertheless, it may precisely be this ease of use and availability that leads skiers to default to the easier task – in terms of effort - (Kahneman, 2011) of simply checking their own beacon at a BCP. Thus, not performing group checks which, when performed correctly in the beginning of a trip, have a lot of benefits in case of a companion rescue.

Our results show that many do not do double group checks. In both studies, less than half of the surveyed backcountry skiers did group checks (38% KFC, 36% observational study). In the observational study only 13% did double group checks. The relatively low number of doing group checks, especially double group checks, may be an indication that BCPs influence beacon check behavior in a way that may have undesireable consequences in a rescue scenario. Doing double group checks, instead of only checking the SEND function of one's own beacon at a BCP, has the added benefit of testing both SEND and SEARCH function of every beacon in the group, ensuring that all group members are in SEND mode and that everyone can find everyone and can be found by everyone, and thus reduces uncertainty in case of a companion rescue situation.

It is alarming that 95% of those groups not doing beacon checks in the observational study knew what they were. This indicates that while many participants understand how to do beacon checks (know-how), their understanding of why these checks are crucial (know-why) is not strong enough to influence their safety behavior. We do not know whether this is a psychological, regional or cultural phenomena or whether we see similar neglect of best practice beacon check behavior in other popular ski touring regions of the world, such as North America and the European Alps.

In summary, the findings suggest a neglect in safety behavior that could have dire consequences. This neglect appears influenced by cognitive biases, for example, overestimation of beacon reliability and availability of beacon check points. It may also be influenced by cultural and socio-ecological factors such as safety culture, group dynamics and communicative skills. Future research could explore the effect of these aspects on safety behavior.

6. IMPLICATIONS FOR AVALANCHE EDUCATION

The lack of performing regular beacon checks points to potential areas for improvement in avalanche education, which must emphasize not only the mechanics of using safety devices (*know-how*) but also the reasons and importance of doing beacon checks (*know-why*). Furthermore, avalanche education may improve by teaching the communicative and social skills necessary to implement beacon check practices consistently across various group settings.

We suggest the following behavioral training aspects ought to be included in recreational avalanche courses:

- **Improve *know-how*:** The individual and group technical skills of how to efficiently and practically do double group checks.
- **Focus on teaching *know-why*:** Why doing beacon checks is important, in addition to teaching technical skills.
- **Improve communicative skills:** How to speak up in socially uncomfortable settings. This could be new groups or well established groups where it is difficult to be the one pointing out that a beacon check should be done.
- **Improve social skills:** How to create a culture of safety that promotes double group checks as the default.

7. CONCLUSION

This study highlights a critical need for behaviorally effective and comprehensive educational programs that address both technical, psychological, and communicative skills related to avalanche safety. By holistically addressing these skills and fostering a culture of safety that encourages routine beacon checks we can enhance the effectiveness of these lifesaving devices. Future research should investigate the cultural impact and influence of beacon checkpoints, forecasted danger level and group composition on optimal beacon check procedures, along with the effectiveness of targeted educational interventions in driving behavior change among winter backcountry recreationists.

ACKNOWLEDGEMENT

We want to thank all our study participants for their invaluable contributions to the study. Special thanks to Olav Kvåle Myksvoll and all the volunteers and research assistants collecting KFC data and supplying study participants with hot drinks and carbohydrates after their day in the mountains. Finally, we want to thank the researchers associated with the GUESSED project (Nordforsk project number 105061) for their thoughtful comments and support in carrying out the study.

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