A follow-up study after the Vassdalen avalanche: Surviving soldiers' self-report and experiences 30 years post-disaster

Lars-Petter Bakker

OsloMet Avhandling 2020 nr 10

OSLO METROPOLITAN UNIVERSITY
STORBYUNIVERSITETET

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Lars-Petter Bakker

Dissertation for the degree of Philosophia doctor (PhD)
Faculty of Health Sciences
Oslo Metropolitan University

Spring 2020

OsloMet Avhandling 2020 nr 10

ISSN 2535-471X (trykt)
ISSN 2535-5414 (online)

ISBN 978-82-8364-236-0 (trykt)
ISBN 978-82-8364-285-8 (online)

OsloMet – storbyuniversitetet
Universitetsbiblioteket
Skriftserien
St. Olavs plass 4,
0130 Oslo,
Telefon (47) 64 84 90 00

Postadresse:
Postboks 4, St. Olavs plass
0130 Oslo

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Acknowledgments

This thesis is part of a larger research project that started more than 30 years ago. The present project was carried out from 2016 to 2019 as a collaboration between the Faculty of Health Sciences, Oslo Metropolitan University (OsloMet), Norway and The Norwegian Armed Forces Joint Medical Services (FSAN), Institute of Military Psychiatry (IMPS), Oslo, Norway. Without this collaboration and financial support this project would never have been carried out. I am grateful to both these institutions for giving me the opportunity to fulfill my dream of completing this important project.

First and foremost, I am indebted to all the participants for their willingness to participate and to share their experiences once again after so many years participation in this study.

A number of people have supported me in this project, and this thesis would not have been possible without the support and excellent supervision of several people who believed in me and had faith in my project. First, I am sincerely grateful to my supervisor, Professor Ellen Karine Grov. Thank you for being available at all hours and for always encouraging me through all phases of the project with your invaluable knowledge, guidance and constructive feedback, and for your support and enthusiasm. You are a generous person from whom I have learned so much. Further, I am very grateful to my co-supervisor, commanding general (CG) of the Norwegian Armed Forces Joint Medical Services /Dr.med /psychiatrist/major general, Jon G Reichelt, who gave me the opportunity to go ahead with this project in the first place, and for all the valuable dialogues, encouragement and thoughtful comments through all the phases in this project.

Many thanks to all my co-authors – you have all been very important for my development as a future researcher. Associate Professor Milada Cvancarova Småstuen, thank you for your statistical help and for your clear and well-considered advice, and for all other interesting conversations we have had during the project. Further, I would like to express my sincere gratitude to Professor Siren Eriksen for her skillful supervision and constructive criticism and for sharing her qualitative methodological knowledge in this project. Thanks to Professor Emeritus, M.D. Lars Weisæth, and M.D. Pål Herlof Herlofsen, who organized the three first waves of data collections after the avalanche disaster and for their contributions as co-authors. Thanks to all my wonderful work colleagues at IMPS for your patience, dialogues and support during this project. A special thanks to my two colleagues, and co-authors, PhD-fellow, Cand.psychol, Christer Lunde Gjerstad, and Dr.psychol., PhD Arnfinn Tønnessen, for helping

and supporting me during the project. Thank you to commanding officer (CO) lt.col / M.D / psychiatrist / IMPS, Tore Tveitstul, for your support during the project, it has been essential for this project. Further, I want to thank Professor Astrid Bergland, the head of the PhD program in Health Sciences, for her interest in our project.

Finally, thanks to my family. Thank you, mom and dad († 2018), who have always encouraged and supported me. Thank you for being such good role models, and I wish my father could have experienced this moment with me – may he rest in peace. My beloved friend and wife, Helene Maria, words cannot express my gratitude to you, my love. Thank you for all the sacrifices you have made and for being the rock in the family for our two beautiful girls, Isabelle Natalie and Jasmine Elvira, so I could pursue my dream. Thank you all three for reminding me every day of what is most important in life – "I love you to the moon and back."

Fredrikstad, March, 2020

Sammendrag

Bakgrunn

Snøskredet i Vassdalen i 1986 kostet 16 mennesker livet, og 15 overlevde. Kort tid etter ulykken ble et forskningsprosjekt igangsatt for å studere psykiske konsekvenser av det å bli tatt av et snøskred. Prosjektet har fulgt de overlevende – og en gruppe medsoldater av dem som mistet livet i snøskredet - over tre tiår. Innvirkningen av livshendelser og sammenheng mellom fysisk- og psykisk helse og ulykker er generelt godt dokumentert, og viser seg å gi utfordringer i både behandling og samhandling. I norsk sammenheng er det estimert at rundt 1,4 prosent av norske menn kan bli eksponert for en naturkatastrofe en eller annen gang i livet. Av disse 1,4 prosentene er det estimert at 9,1 prosent sannsynligvis vil kunne være i faresonen for å oppfylle diagnosekriteriene for posttraumatisk stresslidelse (PTSD).

Oppfølgingsstudier av norske Libanon- og Afghanistan veteraner har vist at traumer kan ha alvorlige langtidsvirkninger. Videre har tidligere langtidsstudier av norske krigsseilere, overlevende etter konsentrasjonsleirer fra andre verdenskrig, overlevende etter Alexander L. Kielland ulykken (1980) og norske overlevende etter tsunamien i Asia 2004 indikert alvorlige helsemessige langtidskonsekvenser. I norsk sammenheng er det likevel et begrenset antall forskningsprosjekter som over tid har undersøkt langtidskonsekvensene av en ekstrem enkelthendelse, og hvordan det er å leve med en traumatisk hendelse gjennom tre tiår.

Hensikt

Vassdalen-ulykken i 1986 har gitt en sjelden anledning, i norsk sammenheng, til å undersøke langtidskonsekvensene av en naturkatastrofe. Det overordnede målet med denne avhandlingen er å kartlegge hvordan den mentale helsen til soldatene har vært gjennom de 30 årene som er gått siden ulykken og utforske om stresspåkjenningene den gang har hatt betydning for soldatenes daglige liv. Målene med denne avhandlingen kan oppsummeres i følgende punkter:

- Å kartlegge mulige langtidsvirkninger et snøskred har på mental helse over tre tiår etter en snøskred-ulykke for en gruppe overlevende, sammenlignet med en kontrollgruppe medsoldater (artikkel 1).
- Å beskrive mulige forskjeller i aktiveringssymptomer og søvnproblemer mellom de overlevende og kontrollgruppen av medsoldater, og undersøke mulige assosiasjoner mellom aktiveringssymptomer og søvnproblemer (artikkel 2).

- Å utforske og beskrive overlevendes mestringsstrategier og erfaringer i dagliglivet etter å ha opplevd et snøskred for tre tiår siden (artikkel 3).

Metode

Denne Vassdalenstudien er en tverrsnittsstudie, men har inkludert data fra langtidsoppfølging av en kohort over 30 år. Avhandlingen som presenteres her omfatter tre vitenskapelige artikler. De to første artiklene bygger på kvantitative data fra standardiserte spørreskjemaer om psykisk helse og søvnproblemer. De overlevende har blitt undersøkt fire ganger i løpet av de 30 årene som har gått siden ulykken: 4 dager (T1) etter ulykken (1986), 30 dager (T2) etter ulykken (1986), 375 dager (T3) etter ulykken (1987) og 30 år (T4) etter ulykken (2016). Tre standardiserte spørreskjemaer ble brukt i hele oppfølgingsperioden for å måle posttraumatisk stress symptomer (Posttraumatic Stress Scale-10; PTSS-10 og Impact of Event Scale-15; IES-15) og angst symptomer (State Anxiety Inventory-12; STAI-12). I 2016 ble et standardisert måleinstrument som måler søvnproblemer inkludert (The Pittsburgh Sleep Quality Index; PSQI). I tillegg ble det i 2016 lagt til informasjon om alder, sivilstatus, arbeidsforhold, antall opplevde potensielle traumatiske hendelser og spørsmål knyttet til deltakernes subjektive oppfatninger om snøskredet hadde påvirket deres fysiske og psykisk helse, og om deres forhold til alkohol.

En kontrollgruppe medsoldater er også undersøkt med de samme standardiserte måleinstrumentene ved de samme måletidspunktene som de overlevende. Vi brukte ulike statistiske analyser med hjelp av analyseverktøyene IBM SPSS Statistics version 24.0 [1] og Stata version 14.2 (StataCorp, 2005).

Den tredje vitenskapelige artikkelen i denne avhandlingen bygger på data fra kvalitative intervju med 12 av de overlevende soldatene fra snøskredet. Intervjuene ble gjennomført bare én gang (T4). Vi valgte å bruke innholdsanalyse inspirert av Graneheim og Lundman [2] for å analysere tekstdata.

Undersøkelsen har høy oppslutning i begge grupper, og i den siste undersøkelsen i 2016 deltok 12 av 15 fra gruppen overlevende og 9 av15 fra kontrollgruppen.

Resultater

Artikkel 1*:* Oddsen for å skåre over definert grenseverdi (cut-off) var signifikant lavere for begge gruppene etter ett år (T3) sammenlignet med baseline (T1) for måleinstrumentene PTSS-10 (p=.018), og signifikant lavere etter 30 dager (T2) sammenlignet med baseline (T1) for IES-15 (p=.005). Det ble ikke funnet signifikante forskjeller mellom de overlevende og kontrollgruppen når det gjaldt justerte gjennomsnittsskårer eller andeler som har skåret over cut-off for måleinstrumentene PTSS-10, IES-15 eller STAI-12. Imidlertid

viste studien en signifikant effekt av tid – de justerte gjennomsnittsskårene for alle de standardiserte måleinstrumentene falt over tid for begge gruppene: PTSS-10 (p=.001), IES-15 (p=0.026) og STAI-12 (p=.001). Alle målinger tatt i betraktning viste studien signifikant forskjell mellom gruppene når det gjaldt forløpet for PTSS-10 (p=.013). Forløpet for PTSS-10-skåringene var U-formet for den eksponerte gruppen gjennom de observerte 30 årene. For IES-15 viste våre data en lignende, men ikke statistisk signifikant trend.

Artikkel 2*:* Det ble funnet statistisk signifikant assosiasjon mellom de som hadde søvnproblemer (PSQI>5) og PTSD-symptomer (PTSS-10≥4), kombinert med aktiveringssymptomer (PTSS-10≥4+Hyp), 30 år etter katastrofen (p=.046). Våre data viste også at de som hadde søvnproblemer (PSQI>5) 30 år etter ulykken, hadde større sjanse for å ha hatt aktiveringssymptomer under hele oppfølgingsperioden sammenlignet med dem uten søvnproblemer (OR=2.49, 95% CI [0.95-6.55], p=.06).

Artikkel 3*:* Innholdsanalysen førte frem til tre kategorier som beskriver de overlevendes erfaringer med det å leve med en traumatisk hendelse gjennom tre tiår: (i) Et komfortabelt liv; (ii) Et utfordrende, men likevel et fullverdig liv; (iii) Et krevende liv. Det ble identifisert et hovedtema fra disse tre kategoriene: " Finne min egen måte å mestre og håndtere livet på ". De overlevende i den første kategorien "Et komfortabelt liv", syntes å oppleve vellykket håndtering av katastrofen i dagliglivet og uttrykker å ha en balansert livssituasjon. Deltakerne i den andre kategorien "Et utfordrende, men likevel et fullverdig liv", hadde en tendens til å holde fast på sin traumatiske opplevelse, men fortsatte likevel med dagliglivet uten de store negative påvirkningene. De overlevende i den tredje kategorien "Et krevende liv" syntes å beskrive at hendelsen har hatt negativ innvirkning på dagliglivet. De bruker i en større grad enn de overlevende i de to andre kategoriene mestringsstrategier tolket som unnvikelse og distraksjon/avledning.

Konklusjon

Denne studien bidrar til kunnskap om hvordan posttraumatisk stress, angst- og aktiveringssymptomer og søvnproblemer fordeler seg mellom en gruppe direkte og indirekte traumeeksponerte personer. Videre gir studien inngående viten om hvordan det er å leve med en traumatisk hendelse gjennom tre tiår. De viktigste resultatene fra studien understreker at symptomer på PTSD og angst kan fortsette, og til og med øke, i et utvalg av soldater som er godt selektert og trent. Vi fant også en signifikant sammenheng mellom dem med PTSD-symptomer kombinert med aktiveringssymptomer og søvnproblemer 30 år etter snøskredet. De som hadde søvnproblemer 30 år etter snøskredet hadde større sjanse for å ha aktiveringssymptomer under hele oppfølgingsperioden sammenlignet med dem uten

søvnproblemer. Fra den kvalitative delstudien fant vi tre hovedkategorier i gruppen av overlevende deltakere. Det kan se ut til at de overlevende har ulike mestringsstrategier for å mestre og håndtere dagliglivet gjennom de tre tiårene som har gått siden snøskredet.

Basert på funnene i vår studie kan det se ut til å være avgjørende å identifisere negative mentale helsesymptomer tidlig, i særdeleshet posttraumatisk stressymptomer og aktiveringssymptomer, slik at helsepersonell kan bistå for å forhindre negative, langsiktige søvnproblemer etter katastrofer. Fra et folkehelseperspektiv kan resultatene våre bidra til å identifisere sårbare personer og grupper, og antyde passende tiltak/intervensjoner eller omsorg. Videre kan funnene våre brukes til å utvikle screeningverktøy som helsepersonell kan anvende for å måle risikoen for negativ effekt på langsiktig mental helse etter traumatiske hendelser. Avhandlingen bidrar til økt innsikt i hvilke ulike mestringsstrategier overlevende utvikler etter en traumatisk hendelse, og gir et grunnlag for helsepersonell, de overlevende og slektninger til refleksjon over relevante mål for intervensjon, hjelp, råd og veiledning for å håndtere traumatiske hendelser på lang sikt.

Synopsis of the thesis

This thesis contributes to knowledge of how post-traumatic stress, anxiety, hyperarousal symptoms and sleep problems are distributed among a group of directly and indirectly trauma-exposed individuals. Furthermore, this thesis provides in-depth knowledge of what it is like to live with a traumatic event over three decades. The main findings of the study emphasize that symptoms of PTSD and anxiety may persist, and even increase, in a group of well-selected and trained soldiers. We also found a significant association between those with PTSD symptoms combined with hyperarousal symptoms and sleep problems 30 years after the avalanche. Furthermore, we found that those with sleep problems 30 years after the avalanche were most likely to have hyperarousal symptoms during the entire follow-up period, compared to those without sleep problems. Finally, in the qualitative part of the study, we found three different main categories in the group of surviving individuals. It may seem that the survivors have different strategies for coping and dealing with daily life throughout the three decades that have passed since the avalanche. The first category represents a more frequent use of adaptive coping strategies in daily life compared to the other categories. The third category represents the most challenging consequences of living with the experience of the disaster. Among the three, the latter category conveys the most maladaptive coping strategies.

Based on the results and findings in our study, early identifying of negative mental health symptoms, in particular post-traumatic stress and hyperarousal symptoms, may be crucial to shedding light on possible negative long-term sleep problems following disasters. From a public health perspective, this thesis may contribute to the identification of vulnerable individuals and groups, and further, to increase insight into different coping strategies used by survivors after a traumatic event. Such coping strategies may be relevant targets for intervention programs, help, advice and guidance for health professionals, survivors and their relatives, in order to deal with traumatic events in the long run.

Content

Overview of papers and attachments

This thesis is based on work performed during my appointment as external PhD-fellow at the Faculty of Health Sciences, Oslo Metropolitan University, from August 2016 to December 2019, under the supervision of Professor Ellen Karine Grov and CG of the Norwegian Armed Forces Joint Medical Services / M.D. / Dr.med / psychiatrist / major general, Jon Gerhard Reichelt. The thesis contains three papers:

Paper I: Bakker LP., Cvancarova MS., Reichelt JG., Gjerstad CL., Tønnessen A., Weisaeth L., Herlofsen PH., Grov EK. The trajectory of symptom burden in exposed and unexposed survivors of a major avalanche disaster: A 30 year long-term follow-up study. BMC Psychiatry, 2019; 19: 175-186.
DOI: **https://dx.doi.org/10.1186/s12888-019-2159-7**

Paper II: Bakker LP., Cvancarova MS., Reichelt JG., Gjerstad CL., Weisaeth L., Herlofsen PH., Grov EK. Sleep quality problems three decades post-disaster. Nordic Journal of Psychiatry, 2019; 73: 104-110.
DOI: **https://dx.doi.org/10.1080/08039488.2018.1563214.**

Paper III: Bakker LP., Eriksen S., Reichelt JG., Grov EK. The experiences of dealing with consequences of an avalanche – surviving soldiers' perspectives. International Journal of Qualitative Studies on Health and Well-being, 2019.
DOI: **https://dx.doi.org/10.1080/17482631.2019.1689066**

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Appendix I: The Peril Classification and Hazard Glossary (IRDR DATA Publication No. 1)

Appendix II: Overview of differences between DSM-IV; DSM-5 and ICD-10; ICD-11

Appendix III: Overview of patterns and trajectories of psychopathology post-disaster

Appendix IV: Overview of the aim, design, sample size, duration and description of outcomes of relevant avalanche studies

Appendix V: Description of the five-fold coping strategies according to Skinner and colleagues

Appendix VI: Sources and search strategy

Appendix VII: Posttraumatic Stress Scale-10 (PTSS-10)

Appendix VIII: Impact of Event Scale-15 (IES-15)

Abbreviations

CI	Confidence Intervals
CRED	The Centre for Research on the Epidemiology of Disasters
DSM	Diagnostic and Statistical Manual of Mental Disorders
FSAN	The Norwegian Armed Forces Joint Medical Services (Forsvarets sanitet)
ICD	International Classification of Diseases
IES	Impact of Event Scale
IES-R	Impact of Event Scale – Revised
IMPS	Institute of Military Psychiatry
LMM	Linear Mixed Model
M	Mean (values)
MDD	Major Depressive Disorder
NATO	North Atlantic Treaty Organization
OR	Odds Ratio
OsloMet	Oslo Metropolitan University
PSQI	The Pittsburgh Sleep Quality Index
PTE	Potential Traumatic Event
PTS	Posttraumatic Stress
PTSD	Posttraumatic Stress Disorder
PTSS-10	Posttraumatic Stress Scale-10
QoL	Quality of Life
SD	Standard Deviation
STAI	State Anxiety Inventory
TE	Traumatic Event

List of tables and figures

1.0 Introduction

Previous research and literature in the disaster field have indicated that physical and mental problems may persist long after the exposure to disasters [3-21], including a natural disaster like an avalanche [20, 22-24], has ended. Further, it is well documented that Norwegian survivors of traumatic events (TEs) might suffer negative long-term health effects after trauma [19, 25-35].

This study of soldiers directly and indirectly exposed to an avalanche disaster sought to examine the long-term health effects (mainly mental health) of such exposure, both directly or indirectly. Outcomes were findings of posttraumatic stress and anxiety symptoms, sleep quality problems, as well as other relevant background variables that may give answers to challenges that may follow a trauma. This thesis is part of a larger long-term research project that has followed a cohort of survivors and a sample of unexposed peers from the avalanche disaster at Vassdalen 1986 through four waves of data collections; two in 1986 (T1-T2), one in 1987 (T3) and the last one in 2016 (T4). The exposed survivors were interviewed once in 2016 with in-depth interviews with broad open-ended questions based on a thematic interview guide covering the experience of living with an avalanche disaster in everyday life during three decades post-disaster. Long-term follow-up studies of avalanche survivors are rather rare [20, 22-24].

1.1 The avalanche disaster at Vassdalen – 5th March 1986

On March 5, 1986, NATO initiated a military winter exercise called Anchor Express in Northern Norway, with approximately 23.000 male soldiers attending. The weather conditions were bad and deteriorated the last two weeks before the exercise. Temperatures varied from -2 degrees to -34 degrees Celsius, the wind intensity changed and large amounts of snow fell in this period [36].

All these changes in weather conditions resulted in an extreme avalanche risk in Troms county in Northern Norway, and especially in the valley Vassdalen where the avalanche disaster happened [36].

Vassdalen is a long narrow valley without roads and with steep mountainsides. An engineering platoon was given the job of opening a passage through the snow for the transportation of heavy equipment for the NATO exercise near this steep mountainside [36]. A few minutes past 1:00 p.m. March 5th, 1986, a so-called “slab-avalanche” struck the platoon of 31 engineering corps soldiers, leaving 16 dead and 15 survivors. The velocity of the avalanche was

approximately 35 m/s and the average depth was 2.5 meters, with a maximum of 8 meters and a the total volume of 20.000 m^3 [36].

Of the 31 soldiers in the platoon, 17 soldiers were completely buried by the avalanche, 13 soldiers were partly buried, and one not at all. The soldiers struck by the avalanche were isolated for one hour before help could reach them. During this period, six of the 13 partly buried soldiers managed to start a random search of the avalanche area, looking for survivors. Three hours after the impact of the avalanche, the last survivor was found and brought out of the area [36].

Rostrup, Gilbert, and Stalsberg [37] and Stalsberg and colleagues [38] reported a considerable proportion of physical injuries in the group of survivors of the avalanche. Further, Herlofsen [36] has described and reported on mental health symptoms during the first year post-disaster in the two groups investigated: the group of 15 survivors and the group of 15 remaining, unexposed soldiers from the same platoon who were left outside the avalanche area as a reserve.

The unexposed, reserve soldiers were enrolled in the project immediately post-disaster, alongside the survivors. Herlofsen [36] reported that PTSD-symptoms (i.e., posttraumatic stress, distress and anxiety symptoms) were present in all soldiers investigated immediately post-disaster. One year post-disaster there were few signs of PTSD-symptoms in the unexposed group compared to the exposed group. The statistical analysis did not show any statistically significant differences between the two groups during the first year [36].

The Vassdalen avalanche disaster of 1986 is the largest avalanche disaster in Norwegian military history to date. The historical facts about the disaster have been described in more detail by Herlofsen [36].

1.2 Aim of the thesis

The overarching aim of this thesis is to gain more knowledge about possible long-term mental health symptoms (i.e., posttraumatic stress, anxiety and sleep quality problems), and, further, to explore and describe experiences of daily life after having experienced an avalanche three decades ago.

1.3 Specific research questions addressed in this thesis

Paper I:

- Is there a difference between the exposed and unexposed soldiers regarding long-term mental health symptoms?

Paper II:

- Is there a difference between the exposed and unexposed groups regarding sleep quality problems (PSQI>5) – 30 years post-disaster?
- Is there a difference between exposed and unexposed groups regarding hyperarousal symptoms?
- Is there any association between levels of sleep quality problems (PSQI>5) and levels of PTSD-symptoms (PTSS-10≥4; IES-15≥26) with and without hyperarousal symptoms – 30 years post-disaster?
- Is there any association between levels of reported sleep quality problems (PSQI>5) and levels of self-reported hyperarousal symptoms?

Paper III:

- What are the survivors' experiences of their health condition and daily life?
- How do the survivors cope in daily life?

The titles and objectives of the three papers constituting this thesis are presented in Table 1.

Table 1. Titles and objectives, papers I-III

	Title	Objective
Paper I:	The trajectory of symptom burden in exposed and unexposed survivors of a major avalanche disaster: A 30 year long-term follow-up study	To describe and evaluate possible differences in long-term mental health symptoms after a major avalanche disaster between exposed and unexposed soldiers.
Paper II:	Sleep quality problems three decades post-disaster	To describe and evaluate possible differences regarding sleep quality problems and hyperarousal symptoms between exposed and unexposed survivors after an avalanche. To describe any association between avalanche exposure and survivors' self-reported sleep quality problems and posttraumatic stress (disorder) symptoms with and without hyperarousal symptoms.
Paper III:	The experiences of dealing with consequences of an avalanche – surviving soldiers' perspectives	To explore and describe experiences of daily life after having experienced an avalanche three decades ago.

2.0 Background

This thesis is written at Faculty of Health Sciences, Oslo Metropolitan University (OsloMet). The key elements in the PhD-program at this faculty are: interventions in health promotion, preventive health care, treatment, rehabilitation and care. In the recognition that health is a complex and comprehensive phenomenon that involves interaction between physical, psychological and social dimensions, the PhD-program acknowledges to combine quantitative and qualitative methods. This thesis uses both quantitative approaches (by me interpreted as a positivistic paradigm for this study) and a qualitative approach (interpreted as an interpretivistic paradigm), and thus applies different scientific traditions. The use of a qualitative approach with a hermeneutic method (here: text analysis) gives us the opportunity to complement quantitative data (from standardized questionnaires) to gain a deeper understanding of a phenomenon and its complexity in its unique context rather than trying to generalize the base of understanding to the whole population [39]. Although the various professions and disciplines at the faculty place different emphasis on health dimensions, they share a common understanding of the goal of promoting health, quality of life and well-being. This thesis is thus in line with the PhD-program's overall aim of bringing in different approaches and methods, as long as these methodological choices are in line with the specific research questions stated. Additionally, this thesis incorporates the goal of promoting health (describing the challenges for and highlighting the most vulnerable) and exploring daily life in the cohort (to enhance knowledge about their well-being).

2.1 Potential Traumatic Events (PTEs) and Traumatic Events (TEs)

In this section, I will describe the epidemiology of PTEs/TEs from the research literature and describe the definitions and understanding of how these two terms will be used in this thesis. The use of the term PTE seems to be more and more frequent in literature internationally. Furthermore, it seems as if the term PTE reflects the recognition that people may be affected differently by the same PTE - including individuals who do not initially seem to be affected by such exposure [32]. However, the most frequently used term in the trauma research field seems to be traumatic event (TE). This term is often used in daily speech to refer to events that are moderately distressing [32]. However, in psychology the term TEs is used to describe more catastrophic and severely distressing events as documented in e.g. the "Diagnostic and Statistical

Manual of Mental Disorders, Fifth Edition" - (DSM-5). The DSM-5 requires a certain type and level of traumatic event(s) before it can be named as a TE(s) [40]. The victim(s) have to be exposed to actual or threatened death, serious injury or sexual violence in one of four ways [40]:

- Direct experience of the traumatic event(s)
- Witnessing, in person, the event(s) as it happened to others
- Learning that the traumatic event(s) happened to a close family member or friend
- Experiencing repeated or extreme exposure to aversive details of the traumatic event(s); this does not apply to exposure through media such as pictures, movies or television [40].

The understanding and the use of the term PTE and TE in this thesis will, in general, be in accordance with DSM-5's use of the term TE.

Exposure to a broad range of different TEs is described as common in research literature, and studies have shown that between 20 and 90 per cent of the general population will once in their lifetime experience a form of TE [10, 11, 41]. A wide range of different TEs are described in literature - and the types of TEs experienced range from large-scale TEs (often unexpected events described as disasters and which cause destruction of property, death and trauma) [6, 8, 12], to individual exposure (as interpersonal violence often described as physical threat with weapon, rape, sexual abuse, imprisonment/taken hostage/kidnapped or verbal threat/ violence from close relation and, further, individual exposure such as car accident and so on) [10, 11, 41].

Every year disasters affect millions of people around the world (approximately 141 million victims in 2014) [42]), and there is, on average, one disaster reported every day worldwide [5, 12, 42]. Studies have reported that 10-19 per cent of adults will experience some type of disaster in their lifetime [12, 43, 44].

Goldmann and Galea [12] argue in their paper that there is no consistent definition of disasters in the literature. Some literature define disasters as TEs that are collectively experienced, are time-delimited and have an acute onset [45]. However, in literature, disasters often are frequently categorized into three types [12, 45]:

- **human-made** (man-made) **disasters** [12, 45]
  (i.e., intentional acts such as terrorism and mass violence, e.g., Utøya attack, 2011 [46, 47] and the 9/11, 2001, World Trade Centre attacks [48])

- **non-intentional technological disasters** [12, 45]
  (e.g., North sea oil rig disaster, Alexander L Kielland, 1980 [19])
- **natural disasters** [12, 45]
  (e.g., avalanches [20], floods [49], tsunamis [32] and hurricanes [50])

These three types of disasters can overlap and become multi-type disasters (e.g., involve both technological and natural disasters, such as the TEs in Fukushima, Japan, 2011) [12, 51].

2.1.1 Natural disasters

Natural disasters are divided into six sub-groups in the Peril Classification and Hazard Glossary (IRDR DATA Publication No. 1) defined by the Beijing: Integrated Research on Disaster Risk (IRDR) [52]: (1) geophysical, (2) meteorological, (3) hydrological, (4) climatological, (5) biological and (6) extra-terrestrial. See Appendix 1 for more detailed description.

The Centre for Research on the Epidemiology of Disasters (CRED) report in their "CRED Crunch 54 - Disasters 2018: Year in Review" that overall, floods have affected more people worldwide than any other type of disaster in the 21st century [53], followed by storms and earthquakes. Furthermore, Chen and Liu [49] highlight in their systematic review that floods are one of the top 10 natural disasters that threaten human survival today [49, 54], and, further, that earthquakes and tsunamis are the natural disasters that kill most people [53]. Based on this, the vast majority of research on natural disasters has focused on the health of survivors from natural disasters such as floods, hurricanes and earthquakes [6-8]. Although this thesis is about a rarely studied natural disaster category, the avalanche, natural disaster studies in general have value for this thesis. Lastly, a recent Norwegian study reports that the lifetime prevalence of Norwegian men at risk of being exposed to a natural disaster is 1.4 per cent [10].

2.2 Psychopathology and negative health outcomes after disasters

North [5] writes in her methodological review and interpretation of research findings that most knowledge of TEs has, in a historical perspective, been contributed by research on non-disaster traumas [5], and, further, that the history of disaster mental health research and epidemiology is considered as relative young [5]. Historically, the non-disaster research is mostly from TEs involving individuals in the community (e.g., car accidents, childhood abuse, personal assaults) [5, 8, 55] and war combat [5, 56, 57]. However, the exposure to TEs as disasters is a major problem worldwide, and studies of disasters are associated with a broad variety of negative

mental health (psychopathology) and physical health effects [3-20], e.g., psychopathology as PTSD, depression, major depressive disorder (MDD), sleep-related disturbance and chronic anxiety, suicidal behavior, but also reduced quality of life (QoL) and impaired psychosocial functioning [3-20]. Further, studies have shown increased physical health problems such as musculoskeletal problems, impact on the nervous system, cardiovascular disease and gastrointestinal symptoms, and, finally, some studies have also found that substance abuse may be associated with poor physical health and PTSD [3-20].

Studies of TEs have shown that the majority of victims cope very well post-trauma, and do not develop psychopathology [5, 12, 58, 59]. However, the risk of developing psychopathology after trauma is related to what type of TEs one is exposed to, i.e., the incidence and prevalence varies with the type of TEs and duration of exposure [4, 10, 12, 13, 60-62]. Studies have shown that exposure to individual trauma such as interpersonal violence is associated with the highest prevalence rate of psychopathology compared to being exposed to any other type of disaster [4, 10, 12, 13, 17, 60-63].

North [5] argues in her review that it is of central importance to identify psychiatric illness after disasters in order to estimate population needs for psychological interventions, and the logical place to start approaching mental health post-disaster is with psychopathology [5, 64]. Therefore, in this section, I will describe the main categories of psychopathology observed after disasters. As mentioned previously in this section, there is a broad range of negative mental health outcomes after disasters; however, the most commonly studied post-disaster psychiatric disorder, and most likely outcome, is PTSD [5, 6, 8, 12, 64, 65]. This may be because PTSD is usually the most prevalent disaster-related psychiatric disorder described in literature, and it is also regarded as a signature diagnosis of disasters [5, 6, 8, 12, 64, 65]. Further, the term ‘signature disaster’ might explain why PTSD is considered as a reasonable starting point for considering potential psychopathology when studying survivors of disasters [5, 6, 8, 12, 64, 65].

The estimates of lifetime prevalence rates of PTSD in the general populations are described to be between 1.3 to 11.2 % in a broad range of studies in the trauma research field [3, 6, 10, 44, 60, 66]. Furthermore, a recent study by Lassemo and colleagues [10] estimates that 9.1 % of Norwegian men exposed to a natural disaster will probably fulfill the diagnostic criteria for being at risk for PTSD.

Several studies have investigated the prevalence rates of PTSD and other psychiatric illnesses among direct victims of disasters. These estimates of prevalence rates of PTSD have a range from 5-60 % among adult survivors [7]. However, most previous studies report estimates between 30 to 40 % for the prevalence of PTSD among direct victims of disasters [5, 6]. On the other hand, North [5] claims that these latter estimates may indicate too high prevalence of PTSD because the estimates appear to be based on large population studies using symptoms screening instruments and not diagnostic assessments [5, 67-69], and many of the studies include both direct and indirect victims, which may explain in part the large variance of PTSD prevalence between studies [5-7]. Therefore, North, Oliver, and Pandya [69] decided to investigate a series of 10 disasters studies involving 811 directly exposed victims. All these selected studies used structured diagnostic interviews to find the disaster prevalence of PTSD [69]. The mean post-disaster prevalence of PTSD for the 10 studies investigated was 16%, and 20% for any diagnosis [5, 69]. Further, a recent study checking the cross-national lifetime prevalence of PTSD, a part of the World Mental Health Surveys, showed that the cross-national lifetime prevalence of PTSD was only 5.6% among direct victims and 3.9% in the total sample [3].

However, in the disaster research field, depression is the second most commonly studied mental health consequence post-disaster [5, 12], though a recent study by North and colleagues [70] found that the most prevalent post-disaster disorder was MDD. Further, studies of other mental disorders associated with disasters (e.g., suicidality, generalized anxiety, panic and substance use disorders), found these to be less prevalent (i.e., less than 10%) [5, 8, 12, 65].

Disaster-related PTSD commonly presents with psychiatric comorbidity and is rarely presented in isolation [12, 71]. However, there is evidence in the literature that individuals diagnosed with one mental disorder have substantially increased odds for meeting the criteria for at least one other mental disorder [72, 73]. Furthermore, Goldmann and Galea [12] claim, in a recently published review of mental health consequences of disasters, that other studies have found that PTSD after disasters often is accompanied by symptoms of other disorders such as MDD, anxiety disorders, and substance use disorders [12, 65, 74-76]. However, it is important to emphasize that it is a common understanding and agreement in disaster research that drug and alcohol use do not usually begin after disasters, but that preexisting alcohol and drug abuse may recur or worsen [64].

2.2.1 PTSD

As mentioned earlier, PTSD is the most frequently studied psychiatric disorder among the diverse responses to TEs, and the most likely outcome [5, 6, 8, 12, 64, 65]. Although this thesis captures symptoms of PTSD with only validated screening instruments, and not with diagnostic tools, PTSD is still a key concept that must be described in detail here.

PTSD was first included in 1980 in the DSM diagnostic manual, the "Diagnostic and Statistical Manual of Mental Disorders III (DSM-III)" [77]. This inclusion provided a new option for classifying chronic conditions in individuals who had developed long-term symptoms after TEs [77]. Today, two major diagnostic systems are commonly used worldwide to diagnose PTSD among individuals that have developed such long-term symptoms post-disasters: the "International Classification of Diseases (ICD)", presently in its eleventh edition (ICD-11), and the "Diagnostic and Statistical Manual of Mental Disorders (DSM)", presently in its fifth edition (DSM-5) [40, 72, 78]. Historically, both ICD and the DSM diagnostic system have defined most mental health and disorders using similar criteria; however, DSM-5 and ICD-11 propose definitions of PTSD that diverge substantially compared to earlier versions of ICD and DSM diagnostic systems [40, 78, 79]. However, both DSM-5 and ICD-11 begin with criterion A, which requires exposure to a traumatic event for receiving a PTSD diagnosis. Pai, Suris, and North [80:4] emphasize that "Criterion A is not only the most fundamental part of the nosology of PTSD, but also its most controversial aspect" [80, 81]. See Appendix 2 for how DSM-IV; DSM-5 and ICD-10; ICD-11 differs in multiple ways regarding the PTSD criteria.

The survivors from the avalanche disaster in Vassdalen were suddenly and unexpectedly confronted with an extreme stressor. This disaster involved a death threat as they were all struck by the avalanche and many were buried under the snow masses. There is no doubt that this was a horrific TE that posed a direct threat to the lives of all men hit by the avalanche. Many of the survivors of the avalanche witnessed colleagues and friends die or become severely injured. Surviving this TE met all of the stressor criteria for PTSD in both the DSM-5 and the ICD-11 version.

Further, the transfer of PTSD from the anxiety disorders category to a new diagnostic category named "Trauma and Stressor-related Disorders" in the DSM-5 was, perhaps, the most substantial conceptual change [80]. However, moving PTSD to this new diagnostic category in the DSM-5 indicated a common focus of the disorder as relating to adverse events [80].

Furthermore, in ICD-11, acute stress reaction is no longer considered to be a mental disorder, but instead is understood to be a normal reaction to an extreme stressor [82]. Non-specific symptoms common to PTSD and other disorders (e.g., sleep problems, trouble concentrating and irritability) were, in the ICD-11, removed to increase the specificity of the PTSD diagnosis [83].

Although DSM-5 and ICD-11 have made the above described changes to their manuals, it is important to emphasize that in this thesis we have used screening instruments for both anxiety and sleep problems. For anxiety, we have four time-points for symptoms during the three decades post-disaster, and we have therefore added an anxiety instrument because symptoms of anxiety have been reported in individuals post-disasters in several studies [12, 65, 74-76]. Furthermore, additional measures of sleep problems 30 years post-disaster have been added as assessment tool in this project, as sleep problems today are considered as a core feature rather than a secondary symptom of PTSD in research literature [84-90]. The screening instruments of anxiety and sleep problems will be described in more detail in the method section.

2.2.2 Course and trajectories of psychopathology after disasters

The number of long-term natural disaster studies is limited, but the majority of studies indicate that survivors may experience a wide range of negative mental health effects [3-9]. A recent systematic review [91] of the course of PTSD in naturalistic long-term studies claims that PTSD is presumably the core psychopathology post-disaster [6, 55, 91]. However, one of the greatest reviews done in the history of survivors post-disaster [8] shows that only 15% of 225 studies had a follow-up more than one year post-disaster [8, 92]. Studies and knowledge of PTSD's long-term course in survivors are still considered scarce [91, 93, 94].

Several studies have observed a broad variety in posttraumatic stress symptom courses after TEs rather than a consistent and stable level of posttraumatic stress symptoms [32, 59, 95, 96]. Some studies claim that PTSD-symptoms may occur soon, beginning already the first day, after trauma [5, 65, 97] and reach their peak in the first year following trauma and then decline [12, 98-100]. Further, others studies indicate that PTSD-symptoms may persist for months and years for some survivors [12, 98], or the symptoms may for some survivors have delayed-onset, sometimes for years. Delayed-onset is, however, considered rare in literature [12, 59, 98]. Furthermore, several other types of patterns have also been reported regarding the course of PTSD-symptoms and trauma-related psychopathology course, e.g., cyclical, quadratic, sub-syndromal [8, 26, 32, 101, 102] and U-shaped courses [103, 104], i.e., a pattern where there are

high levels of negative mental health symptoms immediately after trauma, then declining during the years of work life but possibly returning as the survivors cope with age-related issues and transition into retirement [103, 104]. However, many survivors will never experience, or be given an opportunity to report, all the symptoms for a full diagnosis of PTSD, but have sub-syndromal or sub-threshold PTSD, with impaired functioning close to a fully diagnosed PTSD [26, 102, 105-108]. As mentioned before, several different researchers have suggested different distinct symptom trajectories or ways in which PTSD could show up in survivors, e.g., chronic pattern, delayed pattern, recovery pattern, resistance and resilience pattern [59, 109]. See Appendix 3 for further descriptions.

Lastly, it is important to mention that over the past few decades interest in resilient and growth patterns or trajectories has increased due to the fact that most people exposed to TEs cope well post-disaster [5, 109-111].

2.3 Short and long-term studies after avalanches

There are few studies that specifically investigate the short- and long-term effects of avalanche disasters on survivors [20, 22-24, 36-38, 112-118]. However, Herlofsen [36] reported that common symptoms seen in PTSD were present in many of the surviving soldiers investigated in our study, both in the exposed and unexposed group, immediately post-disaster. In the follow-up, one year later, the unexposed group showed few signs of PTSD-symptoms compared to the exposed group. However, during all time-points measured the first year post-disaster (T1-T3), the analysis did not show any statistically significant differences between the two groups regarding PTSD-symptom scores [36].

In the same sample of avalanche survivors as in Herlofsen [36] and our study, Rostrup, Gilbert, and Stalsberg [37] and Stalsberg and colleagues [38] reported cases of different physical injuries (i.e., pneumothorax, knee ligament injury, humerus-, leg-, and facial fractures) in survivors that arrived at the hospital immediately after the disaster.

There are also four Norwegian military short-term studies of avalanche victims from other avalanche disasters [114, 116-118]. The first study is a quantitative study by Johnsen and colleagues [114] that reported higher levels of posttraumatic stress symptoms in a group of exposed survivors and rescuers, 2 weeks post-disaster, compared with a group of unexposed subjects. Further, all groups in the Johnsen and colleagues [114] study showed decrement in symptoms on the 4-month follow-up [114]. The second study is a quantitative study by Johnsen

and colleagues [117], and reported higher trauma-related symptoms as well as decreased QoL in the group with repeated exposure to traumatic events. Furthermore, this study reported that an avoidant focused coping style might increase the risk of being sensitized [117].

The third study is a quantitative study by Eid [116]. Eid [116] reported stable low levels of PTSD-symptoms at a 12-month follow-up in two samples of military personnel after two fatal training accidents (i.e., a shipwreck and an avalanche). Further, the study reported that 23% of the individuals revealed a stable high or increasing trend, while 77% revealed a stable low or decreasing trend in avoidance and intrusion symptoms over time [116]. Lastly, the fourth Norwegian study is a mix-method study by Eid, Johnsen, and Saus [118]. They reported, in two military samples exposed to a traumatic event (i.e., shipwreck and an avalanche), that negative emotional expressions were linked to psychological distress and trauma specific symptoms, whereas positive emotional expressions were associated with lower levels of psychological distress [118].

Further, two short-term Icelandic avalanche studies are documented, one by Asmundsson and Oddsson [112] and one by Finnsdottir and Elklit [113]. The first study [112] reported that approximately 40% of adult survivors had PTSD-symptoms. The second study [113] reported that the most common symptoms were anxiety, tension, sadness, intrusive thoughts and feelings post-disaster.

The four Icelandic long-term studies [20, 22-24], following up the short-term avalanche studies done by Asmundsson and Oddsson [112] and Finnsdottir and Elklit [113], reported long-standing negative health effects on survivors' health 16 years post-disaster, manifesting as PTSD symptomology, sleep disturbances and stress related physical symptoms [20, 22-24].

Lastly, to our knowledge there exists one qualitative study of survivors of an avalanche with some relevance for this thesis. In this study, the researchers interviewed ten mountaineers that survived an earthquake and subsequent avalanche at Mount Everest in 2015 [115]. The findings of this study provided detailed insight into the lived experiences of the surviving mountaineers, and the positive role mental toughness has in responding to and coping with a major natural disaster [115]. See Appendix 4 for an overview of the aim, design, sample size, duration and description of outcomes of relevant avalanche studies.

2.4 Trauma and coping

To our knowledge, little attention has been paid to identifying factors or coping strategies that affect functional levels in daily life post-disaster. Further, the majority of previous trauma and disaster studies are quantitative and focus on symptoms of psychopathology [119]. However, what is most interesting for the individuals that experience these symptoms, as well as for the health personnel treating them, is how these symptoms impact their daily life [119-124], in both the short and the long run. To our best knowledge, no qualitative studies highlight avalanche survivors' experiences of dealing with long-term daily life consequences. Knowledge about how survivors cope with different health consequences and symptoms after a natural disaster such as an avalanche, and its impact on daily life, might help health personnel identify targets of intervention that can contribute to reduce possible lasting disabling consequences of natural disasters. Therefore, in order to support well-being and health post-disaster, it is important to explore the phenomena of daily living here and now (cross-sectional) and in a long-term perspective (emphasizing retrospectively), using a qualitative approach.

2.4.1 Coping according to trauma

Previous studies have found significantly more functioning problems in people with psychopathology post-disaster than in those without psychopathology, in the initial days and months post-disaster [5, 94, 97]. A study by North and colleagues [94] found, during a time frame of seven years post-disaster, that functioning problems decline over time and are largely resolved, even among individuals with PTSD that still experience symptoms [5, 94, 97]. North [5] suggests that even though psychopathology symptoms continued post-disaster, individuals managed to find ways to cope with them in their daily life and move on, regardless of whether they experienced PTSD symptoms or not [5].

There are many ways to cope with daily life and adverse life events after experiencing stressful situations and TEs – both short- and long-term. However, in the literature, coping is mainly considered as a regulatory process that can reduce the negative feelings resulting from stressful situations as TEs [125, 126]. Lazarus and Folkman [127] defined coping styles as the behavioral and cognitive efforts (e.g., like the changing of action and thoughts [128, 129]) to manage internal and external stressors. Another definition is that coping strategies are psychological and behavioral efforts to tolerate, overcome or reduce the impact of stressful

events [130]. However, some researchers emphasize that coping is a dynamic process, fluctuating over time, in response to changing appraisals and demands of the situation [125, 131].

In research literature on stress and coping there are two major conceptual distinctions; (i) emotion- and problem focused strategies [132, 133] and (ii) avoidance and approach strategies [134, 135]. Based on the theory of stress and coping it is relevant to assume that different coping strategies (i.e., emotion, problem, avoidance and approach strategies) are used to manage stressful experiences such as avalanches. Most of the current coping-strategy literature relates coping to problem solving (e.g., active planning, specific behavior to overcome the problem) and active emotional strategies (e.g., cognitively reframing the problem, humor) to positive psychological adjustment [136-142]. On the other hand, avoidant emotional coping strategies are viewed as more maladaptive coping strategies that may interfere negatively with mental health [136-142]. Further, several quantitative studies have reported that coping strategies interpreted as adaptive, especially problem solving and seeking support, have been found to contribute to better and healthier functioning [139, 141, 142]. However, qualitative studies after natural disasters are also consistent with these findings, and the most cited adaptive coping styles were support seeking, problem solving and seeking meaning [143-145]. On the other hand, previous quantitative and qualitative studies after natural disasters have also shown that maladaptive coping styles, such as e.g., avoidance and distraction, are the most cited maladaptive coping styles [136, 143-145] and have been found to be associated with impaired functioning, psychological distress and poor health [138-142]. Avoidance has for example been associated with more acute stress reactions [146], and has been found to increase stress symptoms over time [147], to increase the risk of sensitization [147], and to increase the alcohol consumption and low well-being [147] in a couple of Norwegian military disaster studies too. Further, one Norwegian mixed-method study of a group of military shipwreck and avalanche survivors investigates the relation between indicators of emotional processing, psychological distress and PTSD-symptoms, and showed that negative emotional expressions were linked to trauma, whereas positive emotional expressions were associated with lower levels of psychological distress [118]. It is important to emphasize that the relationships between TEs, reduced QoL, negative health outcome and coping strategies are complex and still not fully understood [148, 149]. Another issue important to highlight is that research literature argues that rigid reliance on just a few coping strategies may indicate problems in managing maladaptation and stress [142]. We also

have to keep in mind that the classification of coping strategies is nuanced, and that some of the coping strategies interpreted as used by individuals in studies of coping, may overlap [150]. A specific mind-set or coping strategy may serve one or several purposes [150], e.g., working may represent both a problem-solving and a distraction strategy/activity for survivors post-disaster. Nevertheless, there might be several other theories and models of interest in the literature concerning coping and which should be mentioned here such as e.g., the relation between personality and coping, and resilience and coping. Coping has also been described by Bolger and Sarason [151:525] as "personality in action under stress". Another theorist, Vollrath [152:341], suggested that "coping ought to be redefined as a personality process". However, this thesis is based on the well-established formulations in which the previous described coping strategies and approaches are integrated, based on the analysis of 100 coping category systems by Skinner and colleagues [149], i.e., Skinner and colleagues [149] theory of coping strategies [153]

Skinner and colleagues [149:216] claim in their paper, "Searching for the structure of coping: A Review and Critique of Category Systems for Classifying Ways of Coping", that ways of coping, in the broadest sense, are the basic categories used to classify how people cope. These basic categories of ways of coping capture the ways people actually respond to stress, such as through cognitive restructuring, seeking help, rumination, denial and problem solving [149]. Further, Pearlin and Schooler [154] seem to interpret categories of ways of coping as what is happening during coping episodes [149]: "specific coping response: the behaviors, cognitions, and perceptions in which people engage when actually contending with their life-problems" [154:5]. However, they point out that "Coping, in sum, is certainly not a unidimensional behavior" [154:7-8], since core categories of ways of coping are organizational constructs used to encompass the countless actions individuals use to handle stressful situations [149]. Furthermore, categories of ways of coping are considered as mechanisms through which coping has long-term effects on physical and mental well-being as well as short-term effects on the resolution of the stressor [149]. Nevertheless, in the literature coping is a contested concept and many researchers have tried to develope assessment scales and frameworks over the past four decades that attempt to distinguish its key components [150] (e.g., Carver, Scheier and Geen [132]; Folkman, Lazarus and Hogan [133]; Roth and Cohen [134]; Snyder [135]). Despite the lack of consensus in the field regarding core categories of coping, the coping researchers in general agree that the study of coping is fundamental to enhancing understanding of how stress affects people, for better and for

worse [149]. However, some researchers have tried to identify best practices for constructing coping category systems; Skinner and colleagues [149] for example tried to analyze 100 coping category systems proposed from the 1980s to 2000. From this analysis, a list of 400 ways of coping was compiled. In more than 100 category systems Skinner and colleagues [149] examined in their review, no two included the same set of categories [149:216, 155]. From the latter, we can understand that there is a clear need in this research field for consensus on dimensions or categories that best distinguish between different coping strategies.

The Skinner and colleagues [149] analysis ended up with five core categories of coping: (i) problem solving, (ii) support seeking, (iii) avoidance, (iv) distraction and (v) positive cognitive restructuring. See Appendix 5 for a more detailed description of the Skinner and colleagues [149] five core categories of coping.

Even though Skinner and colleagues [149] concluded with five core categories of coping that were very clear, they claim that four more categories could be considered strong candidates, i.e., emotional regulation, rumination, social withdrawal and helplessness. However, I will in this thesis use the Skinner and colleagues [149] five categories to interpret and organize the coping strategies for the categories we found through our main theme in our content analysis in paper III (see Appendix XV). Lastly, I decided to use the Skinner and colleagues [149] five core categories of coping because these well-processed categories are broadly supported in literature on coping, and cover a wide range of behaviors and thoughts. Another argument for using the Skinner and colleagues [149] five core categories of coping are that the authors argue for a model depicting coping as a multi-level adaptive system that includes both coping and resilient features [153]. Skinner and Zimmer-Gembeck [153:36] claim that the study of multi-level systems of coping "has the potential to add value to work on risk and resilience by investigating how overarching risk factors may (or may not) produce daily encounters with stress, and how individuals' everyday dealings with stress may (or may not) contribute cumulatively to lasting resources and vulnerabilities."

2.5 Risk factors and adverse health outcomes and planning for interventions post-disaster

Many studies aim to find risk factors that can predict different adverse health outcomes after disasters and TEs [6-8, 56, 156-158]. To study factors that may identify population or individuals at risk of developing PTSD, the most common approach referred in the literature is to predict adverse health outcomes post-disaster. This is consistent with life-course epidemiologic perspectives in literature [12, 159]. Furthermore, Goldmann and Galea [12] argue that experiences and characteristics of individuals pre-, peri- and post-disaster may interact to produce psychopathology and to influence mental health outcomes in trauma populations [12]. However, it is important to mention that predictors of physical health problems are not so broadly studied in the trauma field as the predictors of posttraumatic psychopathology. Nevertheless, a large portion of the elevated levels of physical health problems seen in populations exposed to trauma are linked to posttraumatic psychopathology in several studies (e.g., studies of trauma populations have found that especially PTSD and, further, depression have been found to mediate the relationship between trauma and physical health problems) [160-164]. These findings are consistent with studies of general populations, both in Norway [165] and in the U.S. [166], that indicate that physical health problems are also linked to depression and anxiety in general [165, 166]. However, studies to predict adverse health outcomes after disasters are important in general and may give us the opportunity to detect vulnerable individuals and groups.

The risk factors can be divided into three (i-iii) groups: risk factors that may predict and increase vulnerability to psychopathology (i) before (pre), (ii) during (peri) and (iii) after (post) trauma [12]. Table 2 gives a summary of these three different groups of risk factors for predicting psychopathology (i.e., mainly PTSD). This overview is important as risk factors may predict and increase vulnerability to psychopathology, which is important to describe with regard to the aim of this thesis, see Table 2 on the next page.

Table 2. Risk factors for predicting psychopathology divided into three groups

	Risk factors for predicting psychopathology
Pre-disaster	• Three (i-iii) pre-disaster risk factors are considered as key predictors for psychopathology: (i) prior mental health problems [5, 6, 8, 12, 13, 56, 65, 69, 167-169], (ii) female gender [3, 5-8, 12, 65, 69, 70, 169-171], and (iii) younger age [12, 56, 98] • Other pre-disaster risk factors are: low socioeconomic status [4, 7, 8, 12, 56, 167-169], minority ethnic status [7, 8, 12], low social support or poor relationships [5-7, 12, 167], being single [4, 12, 167], having children [8, 12], experienced traumatic or stressful events prior to the disaster [6, 12, 156, 167], being less educated [3, 56], and personality characteristics such as trait worry, neuroticism, avoidance coping [6, 8, 12, 172-175]
Peri-disaster	• The most predictive risk factor peri-disaster considered in the literature is the nature of trauma, i.e., the degree or severity of the exposure and proximity (e.g., death toll, proximity to where disaster occurred, number and intensity of disaster-related events, the type of disaster and duration of disaster) [6, 8, 12, 51, 56, 167, 176-178] • Other peri-disaster risk factors are: physical injury [179], bereavement [180, 181], and various subjective perceptions of components of the stressor, i.e., peritraumatic dissociation [156, 182], peritraumatic distress [183, 184], peritraumatic perceived fear, and subjective death threat [179, 185, 186]
Post-disaster	• Two (i-ii) post-disaster risk factors are considered as key predictors for psychopathology [12]: (i) Post-disaster life stressors (e.g., stressors as job loss, property damage, physical health conditions, and marital stress) [5, 12, 69] (ii) Social support, i.e., reduction in and low level of social support [5, 7, 8, 12, 56, 69, 156, 167, 168] • Other post-disaster risk factors are: early traumatic stress responses/acute stress disorder (ASD) [96, 156, 187-189], psychiatric comorbidity [13], individuals exposed to multiple PTE types [4, 63], catastrophic thinking and maladaptive self-appraisals post-disaster [190, 191], tendencies to engage in avoidant coping [192] or emotion focused coping [193], and substance abuse [194-197]

Norris and colleagues [198:176] suggest that post-disaster factors are more predictive of depression, whereas peri-event risk factors, such as the degree of disaster exposure, play a more significant role in the development of PTSD.

Several researchers have tried to provide general flow-charts for planning interventions after a disaster. Among those are Bryant and Litz [199:328], see Figure 1. Many of these charts mostly focus on the individual level, as does the presentation by Bryant and Litz [199:328]. However, disasters and traumas cannot be viewed narrowly; instead, they need to be seen through a broader lens, e.g., in a contextual connection integrating both individual-, interpersonal-, community, organizational-, societal, cultural- and developmental factors, and the period of time in history the assessments are done [200:16]. Center for Substance Abuse [200:16] has developed an integrated model showing trauma in the context of the individuals' environments, a so-called social-ecological model, see Figure 2.

In this thesis we have tried to modify and develop a new model, a theoretical framework, from the individual, focused flow-chart for planning interventions post-disaster by Bryant and Litz [199:328], and from a social-ecological framework to understand trauma suggested by the Center for Substance Abuse [200:16]. Our new combination model may be a first step contribution to further development of the social-ecological framework to understand trauma. We recommend using and further expanding this contextual framework for risk assessment in the short and long run after disasters, and use it to develop health promotion strategies, treatment interventions, coping/resilience programs and evaluate protective factors to improve well-being, see Figure 3.

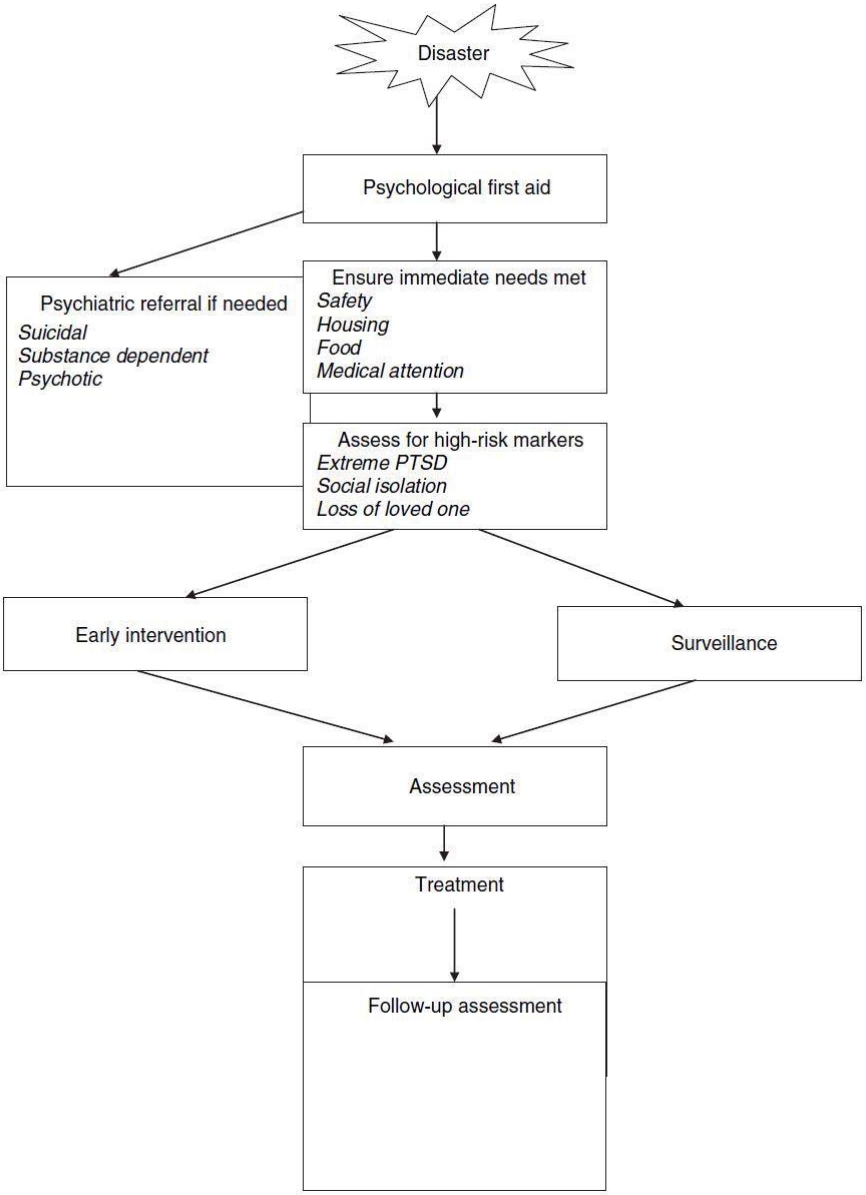

Figure 1. A figure developed by Bryant and Litz [199:328]: "Diagram for Managing Post-Disaster Mental Health Needs".

Individual Factors	Interpersonal Factors	Community and Organizational Factors	Societal Factors	Cultural and Developmental Factors	Period of Time in History
Age, biophysical state, mental health status, temperament and other personality traits, education, gender, coping styles, socioeconomic status	Family, peer, and significant other interaction patterns, parent/family mental health, parents' history of trauma, social network	Neighborhood quality, school system and/or work environment, behavioral health system quality and accessibility, faith-based settings, transportation availability, community socioeconomic status, community employment rates	Laws, State and Federal economic and social policies, media, societal norms, judicial system	Collective or individualistic cultural norms, ethnicity, cultural subsystem norms, cognitive and maturational development	Societal attitudes related to military service members' homecomings, changes in diagnostic understanding between DSM-III-R* and DSM-5**

**Diagnostic and Statistical Manual of Mental Disorders,* Third Edition, Revised (American Psychiatric Association [APA], 1987)

***Diagnostic and Statistical Manual of Mental Disorders,* Fifth Edition (APA, 2013a)

Figure 2. A figure developed by Center for Substance Abuse [200:16]: "Understanding the Levels Within the Social-Ecological Model of Trauma and Its Effects".

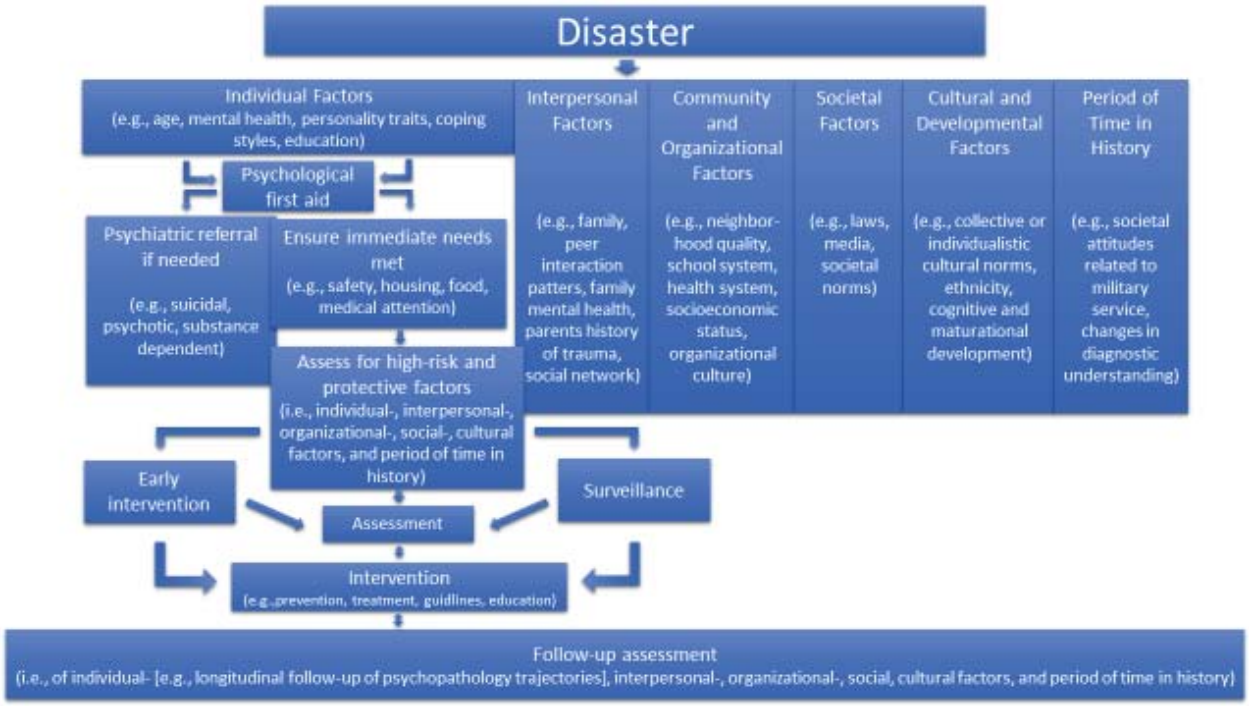

Figure 3. A Modified Social-Ecological Assessment Model for Assessing Mental Health Needs and Well-being in a contextual framework after trauma developed by Lars-Petter Bakker, inspired and modified from Bryant and Litz [199:328] "Diagram for Managing Post-disaster Mental Health Needs" and from the Center for Substance Abuse [200:16] «Understanding the Levels Within the Social-Ecological Model of Trauma and Its Effects". See Appendix XX for a better view of the figure.

3.0 Methods and materials

This thesis comprises three papers: two quantitative substudies (paper I and II) and one qualitative substudy (paper III). Paper I and II investigate the sample of soldiers, directly and indirectly to a major natural disaster, the Vassdalen avalanche. In the first two papers the overall methods of recruitment and data collection were identical, and statistical analyses were adjusted in relation to the aims of each paper. For the third paper, only the directly exposed soldiers were included in individual interviews, and the transcribed text was analyzed by means of content analysis, inspired by Graneheim and Lundman [2]. A search for relevant articles written in English and Scandinavian languages was performed in nine electronic databases up to May 2, 2019 (see appendix 6 for sources and search strategy). The study designs for all papers, together with the study sample, data collection methods and analyses, are presented in Table 3.

Table 3. Overview of study design, study sample, data collection and data analyses, papers I-III

	Paper I	Paper II	Paper III
Study design:	A cross-sectional design adding retrospective quantitative data from the same cohort study	A cross-sectional design adding retrospective quantitative data from the same cohort study	An explorative, cross-sectional qualitative study
Study samples:	12 directly exposed soldiers and 9 indirectly exposed soldiers of the Vassdalen avalanche	12 directly exposed soldiers and 9 indirectly exposed soldiers of the Vassdalen avalanche	12 exposed soldiers of the Vassdalen avalanche
Data collection:	Self-report measures designed to assess current subjective distress, posttraumatic stress disorder symptoms and anxiety symptoms: PTSS-10, IES-15 and STAI-12	Self-report measures designed to assess sleep quality problems, subjective distress, posttraumatic stress disorder symptoms and hyperarousal symptoms: PSQI, PTSS-10, IES-15 and PTSS-10/Hyp index	Qualitative in-depth interviews with broad open-ended questions based on a thematic interview guide
Analysis:	Descriptive statistics, t-test, Wilcoxon-Mann-Whitney test, Chi-square, Fisher's exact test, Binary logistic regression and Linear mixed model-analyses	Fisher's exact test, Binary mixed model regression analyses for repeated measures	Content analysis inspired by Graneheim and Lundman [2]

3.1 The quantitative papers (papers I and II)

3.1.1 Procedure and study samples

The first wave (T1) was conducted four days' post-disaster, the second wave (T2) at 30 days, the third wave (T3) at 375 days, and the last wave (T4) was conducted 30 years (between August 2016 and August 2017) post-disaster. All data were available for analyses in this study.

Participants for the 30-years, quantitative long-term follow-up study were recruited from all survivors and the sample of unexposed peers who took part in the one-year follow-up study (T1-T3) post-disaster.

By law, the Norwegian Armed Forces Joint Medical Services' record has an overview of the sample in this survey. Information about the survey (T4) and the questionnaire, with a sheet to sign for written consent, was sent by postal mail to all potential participants. The population comprised 15 men in the exposed (survivor) group and 15 men in the unexposed group. They were informed that answering and returning the questionnaire and the signed consent form were considered as consent to participate in the study. The participants were followed up by a phone call and a message via mail or postal mail, thanking those who had returned the questionnaire and reminding those who had not returned the questionnaire.

Informed consent was given by 12 in the exposed group, while 3 declined, at T4. Further, informed consent was given by 9 in the unexposed group, 1 never responded and 5 declined, at T4. The questionnaire files did not contain the names of the participants, and a separate "key" with the participants' names was created on a secure, separate drive, matching the file with the participants' codes. Due to the military selection procedures in 1986, both samples, the exposed and the unexposed group, comprised only men.

For an exact overview of the response rate for all questionnaires used at all time-points (i.e., from T1-T4) in this study, see Table 4 at the end of section 3.1.2.

3.1.2 Measures

Demographic information and measures:

Demographic and background characteristics information, such as number of potential traumatic events and questions about whether the disaster has had any negative impact on physical and mental health, was collected from the exposed and unexposed soldiers at T4 only.

Longitudinal measures of posttraumatic stress, hyperarousal, distress and anxiety:

Posttraumatic Symptom Scale-10 (PTSS-10; [201]), see Appendix VII:

There are two versions of PTSS, one 10-item and one 12-item version (i.e., PTSS-10 and PTSS-12) [185]. The PTSS-10 comprises a 10-item self-report questionnaire, originally developed by the Division of Disaster Psychiatry (at the Armed Forces Joint Medical Service in Oslo, Norway) [201]. The scale covers general stress manifestations such as irritability, sleep difficulties, depressed mood and startle reactions. PTSS-10 response alternatives are usually given on a seven point Likert scale from 1=rarely/seldom to 7=often. PTSS-10 had originally a dichotomous scoring option. The 10-item version with dichotomous scoring option (i.e., not present – No (0), and present – Yes (1)) was used at all time-points of this study. The PTSS-10 sum scores constitute the summation of the ratings (score range: 0-10), the total sum being interpreted according to the two following levels of PTSD-symptoms: 0 to 3 (mild/moderate range) and 4 to 10 (moderate/severe range). Most often a score of 6 or more represents "case" and 4-5 represent "caseness". In the current study a cut-off point of 4 or above indicates a need for psychological referral.

Four items in PTSS-10 have previously been used to construct a measure of hyperarousal symptoms [116, 202] (i.e., items no.1 (sleeping problems), no. 4 (startle reactions), no.6 (irritability), and no.10 (bodily tension)). In this study, we decided to not use item no.1 (sleeping problems), because this may represent a tautological problem as we compare the hyperarousal index with a sleep quality problem instrument. Only items no.4, no.6 and no.10 were used in this study to form a hyperarousal index (PTSS-10/Hyp index) (Hyp; range 0-3). Scores range 0 indicate no hyperarousal symptoms and scores ≥ 1 indicate hyperarousal symptoms.

The present study used this PTSS-10/Hyp index to evaluate symptoms of hyperarousal at T1-T4. Further, using the PTSS-10/Hyp index, we assigned all participants (from exposed and unexposed groups) with scores above cut-off point for the PTSS-10 into two groups: the first group being those with both PTSS-10≥4 and hyperarousal symptoms (PTSS-10≥4+Hyp group) and the second group those with PTSS-10≥4 but without hyperarousal symptoms (PTSS-10≥4-Hyp group).

PTSS-10 has demonstrated satisfying validity, reliability and internal consistency [185, 201, 203-205]. Further, the instrument has shown high specificity and sensitivity for trauma related health complaints [206]. Furthermore, the PTSS-10 has also been found to provide good face validity, and the direct wording of the items was closely related to the PTSD diagnostic

criteria [207]. However, it is important to note that PTSS-10 scores alone cannot give a formal PTSD diagnosis. Nevertheless, PTSS-10 can give an indication of the levels of symptoms empirically associated with PTSD. The PTSS-10 was used in all four waves (T1-T4). Participants were asked to report current PTSD-symptoms.

Impact of Event Scale-15 (IES-15; [208]), see Appendix VIII:

The IES-15 is a self-report measure designed to assess current subjective distress and PTSD-symptoms for any specific life event [208, 209]. The scoring method for measuring distress used a 6-point scale: 0; not at all, 1; rarely, 2; somewhat, 3; sometimes, 4; very much so, and 5; often. The 15-items scale provides a total distress score and two sub-scores: Intrusion (7 items) (range = 0-35) and Avoidance (8 items) (range=0-40). Scores from 0-8 indicate low level of distress, 9-19 represent moderate distress, and 20 or more, high level of distress, in both sub-scores. High levels of distress indicate need of professional evaluation and possible treatment, while moderate levels of distress are considered cause for concern [210]. The total distress score (score range: 0-75) represents the sum of the constructions "Intrusion" and "Avoidance". The instrument is closely connected with symptoms of PTSD [211]. The present study used IES-15 to detect distress and PTSD-symptoms in all our four waves (T1-T4). The total distress score can be interpreted according to the following four levels of PTSD-symptoms: 0 to 8 (subclinical range), 9 to 25 (mild range), 26 to 43 (moderate range), 44 and higher (severe range) [211]. Sterling [211] suggests that cut-off points of 26 or above indicate psychological referral. The IES-15 has demonstrated acceptable validity, reliability and internal consistency [208, 209], but does not include the third major cluster of PTSD-symptoms, a hyperarousal subscale [211].

Participants were asked to report current intrusion and avoidance symptoms during the past two weeks.

State Anxiety/Aggression Inventory-12/18 (STAI-12/18; [212]), see Appendix IX:

The STAI-18 is a self-report questionnaire designed to measure the presence and severity of current symptoms of anxiety and the generalized propensity to be anxious and aggressive [212]. The version used at all four data collection waves (T1-T4) contained only the 12 anxiety items. Data for the dimension aggression were not used due to missing data (6 items). In the present study STAI-18 will be named STAI-12.

The values measuring anxiety relate to a 4-point scale; 1; not at all, 2; somewhat, 3; moderately so, and 4; very much so. The STAI-12 sum scores represent the summation of the

ratings (score range: 12-48), and cut-off points of 30 or above would be grounds for psychological referral.

The instrument STAI-18 has demonstrated satisfying validity, reliability and internal consistency [212-214]. Participants were asked to report current symptoms of anxiety.

Measure of sleep quality problems:

The Pittsburgh Sleep Quality Index (PSQI; [215]), see Appendix X:

PSQI is a 19-items self-report questionnaire assessing seven components of sleep quality: (1) subjective sleep quality, (2) sleep latency, (3) sleep duration, (4) habitual sleep efficiency, (5) sleep disturbances, (6) use of sleeping medication, and (7) daytime dysfunction for the past month. A PSQI global score (a summary of the seven subcomponents) of >5 was used to indicate sleep quality problems [215]. The PSQI questionnaire was used only on the fourth wave (T4).

A systematic review and meta-analysis paper regarding the use of PSQI found strong positive evidence for validity and reliability, whereas moderate positive evidence for structural validity testing in a variety of non-clinical and clinical samples was found regarding the use of the instrument PSQI [216] .

Table 4 shows the response rate at the different measurement points and the different questionnaires used in this study.

Table 4. Overview of the questionnaires used in the study and the response rate

Response rate T1-T4 (N=15)	Instruments			
	PTSS-10	**IES-15**	**STAI-12**	**PSQI***
Exposed group T1 (n/N)	15/15	15/15	15/15	--
Unexposed group T1 (n/N)	15/15	14/15	15/15	--
Exposed group T2 (n/N)	12/15	12/15	12/15	--
Unexposed group T2 (n/N)	13/15	13/15	13/15	--
Exposed group T3 (n/N)	15/15	15/15	15/15	--
Unexposed group T3 (n/N)	15/15	15/15	15/15	--
Exposed group T4 (n/N)	12/15	12/15	12/15	12/15
Unexposed group T4 (n/N)	9/15	9/15	9/15	9/15

* The questionnaire PSQI was used only at T4 and described only in paper II.

3.1.3 Statistical analysis

Data were analyzed using the statistical program IBM SPSS Statistics version 24.0 [1] and Stata version 14.2 (StataCorp, 2005).

Paper I

Paper I is a quantitative study with long-term follow-up of a cohort over 30 years. The sample is described using descriptive statistics. Continuous variables are reported with mean (*M*) and standard deviation (*SD*), categorical ones with counts and percentages. Possible crude differences between groups (exposed and unexposed) at T1-T4 were assessed using the Wilcoxon-Mann-Whitney test for continuous variables and Chi-square or Fisher's exact test for categorical variables.

Further, for the continuous variables, linear mixed model (LMM) regression analyses were used to estimate possible differences between groups over time. An unstructured covariance matrix was specified to accommodate for heterogeneous residual variances across time.

Restricted maximum likelihood estimation was used to produce unbiased estimates of the model parameters. All overall effects were analyzed using *F* tests. The results were presented as estimated *Ms* with 95% confidence intervals (CI). Least significant difference post hoc tests were used to compare *Ms* at given time points.

All models were fitted with group, time and group*time interaction terms. All outcome measures were dichotomized, and odds for scoring over a given cut-off value were modeled using binary logistic regression models for repeated measures. The models were fitted with group and time. The results were expressed as odds ratios (OR) with 95% CI.

All available data were used because fitting linear mixed models and binary logistic regression models does not require imputation of missing data.

All tests were two-sided and p-values <0.05 were considered statistically significant. We regarded our study as an exploratory analysis and did not adjust for multiple testing in paper I.

Paper II

Paper II is a quantitative study with long-term follow-up of a cohort over 30 years. Differences between the exposed and unexposed group were analyzed using Fisher's exact test. Since the two study groups (the exposed and unexposed) reported similar levels of sleep quality problems and hyperarousal symptoms, we merged the groups for several of the analyses in this study.

PSQI measured 30 years post-disaster was dichotomized using a cut-off PSQI>5 to indicate sleep quality problems. Further, crude associations between this binary variable and other constructed binary variables (i.e., PTSS-10≥4+Hyp, PTSS-10≥4-Hyp, IES-15≥26+Hyp and IES-15≥26-Hyp) were analyzed using Fisher's exact test.

Binary mixed model regression analyses for repeated measures were used to estimate possible differences between the two groups over time regarding sleep quality problems and hyperarousal symptoms (PTSS-10/Hyp index). The results were expressed as odds ratios (OR) with 95% CI.

All available data were used because binary mixed models do not require imputation of missing data. All tests were two-sided and *p*-values<0.05 were considered statistically significant. We regarded our study as an exploratory analysis and consequently did not adjust for multiple testing in paper II.

3.2 The qualitative paper (paper III)

Most of the studies to date have used quantitative methods with standardized screening instruments to assess coping. Only a few studies have used qualitative methods, with in-depth interviews, to explore in more detail how survivors cope and manage their daily life after a natural disaster. Therefore, we performed a qualitative substudy.

3.2.1 Design and aim

A cross-sectional, explorative qualitative study was used in paper III to explore and describe experiences of daily life after experiencing the avalanche in Vassdalen three decades ago.

3.2.2 Procedure and study samples

The procedure of sending out information about the survey and the sheet to sign for written consent were the same as described in section 3.1.1

As described in section 3.1.1, all participants were followed up by a phone call in which they were also asked to make an interview agreement if they wanted to participate. However, in paper III only the survivors' interviews were included and analyzed. Twelve survivors entered into an interview agreement, while 3 declined to participate.

All the interviews were recorded as audio files, transcribed verbatim by a professional firm, and safely stored. The audio files and transcripts did not contain the names of participants, and a separate "key" with the participants' names was created on a secure, separate drive, matching the file with the participants' codes. The verbatim account was reviewed in full by the interviewer, Lars-Petter Bakker (LPB), and one of the co-authors, Ellen Karine Grov (EKG), and in part by the co-author Siren Eriksen (SE).

3.2.3 Interview guide

This study uses in-depth interviews with broad open-ended questions. The interviews were guided by a thematic interview guide, see Appendix XI. All the interviews were dialogical and adjusted to the responses of the participants. The interviews lasted between 20 and 180 minutes. Most interviews took place in hotel rooms, a few in Lars-Petter Bakker's office, and one interview, of a survivor, was held in the participant's home, according to his own wish. All conversations were private and conducted away from other people. With most participants, the dialogue flowed very well during the whole interview, and some of them confirmed that the conversation had turned out better than they had expected. In total, all participants confirmed that

they had a positive opinion of the session at the end of the interview. The PhD-fellow LPB performed all the interviews in this thesis.

3.2.4 Content analysis

The qualitative content analysis, with the search for manifest and latent meanings, was led by LPB and performed in several steps, see paper III, Appendix XV, to see all the steps. The analysis was inspired by Graneheim and Lundman [2] [217:215]. One of the co-authors, EKG, participated fully in the analysis process, in which the first step was to become acquainted with the data from the interviews without applying any theoretical perspective. Further, we discussed the actual theme and suggested descriptions (the manifest meaning) that emerged from the content analysis. See Appendix XII for examples of development from unit of meaning to categories.

4.0 Summary of results papers I-III

In the originally published papers, attached to this thesis, a more detailed description of the results can be found, see Appendix XIII-XV.

The summaries of the results from the two quantitative papers (paper I and II) are presented first. A description of the main findings from the qualitative paper follows (paper III).

4.1 Paper I: The trajectory of symptom burden in exposed and unexposed survivors of a major avalanche disaster: A 30 year long-term follow-up study

The exposed and unexposed soldiers reported almost similar numbers of experienced PTEs in their lifetime ($p>0.05$). Most of the remaining background characteristics were similar in both groups, except exposed group self-affection for the disaster's negative impact on physical ($p=0.005$) and mental health ($p=0.024$).

Inspection of unadjusted *M*-values for PTSS-10, IES-15 and STAI-12 scores indicated different patterns between the two groups, especially for PTSS-10 and IES-15, from T1 to T4. However, these changes did not reach the level of statistical significance using Wilcoxon Mann-Whitney test (all $p>0.05$, data not shown).

Further, LMM analyses did not reveal any statistically significant differences between the groups in adjusted *Ms* for mental health scores when assessed with PTSS-10, IES-15 and STAI-12 when all measurements were considered. As mentioned above, PTSS-10 did not reveal any statistically significant differences between the groups; there was, however, a significant effect of time. The *M*-levels of PTSS-10 declined over time, $p=0.001$, for both groups, and the shape of the time trajectories showed a statistically significant difference between the groups ($p=0.013$ for interaction term time*group). The IES-15 did not reveal any differences between groups; there was, however, a significant effect of time. The *M*-levels of IES-15 declined over time, $p=0.026$, for both groups. The time trajectories tended to differ between groups; this did not, however, reach the level of statistical significance. Lastly, the STAI-12 did not reveal any differences between groups; however, there was a significant effect of time. The *M*-levels of STAI-12 declined over time, $p= 0.001$, for both groups. The shape of the time trajectories was not different between the groups.

In 2016 (T4), 5/12 (42%) in the exposed group reported current PTS-symptoms (PTSS-10≥4), one half reported distress symptoms (IES-15≥26), and none reported anxiety symptoms

(STAI-12≥30) above cut-off points, which would indicate a need for psychological referral. Although not significant (all $p>0.05$), the unexposed group reported lower proportions of individuals above cut-off points for almost all instruments, except for STAI-12, compared to the exposed group at T4.

Further, binary logistic regression analysis revealed no difference in odds to score above the cut-off between the groups for PTSS-10 (OR=1.06, 95%CI [0.45–2.46], $p= 0.901$). The odds to score above the cut-off were lower for T2 and T4 compared to the T1 measurements; however, the difference did not reach the level of statistical significance. The odds to score above the cut-off were significantly lower at T3 compared to T1 (OR=0.25, 95%CI [0.08–0.79], $p= 0.018$). The soldiers were about 75% less likely to score above the cut-off at T3 compared to T1. For the IES-15 there was no difference in odds to score above the cut-off between the groups (OR=0.59, 95%CI [0.24–1.45], $p=0.249$). The odds to score above the cut-off were lower for T2, T3 and T4 compared to the T1 measurements; however, the difference did not reach the level of statistical significance for T3 and T4. The odds to score above the cut-off were significantly lower at T2 compared to T1 (OR=0.10, 95%CI [0.02– 0.49], $p=0.005$). The soldiers in both groups were about 90% less likely to score above the cut-off at T2 compared to T1. However, the odds were similar at T3 and T4 compared to T1 (all $p>0.05$). For the instrument STAI-12, there were too few individuals above the cut-off, and therefore the model could not be fitted.

4.2 Paper II: Sleep quality problems three decades post-disaster

No statistically significant differences were revealed between the groups regarding sleep quality problems (PSQI > 5), 30 years post-disaster.

There was a significant association between those with PTSS-10≥4 combined with hyperarousal symptoms (i.e. PTSS-10≥4+Hyp) and sleep quality problems (PSQI > 5) ($p=.046$), 30 years after the avalanche. No significant associations were revealed between those with sleep quality problems and PTSS-10≥4 combined without hyperarousal symptoms (i.e. PTSS-10≥4-Hyp) (data not shown). When posttraumatic stress symptoms were assessed with IES-15≥26, no significant associations were revealed between those with sleep quality problems and the instrument Impact of Event Scale-15, neither for those with, nor without, hyperarousal symptoms (i.e. IES15≥26+Hyp and IES-15≥26-Hyp) (data not shown).

Our data showed that those who had sleep problems (PSQI> 5) (in both groups) 30 years after the accident were most likely to have a higher chance of having hyperarousal symptoms throughout the follow-up period compared to those without sleep problems. The odds for having such symptoms did not change from T1 to T2, T3 or T4.

The analysis did not show any statistically significant difference between the exposed and unexposed groups regarding hyperarousal symptoms over time (OR = 0.98, 95%CI [0.44–2.20], *p*=.969. The odds for having such symptoms did not change from T1 to T2, T3, or T4.

4.3 Paper III: The experiences of dealing with consequences of an avalanche – surviving soldiers' perspectives

The content analysis revealed three different categories that describe the participants' experiences of living their daily lives during three decades post-disaster: (i) A comfortable life; (ii) A challenging, yet accomplished life; (iii) A demanding life. The survivors have different ways and ranges of coping strategies for dealing with their daily lives during the three decades post-disaster. Some of the survivors experienced "A comfortable life" with successful coping with the disaster in daily life and seemed to have a balanced life situation. They had more or less left the avalanche behind and looked ahead rather than back. Other survivors experienced "A challenging, yet accomplished life", where they tended to hold on to their traumatic experience, but nevertheless continued with daily life. The third way of the survivors' experiences was "A demanding life", in which the influence of the disaster was evident in daily life. The survivors with "A demanding life" seemed to use maladaptive coping strategies, interpreted as avoidance and distraction. From these three categories one main theme was identified: "Finding my own way of managing and dealing with life".

4.4 A summary of all three papers, presented in a theoretical framework

If we assumed that all persons that experience disasters were in need of mental health care, existing psychiatric services would clearly not have the capacity to meet such demanding amount of individuals [218]. Therefore, in a disaster context, to develop and implement assessment and surveillance methods to identify people who are at high risk for developing psychopathology, will be useful in order to indicate if such individuals require mental health interventions. As mentioned in section 2.5, I have developed a modified conceptual model of the Bryant and Litz

[199:328] version of "Diagram for Managing Post-disaster Mental Health Needs" and the Center for Substance Abuse [200:16] "Social-Ecological Model". Our results and findings in this thesis fit very well into such a theoretical framework. This model gives an overview of where to assess and where to indicate mental health interventions or assessments for other kind of support needed, see Figure 4, i.e., especially the boxes "Individual Factors" and "Follow-up assessment", where our results and findings are highlighted.

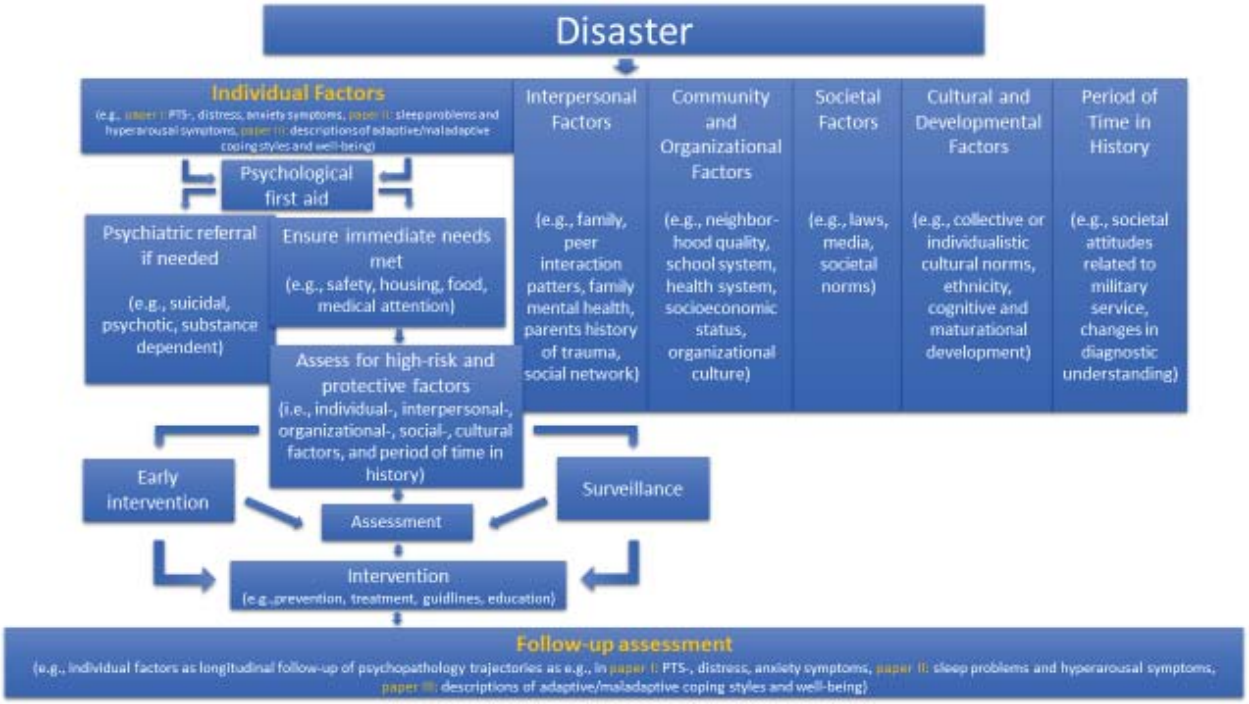

Figure 4. A Modified Social-Ecological Assessment Model for Assessing Mental Health Needs and Well-being in a Contextual Framework after Trauma developed by Lars-Petter Bakker, inspired and modified from Bryant and Litz [199:328] "Diagram for Managing Post-disaster Mental Health Needs" and from Center for Substance Abuse [200:16] «Understanding the Levels Within the Social-Ecological Model of Trauma and Its Effects". See Appendix XXI for a better view of the figure.

5.0 Discussion

The overarching aim of this thesis was to gain more knowledge about the long-term impact of a traumatic event in a group of directly and indirectly exposed survivors of an avalanche, and, further, to explore and describe experiences of daily life after having experienced an avalanche three decades ago – from a group of surviving soldiers' perspectives.

The purpose of this section is to discuss methodological considerations, the main results and findings of the entire study (all papers I-III). First in this section, the methodological strengths, caveats and limitations are discussed separately for the quantitative papers (I-II) and the qualitative paper (III), followed by a discussion of the main results/findings in our study (paper I-III). Lastly, in this section, implications for clinical practice and future research are proposed.

5.1 Methodological considerations

One strength of this thesis is that we have data from 30 years back in time, and that I combine two different methodological approaches to get an even better picture of the survivors' reports and experiences, thus more nuanced and with more perspectives than if I had only selected one methodological approach. However, there are several design and methodological strengths and limitations regarding our study that will be highlighted in this section. As mentioned above, we used both quantitative (paper I and II) and qualitative methods (paper III) to gain knowledge regarding our overarching aim. In this thesis a limitation might be that we decided not to use mixed-methods design that would have provided our study with pivotal information that could help us to better understand and interpret the data gathered through our quantitative questionnaires. However, mixed-method designs are very time-consuming and would demand significant funding and resources [219] that our study did not have. In advance, we could have performed a system of indicators for comparing the results and findings; however, a mixed-method was not the approach for this study. Furthermore, a mixed-method might also have increased the chances of retrospective identification of cases in our two small groups of well-known individuals.

However, in addition to using psychometric tested instruments, our face-to-face in-depth interviews with the survivors 30 years post-disaster gave us valuable and detailed information about how the survivors experienced dealing with consequences of an avalanche and how the survivors coped in daily life.

Literature biases in all papers (I-III)

Regarding the search for relevant English and Scandinavian articles and literature in nine electronic databases (see Appendix 6), I offer some reflections. As a method to supplement the database search, we reviewed the reference list of the articles we included as relevant for our study. For a variety of reasons, our search may have failed to include relevant articles, which may have affected all our results/findings in this study (paper I-III). We recognize a potential bias in our literature search strategy in the databases as a considerable number of our included studies were retrieved from supplementary sources and not from the database search (e.g., from reference lists of included studies and from other natural disaster studies (i.e., meta-analyses and reviews) rather than direct avalanche studies). The search terms are therefore significant.

In general, it is difficult to compare prevalence rates of psychopathology after natural disasters because of differences in type of disaster, degree of exposure, selection of study population, cultural setting and different use of screening and diagnostic instruments [5, 12]. Regarding type of disaster, authors of several studies have argued that natural disasters have potentially less severe mental health effect than man-made disasters [5, 7, 8, 13, 98], and a recent study by Morina and colleagues [93] showed that studies on PTSD among survivors of natural disasters reported the highest remission rate compared to survivors from other type of disasters. This is in line with several previous studies that have found that PTSD prevalence rate in survivors of natural disaster is somewhat lower compared to survivors of other types of TEs [6-8, 62, 93]. However, there exists a review-study by North, Oliver, and Pandya [69], "Examining a Comprehensive Model of Disaster-Related Posttraumatic Stress Disorder in Systematically Studied Survivors of 10 Disasters", that did not find any associations between PTSD and disaster types [69]. Mainly, the argument that natural disasters have potentially less severe mental health effect than man-made disasters is based on that population sampling after natural disasters tend to include a larger area of exposure, which may also comprise less affected individuals who are less likely to develop psychopathological patterns. However, we also know from research that disasters that are accompanied by a high death toll, physical injuries and fear of dying, result in higher risk and prevalence of psychopathology post-disaster [6, 7, 12]. Regarding our study, we have to highlight that 16 soldiers in the platoon died, and 14 of 15 soldiers in the exposed group were buried by the avalanche and reported a considerable proportion of physical injuries after the avalanche [36-38]. Furthermore, we have to emphasize that natural disasters seem to follow the same psychopathological patterns as other types of disasters [7, 32].

North [5] points out that in disaster literature there is a lack of consensus in many published articles regarding the use of the terms posttraumatic stress- (PTS) and PTSD-symptoms. Most studies published present posttraumatic stress symptom data assessed through screening measures without full diagnostic assessment, and the terminology in the research literature is thus likely to be confusing for readers who are not carefully attuned to methodological differences between symptoms screening and full diagnostic assessment [5, 12]. However, we recognize this and are aware that our study uses the terms PTS- and PTSD-symptoms assessed through screening measures without full diagnostic assessment. Further, we also recognize that the variety in methodological approaches of articles we have used may lead to variability in the results/findings, and that inadequately conducted research in such articles may have resulted in misleading comparisons of the results/findings in all of our papers (I-III).

5.1.1 Methodological considerations Paper I and II

Design and methodology of the study

First of all, the main strength of this study is the long-term follow-up of a complete sample of survivors across three decades in combination with a comparison group of peers. These conditions make our study unique in disaster related research and constitute major strengths. The quantitative papers (I-II) in this study are based on cross sectional survey data. However, we had data from three earlier waves, with the same measures, which gave the opportunity for repeated measures analyses. The whole Vassdalen study (all four waves) is thus a longitudinal study, which is a tremendously good research design [220]

Measures

A challenge and a limitation in our quantitative papers might be the selection of relevant measures consistent with our aim and research questions. However, various alternatives were considered for the major outcome instrument. Nevertheless, an important principle in our study has been to select standardized, validated instruments that were measured prior to the outcome at T4. The decision to use such previously used instruments (i.e., PTSS-10, IES-15 and STAI-12) in T4 was made due to the retrospective value of the instruments linked to the longitudinal dataset 30 years before. It is considered a strength in our study that we use retrospective data, allowing us to analyze changes over time regarding PTS, distress and anxiety symptoms with a mixed model (LMM) and binary regression analyses. A possible limitation of doing this might be the 29 years that have passed between the last two data collections from 1987 (T3) and 2016 (T4). Another

limitation may be that in paper II we used a self-report questionnaire (PSQI) that did not exist in the early phases of the data collection (i.e., T1-T3), and could only be included at the last wave, T4. However, adding an instrument that measures a particular challenge (sleep problem) for survivors after disasters [85-91] might also be considered a strength. Further, we used the retrospective data from PTS- and distress symptoms collected four times during the 30 years (T1-T4), in combination with a sleep quality problem measure collected only once, 30 years post-disaster (at T4). Therefore, it is impossible exactly to infer what might have been the link between the reported level of sleep quality problems (only measured at one time-point, T4) and the participants' negative mental symptoms and hyperarousal symptoms from earlier points in time (paper II). However, our decision to include measures of sleep quality problems was made because sleep problems are acknowledged as a core feature rather than a secondary symptom of PTSD [84-90].

Another possible limitation in paper II may be that the PTSS-10 instrument was designed as a tool for screening posttraumatic stress (disorder) symptoms, and not as an instrument for providing data on hyperarousal symptoms specifically. Furthermore, we decided not to use the full constructed hyperarousal index (i.e., did not use item no.1 - sleeping problems) from PTSS-10 because this may represent multi-collinearity and a tautological problem if we compared the hyperarousal index that includes a sleep problem item with a sleep quality problem instrument. We therefore used only items no.4, no.6 and no.10 in our study to form a hyperarousal index.

The participants may have experienced fluctuations over the years that our questionnaire approach did not detect. And we have to mention that our study is limited by a lack of information on pre-disaster mental health status and sleep quality problems. Furthermore, we did not include measures of personality traits in this study. Such traits have been found to predict posttraumatic outcomes in trauma survivors [125]. It is, however, important to emphasize that procedures for personnel selection and medical standards in the Norwegian Armed Forces make it fair to assume that no serious psychopathology was present pre-disaster. Nevertheless, even 'controlled' for the procedures for personnel selection process, it is possible that there are personality confounders influencing our results.

Further, the fact that our study relies on self-report of symptoms rather than physical and mental examinations and diagnostic tools, may cause deviation in true symptoms. However, we recognize and are aware that our study use screening measures without full diagnostic

assessment. Nevertheless, both instruments used to measure PTS and distress (i.e., PTSS-10 and IES-15) are closely related to the diagnostic criterias in DSM-5 and ICD-11 [40, 41, 207, 211], and furthermore, there is no doubt that all exposed survivors of this avalanche met all criteria for PTSD in both the DSM-5 and the ICD-11 version at T1.

Furthermore, another Scandinavian trauma study found that the PTSS-10 and IES-15 have relatively high convergent validity [221]. This may strengthen our case for using the selected screening instruments, and may be in accordance with what can be seen in our study too, regarding our results from the PTSS-10 and IES-15. On the other hand, we must remember that PTSS-10 is a Norwegian-developed instrument [201], while IES-15 is an American instrument [208]. This may lead to challenges in the translation process of the instrument (i.e., IES-15), especially due to cultural differences [222]. We did not perform any statistical tests to check the convergent validity for those two instruments in our study.

However, there is strength in that PTSS-10 was developed in a Norwegian sample of men, and is therefore thoroughly validated for Norwegian samples [19, 25]. Furthermore, another possible strength may be that PTSS-10 has previously been used concurrent with PTSD diagnostic interviews, and a high rate of consistency between the self-reported measures in PTSS-10 and the diagnostic interview CAPS-DX [223] was found. Further, PTSS-10 has been a commonly used instrument in clinical evaluation of military personnel in Norway after critical incidents the last three decades, and has shown good screening outcome for those who need professional help in a clinical setting.

A limitation may be that we used the total distress score, which represents the summation of the total sub-scores of intrusion and avoidance of the IES-15 instrument for our analysis, instead of additionally running two separate analyses of the two sub-categories. Paper I would have been strengthened if we had included such analyses in our study regarding the interpretation of eventual results of avoidance and intrusion symptoms related to psychopathology symptoms. This may also have supplied substantial information regarding our findings in paper III, related to maladaptive coping strategies interpreted as avoidant coping styles, although this thesis is not to be considered as a mixed-method study.

A further limitation may relate to our measuring of sleep quality problems with PSQI. PSQI does, to a small extent, detect variation patterns in the respondent's sleep and, therefore, cannot be used directly to diagnose sleep disorders [224]. This is the reason we describe the presence of

symptoms as “sleep problems”. Nevertheless, there is strength in using the PSQI in research since PSQI is relatively simple to administer and has been used in a number of studies, which offers great opportunities for comparisons of results [224].

Statistical issues

Our study includes only a small sample size of males (however, close to the whole population), which may evoke skepticism about whether the collected data can be subjected to statistical tests [225]. This may represent a limitation regarding statistical power and sex differences in our study. However, according to our power calculations, we would require 25 (PTSS-10), 23 (IES-15) and 121 (STAI-12) participants in both groups to reveal our findings as statistically significant with anticipated effect sizes as defined by Cohen [226] (in paper I). We did not conduct a power analysis of how many participants we would need in both groups for measuring sleep quality problems with PSQI (paper II). However, we assume the same results regarding power calculations for the instrument PSQI in paper II as for the instrument used in paper I, i.e., a need of more participants in both groups. Further, there is a definite risk for type II statistical error in all our non-significant differences due to our low sample size. However, a strength may be that the results that do show statistical differences in our study are stated as significant, despite the small sample size [39].

Generalizability

This study focuses on a single, sudden TEs, and this may limit the generalizability of the outcome to other forms of trauma [5, 12]. Several studies have argued that natural disasters have potentially less severe mental health effects than man-made disasters [5, 7, 8, 13, 98]. However, natural disasters follow a psychopathological pattern similar to other types of disasters [7, 32].

Several studies have revealed significant sex differences in responses to traumatic events [170, 227, 228]. Any generalization of our study’s results (paper I-II) to populations other than selected, well-trained males should therefore be done with caution. Nevertheless, it is important to emphasize that Thordardottir and colleagues [23] found no significant sex differences in the prevalence of PTSD 16 years after an avalanche. However, it is important to note that although our study includes only males, this may also represent a strength of this study since it is a small, homogeneous group (i.e., in terms of type of trauma, age, sex and time since trauma). Additionally, we have studied nearly the whole sample of soldiers affected by the avalanche disaster, 30 years post-disaster. The effect of non-participation may be an underestimation of

severe and intense negative mental health symptoms in paper I-II. Previous studies claim that people experiencing PTSD-symptoms are less likely to answer follow-up studies [93, 100]. Lastly, a limitation may also be that we did not have any access to normative data (results from the general population) for comparative purposes in paper I-II. It might be of interest in future research to compare our sample with data from the general population, e.g., results from the HUNT study, https://www.ntnu.no/hunt.

5.1.2 Methodological considerations paper III

Most researchers who write method literature today agree that it is difficult to evaluate qualitative studies in light of the traditional requirements for reliability and validity used in quantitative studies [229]. However, several authors on research methods have demonstrated how qualitative researchers can incorporate measures that deal with these issues. One such author is Guba [229-231]. Guba introduces a strategy for ensuring trustworthiness in qualitative studies [229]. By addressing similar issues (i.e., validity/reliability), Guba proposes four criteria that correspond to the criteria employed by the positivists: i.e., (i) credibility (in preference to internal validity), (ii) transferability (in preferences to external validity/generalisability), (iii) dependability (in preference to reliability) and (iv) confirmability (in preference to objectivity) [229-231]. To ensure trustworthiness in our qualitative study, the understanding of Guba's conceptualization and interpretation through Shenton's descriptions of "Strategies for ensuring trustworthiness in qualitative research project" will be used [229].

Credibility

Credibility is considered as the most important factor in establishing trustworthiness [229, 231]. In our study, a purposive sample of survivors of an avalanche was recruited. In order to provide background information to help us shed more light on the group of survivors, we talked with central personnel/witnesses and read a lot of written reports and newspapers that provided information about the disaster. We also watched several documentaries of the disaster. Based on all this information, we decided that we had to gather all relevant participants for a meeting. To discuss the feasibility of conducting this study, we first gathered possible participants for such a joint meeting. This was also done to gain an adequate understanding of the group of survivors and to establish a relationship of trust between the parties involved in this project. We recognized in this joint meeting that the discussions tended to veer toward irrelevant issues and the dialogue seemed to suffer from the dominance by some participants. Based on these observations and to

gain more detailed information from each participant, we decided to use individual interviews. Individual interviews may offer insight into the participants' personal experiences, feelings, thoughts and world view [232, 233], and participants may express their feelings more openly in individual interviews rather than in focus groups. All participants were given the opportunity to refuse to participate in the project without fear of losing credibility in the eyes of managers of the project and the military as an institution. We also made it clear to all participants that they had the right to withdraw from the study at any point without any explanation. This procedure ensured that the data collection sessions involved only those who genuinely wanted to take part in the project, which was ethically important. We have included and interviewed almost all the survivors (12/15), and the data were well saturated. The high degree of saturation may indicate that key points were well-covered.

A limitation might be that only data from a one-time interview were collected 30 years' post-disaster (T4). This gives us just a snapshot of the participants' opinions and experiences at the time of the interviews, and includes a risk of recall bias since the interview had a retrospective nature in addition to asking about the participants' experience here and now. We know that coping is a dynamic process that fluctuates over time in response to changing appraisals and demands of the situation [125, 131]. On the other hand, to explore and describe experiences of daily life after an avalanche and, further, to detect coping strategies within a frame of several decades, as in our sample, interviewing is the only feasible approach. Moreover, the findings presented in our study are highly context-specific, and might present an oversimplification of the survivors' coping with the disaster in their daily lives; other important experiences, not identified in the interviews, may have influenced the way they coped with the disaster.

The interviews were in-depth interviews with broad, open-ended questions, led by a thematic interview guide developed in agreement with all authors. The strength of this approach was that it enabled easy communication. Further, reflections on self-awareness and pre-understanding of the first author as interviewer (LPB), three of the authors as nurses and interpreters (LPB, SE, EKG) and one psychiatrist (JGR) were discussed. The first (LPB) and third (JGR) authors were also familiar with the context in terms of their professional background as officers and their work at a military psychiatry unit; the second (SE) and fourth (EKG) authors

have a preunderstanding related to in-depth research into a broad spectrum of health related issues.

Another limitation may be that we did not use multiple theoretical perspectives to examine and interpret our data. Other theories and angles might have given different descriptions and outcome (e.g., other coping theory, resilience, personality trait and trauma theories). However, a strength in our study may be that we chose a theoretical perspective of coping that includes both coping and resilient features. Skinner and colleagues [149] argue that they present a model depicting coping as a multi-level adaptive system that includes both coping and resilient features [153]. Nevertheless, the present study yields rare insight into a trauma area where hardly any study supplies survivors' descriptions. This is an advantage of using a qualitative method. Further, our findings are congruent with the few previous qualitative studies in the research field of natural disasters [143-145]. We can relate our findings to the existing body of knowledge, which might be considered a strength of our study.

Transferability

Transferability (equal with external validity) represents the extent to which our findings have applicability in other contexts [229, 231]. In this study, only a small number of males are included, which might constitute a limitation regarding the transferability of the findings, and findings must be used carefully regarding generalizability. Nevertheless, a strength of this study may be that the group is homogeneous (in terms of type of trauma, age, sex and time since trauma) and data were well saturated. However, the term to generalize findings is used in a limited way in qualitative research [39], and the intent of this form of inquiry is not to generalize findings to individuals outside those under study, but to shed light on a topic and gain in-depth knowledge from the participants [39, 220]. The hallmark of good qualitative research is in fact the value of the descriptions of particularities rather than generalizability [39].

Another strength is that we have documented and explained the research process in detail and hopefully described the findings in a way that allows the reader to search for alternative interpretations, see paper III, Appendix XV, section "METHOD".

Since the participation in our study was voluntary, it is possible that survivors with more negative or positive experiences of the consequences of the avalanche, and how they cope in daily life, were unwilling to participate. This may represent a limitation in our study, called non-responder bias.

Dependability

It is important to emphasize that there are close ties between credibility and dependability [229, 231]. However, Shenton [229] argues that in order to address the dependability issue more directly, the processes within the study should be reported in detail. The strength in our study is that the interview guide (see Appendix XI) and the criteria used to select participants in our study are described very well, and, further, by law, that the Norwegian Armed Forces Joint Medical Services' record has an overview of the sample in our study. This may be a help in enabling a future researcher to replicate the study, i.e., repeat our study with the same participants, interview guide, methods and context. However, a limitation may be that others will not necessarily get the same results as we did due to the changing nature of the phenomena scrutinized by qualitative researchers [229].

Confirmability

Confirmability represents a degree of neutrality, or the extent to which the findings of a study are shaped by the participants and not the researcher bias, motivation or interest [229, 231]. In our study, we have taken some steps to foster reflexivity regarding these issues. However, it is worth noting that the idea of involving multiple investigators in qualitative studies and fostering a reflexive dialogue is most often not done to reach consensus and foster reliability [234]. Nevertheless, we have designed our study in a way that includes multiple investigators. This has fostered dialogue, and led to the development of complementary as well as divergent understandings of our study situation, and, further, provided a context in which all included researchers' - often hidden - beliefs, values, perspectives and assumptions could be revealed and discussed. These latter issues have been described in detail under the section credibility, i.e., the reflections, pre-understandings and self-awareness regarding all the authors' background and theoretical perspectives used in our study. However, we have to emphasize that a limitation may be that the first author (LPB) is a survivor of a severe natural disaster, a tsunami, and might have a preconception of being a victim of a natural disaster. This may have affected the angle of investigation, the methods judged, the findings considered most appropriate, and the framing and communication of conclusions. However, Malterud [235:484] argues that preconceptions are not considered the same as bias, unless the researcher fails to mention them. Further, the qualitative content analysis process, with the search for manifest and latent meanings, involving multiple investigators, is described in detailed in paper III, see Appendix XV. The first author (LPB)

conducted all the interviews, which were recorded as audio files and transcribed verbatim by a professional firm. Further, in order to catch the impression of the whole, the first author (LPB) and the fourth author (EKG) independently read closely all the transcribed interviews several times. Both researchers' impressions of every interview were written down separately and summarized in a short text of 400-800 words, and thereafter discussed in depth several times by the first author and all the co-authors. An early consensus on the impressions of the interviews was established through those discussions. Further, after several meetings and dialogue between the first (LPB), second (SE) and fourth (EKG) author, the underlying, latent content of the three categories was formulated into one theme. Examples of the development from units of meaning into codes and categories are given in Appendix XII.

5.1.3 Ethical considerations paper I-III

Our study was approved by the Norwegian Regional Committee for Medical Ethics (Reference number: 2016/392), see Appendix XVI. Informed consent was obtained from all the participants in the follow-up study in 2016, see Appendix XVII. The SPSS-files, audio and transcript-files did not contain the names of participants, and a separate "key" with the participants' names was created on a secure, separate drive, matching the SPSS-file, audio- and transcript-files with the participants' codes. All people in contact with the SPSS-file, audio files and the transcribed interviews signed confidentiality agreements. Due to ethical considerations, access to and transparency of this study's documented analysis are limited.

Qualitative research methods, such as the in-depth interviews used in this study, have the privilege of viewing participants' lives and experiences in great detail. However, in our study this constitutes an ethical dilemma with regard to the dissemination of this rich data. This dilemma involves the conflict between communicating detailed and rich data at the expense of protecting the participants' identity. In this thesis, we have emphasized the respondents' confidentiality more than the need for using detailed data. The reason for this decision is that the participants in our study are easy to find in news documents on the Internet on the serious avalanche disaster, and this may make them easy to identify. This decision is in accordance with literature on deductive disclosure, also known as internal confidentiality. Deductive disclosure occurs when the traits of groups or individuals make them identifiable in research reports [236].

The raw data are confidential and cannot readily be shared. Data may be shared with researchers obtaining permission from the Norwegian Regional Committee for Medical Ethics

and Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry, within a time limit (i.e., until 2025.03.01). After permission has been obtained, data can be made available from The Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry.

There are studies that indicate that participation in trauma-studies can result in increased psychological distress [32, 237, 238], and other studies show that participation in trauma-studies may even be beneficial [32, 239-241]. However, there is no evidence of traumatization among participants, and disaster research suggests that participants should not be automatically considered vulnerable [32, 242]. On the other hand, ethical aspects regarding this issue require procedures to be in place to aid participants who experience serious distress. Due to anonymization, we had no possibility to follow those participants who revealed a high symptom level in questionnaires (paper I and II). However, during the interview study (paper III) we decided that all participants in need of professional help would be offered support from the Institute of Military Psychiatry, and/or arranged for proper support and follow-up by the local health care system. A couple of participants were identified to have need for support and treatment, and were referred to specialists by the first author. All participants were told that they could withdraw whenever they wanted to during the survey, without any further explanation, and that withdrawal would not affect their contact with the Norwegian Armed Forces Joint Medical Services in the future.

5.2 Discussion of the results and findings paper I-III

Our study has identified essential knowledge regarding the long-term impact of a traumatic event on a group of both directly and indirectly exposed survivors (paper I and II). Furthermore, our study has contributed with in-depth knowledge of what it is like to live, and cope, with a traumatic event in daily life through three decades - in a group of directly exposed survivors (paper III). However, it is important to emphasize that conclusions from this thesis can only suggest trends.

Researchers have asked whether the concept of PTSD is adequate to describe the passage of trauma related symptoms through the life span of survivors [103]. That 42% suffer from current PTS-symptoms, 50% from distress symptoms, and 50% from sleep quality problems above cut-off point (i.e., the exposed survivors), which would indicate need for psychological referral 30 years after the traumatic exposure, may be a robust indicator that PTSD is a

reasonable concept regarding our sample of survivors. Furthermore, our results are mainly in accordance with previous research that indicates that PTSD is most likely the central psychopathology post-disaster [5, 12-14, 20, 23, 243].

In line with previous research [5, 12, 199], our results from the self-report instruments of PTSD-symptoms indicate that symptoms decline during the first year aftermath in both groups investigated. It is notable that the comparison group started with higher levels of symptoms than the exposed group. Herlofsen [36:18] points out that this latter finding could be because the unexposed soldiers had been getting little or no attention, had not been part of the rescue effort, and only received information from the radio news bulletins. This lack of personal attention from superiors aggravated their natural feelings of aggression, anxiety and sorrow for their lost comrades. Further, Herlofsen [36:18] describes that sleeping was impossible and mental arousal was high for this unexposed group in the initial phase post-disaster compared to the exposed group. However, after the first year the results from the comparison group showed lower levels of PTSD-symptoms compared to the exposed group, although not statistically significant. A possible explanation of the levels of PTSD-symptoms declining more the first year for the unexposed group compared to the exposed group, may be that the unexposed group had a better opportunity to work through their emotional state during the first year as they did not have a direct life-threatening experience [36]. Furthermore, a possible explanation for the non-significant differences in PTSD-symptoms between the two groups in our study the first year post-disaster may be related to the fact that the soldiers in the exposed and unexposed group served in the same platoon and that they knew each other very well. Therefore, the exposed and unexposed soldiers were affected by the trauma directly or indirectly. Thus, the unexposed soldiers could be considered as victims (although indirectly). A previous study supports an assumption that the level of direct and indirect exposure to trauma may affect individuals regardless of exposure impact [178]. However, most short-term (and long-term) studies find a gradual decline in symptoms as a function of time [19, 20, 116, 188, 244, 245].

Although no statistically significant differences were observed regarding overall PTS-, distress and anxiety symptoms (or sleep quality problems at T4) (measured by PTSS-10, IES-15, STAI-12 and PSQI), we found statistically significant differences in the exposed groups regarding time trajectories for posttraumatic stress symptoms and more subjective, pronounced negative impact on their mental and physical health compared with the unexposed group. From

these latter results, it may appear that the survivors in the exposed group may be characterized as more affected mentally since they report statistically significant differences regarding the time trajectories for the PTS (measured by PTSS-10) compared with the comparison group. This result indicates a U-shaped course for the exposed group as a whole during the observed 30 years. Further, the exposed group reported that the disaster had a significantly more pronounced negative impact on their physical and mental health compared to the unexposed group, which may be a consequence of the severity of the disaster [36-38].

Furthermore, the results from the IES-15 (i.e., IES-15 trajectories showed the same trend as the PTSS-10 trajectories for the exposed group) may support the idea that the occurrence of avoidance and intrusion in the long-term can be related to the experience of more psychopathology symptoms [5, 246-249] in the exposed group. However, a limitation of these latter results may be that we used the total distress score, which represents the summation of the total sub-scores of intrusion and avoidance of the instrument (i.e., IES-15) for our analysis, instead of additionally running two separate analyses of the two sub-categories to strengthen such ideas.

Further, we found a significant association between participants with PTS-symptoms above cut-off point combined with hyperarousal symptoms and sleep quality problems, 30 years post-disaster. It is possible that the initial and persistent, high hyperarousal symptoms over time could have mediated the risk of increased later high levels of PTS, distress symptoms and sleep quality problems in our group of exposed avalanche survivors. This is supported in research literature and research suggests that hyperarousal symptoms over time may cause abnormal levels of stress hormones, increasing the risk of problems such as sleep problems and PTSD [250, 251]. Furthermore, a study of 899 Norwegian survivors of the 2004 South-East Asia Tsunami, using almost the same screening instrument as our study (IES-15), but a revised one (i.e., Impact of Event Scale-Revised (IES-R) with intrusion, avoidance and hyperarousal subscales), claims that hyperarousal symptoms may mediate the risk of increased later psychopathology [252]. Further, the study also found that hyperarousal may be more closely linked to psychopathology and functional impairment than other symptoms of posttraumatic stress (i.e., avoidance and intrusion symptoms) [252]. These latter findings may appear to support our findings that hyperarousal symptoms may have mediated the risk of increased later high levels of PTS, distress and sleep quality problems in our group of exposed avalanche survivors. Another Norwegian disaster study

by Holgersen and colleagues [30] found a link between the initial response and the negative mental health outcomes several decades later, which may also support our results suggesting that high early stable hyperarousal symptoms may appear to influence later negative outcomes. Holgersen and colleagues [30] demonstrated that early high stable symptoms of stress were found to predict later negative mental health outcomes in a sample of Norwegian male survivors. Lastly, a long-term avalanche study conducted in Iceland may also coincide with our results regarding high level of hyperarousal symptoms and sleep quality problems in a group of avalanche survivors in the long run [20]. They found that survivors were more likely to experience avalanche specific hyperarousal symptoms and sleep problems compared to the comparison group 16-years post-disaster [20].

Some studies have argued that trauma-related psychopathology may follow a U-shaped course as we found in our study [103, 104, 253-255]. A U-shaped course follows a pattern with high levels of PTSD-symptoms directly after the disaster, with a subsequent decline during the following years of work life. However, the symptoms may return again as the survivors have to cope with age related issues, and transition into retirement [103, 104, 253-255]. The last follow-up (T4) in our study gave an indication of increased symptom levels among the exposed survivors (i.e., PTS, distress and sleep quality problems) compared to the unexposed group, although not statistically significant, after 30 years. To which extent factors described in a U-shaped course affect the negative health symptoms reported among our sample of 50-year old survivors is not known. However, our results indicate a trend similar to what is described in the literature, and further, the U-shaped pattern of the trajectories found over time, and the mental health symptoms and sleep quality problems above cut-off point, may reflect the stressful situation these personnel have been in and still are in. On the other hand, we cannot exclude that portions of our survivors investigated may experience PTSD-symptoms that may return again into retirement [103, 104], or that they may develop severe PTSD symptomatology following the onset of other illnesses and disorders in later life [256], or may follow a course of delayed onset or sub-syndromal patterns of psychopathology [26, 257]. In research there is increasing attention on the trajectories of PTSD [257]. Our study may demonstrate that there is not a linear relationship between initial trauma response and the long-term PTSD-symptoms, and that PTSD-symptom levels may fluctuate from the initial years after trauma exposure to decades post-disaster (i.e., e.g., a U-shaped, delayed onset or a sub-syndromal course of psychological

symptoms). This latter reflection regarding fluctuation of PTSD-symptoms is in accordance with what Bryant and colleagues [257] found in their study of trauma survivors (and Bryant and Litz [199:328] model is used as the first step of this thesis' theoretical framework). On the other hand, we also have to consider our qualitative findings of different uses of coping strategies to have fluctuated from initial years of trauma to 30 years post-disaster. This latter consideration is in accordance with what some researchers emphasize [125, 131]. They argue that coping is a dynamic process that fluctuates over time in response to changing appraisals and demands of the situation [125, 131]. This may be the case in our study as well.

Although not statistically significant, a large portion (approximately 50%) of the exposed survivors appear to report a considerable symptom burden in the long-term perspective compared with the unexposed group. On the other hand, if our study had access to normative data (results from the general population) for comparative purposes, the results may have been different than comparing the exposed group with a group of peers in our study. However, as mentioned in section 5.1.1 under "Generalizability", we did not have access to such normative data for comparative purposes. Another possibility, as stated under "Statistical issues" (see section 5.1.1), is that there is a definite risk for type II statistical errors in our non-significant differences due to our low sample size. However, we should not underestimate results that show statistically significant differences in our study, they are stated as significant, due to small sample size [39]. Nevertheless, most of the results in our study regarding PTSD-symptoms in a short and long-term perspective are in line with most of the disaster research field [5, 12], and avalanche disaster research [20, 22-24, 116, 117].

Some of the results in our study may suggest that early stable hyperarousal symptoms post-disaster are important to detect and follow in an early phase. These results could provide insight into potential mechanisms through which disaster experience may influence various mental health outcomes, and suggest areas where interventions may reduce or prevent the severity and course of disaster-related PTSD and sleeping problems in the long run. On the other hand, it is important to emphasise that we have to consider our results 30 years post-disaster in the light of that 29 years have passed between the last two data collections (T3-T4), and we know from literature and research that the complexity of psychopathology trajectories may be indicated by delayed occurrence of PTSD response, which appears to be a result of cumulative stress post-

disaster and the immediate stress response after the avalanche disaster [257]. This may cause fluctuations our study is unable to detect.

Further, we also know from other previous disaster studies [63, 258, 259] and avalanche studies [20, 23] that survivors who have experienced additional traumatic events (TEs) seem to have greater prevalence of psychopathology symptoms in the long run (i.e., e.g., PTSD-symptoms, PTSD hyperarousal symptoms and sleep problems) [20, 23, 63, 258, 259]. One study found that PTSD-symptoms attributed to four or more TEs were associated with longer duration of negative symptoms, greater functional impairment, and elevated hyperarousal symptoms [258]. These latter research results may coincide with our study, although there were no statistically significant differences between our two groups regarding the amount of TEs reported at T4. However, both groups reported a considerable portion of additional TEs in their lifetime at T4, and we have to take this into consideration when we interpret our results of negative outcomes 30 years post-disaster. It is possible that the survivors in our study that report having experienced additional TEs and stress responses in their lifetime may be denoted as having "reactivated PTSD-symptoms", as any such additional distress might have brought up symptoms and memories associated with the avalanche during the 29-year span between T3 and T4. This might indicate a delayed onset or a sub-syndromal course in our study. However, according to previous research, cumulative stressors post-disaster are greater in those who develop delayed-onset PTSD, relative to those who maintain their symptom-free status over time [257, 260-264], although not all studies have reported such a course of PTSD-symptoms [257, 265]. Nevertheless, such findings are in accordance with what Bøe, Holgersen and Holen [26] found in their study of a sample of Norwegian male disaster survivors. They reported that the survivors had experienced more additional traumatic stress later in life post-disaster compared with the comparison group [26]. These traumatic stress responses were also denoted to "reactivated PTSD", i.e., reactivated PTSD including sub-syndromal manifestations [26]. Furthermore, Bøe [266:55] suggests that reactivation of traumatic stress is quite common, probably far more common than the DSM category "delayed onset", which often amounts to a reactivation of a previous stress response, or a delayed recognition of PTSD [259, 266, 267]. However, Bøe [266] argues that "delayed onset" and "reactivated PTSD" may be distinguished and reported separately, on the phenomenological level. Therefore, we should have in mind that "delayed onset" and "reactivated PTSD-symptoms" may overlap in our results, and should not just be

interpreted separately. It is also worth mentioning that a 16-years follow-up of a sample of avalanche survivors reported that survivors experienced more TEs in their lifetime than the comparison group [20], which may represent a risk factor for longer duration of negative symptoms, greater functional impairment and elevated hyperarousal symptoms in the long-term [256].

North [5:141] claims that numbing and avoidance symptoms may mark the onset of the psychopathology process of PTSD that begins when the more normative and common hyperarousal and intrusion symptoms become unbearable. As mentioned in section 5.1.1, we used the total distress score, which represents the summation of the total sub-scores of intrusion and avoidance of the IES-15 instrument for our analysis, instead of separately running two analyses of the two sub-categories. Including such separate analyses in our study may have given us substantial information related to the course of avoidance and intrusion trajectories associated with our results of hyperarousal symptoms. Furthermore, this may also have given us substantial additional information for our qualitative findings regarding portions of survivors with an avoidant behavior. Such results could shed light on our findings related to maladaptive coping strategies interpreted as avoidant coping styles in the different categories found in our qualitative study.

Further, several previous quantitative studies regarding coping strategies have reported that coping strategies, interpreted as adaptive, particularly problem solving and support seeking, are approaches found to contribute to better and healthier functioning [139, 141, 142, 268], and to have a positive effect on mental health symptoms [268]. Several qualitative studies on natural disasters are also consistent with these findings [143-145], even though qualitative studies after natural disasters are rare. On the other hand, previous quantitative and qualitative studies after natural disasters have shown that maladaptive coping styles, such as e.g., avoidance and distraction, are the most cited maladaptive coping styles [136, 143, 145]. Such coping styles are associated with impaired functioning, psychological distress and poor health [138-142]. The findings in our qualitative study appears to be consistent with all these latter quantitative and qualitative research results and findings reported above. For instance, we found three different categories of survivors in our study that used different types of coping strategies in their daily life. The three different categories seem to describe different courses regarding well-being. The first category of survivors (A comfortable life) tended to use strategies such as

problem solving, talking about (e.g., seeking social support) and reflecting on their experiences (e.g., positive cognitive restructuring) and focusing on the positive aspects of their current situations. These strategies appeared to be adaptive for these participants in their contexts and allowed for improved mental well-being. These findings are consistent with previous qualitative research [143-145]. Furthermore, the first category did not describe any negative health symptoms that affected them in everyday life during the interviews. This appears to be consistent with our quantitative results on the group level of the survivors that reported symptoms below cut-off point for PTS, distress, anxiety and sleep quality problems in our study. However, they may have had symptoms of mental illness in the period immediately post-disaster that rapidly declined. Nevertheless, this category of soldiers seem to describe that they follow a resilience pattern during the three decades.

The survivors in the second category (A challenging, yet accomplished life) also described dealing with most of the different types of stressors in everyday life after the disaster, reporting the use of adaptive coping strategies during the whole period. Nevertheless, there were several descriptions of strategies that were interpreted as more maladaptive in this category than in the first category analysed, i.e., avoidant strategies such as avoidance and distraction. These strategies appeared to be more adaptive than maladaptive for these participants in their contexts. However, the survivors in this category described more symptoms associated with negative mental health issues, and these descriptions may appear to be consistent with a broad range of survivors that reported low levels, subthreshold or high levels of negative mental health symptoms in our quantitative studies. This appears to be consistent with our quantitative results, showing a U-shaped pattern of psychopathology on the group level of the survivors. On the other hand, this category might also be interpreted as describing that they have followed a delayed onset or sub-syndromal pattern during the three decades, and if they follow such patterns of psychopathology, they may appear to suffer from more psychopathology in the future [26, 103, 104]. This latter description of the different patterns our survivors may follow, are supported by research in the trauma field that describes survivors that follow such patterns who may suffer from more psychopathology in later life [26, 103, 104, 256, 257]. Although the second category seems to describe a current expression of challenging issues regarding living with the disaster, they describe it as a challenging, yet accomplished life 30 years post-disaster. Nevertheless, health personnel should be aware that such patterns (i.e., delayed onset or sub-syndromal pattern)

might occur in earlier trauma survivors when they meet such survivors later on in institutional settings, such as nursing homes or assisted living facilities or in other settings.

The third and last category (A demanding life) of survivors tended to describe a considerable amount of negative mental health symptoms, and for the most part, a use of strategies such as avoidance and distraction in everyday life post-disaster. These strategies appear to be maladaptive for these participants in their context and allowed for impaired mental well-being. The considerable descriptions of PTSD-symptoms in this latter category may appear to be consistent with our quantitative results on the group level above cut-off point for PTS, distress and sleep quality problems. This last category might seem to describe that they have followed a chronic pattern during the three decades. However, due to ethical and methodological considerations we were not allowed to compare all the results and findings from our quantitative and qualitative papers on an individual or group level, i.e., because of the ethical considerations of the possibility of retrospective identification of cases and restriction in our methodological design (i.e., not a mixed-method study). Nevertheless, all results and findings in our study suggest trends on the group level and shed light on essential parameters, such as mental health, sleep and coping.

We emphasise the disaster research field as a complex and dynamic field, comprising personal, relational and environmental variables which reciprocally interacts with the individual's experiences and environment [269]. To operationalise all these variables into research will probably not be an easy task. [269]. However, we do think there is utility in using the model we have used in our study as an overarching theoretical construct to help synthesise information about various domains that may increase and contribute to better well-being.

5.2.1 Clinical implications

Goldmann and Galea [12:176] point out in their research that whereas characteristics or conditions pre, peri- and post-disaster may influence the development of psychopathology, interventions conducted before, during and after disaster periods can improve mental health outcomes.

All our results and findings provide valuable information for shaping future interventions, e.g., on the individual, interpersonal, community and organisation level. I am a registered clinical mental health nurse, and tend to be rather internally focused in the meeting with clients. However, we have to recognise that the survivors in our study exist in a context (i.e., e.g., life

history, barriers to seek help and support, connection to community, cultural beliefs, traits and attitudes), which may have an impact on their ability to engage in and benefit from interventions that target internal processes. According to Bryant and Litz [199], any intervention after a disaster needs to consider the timing of the intervention and the context in which the intervention will occur. Therefore, TEs cannot be viewed narrowly, we have to see this in a broader perspective - we have to consider the context in which the trauma occurred (e.g., in our study in a military setting) to more adequately understand the trauma's impact on individuals. Understanding trauma from this point of view may help us expand our focus beyond individual characteristics and effects. This is in accordance with social-ecological framework models on trauma and its effects [269:14-16]. Social-ecological models promote the development of contextual models that expand the focus beyond individual characteristics and effects to a broader systemic perspective that acknowledge the influence of individual factors, interpersonal, community, organizational, social and cultural factors, and, further, the period of time in history (e.g., changing in diagnostic understanding of PTSD) [269:14-16].

One good example from our study with regard to seeing beyond individual characteristics is the survivors' descriptions of lack of support from the military system post-disaster. This lack of support might affect the participants in our three categories differently depending on their context. A previous study of veterans returning from wars support these assumptions [270]. This latter study found that less social support from community/organization and lower availability of secure relationships appear to mediate the association between PTSD and poor social functioning. This may be the case for several of our survivors too.

Another good example in our study of seeing beyond individual characteristics and effects to a broader systemic perspective is the finding of similar descriptions in all three categories of the approach of not talking about or thinking about the disaster. However, the success of this approach for the survivor's well-being seemed to depend on the coping strategy employed by the survivor. The first category of survivors used positive cognitive restructuring, whereas the third category of survivors used avoidant coping strategies. A possible interpretation of this variation would be that not talking about or thinking about the disaster, in and of itself, is not necessarily either good or bad, but the success of this as a coping strategy would depend on individual factors (e.g., different personality traits), interpersonal (e.g., seeking support), community, organizational, social, cultural factors and the period of time in history the disaster

occurred (e.g., the existing male military culture of not showing weakness when one experiences something tough). The possible value of this strategy would have to be evaluated and observed in the context of the individuals interviewed. Therefore, interventions should be planned in response to the resources and needs of the survivors affected by the avalanche, taking into account the nature of the post-disaster context [199]. Preventive, early and long term interventions to reduce the symptom load of distress, anxiety, sleep quality problems and use of maladaptive coping strategies, or other kind of support from both military and civilian health care service, are relevant for the survivors. We suggest that such interventions should be offered pre- and post-disaster. This may include building military prevention coping and resilience programs on an individual and organization level, providing individual assessments in the first few days and weeks post-disaster to identify psychological symptoms, current pre-existing psychiatric disorders, level of functioning by using psychometrically well-tested screening instruments and structured diagnostic interviews. Another Norwegian long-term male disaster study, very similar to our study, has also described the importance of early identification of negative psychological symptoms [30]. The study found that high stress scores in the very first days post-disaster and a slow recovery during the initial couple of weeks were associated with high negative psychological symptoms scores in a long-term perspective. The study covered close to three decades [30].

5.2.2 Further research

Our thesis may have contributed to and provided direction for the interpretation of the existing body of knowledge in the research field of natural disasters, and the development of pre- and post-disaster mental health- and coping strategy interventions. Planning and preparedness for adequate interventions for survivors of TEs are greatly needed to reduce the high levels of long-term impairment and reduced well-being they report to experience. Further, this thesis has demonstrated that pre, peri- and post-disaster psychological and coping assessments are challenging and complex fields, and that to identify the most vulnerable individuals and groups at risk after a TE may be of crucial importance to reduce the burden of distress, anxiety, sleep quality problems and maladaptive coping strategies post-disaster. Many of our findings did not demonstrate statistical significance of PTS-, distress, anxiety and sleep quality problems scores between the groups (paper I-II). Such statistical significance of differences and other measures are not, however, necessary for the findings to be of clinical importance to health services or

others involved with personnel that experience traumatic events. North and Pfefferbaum [64] argue that it is critical to understand the differentiation of psychopathology from normative response to trauma to provide effective care for the population exposed to disasters. Therefore, future research needs to focus on how to improve and develop already existing, appropriate screening tools and use full diagnostic assessments tools to give adequate knowledge to shape interventions for vulnerable groups and individuals [5, 12]. On the other hand, based on our study research on directly and indirectly exposed survivors, it may also be of interest to recommend more focus on positive aspects of trauma in future research, i.e. focus on those who remain mentally healthy post trauma and use adaptive coping strategies to overcome the challenges of daily life as well as manage post-traumatic growth. Such knowledge may yield much needed insight into how to cope successfully with adversity, which again can be used to develop preventive coping and resilience programs. However, we have to acknowledge that some survivors may benefit from an intervention program while others do not. This may have to do with contextual factors rather than the intervention programs themselves. This is important to remember when we interpret our results of positive and negative health outcomes and findings of adaptive and maladaptive coping strategies in everyday life, and especially when generating hypotheses for further studies on how to build and develop coping and resilience programs.

We know from research that individuals manage to find ways to cope with daily life and move on, regardless of whether they developed PTSD symptoms or not [5]. In the light of the latter insight, future research should also aim to develop and use more of standardized instruments for coping and quality of life (QoL) and well-being measures combined with qualitative interviews that give in-depth knowledge of individual description of their QoL and well-being in a longitudinal design post-disaster.

Therefore, the most important next frontier for disaster mental health research is to evaluate which interventions (and the timing of the interventions) (e.g., clinical, individual, interpersonal, community, social) that match the needs of different subgroups of survivors in diverse contexts and how these needs - and matching interventions - may change as time passes post-disaster [199, 218]. Nevertheless, it is important to follow up disaster survivors over time because relapses may occur, several problems may not be resolved after treatment and on-going and additional stressors may contribute to new and accumulated problems that were not initially apparent post-disaster [199]. Therefore, research recommends conducting long-term follow-up

assessments over years after disasters to determine the trajectories that may be useful to identify, e.g., recovery, resilience, sub-syndromal and delayed onset and chronic patterns, for use in developing intervention programs [5, 12, 199, 218]. However, we may wonder what happens when the survivors in our study, who now are in their fifties, get older and end up in nursing homes. Research suggests that PTSD symptoms may resurface.

6.0 Conclusion

In this thesis we found that the course of mental health symptoms may persist, and even increase on the group level in a group of selected and trained military personnel 30 years post-disaster (paper I). Furthermore, our findings indicate an association between sleep quality problems and hyperarousal symptoms in soldiers with scores above cut-off point for posttraumatic stress (disorder) symptoms (paper II). Finally, this thesis found that the impact of the disaster on the exposed survivors' everyday life and coping varied within three different categories. The survivors in each of the three categories used more or less adaptive and maladaptive coping strategies in their everyday lives.

The implications of the main results and findings of this thesis for health personnel, military leaders/system, community and others (i.e., peers, family and so on) are to be aware of the possibility that survivors (both exposed and unexposed) will experience high levels of PTS-, distress symptoms and sleep quality problems (paper I-II) associated with their traumatic experience (both initially and in the long run post-disaster). An eventual initial increase of their PTS-, distress symptoms and sleep quality problems should be considered as an expected posttraumatic reaction in this situation (paper I-II). Further, it is of importance to be aware of the survivors' (directly exposed survivors) use of coping strategies in daily life, especially maladaptive coping strategies such as avoidance, which may be associated with negative mental health and impaired functioning. An initial use of maladaptive coping strategies such as avoidance should be expected. This should not, however, be recommended as a coping strategy in the long run (paper III).

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Appendix I

The Peril Classification and Hazard Glossary (IRDR DATA Publication No. 1 [52])

	Classification of disasters	
Natural disaster sub-group	**Disaster main types**	**Definition**
Geophysical	* Earthquake (ground shaking, tsunami) * Volcano activity (ash fall, lahar, lava flow, pyroclastic flow) *Mass movement/Landslide (dry; avalanche)	A hazard originating from solid earth. This term is used interchangeably with the term geological hazard.
Meteorological	* Storm (tropical storm, extra-tropical storm, convective storm; derecho, hail, thunderstorm, rain, tornado, sand, blizzard) * Extreme temperature (cold wave, heat wave, severe winter conditions; snow,frost) * Fog	A hazard caused by short-lived, micro- to meso-scale extreme weather and atmospheric conditions that last from minutes to days.
Hydrological	* Flood (coastal flood, riverine flood, flash flood, ice jam flood) * Mass movement/Landslide (wet; avalanche (snow, debris, mudflow, rock fall)) * Wave action (rogue wave, seiche)	A hazard caused by the occurrence, movement, and distribution of surface and subsurface freshwater and saltwater.
Climatological	* Drought * Glacial Lake outburst * Wildfire (forest fire, land fire; brush, bush, pasture)	A hazard caused by long-lived, meso- to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal climate variability.

Biological	* Epidemic (viral disease, bacterial disease, parasitic disease, fungal disease, prion disease) * Insect Infestation (locust, grasshopper) * Animal accident	A hazard caused by the exposure to living organisms and/or their toxic substances (e.g. venom, mold) or vector-borne diseases that they may carry. Examples are venomous wildlife and insects, poisonous plants, algae blooms, and mosquitoes carrying disease-causing agents such as parasites, bacteria, or viruses (e.g., malaria).
Extra-terrestrial	* Impact (airburst) * Space weather (energetic particles, geomagnetic storm, shockwave)	A hazard caused by asteroids, meteoroids, and comets as they pass near- earth, enter the Earth's atmosphere, and/or strike the Earth, or changes in inter planetary conditions that effect the Earth's magnetosphere, ionosphere, and thermosphere.

Appendix II.

Overview of PTSD criteria in DSM-IV, DSM-5, ICD-10, and ICD-11

DSM-IV, DSM-5, ICD-10, and ICD-11	Symptoms required
DSM-IV criteria	
A1. Exposure to actual or threatened death, serious injury, or threat to physical integrity of oneself or others	
A2. Response to the event involved fear, helplessness, or horror	
B. Persistent re-experiencing	One of five
C. Persistent avoidance and numbing	Three of seven
D. Persistent hyperarousal	Two of five
E. Duration of at least 1 month	
F. Clinically significant distress/impairment	
DSM-5 criteria	
A. Exposure to actual or threatened death, serious injury, or sexual violence	
B. Persistent re-experiencing	One of five intrusion symptoms
C. Persistent avoidance	One of two avoidance symptoms
D. Persistent numbing	Two of seven alterations in cognitions and mood
E. Persistent hyperarousal	Two of six alterations in arousal and reactivity symptoms
F. Duration of at least 1 month	
G. Clinically significant distress/impairment	
ICD-10 criteria	
A. Exposure to a stressful event or situation of exceptionally threatening or catastrophic nature likely to cause pervasive distress in almost anyone	
B. Persistent re-experiencing	
C. Persistent avoidance	
D. Either (1) or (2) below:	
1. Inability to recall important aspects of the stressor	
2. Persistent hyperarousal	Two of five
E. Criteria B, C, and D must all be met within 6 months of the stressful event	
ICD-11 criteria	
A. Exposure to an extremely threatening or horrific event or series of events	
B. Re-experiencing the traumatic event or events in the present in the form of vivid intrusive memories, flashbacks, or nightmares. These are typically accompanied by strong or overwhelming emotions, particularly fear or horror, and strong physical sensations	One of two intrusion symptoms

C. Avoidance of thoughts and memories of the event or events, or avoidance of activities, situations, or people reminiscent of the event or events	One of two avoidance symptoms
D. Persistent perceptions of heightened current threat, for example as indicated by hypervigilance or an enhanced startle reaction to stimuli such as unexpected noises (i.e., hyperarousal symptoms).	One of two hyperarousal symptoms
E. Clinically significant functional impairment (i.e., symptoms persist for at least several weeks and cause significant impairment in personal, family, social, educational, occupational or other important areas of functioning)	

Modified version by Stein and colleagues [83:12].

Appendix III.

Overview of different course and trajectories of psychopathology aftermath [59, 103, 104, 109].

Patterns and Trajectories	Definition of patterns
Resistance [59]	Is defined as experiencing no symptoms of mental illness or only mild symptoms post-disaster.
Resilience [59, 109]	Pattern where symptoms are transiting and do not cause reduced psychosocial functioning following exposure to a TE.
Recovery [59, 109]	Pattern where symptoms are prominent following exposure to a TE, and shows gradual improvement with time.
Chronic [59, 109]	Pattern where symptoms tend to persist across time. This course is only found in relative small proportion of survivors of a TE.
Delayed [109]	Pattern where the symptoms are not very severe or prominent during the first 6 months following exposure to a TE, but tend to increase later (late-onset).
U-Shaped [103, 104]	Pattern where there is high levels of negative mental health symptoms immediately after trauma, then declining during the years of work life but possibly returning as the survivors cope with age-related issues and transition into retirement.

Appendix IV.

An overview of the aim, design, sample size, duration and description of outcomes of relevant avalanche studies

Authors	Aim	Design	Sample size	Duration	Outcomes
Herlofsens [36]	Investigate the mental health effects of an avlanche on a group of survivors and a group of unexposed comrades.	Quantitative, unselected, cross-sectional study, using self-report questionnaires: PTSS-10, IES-15, STAI-15/18 and GHQ-20	15/15	12 months	PTSD-symptoms: present in all soldiers investigated immediate post-disaster. One year post-disaster: few signs of PTSD-symptom in the unexposed group compared to the exposed group. The statistical analysis did not show any statistically significant differences between the two groups, during the first year.
Rostrup and colleagues [37]	Investigation of medical field records from the avalanche survivors.	A descriptive report of medical experiences of an avalanche Hva skal vi kalle dette? Dette er deskriptivt utskrift fra meisisnke journaler gjort fra feltsykehuset og sykehuset Narvik/Harstad	15	Short after disaster	Reported cases of physical injuries in survivors: haemoptysis, lung contusion, concussion, pneumothorax, knee ligament injury, humerus-, leg-, and facial fractures.

Authors	Aim	Design	Sample size	Duration	Outcomes
Stalsberg and colleagues [38]	Autopsies of 12 victims from two avalanches, and surveys of medical field records from 15 avalanche survivors.	A descriptive report of an atopsis, and medical experiences, of an avalanche. Hva skal vi kalle dette? Dette er deskriptivt utskrift fra medisinske journaler gjort fra feltsykehuset og sykehuset Narvik/Harstad	27	Short after disaster	Report of cases of death, and physical injuries in survivors: haemoptysis, lung contusion, concussion, pneumothorax, knee ligament injury, humerus-, leg-, and facial fractures reported in the group of survivors.
Johnsen and colleagues [114]	Investigate the mental health effects of an avlanche on a group of exposed subject (survivors and rescuers) and a group of unexposed subjects.	Quantitative, unselected, cross-sectional study, using self-report questionnaires: IES-15 and PTSS-10	133	4 months	PTSD-symptoms: results showed higher levels of PTSD-symptoms in exposed subjects (survivors and rescuers) compared with unexposed subjects, and a decrease in reported PTSD-symptoms from 2 weeks to 4 months after the avalanche (decrease in self-reported symtoms as a function of time).

Authors	Aim	Design	Sample size	Duration	Outcomes
Johnsen and colleagues [117]	Investigate the effect of multiple trauma exposure and coping style on PTSD-symptoms and QoL in a group of shipwreck and avalanche survivors.	Quantitative, unselected, cross-sectional study, using self-report questionnaires: IES-15, PTSS-10, GHQ-30 and CSQ-30	215	12 months	Effect of multiple trauma and coping style on PTSD-symptoms: repeated exposure to TE yield decreased QoL as well as higher trauma-related symptoms compared with a single-exposure control group. Avoidant coping style might increase the risk of being sensitized compared with an task-focused or emotion-focused coping style.
Eids [116]	Investigate individual and contextual factors associated with PTSD-symptoms in a group of shipwreck and avalanche survivors.	Quantitative, unselected, cross-sectional study, using self-report questionnaires: IES-15 and PTSS-10	122	12 months	PTSD-symptoms: results showed a stable low or decreasing trend for 77 percent of the individuals, while 23 percent had a stable high or increasing trend in avoidance and intrusion symptoms over time. Both groups had stable low-levels PTSD-symptoms at 12-month follow-up.

Authors	Aim	Design	Sample size	Duration	Outcomes
Eid and colleagues [118]	Investigate the relation between indicators of emotional processing, psychological distress , and PTSD-symptoms in a group of shipwreck and avalanche survivors.	Mixed-method: qualitative (e.g., trauma narratives) and quantitative, unselected, cross-sectional study, using self-report questionnaires: IES-15 and PTSS-10, GHQ-30	120	4 months	Relation between indicators of emotional processing, psychological distress, and PTSD-symptoms: negative emotional expressions were linked to trauma, whereas positive emotional expressions were associated with lover levels of psychological distress.
Asmundsson and Oddsson [112]	Investigate PTSD-symptoms in survivors of an avalanche in the Westfjords (Sudavik), Iceland.	Unknown	295?/454? Unknown	14 months	PTSD-symptoms: results reported that approximately 40 percent of adult survivors had PTSD-symptoms

Authors	Aim	Design	Sample size	Duration	Outcomes
Finnsdottir and Elklit [113]	Investigate the posttraumatic sequelae of an avlanche in a group of survivors from the town Flateyri, Iceland, compared with a controll group.	Quantitative, unselected, cross-sectional study, using self-report questionnaires: IES-15, PTSS-10, GHQ-30, and SRRS	104/87	10 weeks	Posttraumatic sequelae: result showed that 25 percent in the survivor group reached level of psychiatric caseness measured by GHQ-30, twice as much than in the control group. Common PTSD-symptoms were intrusive thoughts and feelings, tension, sadness and anxiety. Distress symptoms were related to age, gender, and education.

Authors	Aim	Design	Sample size	Duration	Outcomes
Thordardottir and colleagues [20]	Examine the mental and physical health of avalanche survivors compared with a matched cohort.	Quantitative, unselected, cross-sectional study, using self-report questionnaires: PDS, DASS-21, ANS, PSQI, PSQI-A, self made "sleep paralysis" questions, and physical health questions where ICD-10 was used as reference when classifying symptoms/dieseases.	286/357	16 years follow-up	Mental and physical outcome: 16 percent of the survivors reported avalanche-specific PTSD-symptoms above clinical cut-off, they were more likely to experience avalanche-specific hyperarousal symptoms, had greater risk of experiencing episodes of overwhelming fear, anxiety, or worry in the past 6 month, greater risk of sleep impairment, disruptive nocturnal behaviors, more likely to suffer from musculoskeletal and nervous system problems, and had experienced more TEs in their lifetime than the comparison group.

Authors	Aim	Design	Sample size	Duration	Outcomes
Thordardottir and colleagues [22]	Examine sleep quality across the develomental spectrum among avalanche survivors compared to a matched comparison cohort.	Quantitative, unselected, cross-sectional study, using self-report questionnaires: PSQI, PSQI-A, and PDS.	286/357	16 years follow-up	Sleep quality outcome 16 years post-disaster: survivors age 2-12 at the time of exposure were more likely to have PTSD-related sleep disturbances compared to their non-exposed peers. Survivors age 13-19 were more likely to experience general sleep problems compared to their non-exposed peers. Survivors age 20-39 were omre likely to experience PTSD-related sleep disturbance compared to their non-exposed peers. Survivors 40 or above were more likelt to experience memories or nightmares of trauma compared to their non-exposed peers.

Authors	Aim	Design	Sample size	Duration	Outcomes
Thordardottir and colleagues [23]	Identify factors associated with clinically significant posttraumatic stress symptoms (CD-PTSDS) in avalanch survivors.	Quantitative, unselected, cross-sectional study, using self-report questionnaires: PDS, and individual characteristics qustions, disaster agent characteristics, secondary sequelae and community factors questions.	286	16 years follow-up	Factors associated with CD-PTSDS: education level, current financial status, current employment status, having being on disability at any time since the avalanche were related to CD-PTSDS risk. Moderat and poor financial status, being currently on disability or unemployed was associated with greater risk of CD-PTSDS. Been on disability at any time since the avalanche was associated with CD-PTSDS. Significant predictors of CD-PTSDS were financial hardship-, not having provided assistance-, and lack of social support after the avalanche.

Authors	Aim	Design	Sample size	Duration	Outcomes
Thordardottir and colleagues [24]	Investigate risk factors for PTSD-symptoms and the relationship between PTSD-symptoms in adulthood and socioeconomic status (SES).		108	16 years follow-up	Factors for PTSD-symptoms and the relationship between PTSD-symptoms in adulthood and socioeconomic status: Femal sex, lower education, poor financial status, and unemployment and/or disability were associated with PTSD-symptoms. Lack of social support, traumatic reactions of caregivers predicted PTSD 16 years post-disaster.
Swann and colleagues [115]	Exploring the the role of mental toughness in survivors psychological response to the disaster, and the lived experiences of survivors to the natural disaster	Phenommenological	10	Short after disaster	Findings: detailed insight into the lived experiences of the surviving mountaineers, and the positive role mental toughness has in responding to and coping with a major natural disaster in a short-term perspective.

Appendix V

Description of the five-fold coping strategies according to Skinner and colleagues [149]

Coping strategies (1-5)	Definition
1. Problem solving (appearing in almost every scale of the systems reviewed)	This domain includes categories of Cognitive Decision Making (i.e., Strategizing and Planning), logical analysis of a problem, instrumental action toward a problem, persistence, effort and determination.
2. Seeking social support (was present in 88 of the systems reviewed)	This domain includes a wide array of targets of support such as family, friends, peers, professionals, religious figures and/or others to solicit help, contact, advice, comfort, and/or instrumental help such as money or goods.
3. Avoidance (appearing on over 50 of the systems reviewed)	This domain includes efforts to stay away and/or disengage from stressful transaction/situation (mentally and/or physically). Includes denial, avoidant actions, cognitive avoidance, and engaging in wishful thinking.
4. Distraction (was present in 40 systems reviewed)	This domain refers to different active attempts to deal with a stressful situation. Distraction includes a broad variety of alternative activities where the persons engage in pleasurable activities, such as reading, hobbies, watching television, exercising, seeing friends, working, and substance abuse.
5. Positive cognitive restructuring (was present in over 20 systems reviewed)	This domain refers to active attempts to change one's view of a stressful situation in order to see it in a more positive light. Here the individuals focus on the positive rather than the negative by positive thinking, optimism, and minimization of negative consequences or distress.

Appendix VI

Sources and search strategy:
We conducted our search for relevant English and Scandinavian articles and literature in nine electronic databases up to May 2, 2019.
We searched in following nine electronic databases: Oria, Pubmed, Eric, PubPsych, Cinahl, Cochrane Library, PsycINFO, Web of Science and Scopus.
The search strategy included the keyword avalanche and truncated search terms (as quantitative * or qualitative* or interview or focus group* or theme* or grounded theory* or ethnograph* or experience* or adapt* or cope or coping or managing or manage or phenomenolog* or resilience* or stress* or ptsd* or trauma* or strateg* or daily* or anxiety* or sleep problem* or mental health*).
The search was limited to studies between 1985 to date on which the searches were performed.
As method to supplement database searching, we reviewed the reference list of the articles we included as relevant for our study.

Appendix VII

Posttraumatic Stress Scale-10 (PTSS-10)

PTSS-10:
Jeg er nå for tiden plaget av:
Merk: Sett ett kryss på hver linje

	JA	NEI
1. Søvnproblemer		
2. Drømmer med mareritt om snøskredet		
3. Depresjon, føler meg nedtrykt		
4. Skvettenhet ved plutselige lyder eller brå bevegelser		
5. Tendens til å isolere meg fra andre		
6. Irritasjon (blir lett irritert eller ergelig)		
7. At følelsene svinger lett opp og ned		
8. Dårlig samvittighet, selvbebreidelse, skyldfølelse		
9. Frykt for stedet eller andre situasjoner som kan minne om dette		
10. Anspenthet i kroppen		

Appendix VIII

Impact of Event Scale-15 (IES-15)

REAKSJONER ETTER SNØSKRED.
Nedenfor finner du en del setninger som folk utsatt for store påkjenninger har brukt for å beskrive hvordan de har det. Les hver setning og sett kryss på hver linje for det tallet fra 0 til 5 som tilsvarer hvordan du har hatt det i de siste par ukene. Det finnes ikke riktige eller uriktige svar.

Har du i løpet av de siste par ukene:
Merk: Sett ett kryss på hver linje

	Aldri 0	Litt 1	Noe 2	Middels 3	Ganske mye 4	I høy grad 5
1. Jeg har hatt perioder med sterke følelser omkring snøskredet						
2. Ting jeg har sett og hørt minner meg plutselig om snøskredet						
3. Tanker om snøskredet har trengt seg på også når jeg ikke har villet						
4. Bilder fra snøskredet har plutselig dukket opp i tankene mine						
5. Enhver påminnelse har gjenopplivet følelser knyttet til snøskredet						
6. Jeg har hatt vanskelig for å sove pga tanker og bilder om snøskredet						
7. Jeg har hatt vonde drømmer om snøskredet						
8. Jeg vet mange uforløste følelser er der, men jeg har skjøvet dem bort						
9. Jeg har ikke tillatt meg å bli følelsesmessig berørt når jeg tenker på snøskredet eller blir minnet om det						
10. Jeg har ønsket å bli kvitt minner om snøskredet						

11. Jeg har forsøkt å la være å snakke om snøskredet						
12. Jeg har opplevd det uvirkelig, som om snøskredet ikke har hendt eller ikke var virkelig						
13. Jeg har holdt meg unna ting eller situasjoner som kan minne meg om snøskredet						
14. Mine følelser for snøskredet er nærmest som lammet						
15. Jeg har ikke tillatt meg selv å ha tanker om snøskredet						

Appendix IX

State Anxiety Inventorty-12 (STAI-12)

We are just allowed to include five sample items from this instrument, due to copyrights, see Appendix XVIII for further information.

Nedenfor finner du en rekke påstander som ofte brukes for å beskrive hvordan en føler seg I øyeblikket. Les hver påstand og sett ett kryss på hver linje som best passer med hvordan du føler deg akkurat nå. Tallene betyr 1- aldeles ikke, 2-litt, 3- endel og 4- ganske mye. Det finnes ingen riktige eller gale svar, men svar slik som du umiddelbart synes passer best:
Merk: Sett ett kryss i hver linje

	Aldeles ikke 1	Litt 2	Endel 3	Ganske mye 4
1. Jeg føler meg rolig				
2. Jeg føler meg trygg				
3. Jeg er anspent				
4. Jeg føler meg vel				
5. Akkurat nå tar jeg sorgene på forskudd				

Appendix X

The Pittsburgh Sleep Quality Index (PSQI)

PSQI

Instruksjoner: Følgende spørsmål har med ditt vanlige søvnmønster *den siste måneden* å gjøre. Du skal svare på hva som er mest riktig for *de fleste* dager og netter den siste måneden. Vennligst svar på alle spørsmål.

1. I løpet av den siste måneden, når har du vanligvis lagt deg om kvelden?
   VANLIG LEGGETID_____

2. I løpet av den siste måneden, hvor lang tid (i minutter) har det vanligvis tatt deg å sovne om kvelden?
   ANTALL MINUTTER_____

3. I løpet av den siste måneden, når har du vanligvis stått opp om morgenen?
   VANLIGVIS STÅTT OPP KL_____

4. I løpet av den siste måneden, hvor mange timer søvn har du *faktisk* fått om natten? (Dette kan være forskjellig fra hvor mange timer du oppholdt deg i sengen.)
   ANTALL TIMER SØVN HVER NATT _____

For hvert av de følgende spørsmål, kryss av for det beste svar. Vennligst svar på *alle* spørsmålene.

5. I løpet av den siste måneden, hvor ofte har du hatt problemer med søvnen fordi du…

(a) Ikke klarer å sovne i løpet av 30 minutter

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(b) Våkner opp midt på natten eller tidlig om morgenen

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(c) Må opp for å gå på toalettet

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(d) Ikke klarer å puste ordentlig

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(e) Hoster eller snorker høyt

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(f) Føler deg for kald

Ikke i løpet av den s iste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(g) Føler deg for varm

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(h) Har vonde drømmer

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(i) Har smerter

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(j) Andre grunner, vennligst beskriv_____

_____

Hvor ofte, i løpet av den siste måneden, har du hatt problemer med søvnen på grunn av dette

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

6. I løpet av den siste måneden, hvordan vil du bedømme søvnkvaliteten din totalt sett?
   - Veldig bra _____
   - Ganske bra _____
   - Ganske dårlig _____
   - Veldig dårlig _____

7. I løpet av den siste måneden, hvor ofte har du tatt medisin (med eller uten resept) som hjelp til å sove?

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

8. I løpet av den siste måneden, hvor ofte har du hatt problemer med å holde deg våken under bilkjøring, måltider eller når du holder på med sosiale aktiviteter?

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

9. I løpet av den siste måneden, hvor stort problem har det vært for deg å ha overskudd nok til å få ting gjort?
   - Ikke noe problem i det hele tatt _____
   - Bare et lite problem _____
   - Et visst problem _____
   - Et stort problem _____

10. Deler du seng eller rom med noen?
    - Deler ikke seng eller rom med noen _____
    - Partner/romkamerat i annet rom _____
    - Partner i samme rom, men ikke i samme seng _____
    - Partner i samme seng _____

Hvis du har en partner eller romkamerat, spør han/henne hvor ofte i løpet av den siste måneden du har hatt…

(a) høy snorking

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(b) lange pustestopp under søvnen

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(c) rykninger eller sammentrekninger i beina under søvnen

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(d) episoder med desorientering eller forvirring under søvnen

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

(e) annen type uro under søvnen; vennligst beskriv_____
_____

Ikke i løpet av den siste måneden___	Mindre enn en gang i uken___	En eller to ganger i uken___	Tre eller flere ganger i uken___

Appendix XI

Interview guide

Broad open-ended interview guide

- *Please describe how you have coped/managed to live with the avalanche disaster in daily life afterward?*
    - Follow-up questions during the interview might be e.g., that interviewer asked the survivors to talk about / deepen / describe in more detail the challenges that came up in the interview: i.e.,
        - Can you tell me more about how often you drank alcohol aftermath?
        - Could you describe more the sleep problems you talked about?
        - What do you think about other conditions at work or in your private life that were stressful during the period post-disaster?
        - How did you cope with that in your daily life?
        - Do you have the same resources or coping strategies available today, that you think are important today, 30 years' post-disaster?

Appendix XII

Examples of development from units of meaning to categories

Units of meaning	Code	Category
"I felt I acted quite appropriately then. I was also a bit proud of the way I had responded to the avalanche."	Proud of how I responded to the avalanche	**Consequences of processing the disaster: A comfortable life**
"I have a pragmatic approach to the psyche anyway. I do not dig into things."	Pragmatic approach	**Consequences of processing the disaster: A comfortable life**
"The accident has helped me to reflect more on what's good and what's bad."	Self-reflection	**Consequences of processing the disaster: A comfortable life**
"I needed help to sort things out, because it was bad for my night-time sleep and my concentration at work. I contacted a health professional and made a few appointments with him, and that sorted it out."	Good help to being able to speak about the disaster	**A challenging, yet accomplished life**
"I enjoy physical activity. Is that a flight and a distraction, or is it a pleasure? I'm not entirely sure, but as long as it gives me something, I do not need to have the answer to that."	Could physical activity be a flight or distraction?	**A challenging, yet accomplished life**
"In the period after the avalanche I was not very keen on skiing in the winter, but I did go again a few years later."	Not keen on skiing, but did it anyway	**A challenging, yet accomplished life**
"I do not like the mountains anymore. I prefer them at a distance."	Mountains on a distance	**A demanding life**
"During the first year aftermath there was a lot of drinking […] I think it was to forget everything"	Drinking to forget	**A demanding life**
"I said nothing, or very little about it."	Not talking about the disaster	**A demanding life**

Appendix XIII

Paper I:
Bakker LP., Cvancarova MS., Reichelt JG., Gjerstad CL., Tønnessen A., Weisaeth L., Herlofsen PH., Grov EK. The trajectory of symptom burden in exposed and unexposed survivors of a major avalanche disaster: A 30 year long-term follow-up study. BMC Psychiatry, 2019; 19: 175-186. DOI: **https://dx.doi.org/10.1186/s12888-019-2159-7**

Bakker et al. BMC Psychiatry (2019) 19:175
https://doi.org/10.1186/s12888-019-2159-7

BMC Psychiatry

RESEARCH ARTICLE Open Access

The trajectory of symptom burden in exposed and unexposed survivors of a major avalanche disaster: a 30 year long-term follow-up study

Lars-Petter Bakker[1*], Milada Cvancarova Småstuen[2], Jon Gerhard Reichelt[1], Christer Lunde Gjerstad[1], Arnfinn Tønnessen[1], Lars Weisæth[3], Pål Herlof Herlofsen[4] and Ellen Karine Grov[2]

Abstract

Background: Limited research exists concerning the long-term effects of avalanches on survivors' mental health beyond the first years after the accident. The aims of this study were to describe and evaluate possible differences in long-term mental health symptoms after a major avalanche disaster between exposed and unexposed soldiers using a longitudinal design.

Method: Present mental health symptoms were examined among avalanche exposed ($n = 12$) and unexposed ($n = 9$) soldiers by PTSS-10, IES-15 and STAI-12 in four waves (1986–1987 and 2016).

Results: Binary logistic regression revealed that the odds to score above the cut-off were significantly lower for both groups after one year compared to baseline for PTSS-10 ($p = 0.018$) and significantly lower after 30 days compared to baseline for IES-15 ($p = 0.005$). Data did not reveal significant differences between the exposed and unexposed groups regarding adjusted PTSS-10, IES-15 or STAI-12 mean scores compared. Linear mixed model-analyses revealed significant effects of time. The adjusted mean scores declined over time for both groups: PTSS-10 ($p = 0.001$), IES-15 ($p = 0.026$) and STAI-12 ($p = 0.001$), and the time trajectories for PTSS-10 were significantly different between the groups ($p = 0.013$) . Although not significant (all $p > 0.05$), results indicated that a larger proportion of soldiers in the exposed group experienced posttraumatic stress symptoms (5/12) (PTSS-10 score ≥ 4) and distress symptoms (6/12) (IES-15 score ≥ 26) above cut-off points, 30 years post-disaster.

Conclusions: The course of mental health symptoms may persist, and even increase, in selected and trained military personnel 30 years after exposure to a natural disaster. These findings may be of great importance for health authorities planning appropriate follow-up.

Keywords: Disaster, Avalanche, Posttraumatic stress symptoms, Anxiety, Mental health symptoms, Long-term follow-up

Background

Posttraumatic stress (PTS) may persist long after exposure has ended [1]. It is well documented that soldiers fighting in World War II, Afghanistan, and concentration camp survivors, might suffer from negative long-term health effects after trauma [2–5]. The risk of developing posttraumatic stress disorder (PTSD) is related to exposure to potentially traumatic events (PTEs). However, the incidence and prevalence vary with the type and duration of exposure; exposure to premeditated traumas is associated with the highest prevalence rate: interpersonal events such as physical threat (weapon), childhood abuse, rape, imprisonment, sexual abuse, kidnapping or being taken hostage and verbal threat/violence from close relations [6–11]. Exposure to PTEs is described as common in most epidemiological surveys of PTSD in numerous countries. Studies have shown that between 20 and 90% of the general population will

* Correspondence: lpbakker@mil.no
[1]Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry, PO Box 1550, Sentrum, N-0015 Oslo, Norway
Full list of author information is available at the end of the article

once in their life experience a PTE [6, 12, 13], and estimates of lifetime prevalence rates of PTSD are between 1.3 to 11.2% [6, 7, 13, 14].

A recent study on the epidemiology of PTSD in Norway aimed to assess lifetime incidence and prevalence of exposure to PTEs and PTSD in a sample representative of the Norwegian population [7]. Lassemo and colleagues [7] claim that lifetime prevalence of Norwegian men at risk of being exposed to a natural catastrophe exemplified as a form of PTE is 1.4%, and of those, 9.1% will probably fullfill the diagnostic criteria for being at risk for PTSD.

Studies on the long-term effects of disasters are limited, but the majority indicate that survivors may experience a range of negative health effects. PTSD is one of several psychiatric conditions that can be observed after trauma [15–17]. However, a broad range of other mental health conditions may develop in the wake of trauma, such as depression [17, 18], sleep-related disturbances and chronic anxiety [1, 17, 19–21], and suicidal behavior [22, 23], but trauma exposure has also been associated with reduced quality of life, impaired psychosocial functioning [24], and increased physical health problems [20, 25–30]. Finally, alcohol abuse is often associated with poor physical health and PTSD [31–33].

Neria, Nandi, and Galea [34] and Galea, Nandi, and Vlahov [35] argue that PTSD is one of the most common post-disaster mental health problems. According to Galea and colleagues [35], 5 to 60% of exposed survivors will be affected by PTSD. However, some researchers claim it is better to compare the effects of disasters of the same nature, rather than group different disasters into the same category, as reactions to disasters may be influenced by incident type, location, causes and context [36, 37].

Natural disasters like avalanches allow examination of exposure to a well-defined stressor. Avalanche accidents leave a survivor sample which has been directly exposed to overwhelming death threats. However, not many long-term avalanche studies have been conducted, and findings are limited to the first year post-disaster [20].

To our best knowledge, only four studies exist in the literature on short-term mental health effects of being exposed to avalanche disasters: two in Iceland and two in Norway.

The Icelandic studies examine two different avalanche-exposed communities in small fishing villages the first year post-disaster. These studies indicated that approximately 40% of survivors suffered from PTSD 10 weeks to 14 months after the avalanches [38, 39].

Two Norwegian studies have assessed PTSD prevalence in soldiers who survived an avalanche, during the first year post-disaster [40, 41]. Herlofsen's [40] and Johnsen and colleagues [41] indicate that a substantial proportion of survivors suffered from PTSD-symptoms up to four months post-disaster. Herlofsen's [40] presents data from the first three waves of the present study. Our study aims to compare data presented by Herlofsen's [40] with assessment 30 years post-disaster.

To our best knowledge, only one study exists on long-term health effects after avalanches. This study was conducted in Iceland to follow up the studies done by Asmundsson and Oddsson [38] and Finnsdottir and Elklit [39], and has a 16-year follow-up of the survivors [20, 21, 42, 43].

Thordardottir and colleagues [20] and Thordardottir, Hansdottir, Valdimarsdottir, and colleagues [21] reported avalanche-specific PTSD-symptoms in 16% of survivors (respectively 12% in men and 19% in women).

In the current study we have examined the 30 year trajectory of mental health symptoms after exposure to an avalanche. This presentation is unique, particulary regarding the follow-up time. We studied mental health symptoms, i.e., PTS, distress and anxiety symptoms, and compared the exposed and unexposed Vassdalen soldiers 30 years post-disaster.

We anticipated that the pattern of change for all outcome variables would develop differently across time depending on whether the responders were in the exposed or unexposed group.

Method

Participants

During the two weeks preceding March 5, 1986, the weather conditions in Vassdalen, in Northern Norway, had deteriorated. The changes in weather conditions resulted in increased avalanche risk in the area where the NATO exercise Anchor Express 1986 was scheduled. A few minutes past 1:00 p.m. an avalanche struck a platoon of 31 soldiers from an engineering corps, leaving 16 dead and 15 survivors [40].

All survivors (exposed) ($n = 15$), and the remaining members (unexposed) ($n = 15$) of the platoon who were stand-by outside the avalanche area, were enrolled in the study immediately following the disaster. The unexposed soldiers were included in the study as a comparison group.

When the follow-up study was conducted, 30 years later (2016–2017), the platoon's exposed or unexposed soldiers were all alive and traceable ($N = 30$). The response rate was 80% for the exposed group (12/15) and 60% (9/15) for the unexposed group.

Study design and procedure

This unselected, longitudinal study was designed to compare changes in mental health symptoms (i.e., PTS, distress and anxiety symptoms) among exposed and unexposed soldiers over time. Data were collected at four measuring points, Time1-Time4 (T1-T4), over 30 years. The three first measuring points (T1-T3) aimed to assess

mental health symptoms, and data were collected within the first 375 days post-disaster; T1 after 4 days, T2 after 30 days and T3 at 375 days post-disaster. The fourth measurement (T4) was conducted 30 years post-disaster.

By law, the Norwegian Armed Forced Joint Medical Services' record has an overview of the sample in this survey. Information about the survey, and the questionnaire, with a sheet to sign for written consent was sent by postal mail to all potential participants. They were informed that answering and returning the questionnaire and the signed consent form, were considered as a consent to participate in the study. The participants were followed up by a phone call and a message via mail or postal mail thanking those who had returned the questionnaire and reminding those who had not returned the questionnaire to consider doing so. Participants needing professional psychiatric aid were offered support from the Institute of Military Psychiatry. All participants were told that they could withdraw whenever they wanted during the survey, without any further explanation and that withdrawal would not affect their contact with the Norwegian Armed Forced Joint Medical Services in the future.

Measures

Background information

For this particular study, PTEs were assessed in addition to demographic and background information at the last wave (T4). For details, see Table 1.

Posttraumatic symptom Scale-10 (PTSS-10; Holen, Sund [44])

The PTSS-10 comprises a 10-item self-report questionnaire, originally developed by the Division of Disaster Psychiatry (at the Armed Forces Joint Medical Service in Oslo, Norway) [44]. The scale covers general stress manifestations such as irritability, sleep difficulties, depressed mood and startle reactions. PTSS-10 response alternatives is usually given on a seven point Lickert scale from 1 rarely/seldom to 7 often. In the current study the response alternatives were dichotomous; not present - No(0), and present - Yes(1). The PTSS-10 sum scores constitute the summation of the ratings (score range = 0–10), the total sum being interpreted according to the two following levels of PTS-symptoms: 0 to 3 (mild/moderate range) and 4 to 10 (moderate/severe range). Most often a score of 6 or more represent "case" and 4–5 represent "caseness". In the current study a cut-off point of 4 or above indicates a need for psychological referral.

This measure has demonstrated satisfying validity, reliability and internal consistency [44–47]. The PTSS-10 provides good face validity, and the direct wording of the items was closely related to the PTSD diagnostic criteria. The PTSS-10 was used at all four waves (T1-T4). Participants were asked to report current PTS-symptoms.

Impact of event Scale-15 (IES-15; Horowitz, Wilner [48])

The IES-15 is a self-report measure designed to assess current subjective distress and PTS-symptoms for any specific life event [48, 49]. The scoring method for measuring distress used a 6-point scale: 0; not at all, 1; rarely, 2; somewhat, 3; sometimes, 4; very much so, and 5; often. The 15-items scale provides a total distress score and two sub-scores: Intrusion (7 items) (range = 0–35) and Avoidance (8 items) (range = 0–40). Scores from 0 to 8 indicate low level of distress, 9–19 represent moderate distress and 20 or more, high level of distress, in both subscores. High levels of distress indicate need of professional evaluation and possible treatment while moderate levels of distress are considered cause for concern [50]. The total distress score (score range = 0–75) represents the summation of the constructions Intrusion and Avoidance. The instrument is closely connected with symptoms of PTSD [51]. The present study used IES-15 to detect distress and PTS-symptoms in all four data collection waves. The total distress score can be interpreted according to the following four levels of PTS-symptoms: 0 to 8 (subclinical range), 9 to 25 (mild range), 26 to 43 (moderate range), 44 and higher (severe range) [51]. Sterling [51] suggests that cut-off points of 26 or above indicate psychological referral.

The IES-15 has demonstrated acceptable validity, reliability and internal consistency [48, 49], but does not include the third major cluster of PTSD-symptoms, a hyperarousal subscale [51].

Participants were asked to report current intrusion and avoidance symptoms during the past two weeks.

State anxiety/aggression Inventory-12/18 (STAI-12/18; Spielberg, Gorsuch [52])

The STAI-18 is a self-report questionnaire designed to measure the presence and severity of current symptoms of anxiety and generalized propensity to be anxious and aggressive. The version used at all four data collection waves (T1-T4) contained only the 12 anxiety items. Data for the dimension aggression were not used due to missing data (6 items). In the present study STAI-18 will be named STAI-12.

The values measuring anxiety relate to a 4-point scale; 1; not at all, 2; somewhat, 3; moderately so, and 4; very much so. The STAI-12 sum scores represent the summation of the ratings (score range = 12–48), and cut-off points of 30 or above would be grounds for psychological referral.

The instrument STAI-18 has demonstrated satisfying validity, reliability and internal consistency [52–54]. Participants were asked to report current symptoms of anxiety.

Statistical analyses

The sample is decribed using descriptive statistics. Continuous variables are decribed with mean (*M*) and standard

Table 1 Characteristics of soldiers exposed and unexposed to the avalanche at Vassdalen in 1986

	Exposed ($n = 12$)	Unexposed ($n = 9$)	*P*-values
Age			0.980[1]
Mean age (SD)	52.4 (0.87)	52.4 (0.91)	
Mean age at time of avalanche (SD)	20.5 (0.87)	20.5 (0.91)	
Median age	52.3	52.3	
Median age at time of avalanche	20.5	20.5	
	n (%)	n (%)	
Education			0.135[2]
University	5 (42)	4 (44)	
High school or trade school	5 (42)	5 (56)	
Grade school	2 (16)	0 (0)	
Current living situation			0.154[2]
Married or in a relationship	7 (58)	7 (78)	
Single, divorced or widowed	5 (42)	2 (22)	
Employment status			0.603[3]
Working	9 (75)	8 (89)	
On disability	3 (25)	1 (11)	
Children			0.378[2]
0	2 (17)	1 (12)	
1–2	8 (66)	4 (44)	
3–4	2 (17)	4 (44)	
Did the disaster affect your physical health negatively?			0.005[3]
Yes	8 (67)	0 (0)	
No	4 (33)	9 (100)	
Did the disaster affect your mental health negatively?			0.024[3]
Yes	8 (67)	1 (11)	
No	4 (33)	8 (89)	
Any suicidal thoughts since the accident?			1.000[3]
Yes	2 (13)	1 (11)	
No	10 (67)	8 (89)	
Any PTEs before or after the accident?			0.673[3]
Yes	8 (67)	5 (56)	
No	4 (33)	4 (44)	

[1]T-test (2-tailed, equal variances assumed)
[2]Pearson chi-square (2-sided)
[3]Fisher's exact test (2-sided)

deviation (*SD*), categorical ones with counts and percentages. Possible crude differences between groups (exposed and unexposed) at T1-T4 were assessed using the Wilcoxon-Mann-Whitney test for continuous variables and Chi-square or Fisher's exact test for categorical variables.

Further, for the continuous variables, linear mixed model (LMM) regression analyses were used to estimate possible differences between groups over time. An unstructured covariance matrix was specified to accommodate for heterogeneous residual variances across time. Restricted maximum likelihood estimation was used to produce unbiased estimates of the model parameters. All overall effects were analysed using *F* tests. The results were presented as estimated *Ms* with 95% confidence intervals (CI). Least significant difference post hoc tests were used to compare *Ms* at given time points. All models were fitted with group, time and group*time interaction terms. The model fit for regression models was good and the residuals followed normal distribution.

All outcome measures were dichotomized and odds for scoring over a given cut-off value were modeled using binary logistic regression models for repeated

measures. The models were fitted with group and time. The results were expressed as odds ratios (OR) with 95% CI. All tests were two-sided and p-values < 0.05 were considered statistically significant. We regarded our study as an exploratory analysis and did not adjust for multiple testing.

Data were analysed using the statistical program IBM SPSS Statistics version 24.0 [55] and Stata version 14.2 (StataCorp, 2005).

Results

The exposed and unexposed soldiers reported almost similar numbers of experienced PTEs in their lifetime ($p > 0.05$) (Table 1). In the exposed group 8/12 (67%) reported one or more PTE. For the unexposed group, 5/9 (56%) reported one or more PTE (Table 1).

Most of the remaining background characteristics were similar in both groups except exposed group self-affection for the disaster's negative impact on physical ($p = 0.005$) and mental health ($p = 0.024$) (Table 1).

Inspection of unadjusted *M*-values for PTSS-10, IES-15 and STAI-12 scores indicated different patterns between the two groups, especially for PTSS-10 and IES-15, from T1 to T4. However, these changes did not reach the level of statistical significance using Wilcoxon-Mann-Whitney test (all $p > 0.05$, data not shown) (all unadjusted *Ms*, see Table 2).

The exposed group indicated a decrease in almost all unadjusted *M*-values from T1 to T3; however, the *M*-scores for PTSS-10 and IES-15 increased again 30 years post-disaster (T4), (Table 2). The PTSS-10 and IES-15 *M*-scores for the exposed at T4 were above any earlier measured unadjusted *M*-scores (T1-T3). The anxiety *M*-scores (STAI-12) indicated a decrease from T1-T3; however, the *M*-value at T4 increased again, but not above the previous (T1-T3) measured values (Table 2).

For the unexposed group, our data revealed a decrease in almost all unadjusted *M*-values from T1 to T3, with T4 indicating a very small increase in *M*-scores for PTSS-10 and STAI-12. For all waves, the IES-15's lowest *M*-score was measured at T4 for the unexposed .

The unexposed group seems to be doing better than the exposed group both for the first year post-disaster (T1-T3) and 30 years post-disaster (T4) regarding unadjusted *M*-levels of mental health symptoms. All (T1-T4) reported unadjusted *M*-scores and *SDs* are listed in Table 2.

LMM analyses did not reveal any statistically significant differences between the groups in adjusted *Ms* for mental health scores when assessed with PTSS-10, IES-15 and STAI-12 when all measurements were considered (adjusted *Ms/SD/*95%CI see Table 3).

As mentioned above, PTSS-10 did not reveal any statistically significant differences between the groups; there was, however, a significant effect of time. The *M*-levels of PTSS-10 declined over time, $p = 0.001$, for both groups, and the shape of the time trajectories showed a statistically significant difference between the groups ($p = 0.013$ for interaction term time*group) (Fig. 1).

The IES-15 did not reveal any differences between groups; however, there was a significant effect of time. The *M*-levels of IES-15 declined over time, $p = 0.026$, for both groups. The time trajectories tended to differ between groups; this did not, however, reach the level of statistical significance (Fig. 1).

Lastly, the STAI-12 did not reveal any differences between groups; however, there was a significant effect of time. The *M*-levels of STAI-12 declined over time, $p = 0.001$, for both groups. The shape of the time trajectories was not different between the groups (Fig. 1).

In 2016 (T4), 5/12 (42%) in the exposed group reported current PTS-symptoms (PTSS-10 ≥ 4), one half reported distress symptoms (IES-15 ≥ 26) and none reported anxiety symptoms (STAI-12 ≥ 30) above cut-off points, which would indicate need for psychological referral (Table 2). All (T1-T4) caseness numbers are displayed in Table 2.

Although not significant (all $p > 0.05$), the unexposed group reported lower proportions of individuals above cut-off points for almost all instruments, except for STAI-12, compared to the exposed group at T4.

Further, binary logistic regression analysis revealed no difference in odds to score above the cut-off between the groups for PTSS-10 (OR = 1.06, 95%CI [0.45–2.46], $p = 0.901$). The odds to score above the cut-off were lower for T2 and T4 compared to the T1 measurements; however, the difference did not reach the level of statistical significance. The odds to score above the cut-off were significantly lower at T3 compared to T1 (OR = 0.25, 95%CI [0.08–0.79], $p = 0.018$). The soldiers were about 75% less likely to score above the cut-off at T3 compared to T1 (Table 4).

For the IES-15 there was no difference in odds to score above the cut-off between the groups (OR = 0.59, 95%CI [0.24–1.45], $p = 0.249$). The odds to score above the cut-off were lower for T2, T3 and T4 compared to the T1 measurements; however, the difference did not reach the level of statistical significance for T3 and T4. The odds to score above the cut-off were significantly lower at T2 compared to T1 (OR = 0.10, 95%CI [0.02–0.49], $p = 0.005$). The soldiers in both groups were about 90% less likely to score above the cut-off at T2 compared to T1 (Table 4). However, the odds were similar at T3 and T4 compared to T1 (all $p > 0.05$).

For the instrument STAI-12, there were too few individuals above the cut-off, therefore the model could not be fitted.

Discussion

To our best knowledge, the present study was the first to investigate long-term mental health symptoms over

Table 2 Measures of mental health problems over time in soldiers exposed and unexposed to the avalanche at Vassdalen in 1986

Measure	Exposed					Unexposed				
	n	*M*	*SD*	*Md*	Caseness (%)	*n*	*M*	*SD*	*Md*	Caseness (%)
PTSS-10										
T1 (4 days)	15	2.80	2.5	3.00	5 (33)	15	4.20	2.4	4.00	10 (67)
T2 (30 days)	12	2.42	2.5	2.00	2 (17)	13	3.15	2.5	3.00	5 (38)
T3 (375 days)	15	1.80	1.7	1.00	5 (33)	15	0.93	1.5	0	1 (7)
T4 (30 years)	12	3.75	3.4	2.50	5 (42)	9	1.33	2.4	0	1 (11)
IES-15										
T1 (4 days)	15	18.47	12.3	14.00	6 (40)	14	24.80	12.5	26.00	8 (53)
T2 (30 days)	12	14.75	15.9	9.50	2 (17)	13	13.54	6.0	14.00	0 (0)
T3 (375 days)	15	18.53	13.1	15.00	4 (27)	15	15.40	10.1	15.00	3 (20)
T4 (30 years)	12	25.92	23.9	22.50	6 (50)	9	9.67	12.5	4.00	1 (11)
STAI-12										
T1 (4 days)	15	20.73	7.5	18.00	0 (0)	15	25.07	7.1	24.00	1 (7)
T2 (30 days)	12	20.00	9.1	16.00	1 (8)	13	19.77	5.9	19.00	2 (15)
T3 (375 days)	15	17.47	4.2	18.00	0 (0)	15	15.87	5.0	14.00	0 (0)
T4 (30 years)	12	18.67	4.3	19.50	0 (0)	9	16.67	6.5	14.00	1 (11)

Note. *M, SD*, and *Md* are all unadjusted

three decades after an avalanche disaster. The study aimed to compare possible changes between exposed and unexposed soldiers experiencing an avalanche. The main finding was significant effect of time, where the adjusted mean levels for all measures declined over time for both groups. The time trajectories for PTSS-10 was significantly different between the groups, indicating an U-shaped course for the exposed group during the observed 30 years.

Table 3 Linear mixed model

	Exposed			Unexposed		
	M	*SE*	95% CI	*M*	*SE*	95% CI
PTSS-10						
T1	2.80	0.63	1.50–4.10	4.20	0.63	2.90–5.50
T2	2.07	0.67	0.69–3.45	3.19	0.66	1.83–4.55
T3	1.80	0.42	0.94–2.66	0.93	0.42	0.08–1.79
T4	3.44	0.86	1.64–5.24	2.13	0.94	0.19–4.06
IES-15						
T1	18.47	3.20	11.91–25.03	24.80	3.20	18.24–31.36
T2	14.40	3.27	7.68–21.12	13.41	3.19	6.83–19.99
T3	18.53	3.02	12.35–24.71	15.40	3.02	9.22–21.58
T4	23.75	5.38	12.61–34.88	10.67	5.98	0.00–23.01
STAI-12						
T1	20.73	1.88	16.88–24.59	25.07	1.88	21.21–28.92
T2	19.57	2.09	15.27–23.87	20.34	2.05	16.10–24.57
T3	17.47	1.20	15.02–19.92	15.87	1.20	13.42–18.32
T4	17.76	1.60	14.39–21.12	18.68	1.74	15.05–22.30

Estimated marginal means for PTSS-10, IES-15, and STAI-12

Several studies claim that individuals exposed to multiple PTE types may be at risk of more severe posttraumatic stress symptoms [6–11]. Our study shows no statistically significant differences between the groups regarding lifetime experienced PTEs. Our findings show that the exposed group reported almost the same proportion of PTEs in their lifetime as the unexposed group. These findings are not in accordance with those of Thordardottir and colleagues [20] and Benjet and colleagues [12], who argue that survivors experience more PTEs, and have more PTSD-symptoms, compared to unexposed individuals [12, 20]. Kessler, Sonnega, Bromet, and Hughes [56] claim that one explanation to a trend where survivors experience more PTEs, may be that previous PTEs are a risk factor for additional PTEs. However, the present study shows a large proportion of both the exposed (67%) and the unexposed (56%) soldiers having experienced one or more PTEs before or after the disaster (Table 1). These findings may indicate that the unexposed soldiers have the same pattern over time regarding PTEs. On the other hand, Bøe and colleagues [17] report findings contrary to Thordardottir and colleagues [20] and Benjet and colleagues [12] in their 27-year follow-up study. Bøe and colleagues [17] found additional traumatic exposure reported more frequently in the unexposed group. Bøe and colleagues [17] argue that this may be explained by survivors' adaption to more secure lifestyles, thus reducing their risk of additional traumas. Another explanation might be experience bias making survivors report fewer traumatic

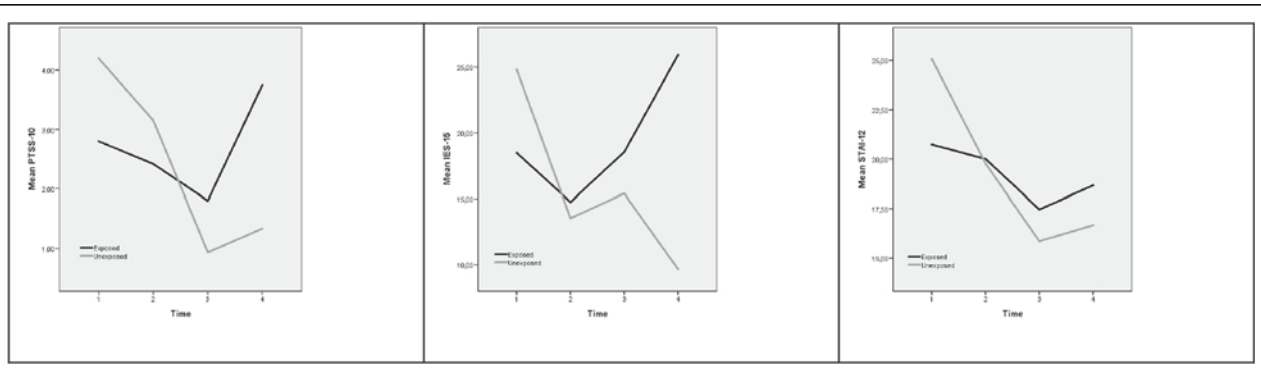

Fig. 1 Changes in mean symptoms of posttraumatic stress, distress and anxiety symptoms by the PTSS-10, IES-15 and StAI-12. Time 1 (T1), Time 2 (T2), Time 3 (3) and Time 4 (T4). Values presented as estimated means with 95% CI from linear mixed models. High scores represent more symptoms of posttraumatic stress, distress and anxiety

experiences, as other PTEs may appear less important than the huge disaster experience [17]. Why our findings indicate almost the same proportion of PTEs in both groups is unclear. It may be a result of serving in the same platoon, being the same age and gender, undergoing the same selection procedures and, of course, both groups were closely related to the disaster, directly or indirectly. An important recent study by Kessler and colleagues [8] highlights that people exposed to earlier traumas are at significantly increased risk of subsequent traumas. This pattern of increased risk of trauma exposure was attributed to differences in individual lifestyles, life circumstances, coping resources and predispositions [8]. This might also be an explanation to the present study regarding the relative high proportion of self-reported PTEs in both groups. Lastly, it is noteworthy that, despite the proportion of PTEs in both groups being similar, the exposed group seem to have higher *M*-levels of PTSD-symptoms and proportion above cut-off (measured by PTSS-10 and IES-15), albeit not significant, compared to the unexposed group at T4.

A possible explanation for the non-significant differences in PTSD-symptoms (measured by PTSS-10 and IES-15) between the two groups in our study, may be related to the fact that the soldiers in the exposed and unexposed group served in the same platoon and that they knew each other very well. Therefore, the exposed and unexposed soldiers were affected with the trauma directly or indirectly. Thus the unexposed soldiers could be considered as victims (although indirectly). A previous study, May and Wisco [57] supports an assumption that level of direct and indirect exposure to trauma may affect individuals regardless of exposure impact.

Table 4 Binary logistic regression analysis

	PTSS-10			IES-15		
	OR	95% CI	*P*-values	OR	95% CI	*P*-values
Group						
Unexposed (ref.)	1					
Exposed	1.06	0.45–2.46	0.901	0.59	0.24–1.45	0.249
Time						
T1 (ref.)	1					
T2	0.39	0.13–1.20	0.101	0.10	0.02–0.49	< 0.01
T3	0.25	0.08–0.79	< 0.05	0.34	0.11–1.05	0.060
T4	0.40	0.12–1.32	0.132	0.54	0.17–1.76	0.309

Odds for scoring above the cut-off for PTSS-10 and IES-15. Binary logistic regression analysis

The exposed group reported that the disaster had a significantly more pronounced negative impact on their physical and mental health compared to the unexposed group, which may be a consequence of the severity of the disaster. These findings are in line with previous studies that claim strong association to type and duration of exposure for the incidence and prevalence of psychopathology post-disasters [6–10]. It is here important to mention that 16 soldiers in the platoon died, and 14 of 15 soldiers in the exposed group were buried by the avalanche. Further, Rostrup, Gilbert, and Stalsberg [58] and Stalsberg and colleagues [59] reported a considerable proportion of physical injuries in the exposed group after the avalanche. The Piper Alpha study may support the findings that disasters may affect the mental health of survivors with physical injuries more negatively. The same study reported high rates of physical injury (83%) directly after the disaster, and high prevalence rates of PTSD (21%) 10 years post-disaster [60, 61].

Several findings in the present study regarding background characteristics are supported by Thordardottir, Hansdottir, Shipherd, and colleagues [43] in their 16-year follow-up study among avalanche survivors. Some previous military research on PTSD and other mental disorders in males also support similar findings. The military studies of Hougsnæs and colleagues [5], Iversen and colleagues [62] and Buckman and colleagues [63] report PTSD and other common mental disorders as more

frequent in single males with lower education, age and rank.

PTSD-symptoms were present in many soldiers in both groups in the immediate aftermath. The severity and intensity of reactions seemed to affect the unexposed group more heavily at first (T1-T2) [40]. Herlofsen's [40] interpreted this as due to an enforced passivity prohibiting the unexposed soldiers from joining the search party and working through their emotional state the first days following the disaster. Previous studies have reported similar findings [64, 65], but another study on unexposed soldiers following an avalanche reporting opposite findings [41]. However, other research on the negative impact of indirect exposure to trauma [57, 66] may be in accordance with Herlofsen's findings [40].

Symptoms of PTS, distress and anxiety exhibited by the exposed and unexposed soldiers decreased during the first year after trauma (T1-T3), and there was a decrease, but not significant, for the unexposed soldiers from T1 to T3 regarding the posttraumatic stress (PTSS-10, IES-15) and anxiety (STAI-12) mean symptom scores. This may point to an ability to work through their emotional state during the first year after the accident and to not having a direct life-threatening experience.

The symptoms remained fairly stable thereafter for the unexposed group (T3-T4), but increased again at T4 for the exposed group. We did not observe a statistically significant difference in PTSS-10, IES-15 and STAI-12 *M*-scores beween the groups. However, our study may illustrate a tendency that the exposed soldiers have a higher PTSS-10, IES-15 and STAI-12 *M*-score, and a higher proportion of soldiers above cut-off points for the PTSS-10 and IES-15 than the unexposed soldiers, which indicate psychological referral 30 years post-disaster. On the other hand, our study showed that the effect of time was statistically significant in both groups regarding all measures, with *M*-levels of PTSS-10, IES-15 and STAI-12 declining over time. The shape of the time trajectories for PTSS-10 was also significantly different between groups, with course pattern of PTSS-10 symptoms increasing in the long-term for the exposed group. The IES-15 trajectories for the exposed group showed the same trend, but did not reach the level of statistical significance.

These results are mostly in line with previous short-term studies finding a marked decrease in PTSD-symptoms after traumatic events [15, 17, 20, 67–69]. Morina, Wicherts, Lobbrecht, and Priebe [70] claim that PTSD related to natural disasters has the highest mean of remission rates (60%) over time, compared to PTSD related to physical diseases (31.4%). It is thus noteworthy that the present study shows no decline after the first year (T3-T4) for the exposed group. However, no other avalanche study has followed up survivors over three decades. These findings are therefore of great importance for health authorities planning appropriate follow-up, and to prepare individuals for a possibly long-term journey after exposure.

There was an increase in PTSS-10, IES-15 and STAI-12 *M*-scores from T1 to T4 in the exposed group, which did not differ significantly from the unexposed group. These findings are contrary to many long-term studies on survivors [15–17, 20, 34, 60, 71–74]. Our findings may be supported by Kessler and colleagues [8], who argue that mean PTSD-symptoms duration is considerably longer than previously recognized, although a considerable minority of PTSD cases remits short time after onset. The present study's findings may indicate that especially the exposed soldiers, carry a burden in the long-term perspective with negative PTSD-symptoms and anxiety symptoms 30 years post-disaster. This may be supported by previous studies claiming that PTSD-symptoms may occur soon after trauma or may be delayed (late-onset), sometimes for years [75]. However, many survivors will never experience, or be given an opportunity to report, all the symptoms for a full diagnosis of PTSD, but have subsyndromal or sub-threshold PTSD, which may impair functioning close to a fully diagnosed PTSD [76–79]. Further, Macleod [80] and Port, Engdahl, and Frazier [81] suggest that trauma-related psychopathology may follow a U-shaped course, a pattern supported in the present study.

Macleod [80] and Port and colleagues [81] report high levels of negative mental health symptoms immediately after trauma, declining during the years of work life but possibly returning as the survivors cope with age-related issues and transition into retirement. In the present study it is not known if such factors affect the level of negative mental health symptoms reported among the exposed 50-year old soldiers.

A significant difference between the groups was notable regarding the shape of the time trajectories for the PTSS-10, and the same trend was seen in the shape of the time trajectories for the IES-15, however not significant.

The present study indicates a higher proportion of exposed soldiers suffering from severe and intense PTSD-symptoms above cut-off points (PTSS-10 = 42%; IES-15 = 50%), compared to the unexposed soldiers (PTSS-10 = 11%; IES-15 = 11%). These findings, 30 year post-disaster, are exactly the same proportions above cut-off (PTSS-10, IES-15) as the exposed soldiers reported four days post-disaster (T1). This is not in accordance with what Bøe and colleagues [17] and Thordardottir and colleagues [20] report in their long-term follow-up studies. Bøe and colleagues [17] reported the incidence of PTSD (early onset) to be 22.9% after the disaster, and after 27 years the

prevalence showed that just 6.3% of the male survivors had a full PTSD diagnosis. The same pattern was reported by Thordardottir and colleagues [20] in their 16 year long-term follow-up study. Further, Thordardottir and colleagues [20] emphasize that Asmundsson and Oddsson [38] and Finnsdottir and Elklit [39] reported that approximately 40% of the survivors suffering from PTSD the first 10 weeks to 14 months after the avalanches. These rates of PTSD declined in the long-term, with 12% of the male survivors suffering from avalanche-specific PTSD symptoms above the clinical cut-off 16 years post-trauma [20].

Thordardottir and colleagues [20] report higher levels of PTSD, while Bøe and colleagues [17] found lower levels than Lassemo and colleagues [7] estimated regarding risk for PTSD after a natural disaster for the general male population in Norway. Lassemo and colleagues [7] estimated that 9.1% of the male population would fill the diagnostic criteria of risk for PTSD after such disasters. These findings and estimates (6.3, 9.1 and 12%) may be lower than we can expect in our exposed male sample when there is no decline in the proportion above cut-off (PTSS-10 and IES-15) 30 years post-disaster, compared to data from T1.

However, it is important to emphasize that the present study uses just a few screening tools that may be efficient for identifying individuals at risk of psychopatologhy, and not structural clinical interviews or diagnostic tools for specific psychiatric diagnoses, like Bøe and colleagues [17]. This may give the present study a false high understanding of the proportion of soldiers with psychopathology when considering only current mental health symptoms above cut-off point, rather than investigating for specific psychiatric diagnoses with diagnostic tools and clinical interviews [82]. The picture may, however, be right, but the proportion of mental impairment among the soldiers both in the exposed and unexposed group may be even higher than expected if the non-responders had been included. Morina and colleagues [70] and Weisaeth [83] claim that the effect of non-participation may be an underestimation of severity and intensity of negative mental health symptoms.

Despite our findings indicating high level PTSD-symptoms among the exposed soldiers, none of them, and just one of the unexposed soldiers, score above the cut-off point regarding anxiety symptoms. These findings are not in accordance with some studies demonstrating the importance of general psychopathology, i.e., subsyndromal PTSD, depression, and anxiety disorders as the most prevalent conditions among survivors in the long-term perspective [17, 84]. The low proportion of anxiety symptoms above cut-off in our study may also be an expression of not using structural clinical interviews or diagnostic tools.

Strengths and limitations

One strength of this study is the long-term follow-up of an avalanche disaster across three decades. Another is the use of standardized, validated measures and the mixed model (LMM) and binary regression analyses, enabling us to model longitudinal data.

This research was, however, conducted on a small sample, from an exclusive group of young Norwegian male soldiers, and the generalizability is likely limited to selected well-trained males; no female soldiers were exposed to this natural disaster. Several studies have revealed significant sex differences in response to traumatic events [85–87]. However, Thordardottir, Hansdottir, Shipherd, and colleagues [43] found no significant sex differences in the prevalence of PTSD 16 years after an avalanche.

Small sample sizes may evoke skepticism about whether the collected data can be subjected to a statistical test. Hackshaw [88] claims that the main problem with small studies is interpretation of results, in particular *p*-values and CIs. Any generalization of this study's results to populations other than selected well-trained males should be done with care. The normality assumptions were tested by means of visual inspection of the residual plots. The model fit was good and the residuals followed normal distribution. The homogeneity of variance was also acceptable. According to our power calculations we would require 25 (PTSS-10), 23 (IES-15) and 121 (STAI-12) in both groups to reveal our findings as statistically significant with anticipated effect sizes as defined by Jacob Cohen [89], being medium (d = 0.5, PTSS-10) and small (d = 0.4, IES-15 and d = 0.4, STAI-12) [89]. Our analyses would require a higher sample size to reveal the main findings as statistically significant. However, due to ethical reasons it was important to present the results despite some of them being largely descriptive. Though the sample size is limited, it is important to emphasize that this study's strengths are a homogeneous group and an almost complete 30 years follow-up.

The effect of non-participation may be an underestimation of severe and intense negative mental health symptoms. Previous studies claim that people experiencing PTSD-symptoms are less likely to answer follow-up studies [70, 83].

The current study is limited by lack of information on pre-disaster health status and the retrospective design. It is, however, important to emphasize that procedures for personnel selection and medical standards in the Norwegian Armed Forces make it fair to assume that no serious psychopathology was present pre-disaster. The retrospective design also introduces the possibility of recall bias when relating to one particular traumatic event. Another possible limitation is the 30 year span between the last two measure points from 1987 to 2016. This may reflect fluctuations this study is unable to detect.

Another possible study limitation is true symptom deviation, as the study relies on self-report rather than

physical examinations and diagnostic tools [82]. An essential strength of this study is its indication of how PTS-symptoms, distress and anxiety symptoms may change over a very long time in a sample exposed directly or indirectly to a Criterion A-event [90]. We recommend long-term follow-up studies after life-threatening events in order to shed light on possible physical, mental and social impairment. In addition to standardized measures, qualitative studies may be valuable in this regard.

Conclusion

This study did not reveal any significant differences in the PTSS-10, IES-15 or STAI-12 adjusted mean levels or scores above cut-off point between the exposed and unexposed groups. However, the study revealed a significant effect of time – the adjusted mean levels for all measures declined over time for both groups. Lastly, the shape of the time trajectories for PTSS-10 was significantly different between the groups, indicating an U-shaped course for the exposed group during the observed 30 years. For the IES-15, our data revealed a similar, but not statistically significant, trend.

This unique long-term study emphasizes that the course of PTS-symptoms (PTSS-10), distress (IES-15) and anxiety (STAI-12) symptoms may persist, and even increase, in selected and trained military personnel 30 years after exposure to a natural disaster. These findings may also be of great importance for health authorities planning appropriate follow-up, and to prepare individuals for a possibly long-term journey after exposure.

Abbrevations

CI: confidence intervals; IES-15: Impact of Event Scale-15; LMM: linear mixed model; M: Mean; OR: odds ratios; PTE: potentially traumatic event; PTS: Posttraumatic stress; PTSD: Posttraumatic stress disorder; PTSS-10: Posttraumatic Symptom Scale-10; SD: Standard deviation; STAI-12: State Anxiety/Agression Inventory; T1: Time 1; T2: Time 2; T3: Time 3; T4: Time 4

Acknowledgements

The authors thank all former soldiers in both the exposed and the unexposed group for their participation.

Authors' contributions

All authors contributed substantially and according to the BMC Psychiatry guidelines to be recognized as authors. Study concept and design: LPB, EKG, MCS, JGR and AT. Data acquisition: PHH and LW for T1-T3 and LPB for T4. Identification and quality assessment of studies: LPB and EKG. Data analysis and interpretation: LPB, EKG, MCS and AT. Manuscript preparation: LPB, EKG and CLG. Manuscript editing: LPB, EKG, MCS and CLG. All authors have read and approved the final version of the manuscript.

Funding

The author(s) received no specific funding for this work.

Availability of data and materials

The raw data is confidential and cannot readily be shared. Data may be shared with researchers obtaining permission from the Norwegian Regional Comittee for Medical Ethics and Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry. After permission have been obtained, data can be made available from The Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry, contact Lars-Petter Bakker: lpbakker@mil.no

Ethics approval and consent to participate

Participants provided written informed consent. The study was approved by the Norwegian Regional Comittee for Medical Ethics (Reference number: 2016/392).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry, PO Box 1550, Sentrum, N-0015 Oslo, Norway. [2]Department of Nursing and Health Promotion, Faculty of Health Sciences, Oslo Metropolitan University, PO Box 4, St. Olavs plass, N-0130 Oslo, Norway. [3]Institute of Clinical Medicine, Division of Mental Health and Addiction, University of Oslo, Gaustad sykehus. Bygg 4, PO Box 1039, N-0315 Oslo, Blindern, Norway. [4]Tranby, Norway.

Received: 21 March 2018 Accepted: 23 May 2019
Published online: 10 June 2019

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Publisher's Note

Appendix XIV

Paper II:
Bakker LP., Cvancarova MS., Reichelt JG., Gjerstad CL., Weisaeth L., Herlofsen PH., Grov EK. Sleep quality problems three decades post-disaster. Nordic Journal of Psychiatry, 2019; 73: 104-110. DOI: **https://dx.doi.org/10.1080/08039488.2018.1563214**.
[Article not attached due to copyright]

Appendix XV

Paper III:
Bakker LP., Eriksen S., Reichelt JG., Grov EK. The experiences of dealing with consequences of an avalanche – surviving soldiers' perspectives. International Journal of Qualitative Studies on Health and Well-being, 2019;
DOI: **https://dx.doi.org/10.1080/17482631.2019.1689066**

INTERNATIONAL JOURNAL OF QUALITATIVE STUDIES ON HEALTH AND WELL-BEING
2019, VOL. 14, 1689066
https://doi.org/10.1080/17482631.2019.1689066

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The experiences of dealing with consequences of an avalanche – surviving soldiers' perspectives

Lars-Petter Bakker [a], Siren Eriksen [b], Jon Gerhard Reichelt[a] and Ellen Karine Grov [c]

[a]Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry, Oslo, Norway; [b]Faculty of Health Studies, Norwegian National Advisory Unit on Ageing and Health, Vestfold Hospital Trust, Tønsberg, Norway, and VID Specialized university, Oslo, Norway; [c]Department of Nursing and Health Promotion, Faculty of Health Sciences, Oslo Metropolitan University, Oslo, Norway

ABSTRACT

Purpose: The aim of the study was to explore and describe experiences of daily life after having experienced an avalanche three decades ago.

Method: This paper presents a qualitative study of 12 male survivors of an avalanche during their military service, interviewed 30 years post-disaster.

Findings: A comprehensive understanding of the categories led to the latent theme "Finding my own way of managing and dealing with life". Findings revealed three categories describing experiences of daily living: (i) A comfortable life; (ii) A challenging, yet accomplished life; (iii) A demanding life. The first category represents a greater degree of using adaptive coping strategies for managing everyday life compared to the other two categories. The third category represents the group having the most challenging consequences. Among the three, the latter category conveys the most maladaptive coping strategies.

Conclusions:The participants had different experiences with regards to their health and how they coped with their everyday life after the avalanche disaster. Insights into coping strategies may provide a guide for appropriate interventions for survivors dealing with traumatic events.

ARTICLE HISTORY
Accepted 31 October 2019

KEYWORDS
Health; avalanche; trauma; coping strategies; daily life; qualitative interviews; content analysis; well-being

Introduction

Every year disasters affect millions of people around the world (approximately 141 million victims in 2014) (Guha-Sapir, Hoyois, & Below, 2015)), and there is, on average, one reported disaster every day worldwide (Goldmann & Galea, 2014; Guha-Sapir et al., 2015; North, 2016). Studies have reported that 10–19% of adults will experience a type of disaster in their lifetime (Darves-Bornoz et al., 2008; Goldmann & Galea, 2014; Kessler, Sonnega, & Bromet et al., 1995). Mainly, the research literature defines disasters as traumatic events (TEs) that are collectively experienced, time-delimited, and have an acute onset (McFarlane & Norris, 2006). Further, in psychology the term TE seems to be used to describe a catastrophic and severely distressing event, e.g., as it is done in the Diagnostic and Statistical Manual of Mental Disorders fifth edition (DSM-5) (American Psychiatric, Association, 2013). Furthermore, in literature, TEs as disasters often are frequently categorized into three types (Goldmann & Galea, 2014; McFarlane & Norris, 2006): (i) man-made disasters, (ii) non-intentional technological disasters, and (iii) natural disasters (Goldmann & Galea, 2014; McFarlane & Norris, 2006). North (2016) writes in her review that most knowledge of TEs has, in a historical perspective, been gained by research on nondisaster traumas. However, the exposure to TEs as disasters are a major worldwide problem, and studies of disasters are associated with a broad variety of negative mental health (psychopathology) and physical health effects (Afari et al., 2014; Ásgeirsdóttir et al., 2018; Benjet et al., 2016; Bøe, Holgersen, & Holen, 2011; Bromet et al., 2017; Bromet, Karam, & Koenen et al., 2018; Galea, Nandi, & Vlahov, 2005; Goldmann & Galea, 2014; Kessler et al., 2017, Koenen et al., 2017; Lassemo, Sandanger, Nygård, & Sørgaard, 2017; Lawrence, Lin, & Lipton et al., 2019; Neria, Galea, & Norris, 2009; Neria, Nandi, & Galea, 2008; Norris, Friedman, & Watson et al., 2002; North, 2016; Pacella, Hruska, & Delahanty, 2013; Thordardottir et al., 2015; Yzermans, van den Berg, & Dirkzwager, 2009). A recent systematic review (Steinert, Hofman, Leichsenring, & Kruse, 2015) of the course of PTSD in naturalistic long-term studies claims that PTSD presumably is the core psychopathology following trauma (Breslau, Chase, & Anthony, 2002; Neria et al., 2008; Steinert et al., 2015). Although, studies of TEs have shown that the majority of victims do not develop a mental health disorder (Breslau et al., 1998; Norris, Tracy, & Galea, 2009), and over the past few decades, interest in resilient and growth patterns or trajectories has increased due to the fact that most

CONTACT Lars-Petter Bakker lpbakker@mil.no Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry, PO Box 1550 Sentrum, Oslo N-0015, Norway

people exposed to TEs cope well post-disaster (Bonanno, 2004; Bonanno, Galea, Bucciarelli, & Vlahov, 2006, Tedeschi & Calhoun, 2004).

A large number of studies aim to find risk factors that can predict different adverse health outcomes after disasters and TEs (Brewin, Andrews, & Valentine et al., 2000; Galea et al., 2005; Neria et al., 2008; Norris et al., 2002; Ozer, Best, Lipsey, & Weiss, 2003, Rubonis, Bickman, & Steinberg, 1991; Shalev, Tuval-Mashiach, & Hadar, 2004). However, description of factors that may identify population or individuals at risk of developing PTSD, are the most common approaches in literature to predict adverse health outcome post-disaster. Further, risk factors can be divided into three groups, respectively risk factors that may predict and increase vulnerability to psychopathology, (i) before (pre) (e.g., prior mental health problems, gender, age), (ii) during (peri) (e.g., the degree or severity of the exposure and proximity) and (iii) after (post) trauma (e.g., stressors as job loss, property damage, reduction in and low level of social support) (Goldmann & Galea, 2014).

Previous studies have found significantly more social and occupational functioning problems in people with psychopathology post-disasters than those without psychopathology in the initial days and months post-disaster (North, 2016; North & Oliver, 2013; North, Pfefferbaum, Kawasaki, Lee, & Spitznagel, 2011). However, a study by North et al. (2011) found, during a time frame of 7-years post-disaster that functioning problems decline over time and largely resolved, even among individuals with PTSD still experiencing symptoms (North, 2016; North & Oliver, 2013; North et al., 2011). North (2016) suggests that even though psychopathology symptoms continued post-disaster, individuals managed to find ways to cope in their everyday life and move on, regardless if they had PTSD-symptoms or not (North, 2016). Several patterns have been reported in the literature regarding the course of PTSD-symptoms, and trauma-related psychopathology, e.g., U-shaped pattern (Macleod, 1994; Port, Engdahl, & Frazier, 2001), chronic pattern (Bonanno, 2004; Norris et al., 2009), delayed pattern (Bonanno, 2004), recovery pattern (Bonanno, 2004; Norris et al., 2009), resilience pattern (Bonanno, 2004; Norris et al., 2009), and resistance pattern (Norris et al., 2009), see Appendix 1.

There are many different ways to cope with everyday life and adverse life events after experiencing stressful situations and TEs—both in short and long term. However, in literature mainly coping is considered as a regulatory process that can reduce the negative feelings resulting from stressful situations as TEs (Afshar et al., 2015; Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). Lazarus & Folkman (1984) defined coping styles as the behavioural and cognitive efforts (e.g., like the changing of action and thoughts (Lazarus, 1991, 1999)) to manage internal and external stressors. Another definition refers to coping strategies as psychological and behavioural efforts to tolerate, overcome, or reduce the impact of stressful events (Carver, 1997). Further, some researchers emphasize that coping is a dynamic process that fluctuates over time in response to changing appraisals and demands of the situation (Afshar et al., 2015; Diehl et al., 2014; Moos, Holahan, & Beutler, 2003). Furthermore, Rice and Liu (2016) argue that coping is actions taken to deal with any type of stressor, regardless large or small, or occurring in daily or in the long run.

In research literature on stress and coping, there are two major conceptual distinctions; (i) emotion- and problem-focused strategies (Carver, Scheier, & Geen, 1994; Folkman, Lazarus, & Hogan, 1985) and (ii) avoidance and approach strategies (Roth & Cohen, 1986; Snyder, 2001). On the basis of the theory of stress and coping, it is relevant to assume that different coping strategies (i.e., emotion, problem, avoidance and approach strategies) are used to manage stressful experiences such as avalanches. Most of the current coping-strategy literature relates coping to problem solving (e.g., active planning, specific behaviour to overcome the problem) and active emotional strategies (e.g., cognitively reframing the problem, humour) to positive psychological adjustment (Bartone et al., 2015; Bei et al., 2013; Cherry et al., 2017, Littleton, Horsley, John, & Nelson, 2007; Penley, Tomaka, & Wiebe, 2002; Schnider, Elhai, & Gray, 2007; Zimmer-Gembeck & Skinner, 2008). On the other hand, avoidant emotional coping strategies are viewed as more maladaptive coping strategies and may interfere negatively with mental health (Bartone et al., 2015; Bei et al., 2013; Cherry et al., 2017; Littleton et al., 2007; Penley et al., 2002; Schnider et al., 2007; Zimmer-Gembeck & Skinner, 2008).

In our discussion section we will consider our findings in the light of the theory of stress and coping strategies (Carver, 1997; Lazarus & Folkman, 1984; Skinner, Edge, Altman, & Sherwood, 2003), and the coping stratgies will mainly be interpreted through Skinner and colleagues' (Skinner et al., 2003) five coping strategies: (i) problem solving, (ii) support seeking, (iii) avoidance, (iv) distraction, and (v) positive cognitive restructuring (see Appendix 2 for more details). Skinner and colleagues' (Skinner et al., 2003) five coping strategies are integrated from analysing 100 coping-category systems proposed from the 1980s to 2000.

There might be several other theories and models in the literature that are related to the concept of coping, e.g., relation between personality and coping, and relation between resilience and coping. In our discussion section, we will also consider our findings in the light of some researchers using resilience theory. However, different coping strategies may be

more appropriate for different people in different contexts and social environments. Therefore, it is important to see beyond individual factors that may promote coping and resilience and look into community factors as well. Several studies have discussed such factors beyond the individual level, such as within communities, families, or organizations (Docena, 2015; Kirmayer, Dandeneau, Marshall, Phillips, & Williamson, 2011; Kruse et al., 2017, Meredith, Sherbourne, & Gaillot et al., 2011; Rice & Liu, 2016; Southwick, Bonanno, Masten, Panter-Brick, & Yehuda, 2014), which will also be important to include and discuss in our paper. And the definition of resilience will be understood in this paper from the theoretical framework by Grotberg (1995, p. 7): "a universal capacity which allows a person, group or community to prevent, minimize or overcome the damaging effects of adversity".

However, coping per se is not considered a characteristic of resilience (Rice & Liu, 2016). Further, Rice and Liu (2016) argue that resilience refers to dealing with commonplace circumstances, while coping refers to encounters in everyday life, as well as dealing with distress. Resilience is often defined as positive adaption to change, while not all coping strategies are necessarily helpful (Rice & Liu, 2016). Thus, while all persons use coping strategies, not everyone using coping strategies is considered resilient (Rice & Liu, 2016). Further, Rice and Liu (2016) claim that resilience refers to the result of adaptive coping strategies following major tragic events.

Quantitative studies on coping strategies have reported that coping strategies interpreted as adaptive, particularly problem solving and support seeking, are approaches found to contribute to better and healthier functioning (Cherry et al., 2017; Littleton et al., 2007; Xu & He, 2012; Zimmer-Gembeck & Skinner, 2008), and have a positive effect on mental health symptoms (Xu & He, 2012). Several qualitative studies after natural disasters are also consistent with these findings (Ekanayake, Prince, Sumathipala, Siribaddana, & Morgan, 2013, Ibañez, Buck, Khatchikian, & Norris, 2004; Rajkumar, Premkumar, & Tharyan, 2008), even though qualitative studies after natural disasters are rare. These qualitative studies indicated that the most cited adaptive coping styles were support seeking, problem solving, and seeking meaning (Ekanayake et al., 2013; Ibañez et al., 2004; Rajkumar et al., 2008). These latter coping styles were also found to contribute to better and healthier functioning (Ekanayake et al., 2013; Ibañez et al., 2004; Rajkumar et al., 2008). On the other hand, previous quantitative and qualitative studies after natural disasters have shown that maladaptive coping styles as e.g., avoidance and distraction are the most cited maladaptive coping styles (Bartone et al., 2015; Ekanayake et al., 2013; Ibañez et al., 2004; Rajkumar et al., 2008). Such coping styles are associated with impaired functioning, psychological distress and poor health (Bei et al., 2013; Cherry et al., 2017; Littleton et al., 2007; Schnider et al., 2007; Zimmer-Gembeck & Skinner, 2008). Further, one recent qualitative study explores the role of mental toughness and lived experience of survivors of an earthquake with a subsequent avalanche (Swann, Crust, & Allen-Collinson, 2016). This study was conducted only a short time after the disaster and did not perform a follow-up of the role of mental toughness in a long-term perspective. To compare a short-term follow-up study like this with our long-term follow-up might be a limitation. However, this study is relevant for our study since the study sample is former military personnel who is presumed to have relatively high levels of mental toughness. Further, mental toughness is considered an important trait regarding coping with stress (Swann et al., 2016). However, the definitions of the term "toughness" are widely-differing. Nevertheless, one proposed definition is that mental toughness is an ability to cope with or handle pressure, stress or adversity (Goldberg, 1998, Gould, Hodge, Peterson, & Petlichkoff, 1987; Jones, 2002; Williams, 1988). The study by Swann, Crust, and Allen-Collinson (Swann et al., 2016) found that mental toughness has a positive role on coping during trauma and shortly post-disaster. The mentally tough survivors in this study reported that they were less likely to dwell over the disaster in the immediate aftermath, and they placed emotions on hold with a task-oriented coping style (Swann et al., 2016). Furthermore, the vulnerable survivors remained in a state of shock longer, and therefore needed support from others (Swann et al., 2016). These survivors were found unable to contribute to the immediate relief efforts as opposed to the survivors that were described as mentally tough (Swann et al., 2016).

Avoidant coping styles have been associated with more acute stress reactions (Eid, Johnsen, & Thayer, 2001), with increased stress symptoms over time (Johnsen, Laberg, & Eid, 1998), with increased risk of sensitization (Johnsen, Eid, Laberg, & Thayer, 2002), and with increased alcohol consumption and reduced well-being (Johnsen et al., 1998) in three different Norwegian military disaster studies (i.e., survivors of shipwreck and avalanche disasters).

However, the most interesting for individuals that experience such symptoms, as well as for the health personnel treating them, are how these symptoms impact daily life in both short term and in the long run (Cerdá, Borfelois, & Galea et al., 2013; Levitt, Malta, Martin, Davis, & Cloitre, 2007, Maguen, Stalnaker, & McCaslin et al., 2009; Malta, Levitt, Martin, Davis, & Cloitre, 2009, Shea, Vujanovic, & Manfield et al., 2010;

Westphal et al., 2011). Adaptive coping strategies (i.e., active coping skills) are considered as a factor promoting resilience (Iacoviello & Charney, 2014). Such skills incorporate behavioural and cognitive components (Iacoviello & Charney, 2014). However, research has reported that coping strategies can be learned and thus be trained (Rice & Liu, 2016). The Australian Army had such a training program, which was designed to facilitate the use of adaptive coping strategies (Cohn & Pakenham, 2008). This study reported that the intervention group had less use of negative coping strategies, less psychological distress, and more positive states of mind than the control group (Cohn & Pakenham, 2008). Knowledge about how survivors cope with different consequences and symptoms after natural disasters as an avalanche, and the impact of daily life, might help health personnel and the institutional system (here: military organization) to identify and improve targets of intervention. Such knowledge can contribute to reduce the lasting disabling consequences following natural disasters. Therefore, gaining knowledge on this topic is important, particularly to explore the phenomena of daily living.

The aim of the study was to explore and describe experiences of daily life after having experienced an avalanche three decades ago.

The specific research questions were:

- What are the survivors' experience of their health condition and daily life?
- How do the survivors cope in daily life?

Context

The background scenario for this study was a military NATO winter exercise called Anchor express. A few minutes past 1:00 p.m., 5 March 1986, an avalanche struck a platoon of 31 young soldiers from an engineering corps at Vassdalen, Norway, and left 16 dead and 15 survivors (Herlofsen, 1994). This study is part of a longitudinal follow-up study among a group of exposed and unexposed soldiers, 30 years post-disaster (Bakker et al., 2019). The participants in our paper are only the directly exposed survivors, not their indirectly exposed peers. However, we know from a recent quantitative study that six out of twelve (6/12) exposed survivors in our study reported present sleep quality problems above cut-off (Bakker et al., 2019), and had most likely greater odds of hyperarousal symptoms during the whole follow-up period compared to those without sleep quality problems 30 years post-disaster (Bakker et al., 2019). Further, this study also reported that eight out of twelve (8/12) survivors had experienced more than one potentially traumatic events (PTE) in their lifetime, three out of twelve (3/12) were on disability, and, lastly, eight out of twelve (8/12) survivors answered that the disaster has affected them negatively both mentally and physically (Bakker et al., 2019). Furthermore, another recent study of our survivors (Bakker et al., 2019) measured posttraumatic stress, distress, and anxiety symptoms at four-time points: 4 days (T1), 30 days (T2), 375 days (T3), and 30 years post-disaster (T4). Findings showed that the mean values across all measures decreased over the first year post-disaster (T1-T3) (Bakker et al., 2019). These results are mostly in line with previous short-term studies investigating TEs (Arnberg, Eriksson, & Hultman et al., 2011; Bøe et al., 2011; Eid, 2003; Koren, Arnon, & Klein, 1999; Sundin & Horowitz, 2003; Thordardottir et al., 2015). However, all latter mentioned mean values increased again from T3 to T4 (Bakker et al., 2019). Measures of posttraumatic stress and distress symptoms at 30 years' post-disaster (T4) were above all previous mean values (i.e., T1-T3) (Bakker et al., 2019). These findings, in turn, are not in line with long-term studies on survivors (Arnberg et al., 2011; Bøe et al., 2011; Green et al., 1990; Holgersen, Klöckner, Bøe, Weisaeth, & Holen, 2011; Hull, Alexander, & Klein, 2002; Lazaratou et al., 2008; Lundin & Jansson, 2007; Neria et al., 2008; Norris et al., 2002, Thordardottir et al., 2015). Caseness above cut-off point from the study, indicates need of psychological referral for (i) posttraumatic stress symptoms (PTS) in five out of twelve, (ii) distress symptoms in six out of twelve, and (iii) anxiety symptoms none of the twelve at T4 (Bakker et al., 2019). Lastly, previous studies by Rostrup, Gilbert, & Stalsberg (1989) and Stalsberg et al. (1989) reported a considerable proportion of physical injuries among our participants directly after the avalanche. For additional new data regarding subjective clinical variables, i.e., variables of alcohol consumption, see Table I.

Method

Design

This study had an explorative design, based on retrospective, qualitative interviews (Graneheim & Lundman, 2004) to provide knowledge about experiences of daily life after having experienced an avalanche three decades ago.

The interviews were analysed by means of inductive qualitative content analysis as described by Graneheim and Lundman (2004). Content analysis is a method of analysing written or verbal communication in a systematic way (Graneheim & Lundman, 2004). Further, this method is useful in analyses of a group's or person's reflections, attitudes, and experiences (Graneheim & Lundman, 2004).

Table I. Subjective clinical variables of soldiers exposed to the avalanche at Vassdalen in 1986–30 years post-disaster.

	Exposed (N = 12)
Age	
Mean age—30 years post-disaster	52.4
Mean age at time of avalanche	20.5
	n/N
Compared to the alcohol consumption pre-disaster, how is your alcohol consumption after the disaster?:	
*Six months post-disaster:**	
Lower than before	1/12
Same as before	6/12
Higher than before	3/12
Much higher than before	1/12
Six to twelve months post-disaster:	
Lower than before	0/12
Same as before	6/12
Higher than before	3/12
Much higher than before	3/12
*Today—30 years post-disaster:**	
Lower than before	5/12
Same as before	6/12
Higher than before	0/12
Much higher than before	0/12

* Missing value = one out of twelve

Participants

Recruitment took place between August 2016 and August 2017. All the exposed avalanche survivors were alive and traceable. In total, 15 survivors were contacted by postal mail, in accordance with the sampling strategy. Three survivors refused participation, yielding 12 interviewed survivors. The survivors' mean age at time of the avalanche was 20.5 years, and mean age at the interviews was 52.4 years. For further description of the characteristics of the exposed soldiers see previously published research (Bakker et al., 2019).

Data collection

This qualitative study uses in-depth interviews with broad open-ended questions. The interviews were guided by a thematic interview guide (see Table II).

Table II. Broad open-ended interview guide.

- *Please describe how you have coped/managed to live with the avalanche disaster in daily life afterward?*
  - Follow-up questions during the interview might be e.g., that interviewer asked the survivors to talk about/deepen/describe in more detail the challenges that came up in the interview: i.e.,
    - Can you tell me more about how often you drank alcohol aftermath?
    - Could you describe more the sleep problems you talked about?
    - What do you think about other conditions at work or in your private life that were stressful during the period post-disaster?
    - How did you cope with that in your daily life?
    - Do you have the same resources or coping strategies available today, that you think are important today, 30 years' post-disaster?

In order to discuss the feasibility of conducting this study, we first gathered possible participants for a joint meeting. We recognized that the discussions tended to veer towards irrelevant issues and the dialogue seemed to suffer from the dominance of some participants. Based on these observations and to gain more detailed information from each participant, we decided to use individual interviews. Individual interviews may offer insight into the participants' personal feelings, thoughts and world view (Knodel, 1993; Morgan, Scannell, & Krueger, 1998).

On average interviews were 95 min in duration, ranging from 20 to 180 min. The majority of the interviews took place in hotel rooms, a few in the first author's office and one of the interviews was held in one of the survivors' home according to the participant's wish. The dialogue flowed very well during the whole interview, and some of the participants confirmed that the conversation had turned out better than they had expected. All participants confirmed that they had a positive opinion of the session at the end of the interview. The first author (LPB) performed all the interviews, which were recorded as audio files, transcribed verbatim by a professional firm, and safely stored. The audio files and transcripts did not contain the names of participants, and a separate "key" with the participants' names was created on a secure, separate drive, matching the file with the participants' codes. The verbatim account was reviewed only by the interviewer (LPB) and by two of the co-authors (EKG and SE).

Data analysis

The qualitative content analysis, with the search for manifest and latent meanings, was led by LPB and performed in several steps. The analysis was inspired by Graneheim and Lundman (2004). One of the co-authors (EKG) participated fully in the analysis process, in which the first step was to become acquainted with the data from the interviews without applying any theoretical perspective. Further, we discussed the actual theme and suggested descriptions (the manifest meaning) that emerged from the content analysis (Carver et al., 1994; Lazarus & Folkman, 1984; Skinner et al., 2003). The analytical process is described in four steps below.

Description of the four analytical steps

Step 1: In order to catch the impression of the whole, the first author (LPB) and one of the co-authors (EKG) read closely all the transcribed interviews several times. Both researchers' impressions of every interview were written down separately and summarized in a short text of 400–800 words, and thereafter

discussed in-depth several times by the first author and co-author. An early consensus on the impressions of the interviews was established through those discussions.

Step 2: Each interview constituted one unit of analysis and was deconstructed into units of meaning that were condensed (LPB and EKG). This was done by focusing on staying as close as possible to the survivors' own descriptions (self-understanding).

Step 3: The meaning units were further abstracted and labelled with a code (LPB and EKG). All the various codes were compared based on similarities and differences and sorted into fields of content and tentative categories (LPB and EKG). The results of step 3 were entered into a spreadsheet (see Table III). From this we were able to perform the analysis across individuals, looking for variations, differences and similarities in the descriptions (LPB and EKG). During this analysis process, three different categories emerged across the survivors, indicating similarities in attitudes and how they coped and perceived their health condition and lived their daily lives.

Step 4: The three different categories found in step 3 were discussed in depth. After several meetings and dialogues between the first- (LPB) and two of the co-authors (EKG and SE), the underlying, latent content of the three categories was formulated into one theme.

Examples of the development from units of meaning into codes and categories are given in Table III.

Table III. Examples of development from units of meaning to categories.

Units of meaning	Code	Category
"I felt I acted quite appropriately then. I was also a bit proud of the way I had responded to the avalanche."	Proud of how I responded to the avalanche	**Consequences of processing the disaster: A comfortable life**
"I have a pragmatic approach to the psyche anyway. I do not dig into things."	Pragmatic approach	**Consequences of processing the disaster: A comfortable life**
"The accident has helped me to reflect more on what's good and what's bad."	Self-reflection	**Consequences of processing the disaster: A comfortable life**
"I needed help to sort things out, because it was bad for my night-time sleep and my concentration at work. I contacted a health professional and made a few appointments with him, and that sorted it out."	Good help to being able to speak about the disaster	**A challenging, yet accomplished life**
"I enjoy physical activity. Is that a flight and a distraction, or is it a pleasure? I'm not entirely sure, but as long as it gives me something, I do not need to have the answer to that."	Could physical activity be a flight or distraction?	**A challenging, yet accomplished life**
"In the period after the avalanche I was not very keen on skiing in the winter, but I did go again a few years later."	Not keen on skiing, but did it anyway	**A challenging, yet accomplished life**
"I do not like the mountains anymore. I prefer them at a distance."	Mountains on a distance	**A demanding life**
"During the first year aftermath there was a lot of drinking […] I think it was to forget everything"	Drinking to forget	**A demanding life**
"I said nothing, or very little about it."	Not talking about the disaster	**A demanding life**

Ethical considerations

The participants were provided written information and signed the consent form. Before and after all the interviews the participants were told that uncomfortable thoughts and feelings might arise, and that some psychological and physical reactions to the interview may occur and last for a few hours, or perhaps as long as a few days after the interview. The interviewer highlighted the fact that such reactions are normal. Furthermore, all participants who wanted professional psychiatric aid were offered support from the Institute of Military Psychiatry.

Given the rich data from qualitative interviews and the reporting of the avalanche disaster in the media, it is a possible risk of reidentification. Therefore, a decision was made to restrict the reporting of demographic characteristics of the sample to protect the participants' privacy. Deductive disclosure, also known as internal confidentiality, occurs when the traits of groups or individuals make them identifiable in research reports (Kaiser, 2009). The study was approved by the Norwegian Regional Committee for Medical Ethics (Reference number: 2016/392), and conforms to the ethical principles for medical research on human beings set out in the declaration of Helsinki (World Medical Association, 2013).

Findings

One main theme was identified from the content analysis: "Finding my own way of managing and dealing with life". Further, the content analysis revealed three different categories which describe the participants' experiences in living their daily lives during three decades post-disaster: (i) A comfortable life; (ii) A challenging, yet accomplished life; (iii) A demanding life.

The theme

The three categories represent different ways dealing with the avalanche experience in a qualitative perspective. A comprehensive understanding of the categories was discussed in light of the aim of the research, and an overall synthesis of the categories generated revealed the comprehensive understanding and the latent meaning expressed as: "Finding my own way of managing and dealing with life".

Description of the three categories

A comfortable life

The survivors in this category described that they considered being alive as being the most important thing after the avalanche. Based on this, they described that the circumstances could have been even worse: "I've been quite fortunate despite the circumstances, I think." Further they described that they could not have acted differently regarding solving the challenges directly and later on during the decades' post-disaster: "I felt I acted quite appropriately then. I was also a bit proud of the way I responded to the avalanche." The survivors also described how they managed to cope with living with the avalanche disaster in everyday life with no special mental problems post-disaster: "No one has any such mental disorders in our family […] so I think that is the case for me too, it is both heritage and environment then." Further, the surviors in this category described that they did not invest much effort in negative thoughts. They grew confident from how they had been able to meet stressors that everyday life had given them so far: "I have a pragmatic approach to the psyche anyway. I do not dig into things." Furthermore, the survivors described active attempts to how they restructured and changed their view of a stressful situation in order to see it more positively: "The accident has helped me reflect more on what is good and what is bad." Another noted: "More positive than negative things have come out of that disaster. I have become more aware that there are things I might have learned from it. It has made me a better person."

Further, the participants of this category described a broad variety of ways to seek support and to talk about the disaster during the three decades' post-disaster. The participants described that they were not afraid turning to others (i.e., family, friends or co-workers) in order to gain emotional support or to talk generally about the disaster and feel comfortable with it: "I got a lot of attention. I had lots of chances to talk about what I had been part of. So I've probably had some therapy through that." Further, the survivors described the cohesion to the other survivors in the platoon was important to cope with the disaster during the 30 years' post-disaster: "I have always been looking forward to the five-year meetings. It has been a very nice group, plus that you, in a way, get to meet others who have had the same experience." However, the surviros described a lack of support from the military system following the disaster: "I believe that the armed forces did not contribute much after the avalanche."

A challenging, yet accomplished life

This category incorporates a wide range of experiences, attitudes and strategies towards the experience of living with the avalanche in daily life. The survivors described that they reacted very differently with regards to how much effort in negative thoughts and behaviour they had used on the disaster in their daily life during the three decades' post-disaster. Survivors in this category described a wide variety of distraction techniques such as working a lot or performing physical activities. However, they described that they were not familiar with these techniques to cope with emotional or other psychological challenges post-disaster: "For a long time, I worked a lot. I wonder afterwards, if that was because I had an interesting and good job, but was it really because I needed a distraction?" Another noted: "I enjoy physical activity. Is that a flight and a distraction, or is it a pleasure? I'm not entirely sure, but as long as it gives me something I do not need to have the answer to that."

Further, other survivors in this category described that they tried to overcome anxiety for winter activities in a period after the disaster: "In the period after the avalanche I was not very keen on skiing in the winter, but I did go again a few years later."

Seeking support and talking about the disaster, and other daily adversities, was described at different levels in this category. This category describes all levels, from not talking about the disaster at all, to talking to others about it, and to seeking advice and help from peers, family, community or health personnel at different periods' post-disaster. This was done differently in the years from directly after the disaster to approximately 30 years' post-disaster: One noted "I needed help to sort things out, because it was bad for my night-time sleep and my concentration at work. I contacted a health professional and made a few appointments with him, and that sorted it out." Another noted: "If you experience negative things, tell someone about it." Other survivors described that they talked a lot during the first year post-disaster: "The first year after the disaster I think I talked a lot and got it out of my system." Other survivors in this category described other ways to overcome/cope with the distress and to talk about the disaster in everyday life: "I understood early that talking about it, even though it was unpleasant, was

good. The more uncomfortable, the more necessary. I have always thought so." Others spoke about how they coped with everyday life challenges by themselves: "I'm probably not a person who actively uses the network around me. I like to get things done by myself." Further, they also described lack of support from the armed forces both in the short and long term: "I feel a legitimate resentment for absenteeism from the armed forces post-disaster."

A demanding life

The participants in the third category described, and emphasized, how they struggled to cope with everyday life after the avalanche disaster. They described symptoms of severe mental consequences (i.e., symptoms of posttraumatic stress, distress, anxiety, and sleep problems) in daily life during the three decades' post-disaster: One noted "After the disaster they began to appear, the nightmares." Others described anxiety and hyperousal symtpoms when thinking of similar situations as the avalanche: "I do not like the mountains anymore. I prefer them at a distance." Another noted: "I don't want to get into situations that remind me of the avalanche, I think about it every day." Further the participants in this category described periods of large alcohol consumption following the disaster: "lots of alcohol followed decades post-disaster […] but I had to stop drinking." Another noted: "during the first year aftermath there was a lot of drinking […] I think it was to forget everything." Furthermore, description of problems with occupational functioning were only described in this category: "after the disaster I have mostly been unemployed."

During the interviews the survivors in this category seemed to describe a limited variety of ways to talk about the disaster to other people. Most of the survivors in this category said that they did not talk to others or ask for advice or help from others to handle daily life after the disaster: "I said nothing, or very little about it", while a very few described that they felt that they talked too much to others about the disaster: "I talked a lot to people about this. I'm sure many were tired of hearing me talking." The participants in this category also described lack of support from the military system post-disaster: "the armed forces did very little for us."

For the participants in the third category, the avalanche was a central concern which represented a daily challenge to live everyday life.

Summary of findings from a theoretical perspective

The three categories seem to represent different ways of dealing with stressors in everyday life post-disaster. "Finding my own way of managing and dealing with life" describes different ways of coping with the situation. The survivors representing the category *"A comfortable life"* tended to use strategies such as problem solving, talking about it (seeking social support), reflecting on their experiences (positive cognitive restructuring) as well as focusing on the positive aspects of their current situations. These strategies appeared to be adaptive for these participants in their contexts and improved their mental well-being. The survivors in the second category *"A challenging, yet accomplished life"* were also dealing with most of the different types of stressors in their everyday life, using adaptive coping strategies during the whole period. However, there were several descriptions of strategies that were interpreted as more maladaptive in this category than in the first category analysed, i.e., avoidant strategies such as avoidance and distraction. These strategies appeared to be more adaptive than maladaptive for these participants in their contexts. For the third category, *"A demanding life"*, the survivors tended to use strategies such as avoidance and distraction in everyday life post-disaster. These strategies appeared to be maladaptive for these participants in their context and resulted in impaired mental well-being.

Discussion

This study aims to explore and describe the experience of survivors' health and how they cope with everyday life after an avalanche disaster during three decades post-disaster.

In an early analytic stage, we saw that our three categories were compatible with coping theories, and we decided to discuss the categories in relation to the coping strategies provided by Skinner et al. (2003) five core categories of coping. Our purpose for applying these coping strategies was to use well-supported and known domains from literature on coping that covered a diversity of behaviours and thoughts (Skinner et al., 2003). However, other theories and literature will be applied to cover a broader perspective to shed light on the topics.

"A comfortable life"

The findings show that the coping strategies described in the first category seemed to result in greater well-being and functioning during the three decades' post-disaster, compared to the other categories. The survivors described how they managed to cope with the avalanche disaster in everyday life by using coping strategies interpreted as adaptive. The first category seemed primarily to be consistent with three of Skinner et al. (2003) core categories of coping: (i) positive cognitive restructuring, (ii) problem solving and (iii) seeking social support. The avalanche disaster did not seem to be of great importance. Furthermore, the participants did not invest much

effort in negative thoughts regarding the disaster, and mainly used a form of positive cognitive restructuring to actively change their thinking around the stressful situation in order to see it more positively. The description of coping strategies used in the first category may fall under what the research literature in the field refers to as problem-solving and active emotional coping strategies (Skinner et al., 2003). In quantitative studies, these types of coping strategies, especially problem solving and seeking support, contribute to better and healthier functioning (Cherry et al., 2017; Littleton et al., 2007; Zimmer-Gembeck & Skinner, 2008). This is also consistent with qualitative studies conducted on survivors after natural disasters, where seeking support, problem-solving, and seeking meaning are the most cited coping strategies contributing to better and healthier functioning (Ekanayake et al., 2013; Ibañez et al., 2004; Rajkumar et al., 2008). Some of the survivors in this category described that they had a "pragmatic approach" to the psyche and did not "dig into things". One could ask if this approach is maladaptive, an avoidance or distraction in everyday life to "forget" about the disaster's impact?

This kind of approach seems to allow the first category of survivors an assimilation and acceptance of the traumatic experience into life and provide opportunities for recovery and growth. This is in accordance with previous research that described the attempt to forget as a kind of cognitive flexibility. This would enable the survivors to reappraise the perception and experience of a TE, providing opportunities for growth and recovery (Cherewick et al., 2015; Iacoviello & Charney, 2014). On the other hand, this may constitute a resilient behaviour: an expression of a personality trait referred as "mental toughness" (Hardy, Bell, & Beattie, 2014), which is also considered as an ability to cope with or handle pressure, stress or adversity (Goldberg, 1998; Gould et al., 1987; Jones, 2002; Williams, 1988). Furthermore, mental toughness might also reflect that these participants felt that they were "acting quite appropriately" during and after the disaster. However, the participants are former military personnel who presumably have high levels of mental toughness and we can assume that they have traits or abilities to cope with adversity. These latter reflections above are consistent with a recent study of survivors of an avalanche, sheding light on the positive role mental toughness has on coping during and shortly after a natural disaster (Swann et al., 2016). Another quantitative study among athletes, reported that higher mental toughness is associated with less use of avoidant/emotional coping and a greater use of problem-solving coping strategies (Nicholls, Levy, & Polman et al., 2011). On the other hand, it might be that the participants in this category are more resilient and have a positive adaption to change than particpants in the other categories. It seems like they act and create their own resilience by using adaptive coping strategies such as problem-solving, cognitive restructuring and seeking social support. This is in accordance with literature on the field of resilience, for instance Iacoviello and Charney, (2014, p. 3) highlighting that: "Resilient individuals use active rather than passive coping skills; they act and create their own resilience." The survivours interviewed seemed to describe a resilient or resistant pattern regarding trauma-related psychopathology (Bonanno, 2004; Norris et al., 2009). However, in disaster literature, adaptive coping styles have been found to be associated with better and healthier functioning, less psychological distress and better health (Ekanayake et al., 2013; Ibañez et al., 2004; Rajkumar et al., 2008; Xu & He, 2012).

Although it seems like the coping strategies described by the participants in the first category influencing their mental health outcomes for the better, compared to the participants in the other categories. Therefore, we have an understanding of the participants using adaptive coping styles such as cognitive restructuring, problem-solving and seeking social support, may have fewer mental health problems. This is consistent with previous research stating that individuals influence their mental health for the better regarding to their ways of coping (Freedy, Saladin, Kilpatrick, Resnick, & Saunders, 1994; North, Spitznagel, & Smith, 2001). However, this could also be in accordance with a natural disaster study which reported that men who apt to adapt adaptive coping strategies may have fewer negative psychological outcomes (Xu & He, 2012).

The latter descriptions and findings might also be in accordance with two recent quantitative studies of our sample (Bakker et al., 2019, 2019) reporting PTSD-symptoms and sleep quality problems below cut-off point for some of the participants. This would indicate no need of psychological referral in some of the survivors 30 years' post-disaster (T4). These previously reported findings regarding our sample, might indicate that the interviewed survivors in this category might fit the reported group of survivors with less severe psychopathology symptoms, and absence of risk factors (i.e. description of no prior mental illness, to have a job, and no prior PTEs before or after the avalanche (Bakker et al., 2019)).

Literature describes that resilient individuals seek acknowledgement of social support (Iacoviello & Charney, 2014). Participants from the first category described that the meetings every fifth year with the other survivor peers seem to contribute to a positive cohesion. This is in line with the literature describing

the importance of contributing to considerable emotional strength for those involved in TEs (Iacoviello & Charney, 2014).

"A challenging, yet accomplished life"

The second category of survivors described a wide range of coping strategies towards the experience of living with a severe traumatic event in everyday life compared to the other categories. The coping strategies described were interpreted as a combination of all Skinner et al. (2003) five coping strategies. Compared to the other categories, the survivors in this category described a much wider view of the impact of the disaster, and whether they had experienced any challenges in their daily life during the three decades' post-disaster. The survivors described that challenges may still exist. However, compared with participants from the third category, they described a greater acceptance and less use of the maladaptive coping strategies in everyday life, which might interfere negatively with mental health. On the other hand, it seems that these survivors are more negatively affected in daily life by the disaster, compared with the first category. Nevertheless, it is difficult to argue that the few adaptive coping strategies described in the first category are more preferable than the combination of coping strategies used in the second category. This is supported by both Skinner and Zimmer-Gembeck (2007) and Zimmer-Gembeck and Locke (2007), who argue that the most adaptive strategy is to be able to use a wide range of coping strategies and being able to employ them when needed. This might be the case for these participants as they described adapting to their environments well, being able to use a broad range of coping strategies and employ/use them when needed. This is in accordance with literature describing coping, and resilience (Kim-Cohen & Turkewitz, 2012), as a dynamic process that fluctuates over time in response to changing appraisals and demands of the situation (Afshar et al., 2015; Diehl et al., 2014; Moos et al., 2003). Even though survivors in the second category used more strategies described as maladaptive (e.g., avoidance and distraction) compared with the first category, it seems like the survivors found that distracting alone and keeping busy with exercise or work could be a successful way of dealing with the disaster in everyday life. These findings are compatible with what Ekanayake et al. (2013) found in their qualitative study of survivors after a tsunami describing that keeping busy was a successful way of dealing with stress (Ekanayake et al., 2013).

The participants in the second category described a broad variety of ways to seek support (i.e., family, peers, community or health personnel). This seemed to make a positive influence on their emotions, thinking about themselves and had a protective impact on negative mental health outcomes. These observations and descriptions are consistent with previous research suggesting that social support influence individuals' own thinking about themselves and protect against negative psychological outcomes of trauma (Panzarella, Alloy, & Whitehouse, 2006). Although the fact that this category describes little use of maladaptive coping strategies and symptoms associated with psychopathology compared to the first category, we observed that the participants in the second category described higher levels of psychopathological symptoms and challenges than the survivors in the first category, but less than in the third category. These observations might be consistent with studies claiming that many survivors of TEs never will experience, or be given an opportunity to report all the symptoms for a full diagnosis of PTSD. However, having a subthreshold or subsyndromal PTSD in periods, may impair functioning close to a fully diagnosed PTSD (Breslau, Lucia, & Davis, 2004; Norman, Stein, & Davidson, 2007; Pietrzak et al., 2012; Schnurr, Friedman, & Rosenberg, 1993).

We might interpret, from the descriptions, that the survivors in the second category might follow different patterns than the survivors in category one, regarding trauma-related psychopathology, i.e., a recovery, delayed (Bonanno, 2004; Norris et al., 2009) or a U-shaped pattern (Macleod, 1994; Port et al., 2001). A previous study of our sample may support a U-shaped pattern for our participants (Bakker et al., 2019) reporting that the time trajectories for PTS-symptoms indicates a U-shaped course for all our participants during the observed 30 years (T1-T4) (Bakker et al., 2019). Regarding the descriptions from the survivors' daily life in the second category, the findings indicate that the U-shaped pattern may fit very well for the participants in this category compared with the two other categories.

"A demanding life"

The descriptions and findings indicate that the few coping strategies that are applied (i.e., avoidance and distraction) by the third category of survivors, are interpreted as difficulties with coping with everyday life after the avalanche.

The disaster is described to be of central importance in this category, and the survivors describe having a lot of negative thoughts and behaviours regarding the disaster three decades' post-disaster. Survivors in this category described that they did not seek support for advice or help from others to handle the consequences of living with the disaster. Furthermore, most of them described that they were uncomfortable talking to others about the disaster

and about their lives. Such behaviour, even though it is shown as different expressions, may be in accordance with previous quantitative research of Norwegian veterans that showed barriers to seek health care for mental health problems (Johnsen & Böe, 2016). Several quantitative studies support that veterans with mental health problems do not seek health care because seeking such care may be associated with weakness (Hoge et al., 2004; Johnsen & Böe, 2016; Kim, Thomas, Wilk, Castro, & Hoge, 2010). This could be an explanation for not seeking support, advice or help.

The descriptions of using maladaptive coping strategies include the presence of several symptoms which are known to go hand in hand with PTSD-symptoms (i.e., PTS, distress, anxiety symptoms, and sleep quality problems), e.g., avoidance of situations that may remind them of the avalanche and nightmares, and further, descriptions of abuse of alcohol in periods afterwards to forget or avoid feelings around the avalanche. According to previous research in the field of coping, the coping strategies described by the third category refer to types of coping strategies that have been found to be associated with impaired functioning, poor health and psychological distress (i.e., avoidance and distraction) (Bei et al., 2013; Cherry et al., 2017; Littleton et al., 2007; Schnider et al., 2007; Zimmer-Gembeck & Skinner, 2008). Furthermore, Horowitz (1986) has described that the more intense the TEs are, more likely survivors will have stress reactions involving avoidance and distraction. In such situations, avoidance and distraction can be considered adaptive by reducing stress in a short period. However, these strategies are considered positive for short-term stressors, and negative if used long term regarding the traumatic situation (Gibbs, 1989; Suls & Fletcher, 1985). The participants in the third category are observed to be describing just such use of long-term trauma avoidance and distraction strategies that might have negative impact on their mental health outcome in the long-run. Further, all PTSD-symptoms (i.e., PTS, distress and sleep problems) described in the third category are consistent with two recent-published studies on our sample (Bakker et al., 2019, 2019). In these two studies the participants reported considerable symptom burden above cut-off point, e.g., in need of psychological referral, respectively five out of twelve above cut-off for PTS symptoms, six out of twelve above for distress symptoms, and six out of twelve above cut-off regarding sleep quality problems (Bakker et al., 2019). Furthermore, the third category also corresponds with previous reported findings from the sample of risk factors that may predict and increase vulnerability to develop a mental health disorder post-disaster, e.g., survivors on disability (Bakker et al., 2019), survivors with grad school or less (Bakker et al., 2019), survivors that reported more PTEs than just the avalance (Bakker et al., 2019) and so on and so forth.

Additional subjective clinical variable reported in our paper, could indicate that some of our participants might abuse alcohol today 30 years' post-disaster, see Table I. This subjective clinical variable indicates that in total six out of twelve of our participants reports "higher" or "much higher" alcohol consumption six to twelve months post-disaster. These latter results could coincide with the descriptions in the third category that described different challenges regarding alcohol during the thirty years' post-disaster. However, it is important to emphasize that some of the participants in the third category described stopping abusing alcohol after a year or decades after disaster.

Furthermore, alcohol intake is associated with possible mental disorders in several studies (Hougsnæs, Bøe, Dahl, & Reichelt, 2017; North, 2016). This could also coincide with the description of psychopathology symptoms in the third category (i.e., PTS, distress and sleep problems). This latter observation are in accordance with a quantitative study of Norwegian veterans which showed that current alcohol intake was significantly associated with probable mental disorders (Hougsnæs et al., 2017). The alcohol abuse described in the third category may be interpreted as an avoidant coping style to handle daily life. This interpretation of the described alcohol consumption can, further, be in accordance with another quantitative study of American veterans that claims that the strongest factor associated with alcohol abuse in returning soldiers is an avoidant coping style (Bartone et al., 2015). Other quantitative studies have also highlighted the connection between PTSD and drinking behaviour as "drinking to cope" (Lehavot, Stappenbeck, Luterek, Kaysen, & Simpson, 2014), drinking to regulate emotions (Cooper, Frone, Russell, & Mudar, 1995), and the use of alcohol to regulate negative effects in the absence of more adaptive emotional coping strategies (Veilleux, Skinner, Reese, & Shaver, 2014); these connections may be present in our study too, and especially for participants in the third category that describes a problematic alcohol consumption.

Two previous quantitative studies of Norwegian soldiers (Eid et al., 2001; Johnsen et al., 1998) may also support that avoidant coping strategies could coincide with the descriptions in the third category (e.g., participants' description of avoidance of situations that may remind them of the avalanche, and description of alcohol as a mean to forget). These two studies describe avoiding coping styles to be associated with more acute stress reactions (Eid et al., 2001) and related to an increase of stress symptoms over time, increased alcohol consumption and low well-being in the soldiers (Johnsen et al.,

1998). From all the observations and descriptions we made from the survivors in the third category it might seem that they describe to follow a different pattern than the survivors in the first and second category, regarding trauma-related psychopathology. It could seem that the participants in the third category, as a whole, give a description of following a pattern described as a chronic pattern, i.e., pattern where trauma-related psychopathology symptoms tend to persist across time (Bonanno, 2004), more than a U-shaped pattern as in the second category.

Lastly, all participants in our study described a lack of support from the military system post-disaster. These descriptions of lack of support might have affected the participants in our three categories differently since we know from literature that our action towards stressors and TEs takes place in a context of interaction with other individuals, cultures, available resources, communities, and organizations (Iacoviello & Charney, 2014; Sherrieb, Norris, & Galea, 2010; Southwick et al., 2014; Walsh, 2006) (e.g., military as an organization), and that we have to see beyond just individual factors that may promote coping and resilience (Docena, 2015; Kirmayer et al., 2011; Kruse et al., 2017; Meredith et al., 2011; Rice & Liu, 2016; Southwick et al., 2014). Nevertheless, our third category is described as a category which has low-seeking of support and high levels of psychopathology symptoms. The third category most likely may have been further adversely affected by a non-supportive military organization. A previous study of veterans returning from wars support these assumptions (Tsai, Harpaz-Rotem, Pietrzak, & Southwick, 2012). This latter study found that less social support from community/organization and lower availability of secure relationships mediated the association between PTSD and poor social functioning.

The descriptions of experiences in all three categories in our study illustrate that it might be a broad variation in how impact of trauma experienced earlier in life might affect the coping strategies in daily life later on.

We know from previous studies that TEs are common and the probability of TEs to occur is high, seen in a lifespan perspective. It is not a question of if, but when it is going to happen! That is why we must prepare individuals for exposure, so this do not happen to be a shock. Additionally, we have to enhance resilience through strengthening adaptive coping strategies to deal with adversity. This is even more important to the individuals who are considered less resilient, because not everyone who uses coping strategies is considered resilient (Rice & Liu, 2016). And we know from literature that active coping strategies mediate promoting resilience (Iacoviello & Charney, 2014). Further, it is important to emphasize that research has found that coping strategies can be learned and thus can be trained (Cohn & Pakenham, 2008; Rice & Liu, 2016). Therefore, insight into coping strategies may provide a guide for appropriate interventions for survivors in dealing with TEs in the short and long run, e.g., through building coping and resilience programmes on an individual, organization and community level.

Strengths and limitations

The coping strategy findings presented in our study are highly context-specific, and might present an oversimplification of the survivors' coping with the disaster in their daily lives; other important experiences, not identified in the interviews, may have influenced the way they coped with the disaster. However, the present study yields rare insight into a trauma area where hardly any study supplies survivors' descriptions. This is an advantage of using a qualitative method.

We used trauma, stress and coping strategy theories in the interpretations of the findings. It is important to emphasize that the relationships between TEs, negative health outcome, reduced quality of life and coping strategies are complex and still not fully understood (Araya, Chotai, & Komproe et al., 2007; Skinner et al., 2003). Further, it is also important to emphasize that research literature argues that rigid reliance on just a few coping strategies may indicate problems in managing stress and maladaptation (Zimmer-Gembeck & Skinner, 2008). Furthermore, there might be several more descriptions of patterns that have been reported in the literature regarding the course of PTSD-symptoms and trauma-related psychopathology than our study have chosen to use, e.g., cyclical and quadratic patterns (Davidson & McFarlane, 2006; Norris et al., 2002). Nevertheless, we consider the patterns described and chosen in our study to cover the most cited patterns in literature.

Our purpose in applying the five-fold coping strategies developed by Skinner et al. (2003) was to use well-supported domains from literature on coping that cover a broad variety of behaviours and thoughts. However, the five coping strategies by Skinner et al. (2003) are nuanced, and coping strategies may overlap in our material. A specific mindset or coping strategy may serve one or several purposes (Seguin, Lewis, Razmadze, Amirejibi, & Roberts, 2017), e.g., working may represent both a problem-solving and a distraction strategy/activity for the survivors in our study. Another limitation in our study might be that the survivors in all three categories seem to use the same approach of not talking about or thinking about the disaster. This may seem contradictory. They used different coping strategies to solve this which had different impact on the survivors' well-being

(e.g., the first category used positive cognitive restructuring, the third category avoidant coping strategies to approach this). However, these latter differences described may be the result of the survivors' different personality traits (e.g., the survivors in the first and second category seem to have more adaptive coping style traits compared with the survivors in the third category). Nisa and Rizvi, 2017, p. 437) emphasizes that personality traits may influence the effectiveness of coping strategies, with strategies that are beneficial for some individuals being less effective, or even directly harmful, for those with different personality traits (Bolger, Zuckerman, & Geen, 1995; DeLongis & Holtzman, 2005; Nisa & Rizvi, 2017). This might be the case in our study too. Nevertheless, we cannot conclude that thinking/talking about or not thinking/talking about the disaster is an effective or ineffective approach to cope in general from our study. It has to be evaluated and observed in the context of the individuals interviewed.

Other theories and angles might have given different descriptions and outcome (e.g., other coping, resilience, personality trait and trauma theories). Further, another limitation could be that mental toughness has been examined within a traditional team sport setting (Cook, Crust, Littlewood, Nesti, & Allen-Collinson, 2014) and among high-altitude mountaineers (Crust, Swann, & Allen-Collinson, 2016), as in the Mount Everest study (Swann et al., 2016). The fact that mental toughness primarily is used to study sport athletes and high-altitude mountaineers may potentially provide too narrow view of the construct, and may leave limitations regarding transferring the findings to our sample of avalanche survivors. However, a strength in our study might be that we consider our sample basically selected to have relatively high levels of mental toughness ahead of the military service. We have no existing data related to our sample regarding personality traits, which could have given us some indications of traits that could be associated with adaptive (e.g., trait as extraversion) or maladaptive (e.g., trait as neuroticism) coping strategies. Although, we support findings from studies highlighting that coping may generally be affected by personality traits (Connor-Smith, Flachsbart, & Carver, 2007). Further limitations regarding comparison with other studies could be that the Mount Everest study (Swann et al., 2016) was conducted short time after the disaster and did not perform follow-up in a long-term perspective.

Furthermore, another limitation might be that we have compared findings from previous quantitative studies of the same sample as in our study, and drawn up associations of these finding to this present qualitative study. These previous quantitative studies (Bakker et al., 2019, 2019) relies on self-report rather than physical examinations and diagnostic tools. However, a strength in our study is that this is the same participants that completed the interviews short time after the survey (Bakker et al., 2019, 2019), at T4.

Our interview guide was designed for broad, open questions and emphasized daily living. The strength of this approach was that it enabled easy communication.

The findings described in this paper are based on one-time interviews, 30 years' post-disaster. This may have reduced the depth of the discussions compared to having performed repeated interviews during the whole follow-up period. It is important to emphasize that we have to consider that the survivors' experience of the traumatic event may vary in intensity throughout the 30 years post-disaster, and that coping is a dynamic process that also may vary over time as the survivors adapt to difficult life events (Carver et al., 1994; Cherry et al., 2017). This is compatible with what most other researchers suggest (Carver et al., 1994; Cherry et al., 2017). Further, we have to take into consideration recall bias.

With regard to reflexivity, the interviewer is a military officer and a registered nurse, and a survivor of a severe natural disaster. Further, throughout the whole analysis process, the authors emphasized reflexivity, in particular considering our backgrounds and the possible influence of the pre-understanding on the interpretation of data (Finlay, 2003).

We have presented the data with limited illustrative quotes, due to ethical considerations, because we had to reduce the potential for identifying the participants. However, the three categories are closely described, and the analysis process well documented.

Only males are included, which might be a limitation regarding the transferability of the findings. Nevertheless, a strength of this study may be that the group is homogeneous (in terms of type of trauma, age, sex, and time since trauma). However, the purpose of qualitative studies is not to generalize, but to shed light on a topic and gain in-depth knowledge from the participants (Polit & Beck, 2017). Further, in this study, we have interviewed almost all of the survivors (12/15) of the avalanche disaster at Vassdalen 30 years' post-disaster, and the high degree of saturation in the findings may indicate that key points were well-covered.

Conclusion

The survivors' experiences of living their daily lives during the three decades' post-disaster after an avalanche can be concluded in "Finding my own way of managing and dealing with life". The survivors have different ways and ranges of coping strategies for dealing with their daily lives during the three

decades' post-disaster. Some of the survivors' experience "A comfortable life" with a greater degree of successful coping with the disaster in daily life and seemed to have a balanced life situation. They had more or less left the avalanche behind them and looked forward more than backwards. Other survivors experience "A challenging, yet accomplished life", where they tended to hold on to their traumatic experience, but nevertheless continued with daily life. The third way of the survivors' experiences was "A demanding life", which influenced the way they live with the disaster in daily life. The survivors with "A demanding life" seem to use maladaptive coping strategies interpreted as avoidance and distraction.

This paper increase insight into the consequences of adaptive and maladaptive coping strategies in a sample of avalanche survivors. Knowledge about how the survivors coped with different consequences after the avalanche, and the impact of their daily life, might help survivors, health personnel and the military system to be able to generate hypotheses for further studies and identify intervention, such as to build coping and resilience programs on an individual, organization and community level.

Acknowledgments

The authors wish to thank all the participants who shared their personal stories.

Availability of data and materials

The raw data is confidential and cannot readily be shared. Data may be shared with researchers obtaining permission from the Norwegian Regional Committee for Medical Ethics and Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry. After permission has been obtained, data can be made available from The Norwegian Armed Forces Joint Medical Services, Institute of Military Psychiatry, contact Lars-Petter Bakker: lpbakker@mil.no

Authors' contributions

All authors contributed substantially and according to the *International Journal of Qualitative Studies on Health and Well-being* guidelines to be recognized as authors. LPB, JGR and EKG planned and prepared the study. The thematic interview guide was developed by LPB in consultation with one of the co-authors (EKG). Further, the verbatim accounts were reviewed by the interviewer (LPB) and two of the co-authors (EKG and SE). LPB informed, invited the participants, and conducted all the interviews. LPB and EKG participated equally in the analysis of transcripts with essential methodological contribution from SE. LPB and EKG prepared the initial draft of the manuscript, which was later worked out in collaboration with all authors. Manuscript editing: LPB, SE, JGR and EKG. All authors have read and approved the final version of the manuscript, and share the responsibility for what is published.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Lars-Petter Bakker http://orcid.org/0000-0001-5586-8315
Siren Eriksen http://orcid.org/0000-0002-5541-0934
Ellen Karine Grov http://orcid.org/0000-0002-5347-8812

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Appendix 1.

Overview of different course and trajectories of psychopathology aftermath (Bonanno, 2004; Macleod, 1994; Norris et al., 2009; Port et al., 2001)

Patterns and Trajectories	Definition of patterns
Resistance (Norris et al., 2009)	Is defined as experiencing no symptoms of mental illness or only mild symptoms post-disaster.
Resilience (Norris et al., 2009, Bonanno, 2004)	Pattern where symptoms are transiting and do not cause reduced psychosocial functioning following exposure to a TE.
Recovery (Norris et al., 2009, Bonanno, 2004)	Pattern where symptoms are prominent following exposure to a TE, and shows gradual improvement with time.
Chronic (Norris et al., 2009, Bonanno, 2004)	Pattern where symptoms tend to persist across time. This course is only found in relative small proportion of survivors of a TE.
Delayed (Bonanno, 2004)	Pattern where the symptoms are not very severe or prominent during the first 6 months following exposure to a TE, but tend to increase later (late-onset).
U-Shaped (Macleod, 1994, Port et al., 2001)	Pattern where there is high levels of negative mental health symptoms immediately after trauma, then declining during the years of work life but possibly returning as the survivors cope with age-related issues and transition into retirement.

Appendix 2.

Description of the five-fold coping strategies according to Skinner et al. (2003)

Coping strategies (1–5)	Definition
1. Problem solving	This domain includes categories of Cognitive Decision Making (i.e., Strategizing and Planning), logical analysis of a problem, instrumental action towards a problem, persistence, effort and determination.
2. Seeking social support	This domain includes a wide array of targets of support such as family, friends, peers, professionals, religious figures and/or others to solicit help, contact, advice, comfort, and/or instrumental help such as money or goods.
3. Avoidance	This domain includes efforts to stay away and/or disengage from stressful transaction/situation (mentally and/or physically). Includes denial, avoidant actions, cognitive avoidance, and engaging in wishful thinking.
4. Distraction	This domain refers to different active attempts to deal with a stressful situation. Distraction includes a broad variety of alternative activities where the persons engage in pleasurable activities, such as reading, hobbies, watching television, exercising, seeing friends, working, and substance abuse.
5. Positive cognitive restructuring	This domain refers to active attempts to change one's view of a stressful situation in order to see it in a more positive light. Here the individuals focus on the positive rather than the negative by positive thinking, optimism, and minimization of negative consequences or distress.

Appendix XVI

Approval from the Norwegian Regional Committee for Medical Ethics (REK reference number: 2016/392)

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK sør-øst	Hege Holde Andersson	22845514	03.08.2016	2016/392/REK sør-øst B
			Deres dato:	Deres referanse:
			05.07.2016	

Vår referanse må oppgis ved alle henvendelser

Til Ellen Karine Grov
Institutt for sykepleie og helsefremmende arbeid

2016/392 Oppfølgingsstudie etter Vassdalen-ulykken, mars 1986.

Forskningsansvarlig: Forsvarets sanitet
Prosjektleder: Ellen Karine Grov

Vi viser til tilbakemelding på komiteens merknader til ovennevnte prosjekt, slik de fremkom i vedtaksbrev av 01.07.2016. Tilbakemeldingen er behandlet av leder for REK sør-øst B på fullmakt, med hjemmel i helseforskningsloven § 11.

Saksgang
I brev datert 01.07.2016 utsatte komiteen vedtak i saken. Komiteen skrev:

«Komiteens vurdering ved første gangs behandling
I brev av 15.04.2016 , skrev komiteen følgende:

*«**Komiteens vurdering***
Komiteen har ingen innvendinger til studien som sådan. Studien er en oppfølging av en tidligere gjennomført studie, og komiteen mener studien er potensielt nyttig.

Komiteen har imidlertid noen merknader til reservasjon og oppbevaring av data.

Deltagerne i studien vil først bli kontaktet via et brev med informasjon om formålet med studien, når den vil bli gjennomført, og at de vil bli kontaktet pr. telefon med en forespørsel om å delta. Dersom de ikke ønsker å delta kan de kan skriftlig informere prosjektleder hvis de ikke ønsker å bli kontaktet. Komiteen mener man må kunne reservere seg mot deltagelse på andre måter enn ved skriftlig henvendelse, for eksempel ved sms eller e-post. Komiteen er derfor om at det utarbeides tydeligere reservasjonsmuligheter.

Lagring av data
Data som samles inn i studien vil bli lagret i Forsvarets helseregister (FHR). Dersom man samtykker til deltagelse i studien samtykker man samtidig til at data inngår i Forsvarets helseregister (FHR). I informasjonsskrivet står det oppgitt at dersom man ønsker å trekke seg fra studien kan man når som helst, og uten å oppgi noen grunn, trekke seg fra studien. Dette er i tråd med helseforskningslovens § 16 Tilbaketrekking av samtykke. «Et samtykke til å delta i et forskningsprosjekt kan når som helst trekkes tilbake. Ved tilbaketrekking av samtykke må forskningen på vedkommendes biologiske materiale eller helseopplysninger opphøre. Den som har trukket sitt samtykke tilbake, kan kreve at det biologiske materialet destrueres og at helseopplysningene slettes eller utleveres innen 30 dager.»

På bakgrunn av dette ber komiteen om en tilbakemelding på om det er mulig å delta i studien uten at data inngår i Forsvarets helseregister (FHR). Hvilke data fra studien tenker man inkludert i registeret? Dersom man trekker seg fra studien, vil data fra studien likevel inngå i Forsvarets helseregister (FHR)?

Komiteens beslutning
Vedtak i saken utsettes. Komiteen tar stilling til prosjektet ved mottatt svar.»

Prosjektleders tilbakemelding
Komiteen mottok prosjektleders tilbakemelding 26.04.2016.

Når det gjelder å kunne reservere seg mot deltagelse skriver prosjektleder: Deltakerne blir i vedlagte Informasjonsskriv informert om at de kan reservere seg fra deltakelse ved skriftlig henvendelse via e-post eller postadresse. Dessuten kan de ringe prosjektleder Bakker på oppgitt telefonnummer.

Når det gjelder lagring av data skriver prosjektleder:
1) Det er kun data fra spørreskjemaundersøkelsen som vil bli lagret i Forsvarets helseregister (FHR). Dersom en deltaker ønsker å trekke seg fra studien, vil dennes data fra spørreskjemapakken, bli slettet fra FHR.

2) Data fra intervjustudien vil ikke bli registrert i FHR. Disse dataene vil bli slettet ett år etter studiens slutt (etter disputas).

De to ovennevnte punkene om lagring av data og mulighet til å trekke seg fra studien, er nå inkludert i informasjonsskrivet til deltakerne

Komiteens vurdering
Komiteen har ingen innvendinger til de prosedyrer man nå har i forhold til å kunne reservere seg fra deltagelse i studien.

Etter prosjektleders tilbakemelding er det imidlertid fortsatt uklart for komiteen hvordan data fra studien skal benyttes i Forsvarets helseregister (FHR). Slik komiteen forstår det er studien nå er utformet slik at data fra spørreskjema blir lagret i Forsvarets helseregister (FHR). Opptak av intervjuer og transkriberte intervjuer blir ikke lagret i FHR, en forskningsfil og blir slettet etter prosjektets slutt. Komiteen mener det er uheldig at man ved å samtykke til deltagelse i studien samtidig samtykker til at data inngår i FHR. Data fra undersøkelsen kan ikke inngå i registeret uten at deltagerne får spesifikt spørsmål om det og gir tillatelse. Det må være et separat samtykke til at data inngår i registeret, eventuelt en egen avkrysning i samtykkeskjema. Komiteen anbefaler at alle data fra prosjektet oppbevares en forskningsfil, og at man ber om eksplisitt samtykke fra deltagerne for de data man ønsker skal inngå i Forsvarets helseregister (FHR).

Komiteens beslutning
Vedtak i saken utsettes. Komiteens leder tar stilling til prosjektet ved mottatt svar.»

Prosjektleders tilbakemelding
Komiteen mottok prosjektleders tilbakemelding 05.07.2016. I tilbakemeldingen skriver prosjektleder at på bakgrunn av REK Sør-Øst sin anbefaling i vedtak av 01.06.16, vil ikke data fra studien *Oppfølgingsstudie etter Vassdalen-ulykken, mars 1986*, kobles mot Forsvarets Helseregister (FHR).

Data fra prosjektet oppbevares i en forskningsfil. En slik separat fil vil ha en ID-nøkkel der resultatarkene fra undersøkelsen oppbevares uten deltakerens navn og fødselsdato (avidentifisert). Resultatarkene, svarskjemaene fra spørreskjemaundersøkelsen og transkriberte data fra intervjuene, oppbevares nedlåst i journalarkivet ved Institutt for militærpsykiatri/Forsvarets sanitet (IMPS/FSAN). Ved transkripsjon av data fra intervju, vil navn som nevnes i intervjuet, avidentifiseres med bokstaven x. Alle data fra studien *Oppfølgingsstudie etter Vassdalen-ulykken*, mars 1986, slettes ett år etter studiens slutt.

Komiteens vurdering
Komiteen mener prosjektleder har svart tilfredsstillende på de merknader komiteen hadde**.**

Prosjektleder skriver at alle data fra studien skal slettes ett år etter prosjektslutt. Av dokumentasjonshensyn skal opplysningenebevares i 5 år etter prosjektslutt, jf. helseforskningsloven § 38.

Komiteen setter derfor følgende vilkår for prosjektet:
- Data fra studien skal oppbevares i 5 år etter prosjektslutt.

Vedtak
Komiteen godkjenner prosjektet i henhold til helseforskningsloven § 9 og § 33 under forutsetning av at ovennevnte vilkår oppfylles.

I tillegg til ovennevnte vilkår, er godkjenningen gitt under forutsetning av at prosjektet gjennomføres slik det er beskrevet i søknaden.

Tillatelsen gjelder til 01.03.2020. Av dokumentasjonshensyn skal opplysningene likevel bevares inntil 01.03.2025. Opplysningene skal lagres avidentifisert, dvs. atskilt i en nøkkel- og en opplysningsfil. Opplysningene skal deretter slettes eller anonymiseres, senest innen et halvt år fra denne dato.

Forskningsprosjektets data skal oppbevares forsvarlig, se personopplysningsforskriften kapittel 2, og Helsedirektoratets veileder "*Personvern og informasjonssikkerhet i forskningsprosjekter innenfor helse- og omsorgssektoren"*

Sluttmelding og søknad om prosjektendring
Prosjektleder skal sende sluttmelding til REK sør-øst på eget skjema senest 01.09.2020, jf. hfl. § 12. Prosjektleder skal sende søknad om prosjektendring til REK sør-øst dersom det skal gjøres vesentlige endringer i forhold til de opplysninger som er gitt i søknaden, jf. hfl. § 11.

Klageadgang
Komiteens vedtak kan påklages til Den nasjonale forskningsetiske komité for medisin og helsefag, jf. Forvaltningslovens § 28 flg. Eventuell klage sendes til REK Sør-øst. Klagefristen er tre uker fra mottak av dette brevet.

Vi ber om at alle henvendelser sendes inn med korrekt skjema via vår saksportal: http://helseforskning.etikkom.no. Dersom det ikke finnes passende skjema kan henvendelsen rettes på e-post til: post@helseforskning.etikkom.no

Med vennlig hilsen

Grete Dyb
professor, dr. med.
leder REK sør-øst B

Hege Holde Andersson
komitésekretær

Kopi til:j.reichelt@mil.no

NAVN
ADR
POSTNR

Dato:

Invitasjon til å delta i etterundersøkelsen:

«En oppfølgingsstudie av soldater som ble rammet av skredulykken i Vassdalen 5.mars 1986»

Bakgrunn og hensikt:

Det har i de senere år vært mye oppmerksomhet rundt helsetilstanden til soldater som har opplevd alvorlig livstruende hendelser. I denne sammenhengen er de som ble rammet av snøskredulykken i Vassdalen i 1986 en viktig gruppe. Institutt for militær psykiatri og stressmestring (IMPS) / Forsvarets Sanitet (FSAN), har fått i oppdrag å gjennomføre en undersøkelse for å kartlegge omfang og alvorlighetsgrad av psykiske plager etter hendelsen i Vassdalen 1986.

Forsvaret arbeider kontinuerlig med å øke kvaliteten på sin undervisning og oppfølging av både personell i tjeneste, tidligere tjenestegjørende personell og veteraner med tanke på stressmestring og psykiske belastningsskader. Forsvaret og andre hjelpeinstanser er avhengig av å få innspill til virksomme tiltak fra de som har opplevd alvorlige livstruende hendelser. For å få dette til, er det avgjørende å vite mest mulig om hvordan det har gått med dere som har opplevd alvorlig livstruende hendelser i tjenesten som vernepliktig eller som yrkestilsatt grenader/befal. Også terrorhandlingene i Oslo sentrum og på Utøya 22. juli 2011 gjør at det er viktig for samfunnet å samle kunnskap om menneskers opplevelser og reaksjoner etter livstruende hendelser.

Dette er en invitasjon til å delta i en undersøkelse om virkningene av Vassdalen-ulykken etter 30 år. Hensikten er å fremskaffe kunnskap om hvordan dere som opplevde snøskredulykken i Vassdalen har det nå 30 år etter ulykken. Vi vil derfor stille spørsmål for å finne ut om

Vassdalen-ulykken har påvirket din psykiske helse og livskvalitet. Det er også viktig for Forsvaret å få kunnskap om hjelpetiltakene som ble iverksatt av Forsvaret etter ulykken, var gode nok. Økt kunnskap innenfor dette feltet er viktig for forståelse av både negative og positive langtidsfølger av alvorlige stresspåkjenninger, og for planlegging og gjennomføring av psykososiale støttetiltak etter katastrofer.

Vi ber deg om å sette av litt tid og besvare vedlagte spørreskjema. Det tar omtrent 25 minutter å svare på alle spørsmålene. For å få et korrekt bilde er det viktig at så mange som mulig svarer. Det er således like viktig å motta svar fra både de som ikke har psykiske plager og de som har psykiske plager. Vi håper du har anledning til å besvare og returnere dette spørreskjemaet i vedlagte frankerte svarkonvolutt. Svar så fort du har anledning. Ved manglende svar vil du motta en purring etter 2 uker fra nå.

Vi understreker at deltagelse i undersøkelsen er frivillig.

Undersøkelsens spørreskjemadel besvares på følgende måte:

1. Papir: Fyll ut vedlagte spørreskjema og returner det i vedlagte frankerte svarkonvolutt. Skjemaet vil bli avlest digitalt og det er derfor viktig at du markerer ditt svar tydelig, helst med svart eller blå kulepenn.

Andre del av undersøkelsen består av et intervju. Intervjuet kan gjennomføres på tre (3) ulike måter:

1. Intervjuer besøker deg på ditt hjemsted for å gjennomføre intervjuet der.
2. Du kommer til IMPS sine lokaler i Oslo for å gjennomføre intervjuet.
3. Telefonintervju

Reiseutgifter, kost og losji vil bli dekket av Forsvaret i forbindelse med intervjuet.

Hva innebærer studien?

Spørreskjemaene som er lagt ved dette skrivet kan svares på - og sendes inn - uavhengig av intervjudelen.

Om kort tid vil du bli oppringt av en som jobber ved Institutt for militær psykiatri og stressmestring (IMPS) i Forsvarets sanitet (FSAN). Vedkommende vil vise til dette brevet, og spørre om du er villig til å delta i undersøkelsen og bli intervjuet. Dersom du ønsker å være med på intervjudelen, vil det avtales tid og sted for intervju.

Intervjuet vil vare ca 45-60 minutter.

Hvem kan delta

Dersom du er én av de menn som i 1986 tjenestegjorde i Ing.tr.2 og ble rammet av - eller opplevde - snøskredet i Vassdalen i 1986 kan du delta i undersøkelsen.

Frivillig deltakelse

Det er frivillig å delta i undersøkelsen. Du kan når som helst, og uten å oppgi noen grunn, trekke deg fra studien.
Dersom du ikke ønsker å delta i undersøkelsen eller bli kontaktet på telefon, kan du reservere deg fra dette ved å sende brev eller e-post til:

«Institutt for militær psykiatri og stressmestring (IMPS),
ATT: Lars-Petter Bakker, Postboks 1550 Sentrum, 0015 Oslo»
eller ved å sende en e-post til lpbakker@mil.no

Du kan også ringe major/prosjektleder Lars-Petter Bakker på telefon 976 13 371 for nærmere informasjon.

Dersom du har deltatt i den planlagte undersøkelsen (spørreskjema og intervju), men senere ønsker å trekke deg, kan du kontakte major/prosjektleder Lars-Petter Bakker med den samme postadressen, e-post adressen eller telefonnummer oppgitt over.

Hva skjer med informasjonen om deg?

Om bruk og lagring av data:

Spørreskjemadelen
Ingen opplysninger vil være personidentifiserbare, og alle beregninger og statistiske analyser foretas på avidentifisert datafil, slik at ingen enkeltpersoner kan gjenkjennes. Disse dataene slettes ett år etter studiens slutt.

Intervjudelen
Når vi ringer eller møter deg for intervju, registreres et tilfeldig løpenummer som din identifikasjon, slik at ditt navn og adresse ikke kan kobles til svarene du gir. Ved transkripsjon

av data vil navn som nevnes avidentifiseres med bokstaven X. Disse dataene slettes ett år etter studiens slutt. Intervjueren og alle andre som arbeider med studien har taushetsplikt.

Studien er godkjent av Regional komité for medisinsk forskningsetikk (REK). REK referansenummer 2016/392.

Trenger du profesjonell hjelp?

Siden forskerne kun vil få tilgang til avidentifisert data, har vi i Forsvarets psykiatri ikke muligheten til gå tilbake og identifisere de som besvarer spørreskjema eller intervjudelen. Derfor oppfordres de som opplever å ha plager, og ønsker hjelp til egen helse, om å ta kontakt med Nasjonal Militærmedisinsk Poliklinikk (NMP) som er Forsvarets sanitets kontaktpunkt for personell som har tjenestegjort:

Nasjonal Militærmedisinsk Poliklinikk (NMP)
Postboks 1550 Sentrum
0015 Oslo
Epost: NMP@mil.no
Telefon: 23 09 79 30

Med vennlig hilsen

Jon G Reichelt
Prosjektansvarlig, sjef IMPS/FSAN
oblt/dr.med/psykiater

Lars-Petter Bakker
Prosjektleder/IMPS/FSAN
maj/psyk.spl/rådgiver

Appendix XVIII

Permission to use State-Trait Anxiety Inventory for Adults Instrument (STAI)

State-Trait Anxiety Inventory for Adults Instrument (Adult Form) and Scoring Guide

English and Norwegian versions

Developed by Charles D. Spielberger
in collaboration with R.L. Gorsuch, R. Lushene, P.R. Vagg, and G.A. Jacobs

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To whom it may concern,

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Authors: ***Charles D. Spielberger, in collaboration with R.L. Gorsuch, G.A. Jacobs, R. Lushene, and P.R. Vagg***

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Appendix XIX

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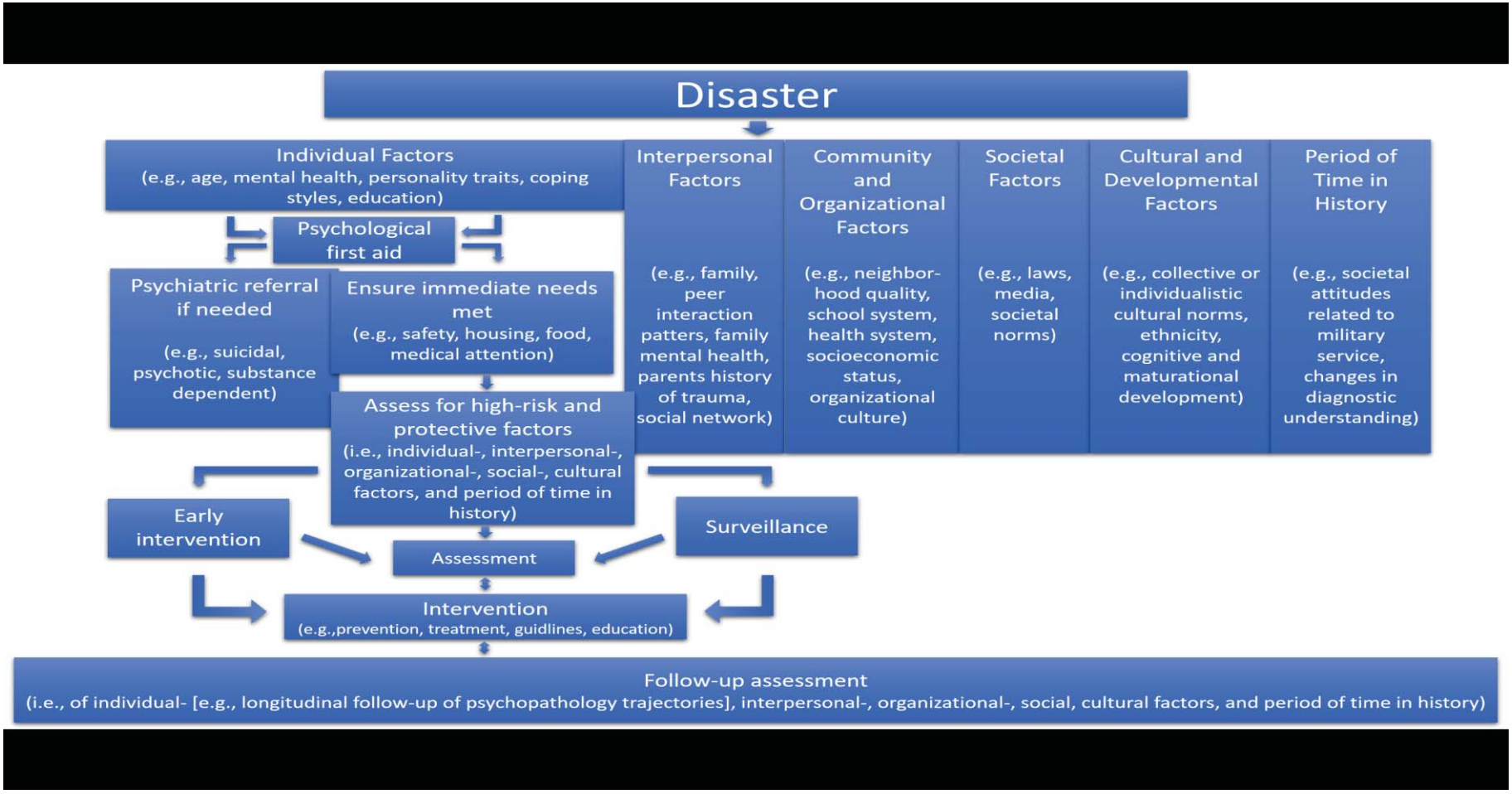
Appendix XX

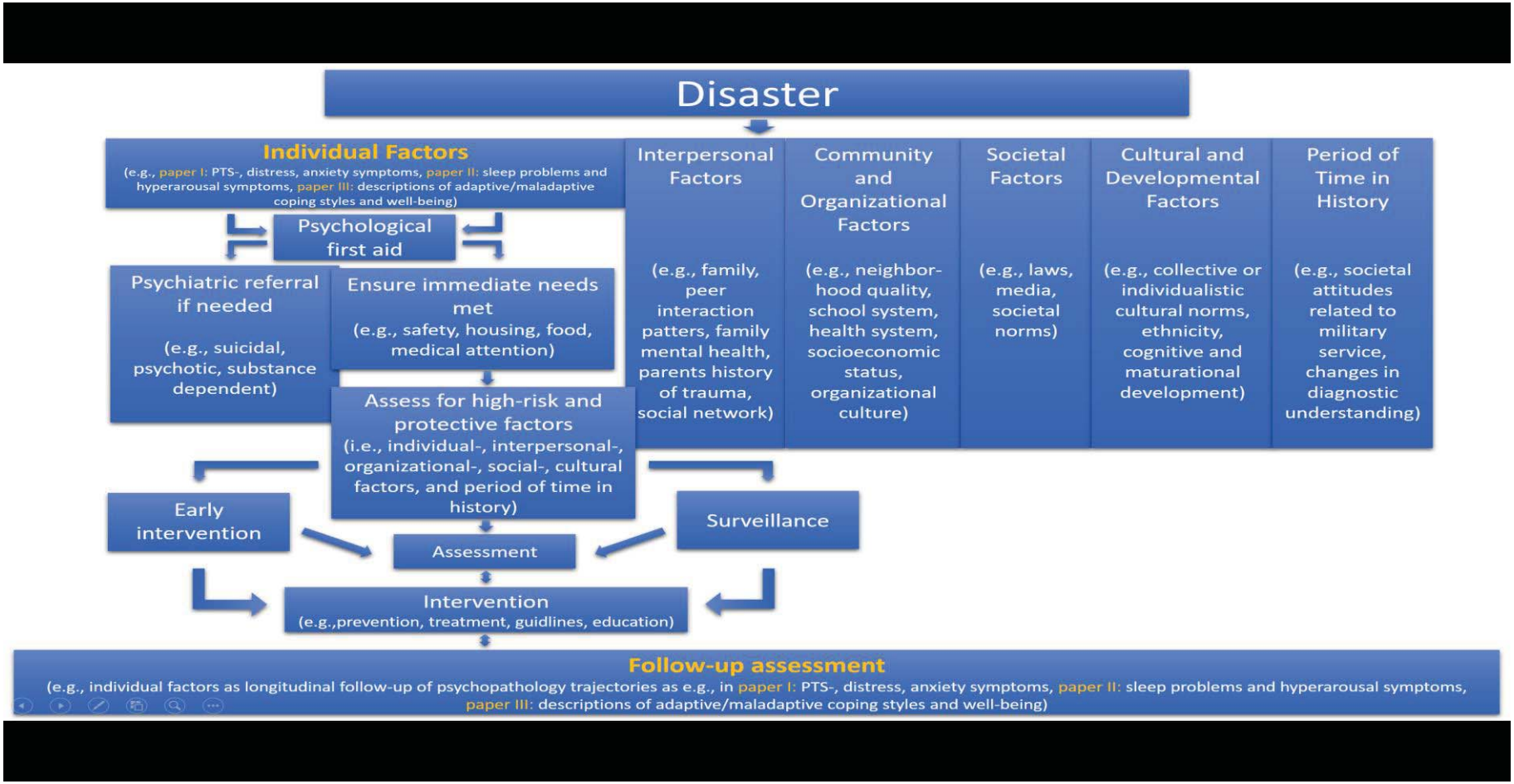
Figure 3 (see section 2.5)



A Modified Social-Ecological Assessment Model for Assessing Mental Health Needs and Well-being in a Contextual Framework after Trauma developed by Lars-Petter Bakker, inspired and modified from Bryant and Litz [199:328] "Diagram for Managing Post-disaster Mental Health Needs" and from Center for Substance Abuse [200:16] «Understanding the Levels Within the Social-Ecological Model of Trauma and Its Effects".

Appendix XXI

Figure 4 (see section 4.4)



A Modified Social-Ecological Assessment Model for Assessing Mental Health Needs and Well-being in a Contextual Framework after Trauma developed by Lars-Petter Bakker, inspired and modified from Bryant and Litz [199:328] "Diagram for Managing Post-disaster Mental Health Needs" and from Center for Substance Abuse [200:16] «Understanding the Levels Within the Social-Ecological Model of Trauma and Its Effects".