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Abridged Risk Information: Effects of Warning Labels on Snus Packages

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Contents

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Abstract

The prevalence of people using snus daily has exceeded the number of daily smokers in Norway. Little is known about how health warning labels on smokeless products affect factors such as risk perception and use intentions. We sought out to review the existing literature in this field, and conduct two studies examining how product warning labels affect perceptions of risk from snus, in a country where the user prevalence makes this topic salient. In Paper 1, we examined previous studies on health warning labels on smokeless tobacco in a systematic review, studied the manipulations in exposure studies, and systematized the outcome measures and main results. Paper 2 examined different textual health warning labels applied in the European Union (e.g., "*Snus is damaging to your health*"), while Paper 3 focused on warning labels comparing risks from snus and cigarettes (e.g., "*Snus is less damaging to your health than smoking*". The two latter papers applied an experimental design, in which we randomized participants to a warning label or control condition, and measured risk perception and intention to use tobacco pre and post warning exposure, collected through social media. The systematic searches ended up in 808 articles, of which 12 were included in the review (six from the U.S., two from Canada and four from India). All studied cognitive outcomes (e.g., risk perception, product appeal), six included outcomes related to behavior (e.g., intention to use). Oral health and addiction were the most common themes in the health warning labels. Graphic health warning labels had stronger effects on some outcome measures, for example on attention and evoking thoughts about health risks. In Paper 2, removing "*can*" from the EU warning "*This product (can) damages your health*" increased long-term risk perception, although not when followed up in a pre-post study. In Paper 3, an EU based warning kept perceptions of risk stable from pre to post, while the "*90% less*" comparative risk warning reduced perceived risks from snus and adjusted its relative perceived risk to smoking closer to expert opinions. Intention to use snus did not differ

between conditions. There are few studies on effects from smokeless tobacco health warning labels, especially about snus, but the tendencies in the literature seem to mimic the effects from cigarette warnings: graphic elements have a stronger effect on some outcome measures such as recall and willingness to try snus. The literature about the effects of comparative snus health warnings is very sparse. Minor verbal changes in textual content, such as in the studied EU warnings, do not seem to have reliable effects on risk perception, but changing the content to comparative risk information can have a stronger impact, especially when using concrete information such as percentages. Intentions to use snus were not affected by the comparative information. Evidence suggests that graphic warnings may be somewhat more effective than text-only warnings. Comparative information in warnings may affect perceptions of risk from snus differently than the non-comparative.

Keywords: snus, warning labels, risk perception, health communication

Sammendrag (Abstract in Norwegian)

Stadig færre røyker daglig i Norge, samtidig som daglig snusbruk har økt og oversteget andelen dagligrøykere. På bakgrunn av dette er helseadvarsler på snusprodukter aktuelt og relevant, men det er forsket lite på hvordan advarsler på røykfrie tobakksprodukter påvirker faktorer som risikopersepsjon og bruksintensjoner. Formålet med denne avhandlingen er å kartlegge status i forskningsfeltet, og studere hvordan helseadvarsler på snusbokser påvirker risikopersepsjon, i et land hvor snusbruk har økt. I Artikkel 1 kartla vi eksisterende litteratur i et systematisk søk om helseadvarsler på røykfri tobakk, studerte innholdet i advarslene som var testet i eksperimenter, og systematiserte funn og hovedresultater. Artikkel 2 sammenligner effekter av tidligere og nåværende snusadvarsler fra EU (f.eks. «*Snus er helseskadelig*»), mens Artikkel 3 fokuserer på helseadvarsler med komparative påstander («*Snus er mindre helseskadelig enn røyking*» eller «*90% mindre helseskadelig*»). Artikkel 2 og 3 var begge eksperimentelle design, hvor vi randomiserte deltakerne til betingelser, samt en kontrollbetingelse (en snusboks uten advarsel). Hovedutfallsmål var risikopersepsjon og bruksintensjoner, og data ble samlet inn via sosiale medier. Det systematiske søket resulterte i 808 artikler, hvorav 12 ble inkludert i reviewartikkelen (seks fra USA, to fra Canada og fire fra India). Alle inkluderte kognitive utfallsmål, seks inkluderte atferdsrelaterte utfallsmål. Munnhelse og avhengighet var de mest vanlige temaene i helseadvarsler som ble brukt i eksperimentelle studier. Bildeadvarsler hadde sterkere effekt enn tekstadvarsler på noen utfallsmål, som oppmerksomhet og interesse for å prøve snus. I Artikkel 2 fant vi at ved å fjerne forbeholdet «*kan*» i EU-advarselen: «*Dette produktet kan være helseskadelig og avhengighetsskapende*», økte risikopersepsjon for langsiktige skader. Det samme resultatet fant vi for øvrig ikke i en oppfølgingsstudie hvor vi også målte baseline risikopersepsjon. I Artikkel 3 beholdt den samme EU-advarselen (uten «*kan*») risikopersepsjon stabil før og etter manipulasjon, mens advarselen «*90% mindre helseskadelig*» nedjusterte risikopersepsjon fra

snus, samt justerte den relative risikopersepsjon fra snus vs. sigaretter mer i samsvar med faglig konsensus. Litteraturen om helseadvarsler på røykfri tobakk er av beskjedent omfang, og tenderer til samme konklusjon som forskningen på røykeadvarsler: bildeadvarsler har muligens noe større påvirkningskraft på enkelte utfallsmål, men grunnlaget her er mangelfullt. Studiene på komparative helseadvarsler er spesielt få. Det ser ut til at ulike tekstformuleringer kan påvirke kognitive utfallsmål, men kanskje ikke så mye ved marginale endringer som fra «*kan*» til «*er*». Den komparative tekstadvarselen «*90% mindre helseskadelig*» ga forøvrig sterkere utslag på risikopersepsjon enn «*mindre helseskadelig*» men hadde ingen effekt på bruksintensjoner. Basert på et begrenset antall artikler antydes det at bildeadvarsler kan ha et sterkere potensiale enn tekstadvarsler, og komparativ risikoinformasjon kan gi andre utslag på risikopersepsjon enn ikke-komparativ informasjon.

Keywords: snus, produktadvarsler, risikopersepsjon, helsekommunikasjon

List of Papers

1. Nilsen, C. V., Wiium, N., & Svartdal, F. (2017). *A systematic review and content analysis of effects of warning labels on smokeless tobacco products: International evidence.* Manuscript in preparation.

2. Nilsen, C. V., Friborg O., Teigen, K. H., & Svartdal, F. (2018). Textual health warning labels on snus (Swedish moist snuff): Do they affect risk perception? *BMC Public Health 18*, 564-572. doi: 10.1186/s12889-018-5461-2

3. Nilsen, C. V., Halkjelsvik, T. B., & Svartdal. F. (2019). *Health warning labels describing snus as less harmful than smoking: Effects on perceptions of risk.* Manuscript submitted for publication.

Abbreviations

AR – Absolute Risk

CLT – Construal Level Theory

HWL – Health Warning Label

SLT – Smokeless Tobacco

EU – European Union

FCTC – Framework Convention on Tobacco Control

WHO – World Health Organization

RR – Relative Risk

RRG – Relative Risk General

RRP – Relative Risk Percentages

TSNA – Tobacco-Specific N-Nitrosamines

Introduction

In Norway, the smokeless tobacco (SLT) product snus (Swedish moist snuff) has caused fiery debates over the last years, often being portrayed as either another way for tobacco producers to recruit young users or as salvation for heavy smokers. In an attempt to strengthen the risk message, the European Union (EU) decided to change the warning label on snus products from "*This product can damage your health and is addictive*" to "*damages your health*" in 2016. What was the rationale for making such a small change? Which effect were they expecting from it? The literature about the effects of warning labels on snus seemed to barely exist at the time. That was where this project started.

This thesis aims to contribute to the limited literature by studying the cognitive effects of health warning labels (HWLs) on SLT and specifically snus packages. More precisely, the research question is how short, textual health risk messages placed on snus packages affect perceptions of risk and other cognitive factors related to product use, such as interest in trying or use intentions. The main foundation of the present thesis is the risk perception field because risk perception is an important predictor of behavior in several health behavior models. In addition, information processing theories and nudging theory are relevant for understanding how a short and to-the-point HWLs may appeal to quick and intuitive System 1 thinking. Similarly, because risk perception may vary over psychological distance (short-term/long-term consequences), research and theory addressing the proximity of feared outcome (Construal level theory) are included.

In Paper 1, the research question is approached broadly through a systematic review with an international scope, studying the effects of warnings on SLT in general. The review examines the textual content of HWLs in experimental studies and the findings from both experimental and observational studies. Paper 1 lays the foundation for Paper 2 and 3, which

focus on the effects of varying words in snus HWLs, examined through experimental designs with risk perception and use intentions as outcome measures. Together, these three papers provide a summary of existing evidence and add relevant studies to the research field of SLT HWLs.

In the sections to come, a brief discussion of health risks associated with using snus and user prevalence will be presented. Then follows a discussion of HWLs as a part of tobacco control, as well as an overview of the harm reduction debate. This is the context of the present research question. Next, relevant research and theoretical models, and empirical evidence of effects from SLT HWLs on cognitive outcome (mainly risk perception and intentions to use) will be discussed. Because the SLT HWL literature is very sparse, research from related fields, (e.g., cigarette HWLs) is included occasionally to fill the gaps.

Snus use in Norway and other Nordic countries

The reduction in Norwegian daily smokers is positive for the former smokers and public health, but the parallel increase in daily snus users (Statistics Norway, 2018) has raised a new concern for health authorities. Among other chemicals, Swedish snus contains the addictive stimulant nicotine, and the carcinogen tobacco-specific nitrosamines (TSNA) (SCENIHR), 2008). While using snus activates a lower risk profile when compared to some other SLT types (SCENIHR), 2008), also when compared to smoking (Levy et al., 2004), using a low-nitrosamine tobacco product such as snus is not without risks. The World Health Organization (WHO) has concluded there is sufficient evidence that smokeless tobacco (including snus) causes cancer of the esophagus and pancreas of humans (IARC, 2012), although a large pooled analysis has weakened the link between snus and pancreatic cancer (Araghi et al., 2017) Official Norwegian resources summarizes health risks from using snus, for example: oral health problems, adverse pregnancy outcomes and fetus development, increased risk of dying if having a cardiac disease or stroke, and for developing diabetes type

2 for those consuming five or more snus boxes per week (Norwegian Institute of Public Health, 2014), and a recent report indicates a possible connection to non-affective psychosis and Parkinson's disease (Norwegian Institute of Public Health, 2019). As for addiction, some have found that dependency from snus is equal to that of smoking cigarettes (Fagerstrom, 2018; Holm, Jarvis, Russell, & Feyerabend, 1992).

Snus is illegal to sell within the European Union (EU) since 1992 (EUR-LEX, 1992), with an exception for the EU-member Sweden, and for the member of the European Economic Area Agreement (EEA), Norway (EU Publications, 1994). The tobacco producer Swedish Match challenged EU's snus prohibition in the United Kingdom in June 2016, but the challenge was rejected (The Court of Justice of the European Union, 2018).

Looking to other Nordic countries may suggest how a ban would affect SLT and smoking prevalences. Although it is not legal to sell snus within the EU, some SLT is imported, which explains why there is some SLT usage in the other countries. Table 1 summarizes percentages of daily smokers and SLT or snus users in five of the Nordic countries. For Norway and Sweden, the user statistics are based on Swedish moist snuff only, while the other countries include other oral tobacco products in their statistics. The percentage of daily SLT users is, as expected, larger in the two Nordic countries in which snus is legal (Norway and Sweden), with around 11%. The other Nordic countries have half as many SLT users, or less. Daily smoking is highest in Denmark (16%) where selling snus is illegal, but the Icelandic smoking percentage is similar to that of Norway despite Iceland having an SLT ban. However, the difference should be interpreted with caution, as the Icelandic statistic does not include youth under 18. Finland enjoined their tobacco act in May 2016, stating that SLT "*may not be sold or otherwise supplied or passed on*" (Finlex, 2014). As the most recent Finnish statistics are from 2014, the effects of this change cannot be evaluated.

Table 1

Daily tobacco use by country in total percentage (male/female share)

Country	SLT regulations	Daily smoking	Daily SLT	Age range and year collected
Denmark	SLT products shall be prohibited from placing on the market from 2001 (EUR-LEX, 2001)	16 (16/16)	1 SLT of which 0.5 snus (gender n/a)	15+ in 2017 (Sundhedsstyrelsen, 2018)
Finland	Smokeless tobacco products may not be sold or otherwise supplied or passed on from May 2016 (Finlex, 2014)	15.4 (17.2/14)	2.6 (5.6/0.4) SLT (snus n/a)	15-64 in 2014 (World Health Organization, 2017)
Iceland	The importation, manufacture and sale of fine-grained snuff and all oral tobacco is prohibited, with the exception of chewing tobacco (Government Offices of Iceland, 2013)	11.5 (11.1/11.9)	5.1 (13/3) SLT (snus n/a)	18-69 in 2015 (World Health Organization, 2017)
Norway	EU prohibition of SLT sale shall not apply (EU Publications, 1994)	11 (12/10)	12 (17/6) snus	16-74 in 2017 (Statistics Norway, 2018)
Sweden	EU prohibition of SLT sale shall not apply (EU Publications, 1994)	9.5 (8/11)	10.8 (18/4) snus	16-84 in 2016 (Public Health Agency of Sweden, 2018)

As mentioned, the number of Norwegians using snus is increasing, and in 2017 the share of people from 16-74 years old using snus daily (12%) surpassed the number of daily smokers (11%) (Statistics Norway, 2018), as seen in Figure 1. More men than women use snus, and men under 34 years old constitute the largest group of snus users with about 30% versus 10% of same-aged women. More women under 34 use snus compared to older women (13% vs 2%). Daily smoking is more frequent (15%) and evenly distributed among men and women over 45 years old. Fewer under 45 years old smoke daily (8%), but there are more men in this age group. In sum, men and young people use snus the most.

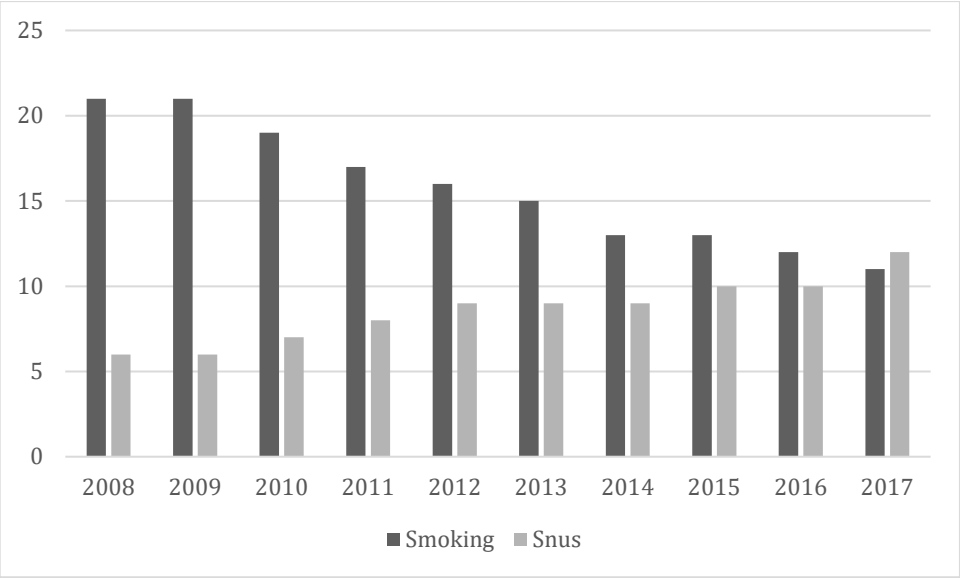

Figure 1. Daily tobacco use by subtype among the Norwegian population aged 16-74 years in 2017. Adapted from Statistics Norway (2018).

It is well known that smoking is very health damaging, and if the growing snus prevalence mainly consists of former smokers, this could gain public health, as well as the individual health of the former smoker. However, if the share of new snus users is recruited mostly among non-smokers, and especially young non-smokers, the health of the previously non-tobacco user could deteriorate, and eventually public health as well. Lund, Vedoy, and Bauld (2017) refer to this as the tipping-point: if the share of never-smokers relative to smokers among snus users shifts from a net gain to a net loss for public health.

Following 2067 Norwegian males from 2003-15, never-smokers who reported using or having used snus increased from 21 to 36,6% (Lund et al., 2017). This indicates that some of the new snus users initially were never-smokers, although smokers and former smokers compose the majority of snus users. In support, a Swedish study on a nationally representative sample of 60 675 individuals in the period 2003-11 found that the number of first-time snus users had increased gradually while first-time smokers had become fewer (Ramstrom, Borland, & Wikmans, 2016). They also found that few of the people who started using snus

started smoking later, and many smokers had used snus to quit smoking. Thus, these studies suggest that snus users are recruited from both smokers and never-smokers. If the latter group eventually outnumber the first, public health may suffer. From an individual's perspective, using no tobacco product would provide the lowest risks.

As for the perception of risks from snus and smoking, the Norwegian public seems to be exaggerating the relative risks between using snus and cigarettes (Lund & Vedoy, 2019), at least when the public's estimates are compared to those of some experts (Levy et al., 2004). In a study of people varying from 16-79 years old, females and people over 25 were most likely to perceive snus as "very harmful" (max values on the scale) (Lund & Vedoy, 2019). These findings imply a communicative challenge: How to design information that conveys the relative risk from snus compared to smoking? Next, if people become informed that snus is less hazardous than smoking, will the information contribute to increased snus use among never-smokers? This question is discussed more closely in later sections.

Health warning labels in tobacco control: Legal perspective

Health warnings on tobacco products represent a source of health information, and are part of international tobacco control policies that regulate tobacco consumption and protect public health (Hammond & Reid, 2012). Tobacco control has successfully reduced the smoking prevalence in Norway. SLT is a product group that is subject to less restrictive tobacco control regulations than cigarettes, possibly because SLT is associated with other user characteristics and health risks than cigarettes, and some types are proposed as a safer alternative to smoking. There is, however, a broad variation in harm profiles across the SLT product subtypes, and snus is a low-nitrosamine variant with reduced health risks compared to some other SLT types (IARC, 2012). Because of the reduced risk compared to cigarettes, HWLs on SLT products may have other effects on risk perception and behavior than HWLs on cigarette packages do. While there is a lot of research on effects from HWLs placed on

cigarettes, the corresponding studies on SLT are few (Hammond, 2011; Levy, Mays, Boyle, Tam, & Chaloupka, 2016).

Health information is a central part of tobacco control. This strategy derives from the understanding that health is a part of human rights. The WHO established health as a human right in 1946, and in the 1948 Universal Declaration of Human Rights. Health information is defined as one of the underlying determinants of health, which amongst other things obligates states to provide the public with health-related information, for example about harmful substances such as tobacco. Third parties should be prevented from interfering with the right to health. Also, the health information provided by states should not be misrepresenting or censored (Office of the United Nations High Commissioner for Human Rights, 2008). Health literacy is another relevant aspect, as it concerns an individual's capacity to understand and use such health information (Baker, 2006).

In the 1600s, some countries punished tobacco users with jail, starvation, or even death (Christen, Swanson, Glover, & Henderson, 1982). Modern tobacco policies practice a less severe approach. Aiming to reduce health damages deriving from tobacco usage especially, the WHO Framework Convention on Tobacco Control (FCTC) was founded in 2003, and it defines tobacco control as: "*a range of supply, demand and harm reduction strategies that aim to improve the health of a population by eliminating or reducing their consumption of tobacco products and exposure to tobacco smoke*" (p. 4) (WHO Framework Convention on Tobacco Control, 2003). The FCTC strategies are divided into 1) price and tax measures such as well-known Norwegian policies tobacco taxes (Skatteetaten, 2019) with high efficiency on tobacco prevalence (Near, Blackman, Currie, & Levy, 2014), which will not be discussed in the present context, and 2) non-price measures. Among the latter are several information-based measures, education, public awareness, cessation aids, and the object for this thesis: labeling of products, which is part of the FCTC measures to reduce the

demand for tobacco. Another non-price measure recently applied in Norway is the restricted access to tobacco products in stores (Lovdata.no, 2018b).

Of particular relevance to the present thesis is the content of abridged health information in HWLs on snus packages. Other related package characteristics such as standardized packages of a certain color, size, and font (Lovdata.no, 2018b) are not the main focus, but as they are the object of HWL placement, a brief summary is provided here. In short, the standardized packages were designed to reduce the appeal of tobacco packages, as the tobacco manufacturers can use design elements to appeal to youth and recruit users. Packaging elements do seem to be related to the user's identification, brand preference and can strengthen positive attitudes towards snus (Scheffels & Lund, 2017). Additionally, and relevant for the outcome measures of this thesis, dark colored snus packages made the product appear *more harmful* than lighter colors did. The light and bright colors often gave association to other products (e.g., candy or cosmetics), which made the product appear less harmful to adolescents in this study. In contrast, the Norwegian media have reported that many people find the standardized design more appealing than the original brand designs. Still, a Cochrane review suggests that this tobacco measure does reduce smoking, although only Australia had applied standardized packages when this particular study was conducted (McNeill et al., 2017). Standardized packages were however not the only alteration in Australian tobacco control at the time, they applied graphic HWLs on packages simultaneously. As the main study of the review also is based on an observational study, the conclusions must be assessed with that in mind.

Focusing again on the HWLs, the textbox (Figure 2) summarizes Article 11 of the FCTC, which states that characteristics of tobacco products have to be described accurately, not deceptive or creating a false impression that any tobacco product is safer than another. Packages have to carry authority approved warnings describing the harmful effects of tobacco use, and cover at least 30% of the tobacco package (WHO Framework Convention on Tobacco Control, 2003). In sum, HWLs are an information-based measure in a larger tobacco control framework, aiming to protect the human right to health.

1. Each Party shall, within a period of three years after entry into force of this Convention for that Party, adopt and implement, in accordance with its national law, effective measures to ensure that:

(a) tobacco product packaging and labelling do not promote a tobacco product by any means that are false, misleading, deceptive or likely to create an erroneous impression about its characteristics, health effects, hazards or emissions, including any term, descriptor, trademark, figurative or any other sign that directly or indirectly creates the false impression that a particular tobacco product is less harmful than other tobacco products. These may include terms such as "low tar", "light", "ultra-light", or "mild"; and
(b) each unit packet and package of tobacco products and any outside packaging and labelling of such products also carry health warnings describing the harmful effects of tobacco use, and may include other appropriate messages. These warnings and messages:

(i) shall be approved by the competent national authority,
(ii) shall be rotating,
(iii) shall be large, clear, visible and legible,
(iv) should be 50% or more of the principal display areas but shall be no less than 30% of the principal display areas,
(v) may be in the form of or include pictures or pictograms.

2. Each unit packet and package of tobacco products and any outside packaging and labelling of such products shall, in addition to the warnings specified in paragraph 1(b) of this Article, contain information on relevant constituents and emissions of tobacco products as defined by national authorities.

3. Each Party shall require that the warnings and other textual information specified in paragraphs 1(b) and paragraph 2 of this Article will appear on each unit packet and package of tobacco products and any outside packaging and labelling of such products in its principal language or languages.

4. For the purposes of this Article, the term "outside packaging and labelling" in relation to tobacco products applies to any packaging and labelling used in the retail sale of the product.

Figure 2. Textbox. WHO Framework Convention on Tobacco Control: Article 11 Packaging and labelling of tobacco products

The harm reduction perspective: "Snus is less harmful than smoking". As mentioned, one perspective of tobacco control is that smokeless tobacco low in nitrosamines, such as snus, can function as an alternative, harm reduced products for smokers (Savitz, Meyer, Tanzer, Mirvish, & Lewin, 2006). Some experts estimate that the relative risk of total

mortality from using snus is overall 90% reduced compared to smoking cigarettes (Levy et al., 2004). More specifically, when compared to cigarettes, risks from snus are substantially lower for respiratory and cardiovascular disease, and eliminate hazards from passive smoking (SCENIHR), 2008). However, official SLT HWLs do not convey harm reduction information, and the following ethical breach may illustrate why.

Benefits and harms of a harm reduction strategy are objects to an ethical debate (Fox & Cohen, 2002; Guttman & Salmon, 2004), as multiple ethical theories are activated in the harm reduction controversy, for example: 1) respect for autonomy (the individual's right to choose), 2) the utilitarian principle (greatest good for the greatest number) and 3) paternalism (regulate other peoples autonomy to promote good) (Hall, Gartner, & Forlini, 2015; Kozlowski & Sweanor, 2016). Harm reduction proponents focus on the health benefits for smokers who switch to snus, and how withholding this information from smokers is paternalistic and violates autonomy. Opponents point out that using snus brings along other health risks, as it may function as a gateway to smoking and that no tobacco should be promoted at all (Gartner, Hall, Chapman, & Freeman, 2007; Pierce, 2002). Other unintended consequences of a harm reduction strategy could be decreased tobacco quitting rates all over, combined use of tobacco products, increased non-smokers initiation, and former smokers relapsing (Martin, Warner, & Lantz, 2004).

Fronting a harm reduction strategy could reduce health risks for smokers, and if the number of snus users does not exceed the public health net gain from reduced smokers, it can reduce the negative load for society as a whole. Or, as illustrated by the risk/use equilibrium: public health can be advantaged if the risks associated with using a less hazardous product decrease faster than the use rises, but disadvantaged if the use increases faster than the risk is reduced (Kozlowski, Strasser, Giovino, Erickson, & Terza, 2001). Still, from another perspective, the concept of snus as harm reduction maintains tobacco usage in the population.

Maybe smokers should be offered cessation support other than alternative tobacco products that stimulate addiction? Kozlowski and Sweanor (2016) suggest a reframing: when making a harm reduced product legal, the relative risk information should be made available alongside the product, and only reconsidered if that information is proven to damage public health. They also challenge the concept of relative risk information as a mere promotion of harm reduced products and ask if relative risk information would rather increase health literacy and empower the public.

Considering that both snus and cigarettes are legal in Norway and Sweden, should the corresponding relative risk information be conveyed to the public, as Kozlowski & Sweanor suggest? The FCTC regulations state that HWLs shall not: "*directly or indirectly creates the false impression that a particular tobacco product is less harmful than others"* (WHO Framework Convention on Tobacco Control, 2003). Whether this means that tobacco products should not be compared at all in HWLs, or that the message must be sure to convey a "correct impression", is somewhat unclear.

In sum, promoting snus as a harm reduction measure is debated, and activates important points. First, using snus is associated with health risks that must be clearly communicated to users and potential users. Secondly, using snus is a lot less risky than smoking, and perhaps smokers should be made aware of this information. One of the studies in this thesis focuses on how relative risk information in HWLs affects risk perception and intentions to use snus. However, as the harm reduction discussion illustrates, applying such HWLs is not only about how the labels are perceived but also concerns larger political and ethical implications.

Theoretical models and research context

Perspectives and models other than risk perception can illuminate how brief warning messages affect snus use, and I briefly comment on two and explain how they are related to this thesis. First, attitude change models may be relevant, as HWLs can evoke more negative attitudes toward smoking (e.g., Noar et al. (2016), and in that appealing packages can strengthen positive attitudes towards snus (Scheffels & Lund, 2017). Attitude models involve evaluations of an object, such as how much someone likes a person or a product (Albarracin & Shavitt, 2018), in this case, snus. Furthermore, attitudes may be important for the current project as risk evaluations may be affected by a person's attitude towards snus use. For example, a snus user will likely perceive snus as more attractive compared to a non-user, which may affect the perception of risk from snus as well. Likewise, feelings associated with an object can influence and adjust judgments about the product, an effect known as the affect heuristic (Slovic, Finucane, Peters, & MacGregor, 2007). Thus, having negative feelings towards snus could presumably lead to enhanced perceptions of risk from using it, and vice versa. However, as the main focus in the current project is on risk messages of HWLs and the perceived probability of risk directly after a warning exposure, we do not assess whether attitudes or affect are relevant in assessing warnings. Thus, most of the items used in the present research concern beliefs regarding the potential harm of snus use, not attitude- or affect-relevant items (e.g., how much a person likes/dislikes snus or their feelings towards the product).

Second, the persuasion literature is relevant as brief text messages may be seen as attempts to modify behavior by inducing compliance (O'Keefe, 2015). As discussed, the current project focuses on risk perception and the outcome of relevance is how the HWLs communicate risk and harm from the products, rather than induce compliance. The philosophy behind persuasion and compliance is in the context of tobacco control related to

paternalism (regulating other people's autonomy to promote good). This thesis aims to maintain a focus on the assessment and perception of HWL information, building on the individual's right to health information and respect for autonomy.

The research areas of attitudes and persuasion may indirectly be relevant for the current research in another way. Both emphasize the important role of heuristic processing of information as the low-effort periphery route of the Elaboration Likelihood Model (Petty & Cacioppo, 1986). This kind of thinking can be relevant as the HWLs presented on snus packages probably are processed in brief encounters. In this sense, an HWL could function as a nudge, a measure implemented to relatively gently guide people in a wanted direction, reducing the paternalistic restraint (Thaler & Sunstein, 2008). However, as the HWL by definition is a warning, gentleness and reduced paternalism may be a more suitable characteristic of other types of health information.

As discussed, an important purpose of HWLs is to affect risk perception, in the present case, risk perception related to the hazards of snus use. Accordingly, the present section starts with a discussion of the risk concept and risk perception. As discussed below, increased risk perception in the face of potential harm may be an important effect of HWLs in preventing and reducing snus use. Second, the psychological distance may be a relevant factor in this context, as risk can relate to both short-term and long-term consequences of snus use. Hence, a brief discussion of risk and distance as in the Construal level theory is necessary. Third, many health behavior models include risk as a factor in predicting intentions (e.g., to use snus). Finally, as HWLs typically convey messages about potential health hazards from using a product, this chapter will close with a discussion about using fear appeal in tobacco control.

Health information in a zero-risk society. The risk field is large and interdisciplinary and has been rapidly growing as a consequence of *"the pursuit of a "zero-*

risk" society" (Slovic, 1987). Society is less willing to accept uncertainty and call for ever more knowledge about the risks related to behavioral and environmental factors. Accumulated knowledge and modern technology make progression possible, although some uncertainty will always exist. This progression has resulted in vast amounts of easily available health information, of which much concerns risks associated with certain behaviors. Health literacy affects how people understand and process such information (Baker, 2006). Some risks are manageable and controllable (but the behavior is not necessarily easy to regulate), for example, through diet and physical activity, as opposed to risks that are harder to manage, such as genetic predispositions. Using tobacco is essentially (at least in the beginning) a voluntary behavior, although after using it for a while, the nicotine will likely cause addiction.

People react differently to growing access to risk information. On the one extreme, some may avoid or deny the validity of risk information completely, and go on with their favored lifestyle regardless. In the case of smoking, denying risks can be a predictor of lower readiness to quit (Peretti-Watel, Halfen, & Grémy, 2007). The other extreme is becoming overly concerned about disease, even to the extent of developing health anxiety (Hedman-Lagerlöf, Tyrer, Hague, & Tyrer, 2019) or obsessing with healthy eating as in the case of orthorexia nervosa (Cena et al., 2019). Most people probably are somewhere in between the two extremes. The pressure from society to maximize and improve everything is present also through social media and influencers, presenting seemingly perfect healthy and balanced lives. Health is just one of the aspects, but a highly relevant one. New diets and ways of exercising are constantly popping up online, and it is up to the individual how to relate to the information. Some counteractions to these trends are the growing interests for offline time, social media detox and mindfulness, all intending to give people a break from the constant stream of information.

In sum, people are exposed to a vast amount of risk information in their everyday lives, and they cope with the information load in different ways. HWLs aim to affect the (initially) voluntary behavior of tobacco use, but the product labels only represent a fraction of everyday health information in modern society. Therefore, the effects that HWLs have on perceptions of risk may not be strong, given that they compete with a lot of other information sources.

The risk concept. Product HWLs typically communicate a short message about risks associated with using a product, with the expectation that behavior will be affected by an individual's perception of risk from that product. Behavior is, as will be discussed in later sections, a product of more factors than risk perception alone. Tobacco use will likely be a product of several other factors, of which some are positive, in contrast to the negative perspective of risk and harm. For example, using snus can be relaxing and pleasurable. The chosen attention to risk perception in this thesis is suiting because of its relevance to HWLs: how do the messages convey risk information. First, an examination of the definition of risk.

Risk is usually understood as consisting of two components: the *probability* of an adverse event after exposure to a hazard, and *effect* being the extent of the adversity (Breakwell, 2014). For example, snus is a hazard, and using snus is associated with risk: meaning a certain probability of adverse events of a certain magnitude. Probability and effect are commonly, but not always, examined together when measuring risk (Breakwell, 2014), and are found to be distinct dimensions of the risk concept, see for example Weissfeld, Brock, Kirscht, and Hawthorne (1987).

Analyses of risk can focus on different aspects, for example, communication of risk information, measurement and assessment of risk, how risk information is perceived, and how risk is managed (Berry, 2004). The focus of this thesis is on how people perceive risk. In

contrast to the more technical concept of risk as probability*effect defined above (Breakwell, 2014), risk perception concerns an individual's subjective judgment of the probability and seriousness of an unwanted event, and can be moderated by factors such as personal traits, age, experience, controllability, voluntariness of exposure, familiarity of the risk and dread (Michalsen, 2003; Slovic, 1987). Thus, the expert's evidence-based calculations of risks may be quite different from a layman's perceived risk from the same product, although laymen are capable of producing similar estimates even if their subjective risk perception may differ (Slovic, 1987).

In the risk perception literature, risk perception has been operationalized in different ways, for example as deliberative (reason-based and logical likelihood of negative outcome), affective (worry or anxiety associated with the risk) and experiential (assessment of vulnerability) (Ferrer & Klein, 2015). A recent review found low coherence of risk perception measurement applied in tobacco control research (Kaufman, Persoskie, Twesten, & Bromberg, 2018). Specifically, the authors found variation in the number of risk items applied in studies, a mix of general/specific health focus, and in risk target (e.g., yourself vs. others). As people tend to estimate personal risk as much lower than the general risk (for other people) (Sjöberg, 2003), therefore the risk target should be specified in risk perception research.

Relative risk. As discussed, snus is relatively less harmful when compared to smoking cigarettes, something which is not reflected in HWLs on snus, and very few studies look into the perception of relative risk information in HWLs. Relative risk (RR) is "*a ratio of the probability of an event occurring in the exposed group versus the probability of the event occurring in the non-exposed group*" (Tenny & Hoffman, 2019). The RR of an event can also be estimated between groups of different exposures, as for SLT users vs smokers in this case. While RR is an estimation of the relationship between risk for two groups or conditions, absolute risk (AR) describes the actual risk for an event occurring. A small change in AR can

give large changes in RR, as a 50% reduction in RR could be an AR reduction from 2 of 100 to 1 of a 100 (Tenny & Hoffman, 2019). The RR between two groups can also be conveyed in more general verbal terms, such as “x is less hazardous than y” or “x is substantially less hazardous than y”. Some argue that risk should always be communicated in absolute risk format because the relative risk information alone is insufficient and deceiving (Gigerenzer, Wegwarth, & Feufel, 2010).

Immediate vs. distant risks in HWLs. As will be discussed, perceptions of risk from specific hazards are measured for short and long term in the current project (Paper 2), making the Construal level theory particularly relevant. Construal level theory (CLT) outlines how psychological distance can affect levels of abstraction in mental construal of a phenomenon (e.g., health hazards from tobacco usage) (Trope & Liberman, 2010). When applied to HWLs, the abstraction could target, for example, the textual content (close/distant future) or format (concrete image/abstract text).

For example, health hazards that usually develop slowly and strikes in a distant future (e.g., cancer), can be perceived as more abstract than an immediate hazard such as gum recession or heightened blood pressure. Thus, the words in HWLs can have different levels of abstraction. As for the format of HWLs, graphic HWLs are more concrete representations of hazards (low-level construal), compared to text-only HWLs that provide less immediately available representations (high-level construal) of hazards, abstracted through words. For example, Amit, Algom, and Trope (2009) found that pictures convey closeness to an object, while words represent distal objects. HWLs could perhaps benefit from this mechanism by enhancing short-term consequences through graphic formats, and long-term consequences through text.

As a final note on CLT and snus use (or tobacco use in general), the risks from using a product are abstract and distant, given that risk is defined by probability, implying the uncertainty of being a victim to a hazard. On the contrary, the positive effects of using a nicotine product are quite certain and rapid, thereby concrete and low in abstraction. This contrast between perceived risk and benefit from using a tobacco product can perhaps explain some of the product appeal.

Risk and health behavior models. This section focuses on how risk perception is related to behavior, and factors similar to risk perception are included in several models designed to predict health behavior. As this project focuses on how HWL affect perceptions of risk, its relevance to actual behavior is of interest. Noar and Zimmerman (2005) summarize some of the health behavior theories: The Health Belief Model includes perceived susceptibility and severity as a part of the beliefs that predicts action (Rosenstock, 1974), Bandura's Social cognitive theory includes negative expectancies (Bandura, 1998), and Prochaska and DiClemente's Transtheoretical model has the factor dramatic relief (e.g., "*Warnings about health hazards move me emotionally*") (Prochaska & DiClemente, 1983). The Transtheoretical theory is an example of how behavior change is a process that goes through specific stages, starting with a person not being ready for change (precontemplation), gradually becoming ready, starting a new behavior, and (hopefully) resulting in maintenance of a healthier behavior. The process often goes back and forth between stages, not necessarily forward all the time, as relapses are common and expected. Several cognitive, affective and behavioral factors change within the stages, with dramatic relief being the one factor more closely related to our focus outcome measure, risk perception. This factor concerns awareness of one's feelings about behavior, like fear or worries about the consequences of smoking (Prochaska & DiClemente, 1983; Prochaska & Velicer, 1997).

Possibly, HWLs may serve different purposes and have varying effects depending on where a person is in the change process. For a person who is not ready for smoking cessation, an HWL may be a (likely unwanted) reminder that there exists risk information that should be sought out and considered. If a person does become ready and goes through with the behavior change, the HWL can function as a reminder of why one is trying to quit smoking. Dramatic relief could follow if the HWL succeeded in activating, for example, fear before a relapse, and the person because of the reaction decides not to relapse into smoking. The HWL being placed on products could be a strength, as it makes the information easily available in all stages of the change process.

The health behavior models illustrate how risk perception is only a part of the several factors that are assumed to predict behavior, with some of the other elements in the models being perceived benefits (Rosenstock, 1974), self-efficacy (belief in one's own ability to succeed) (Bandura, 1998), social factors and increasing reinforcement from alternative behavior (Prochaska & DiClemente, 1983). Mood regulation is, for example, found to be a predictor of snus use among Norwegian youth (Wiium & Åro, 2011). Health behavior models have shifted from having a main focus on fear appeal to self-regulation and social support in behavior change (Bandura, 1998).

The health behavior models (with the risk related factors included) are designed to predict behavior, usually through affecting intentions. However, it is a common problem that people often do not follow up on their intentions. This phenomenon is referred to as the Intention-Behavior Gap (Sheeran & Webb, 2016). The current project focuses on risk perception, but risk appraisal alone may not always induce changes in intentions and behavior, although the effects are strengthened when combined with a parallel increase in response efficacy and self-efficacy (Sheeran, Harris, & Epton, 2014). HWLs warning against possible health risks would be more effective if accompanied by cessation resources, or some

sort of encouragement that increases efficacy. Some HWLs include this kind of information, as for tobacco packages in Norway marked with "*Quitting? Look up slutta.no*" (Lovdata.no, 2018a). Slutta.no is a Norwegian webpage for tobacco cessation (Helsenorge.no, 2018).

In summary, risk perception is one of the factors that predict behavioral intentions according to the health behavior models, and predicting intentions do not necessarily predict behavior. Thus, with the current project measuring only one underlying factor for behavior, the implications for actual behavior are limited.

Evidence of effects from health warning labels

A premise for the current project is that HWLs affect risk perception, intentions to use, and in turn behavior. The focus is especially on whether HWLs as texts have this effect, as the text format is most commonly applied to SLT HWLs. HWLs on tobacco packages enable direct communication with tobacco users and potential users (Hammond, 2011), and is a cost-effective method to convey risk information which can potentially affect tobacco usage (Institute for Global Tobacco Control, 2013). HWLs can be broken down to two main components: 1) content elements concerning characteristics of the statement or picture in a warning, and 2) process elements such as color, use of iconic figures (e.g., celebrities) typically used to appeal to heuristic thinking, and exposure such as content rotation (Strahan et al., 2002). The component of content elements and the effects of altering the HWL content is the primary focus of this thesis. As SLT products typically have textual HWLs (instead of graphic), the textual content is especially relevant for SLT HWLs. Because of the sparse SLT HWL literature, results from HWLs on other tobacco products are included in this discussion.

In a review of effects of HWLs on cigarette packages, larger size and graphic content rather than text-only appear to be more effective on for example increasing health knowledge, risk perception and smoking cessation (Hammond, 2011; Noar et al., 2016; Noar et al., 2016).

This finding was supported in a cross-cultural study including seven different countries (Hammond et al., 2018). Still, the studies on how pictorial HWLs affect actual smoking are rather few, and the measurements should be enhanced by building on theories, and by increasing the consistency of applied measurements (Francis, Hall, Noar, Ribisl, & Brewer, 2017).

The very few studies on graphic SLT HWLs indicate that graphics can have stronger effect on some outcome measures, for example on gaining attention, thinking about health risks, and willingness to try an SLT product (Adkison, Bansal-Travers, Smith, O'Connor, & Hyland, 2014; Callery, Hammond, O'Connor, & Fong, 2011; Gravely et al., 2016; Mutti et al., 2015; Oswal, Raute, Pednekar, & Gupta, 2011). When reviewing SLT HWLs as a part of US policies, HWL types were found to have similar effects as for smoking HWLs, but there was limited evidence for warnings portraying relative risks between SLT and smoke, and none targeting dual-use (Levy et al., 2016). The same tendency was found in a review including several non-cigarette tobacco products, such as smokeless tobacco, water pipe, electronic cigarettes and cigars (Cornacchione, Noar, & Sutfin, 2019).

Further support for the stronger effect from graphic content comes from including SLT HWLs in the SimSmoke simulation model, which enables predictions of how tobacco control policies affect the prevalence of SLT use (Levy, Yuan, & Li, 2018). Strong HWLs (large and graphic) are estimated to reduce prevalence the most with 4%, initiation with 2% and increase cessation with 10%, compared to moderate HWLs (covering 1/3 of the package non-graphic) the corresponding percentages were 2%, 2%, 2%, and finally to weak HWLs (smaller than 1/3 of the package non-graphic) 1%, 1%, and 2%. These estimates were identical for cigarette and SLT HWLs. Tax policies were regarded to be the most effective means to reduce tobacco consumption (D. T. Levy et al., 2018).

Some studies examine the effect of smoking from longitudinal exposure to HWLs. For example, a few weeks may not be sufficient time to change behavior, but Malouff, Schutte, Rooke, and MacDonell (2012) found that smokers who were exposed to textual+graphic HWLs did progress more toward smoking cessation than those seeing mere textual HWLs. Factors such as low disengagement beliefs (cognitions to reduce the fear of harm from smoking) or being a heavy smoker can strengthen the effect graphic HWLs have on intentions to quit smoking (Dijkstra & Bos, 2015). This study did not find habituation towards the graphic content as fear and disgust were stable, perhaps because the graphic content varied during the three weeks. A naturalistic clinical trial over four weeks concluded that graphic HWLs increased negative affect from smoking more than text-only did, an effect that carried over to risk perception and strengthened intentions to quit (Evans et al., 2015).

Studies on effects from SLT HWLs mainly use self-reported responses such as rating product appeal and subjective risk perception, but a few related studies apply objective measures. For example, in an eye-tracking study on SLT HWLs in advertisements, male SLT users who saw a graphic HWL spent more time viewing the HWL compared to those seeing the text-only version (2.87 vs 2.05 seconds) (Klein et al., 2017). The recall was also higher for the graphic condition (76% vs 53%), but self-reported cravings did not differ. Functional magnetic resonance imaging (fMRI) enables insight into neural activity from health information to smokers (Falk, Berkman, Whalen, & Lieberman, 2011). One study found that the reduction in cravings after seeing any type of HWL was larger for adolescent smokers than for adult smokers, and graphic HWLs activated the bilateral amygdala more than non-graphics did, indicating stronger activation of emotion processing structures from graphics (Do & Galván, 2015). Young adults had stronger neural activity in brain regions related to cognitive and affective decision-making when looking at the graphic cigarette HWLs, as compared to a visual control condition (Green et al., 2016). One of the concerns about HWLs

is habituation from repeated exposure, a hypothesis that has gained support from fMRI-studies. Adults (N = 16) viewing cigarette HWLs had decreased neurological responses after repeated exposure to an HWL (Fridriksson, Rorden, Newman-Norlund, Froeliger, & Thrasher, 2018). These findings give further support to text HWLs having smaller effects.

In sum, the SLT HWL studies are few, and they indicate that graphic HWLs may have a stronger effect on some measures, also in enduring for a longer time according to studies on cigarette HWLs. The SimSmoke model supports this finding, although the reduction in user prevalence as an effect of either format of HWLs is relatively small. Still, the less restricted regulations for SLT commonly include text-only labels, which probably reduces the HWLs effect.

Textual modifications. As discussed, even if the effects of graphic HWLs outweigh text-only at least on some outcome measures, textual warnings are more commonly applied to SLT products (Hammond & Reid, 2012). For the current project, it is of particular interest to examine the effects of altering the text per se. Such HWL text alterations can address for example health topics (e.g., gum disease or cancer), or the strength of the statement like when the EU changed the moderated statement that snus "*can damage your health*" to the more absolute term "*damages your health*" (EUR-LEX, 2014).

One way of changing the textual content is by focusing on different health hazards. The CLT can be applied to define how the health hazard range can vary from abstract to concrete. For example, the statement in the EU HWL "*Snus is damaging to your health*" is a high-construal message, as it describes an abstract outcome: health damages in general, not specific health hazards such as gum disease or cancer. As for specific health hazards, they can be classified by both severity and time frame, in which CLT can be applied to the latter, as

low-construal immediate and short-term hazards (gum recession) vs. high-construal long-term consequences (cancer).

The same text message can be framed differently, for example by focusing on positive sides of a behavior through gain-frames such as: "*Quitting usage of all forms of tobacco can benefit your health*", as opposed to negative sides in loss-frames: "*Using any form of tobacco damages your health"* (Rothman, Wlaschin, Bartels, Latimer & Salovey, 2008). One meta-analysis (Gallagher & Updegraff, 2012) found that gain-frames encouraged smoking cessation more than loss-frames did, but importantly, the effect was found for *behavior* only, and not for attitudes or intentions towards the behavior. Gain-framed textual HWLs may result in higher positivity and stronger intentions towards quitting smoking (Mays et al., 2015; Mollen, Engelen, Kessels, & van den Putte, 2017). The effect of gain-frames can be enhanced when combined with a focus on short-term, immediate consequences from smoking (Mollen et al., 2017), and may promote abstinence in early stages of cessation treatment (Toll et al., 2007). However, other studies have found no effect from framing in textual HWLs, but an indication of enhanced effect from loss-frames for graphic HWLs (Zhao, Nan, Yang, & Iles, 2014). Perhaps the overall picture is even more complex. Loss-frames seemed to be more persuasive for people with high nicotine dependence and quit intentions, in contrast to gain-frames being more so if nicotine dependence and quit intentions were low (Moorman & van den Putte, 2008). Finally, loss-frames were preferred if the message was intended to convey information about health risks, addiction or social factors, but gain-frames preferred for financial focus (Kong, Cavallo, Camenga, Morean, & Krishnan-Sarin, 2016). The latter study focused on e-cigarettes, not regular cigarettes.

Of particular relevance for the current project is research from judgment and decision making, indicating that small effects can be induced in magnitude and probability estimates from a verbal change from "*can*" to "*will*" (Teigen & Filkuková, 2013). This study found that

absolute terms such as "*will*" activated intermediate or low estimates of numeric values, and association of something being *certain* or *probable*. "*Can*" activated high numeric values (from low to high numbers on a scale), and likelihood estimates similar to the terms *possible*, *uncertain* and *probable*. These results indicate that changing even one single word can have the potential to alter effects from a textual HWL. This specific alteration is the topic of one Paper 2, where we examine risk perception from HWLs in which the EU HWL is phrased as "*can*" or "*will*" damage health.

In sum, the HWL text can be altered in different ways, such as by framing, health topic or verbal alterations. In the current project, verbal changes are the focus of Paper 2, while Paper 3 focuses on another topic of text HWLs, that of relative risk information which is described in the next section.

Relative risk information. The research on comparative information in HWLs, such as RR, consists of a few studies (Levy et al., 2016). Some theories can contribute to illustrating potential mechanisms of comparative HWLs. For example, whether two options are presented separately or together can produce different evaluations of the same options (Hsee & Leclerc, 1998). There is a tendency that people overemphasize minor differences between options when evaluating them together, a phenomenon known as the *distinction bias* (Hsee & Zhang, 2004).

In the case of SLT vs. cigarettes, the relative difference in risk is large, not minor (Levy et al., 2004), and joint evaluation may have a different effect. With most people being aware of the severe risks from cigarettes, some hypothesize that any other tobacco product will likely gain from entering a joint evaluation with cigarettes rather than being evaluated separately (compared to no tobacco use) (Kaufman, Suls, & Klein, 2016). However, one study indicates that a direct joint evaluation may reduce relative risk estimates of SLT vs.

cigarettes, compared to when the relative risk is estimated from two separate questions. In a measure directly comparing risks from the two products ("*Compared to smoking cigarettes, using new smokeless tobacco, such as snus, is less/equally/more harmful*"), 22.1% of the smokers believed using snus was less harmful than cigarettes. However, when the two risk measures were separated ("*In your opinion, how harmful are new smokeless tobacco products, such as snus, to general health?"* and *"In your opinion, how harmful is smoking cigarettes for health?*"), and the answers from these two questions were compared, the share of smokers who believed that snus was less harmful increased to 51.6%. (Popova & Ling, 2013), which is more in line with the expert consensus of a 90% reduction in total mortality (Levy et al., 2004). The share of people believing that snus was more harmful than cigarettes, was more similar for the two conditions, with 18.3% for the direct measure vs. 12.7% for the indirect version.

From another perspective, with the severe consequences of cigarettes being well known, the cigarette risks can represent an anchor that many people can understand and relate to. Although one study found a different effect: overestimation of risks from snus was reduced after reading a newspaper article about RR from snus vs. cigarettes, but then again risks from cigarettes were overestimated (Bergsvik & Rogeberg, 2018). Interestingly, this study also found that reading risk information from a governmental web site produced a highly exaggerated perception of risk from snus. This specific website only presented information about risks from snus and mentioned its relation to cigarettes only for addiction.

Whether comparative warnings are presented alone or along with non-comparative HWLs may matter, at least for smokers. In a study where identical RR information was embedded into either a condition with no HWL, textual or pictorial HWL, the results appeared to vary depending on the format of the latter HWL type (Callery et al., 2011). When the comparative information was accompanied by a textual HWL, willingness to try SLT

increased, but the opposite effect was found when the other HWL was pictorial. The authors argue that seeing a picture may have activated more thoughts about the risks from SLT, rather than the reduced risks compared to smoking. In a recent study on RR HWLs for e-cigarettes, HWLs focusing on reduced risk induced lower perceptions of general risk than an HWL about addiction did (Berry & Burton, 2018). The pattern was opposite for specific health risks, in which the RR HWLs induced higher risk estimates than the standard HWL.

With the literature on RR HWLs consisting of a few single studies, we targeted this topic in Paper 3. More specifically, we looked into how the 90% total mortality reduction concluded by Levy et al. (2004) were perceived when converted to an HWL format as "*Snus is 90% less damaging to your health than smoking*", and compared to the standard EU HWL.

Gradients of fear appeal: The scarier, the better?

This thesis is about the effects of product warning labels, which are designed to induce fear and avoidance of a specific product. Generally, the use of fear appeal in health communication is a debated matter. Some conclude that fear appeals can be contra-productive, due to challenges in making the threat relevant for the public, and in building crucial self-efficacy for behavior change (Ruiter, Kessels, Peters, & Kok, 2014). As discussed, the health behavior models have evolved from a main focus on fear to a more positive and holistic approach. For example, there is a concern about the negative effects of tobacco control measures, such as the target group making fun of and avoiding HWLs. However, in one study, HWL disparagement was positively associated with the likelihood of future cessation attempts (Osman, Thrasher, Yong, Arillo-Santillán, & Hammond, 2017).

As for Norway where the tobacco control measures have been extensive, small effects were found short-term after a fear appeal campaign designed to activate strong reactions in the audience (Halkjelsvik, Lund, Kraft, & Rise, 2013). Those who remembered being exposed

to the campaign had an increase in perceived seriousness of hazards from smoking, risks from daily smoking, and frequency of smoking-related discussions, as measured seven weeks after the campaign. However, the likelihood to quit or reduce smoking did not change. The authors question whether the already extensive Norwegian tobacco control program may explain why the effects were so small. Still, following the results of a meta-analysis including 127 papers, fear appeals are recommended due to their effect on attitudes, intentions, and behavior, especially when including efficacy statements and claiming the high susceptibility and severity of the threat (Tannenbaum et al., 2015).

In sum, large graphic HWLs may have a greater potential for SLT cessation and is on that basis recommended to replace text HWLs (Noar et al., 2016; Pakhale et al.). However, the current stance in harm reduction policies matters for how the fear appeal is applied in tobacco control. If the overall goal is to eliminate all forms of tobacco usage, the HWLs with the strongest cessation effects are preferable for all tobacco products. If the goal, on the other hand, is to decrease smoking with SLT as an alternative harm reduced product, or even as a cessation method, the level of fear appeal in HWLs would have to be designed correspondingly.

Wrapping it all up, the literature about the effects of warning labels on SLT and snus is at its beginning. The field differs from its parallel field of cigarette HWLs, because snus is a less harmful substance, and the tobacco user prevalence in Norway may be shifting to become a majority of snus users. The reduction in smokers may be beneficial for public health as a whole, but an increase of young snus users is at the same time worrisome. Combining these aspects makes knowledge about the effects of snus HWLs highly salient, especially in Norway and Sweden where selling snus is legal. While graphic content seems to have enhanced effects on outcome measure when compared to textual content, the EU regulations for snus is and has historically been, textual HWLs. Thus, the goal of this thesis is to examine

how systematically varying the textual content in snus HWLs affect relevant outcome measures such as perceptions of risk and intention to use snus, among Norwegian citizens. To our knowledge, there are currently no prior studies on snus HWLs in Norway, and the articles in this thesis will, therefore, contribute to the field.

Aims and hypotheses

As discussed, there is a lack of research on how textual warning labels on snus are perceived by the public. Hence, the aim of Study 1 was to examine the literature on SLT HWLs about the effect on factors relevant to behavior change, with a main focus on risk perception. We initially collected and systematized existing research on effects from SLT HWLs, to get an overview of the sparse research field. In this effort, the results were then used to design two empirical studies about how the Norwegian public perceives the content in textual SLT HWLs, with a main focus on the effects of the HWLs on perceptions of risk. The first paper focused on non-comparative health warnings such as the current EU HWL, and the second targeted comparative warnings describing the relative risk between snus and cigarettes.

Paper I

Aim: Summarize existing research on effects from SLT HWLs and build a knowledge foundation for future studies. More specifically by:

1. Systematically mapping international evidence on how SLT HWLs affect cognitive outcome measures and measures related to behavior.

2. Systematizing the HWL content that participants were exposed to in experimental studies.

Paper II

Aim: Examine how the textual HWL currently applied in the EU, and similar versions, affect risk perception.

Hypotheses:

1: Removing *can* from *this product (can) damages your health* increases risk perception, and evokes strong certainty of mild health damages. Keeping *can* evokes less certainty, but associations of more severe health damage.

2: When contrasting *can* and *is* in the same HWL, *can* loses credibility.

3: Explicitly stating *causes cancer* is more alarming than warning about health damages in general.

Paper III

Aim: Examine how the current non-comparative EU HWL ("*Snus damages your health*"), two HWLs with general (RRG) or percentages (RRP) comparative risk information (*Snus is (90%) less damaging to your health than smoking*",) and a control (no HWL) affect risk perception from using snus, and the relative perceived risk from snus use compared to smoking. Intentions to use snus was explored. A decrease in relative risk would imply that the risks from snus and smoking are perceived as more similar, while an increased relative risk would imply greater distance between the two risk profiles.

Hypotheses:

1: The EU HWL increases the perception of risk from snus, and decreases the relative risk perception of snus vs. smoking when compared to the control.

2: The RRG HWL decreases the perception of risk from snus, and increases the relative risk perception of snus vs. smoking when compared to the EU HWL.

3: The RRP HWL decreases the perception of risk from snus, and increases the relative risk perception from snus vs. smoking when compared to the EU HWL.

4: The RRP HWL decreases the perception of risk from snus, and increases the relative risk perception from snus use vs. smoking when compared to the RRG HWL.

Methods

We examined international research on SLT HWLs in a systematic review, something which had not previously been done at the time of the present study. A review of U.S. SLT tobacco measures (Levy et al., 2016) was published concurrently with the writing of our review, which had identified the same U.S. articles we did, except that they included studies on HWLs in advertisements. Next, we contributed to the literature with two empirical studies on how Norwegian participants perceived the risk message in textual HWLs displayed on pictures of snus products, focusing on EU HWLs in Paper II (N = 619), and two generated RR HWLs in Paper III (N = 254). Our survey data were collected with the online software Qualtrics (www.qualtrics.com). Samples were recruited among high school students, university students and by snowballing in Facebook (starting in large groups such as the official Slutta.no page, university pages, and in individuals' private pages).

Paper 1: Systematic review

We registered the review protocol in PROSPERO International prospective register of systematic reviews (National Institute for Health Research, 2017) before starting the review process, and followed guidelines from Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA), which is recommended to enhance quality, transparency and prevent publication bias of systematic reviews (Shamseer et al., 2015).

In the review, we included empirical studies of qualitative and quantitative nature, both observational, quasi-experimental and experimental designs. Our searches yielded rather few studies (N = 12) from diverse countries with equally diverse HWL policies, which we tried to respect and explicate when discussing the results. Because of the small N, we did a thorough examination of both the content SLT HWLs that participants were exposed to within-study, as well as examining the study designs applied.

How HWLs work when they are placed in commercials, advertisements, campaigns, and other informational material is interesting, but the rich surroundings can make it harder to single out effects specifically from the HWL. Thus, we excluded studies in which HWLs were placed in other contexts.

Combustible alternative tobacco products, such as electronic cigarettes, are sometimes compared to snus because of the expected reduced risk from both products, compared to smoking. However, e-cigarettes were excluded from our review, because they represent different health hazards and social expectations, are regulated by other policies and have different user characteristics and prevalence.

Paper 2 and 3: Experimental design

These two papers consist of three experimental studies: two studies in Paper 2, and one study in Paper 3. All three studies were randomized between-group designs, in which participants were randomized to view and assess a specific HWL before answering outcome risk measures. Two of the studies were mixed designs in which participants answered measures pre- and post-exposure to HWLs. Three advantages of experimental design in this context are that randomization makes the comparison of the effects of risk messages over different conditions possible, as systematic differences between groups are eliminated or reduced. Furthermore, within-subjects comparisons pre- and post-manipulation are more sensitive to experimental effects as variation due to differences between individuals is reduced. Also, the control group is used as a comparison to the groups that receive manipulation (Keppel & Wickens, 2004).

The benefits of collecting data through Facebook are the low cost and availability of large non-student samples (Kosinski, Matz, Gosling, Popov, & Stillwell, 2016). On the other hand, Facebook recruitment comes with some challenges, such as not being able to control

whether participants discuss the research topic openly or private, and no knowledge about who saw the invitation but did not respond and the reasons for that (Gelinas et al., 2017). In our studies, it is, for example, possible that people who use snus were less interested in responding because of the research topic, but we cannot know for sure.

The plans for Paper 3 were preregistered and frozen at Open Science Framework (www.OSF.io) before launching the survey online. Some journals recommend that research plans such as design, hypotheses, sample size, and analysis are preregistered before the researcher starts the data analysis, or even before data collection (Association for Psychological Science, 2018). This kind of preregistration enhances transparency in research, can reduce publication bias, helps the researcher clarify the research design at an early stage, and reduces the bias from hypothesizing from looking at data posthoc (Nosek, Ebersole, DeHaven, & Mellor, 2018). There are however some drawbacks with preregistration. For example, some see it as part of a growing bureaucracy that interferes with discovery in research findings (Kupferschmidt, 2018), and other research designs (e.g., exploratory) may lose value and become harder to get funding for (Goldin-Meadow, 2016).

Independent variables. The textual HWLs we used as manipulations, or independent variables (i.e., experimental conditions) were applied on a photograph of a brand-neutral snus package. The photographer of the snus packages was contacted and gave her consent to that the packages could be used for the study purposes. The different textual HWLs were then written on the same photography, for all conditions, in both Papers 2 and 3.

We considered to use the warnings as mere text without the package background but decided that this would make the warnings lose context. Many studies that expose participants to HWLs within an experimental study, also apply brands on the tobacco products, which is useful when testing the perception of brands. In our studies, we chose to exclude brands to

keep the effect of HWL content salient. Participants could view the HWLs for as long as they liked while responding. Thus, the post-rating can also be defined as a rating done "during" exposure. Participants could not go backward in the survey, to prevent changes in pre-ratings.

Dependent variables. Designing the outcome measures was an important and challenging part of the studies. The main outcome measures were risk perception, which is, as discussed, a complex concept to measure. Risk perception involves at least three components: the element of which the risk derives from (e.g., using tobacco), the person for whom the risk is relevant (e.g., me or you), and the person perceiving the risk, (Cano & Salzberger, 2017). We approached risk perception as a deliberative concept, meaning a reason-based and logical estimate of the likelihood of a negative outcome (Ferrer & Klein, 2015), as well as the magnitude of health damages (Breakwell, 2014).

In Study 1, Paper 2, we used two risk items, one concerning the *perceived severity* of health damages, and one concerning the *likelihood* of predefined damages. These two variables were combined in the analyses, adhering to the conventional definition of risk (Breakwell, 2014). In Study 2, Paper 2, we applied the same outcome measures as Lucy Popova and Ling (2014), translated to Norwegian. These outcome measures targeted general risk perception and cancer risks and were combined to a single variable in the analysis.

For the study in Paper 3, we initially used a repeated measure designed pilot to explore tendencies among six versions of relative risk HWLs and to calculate power for a randomized controlled study. The sample size of the pilot was $N = 40$, which is reasonable given the literature on sample size calculation for pilot studies (Hertzog, 2008; Johanson & Brooks, 2009). Before conducting the pilot, the study design and outcome measures were tested qualitatively on six individuals, and based on their independent, unanimous comments, the outcome measures were altered from open-ended to fixed options. The respondents found it

difficult to answer to an open-ended measure such as "*Of 100 people who use snus daily, how many will experience health damages from the snus usage. Fill in the number*" when assessing the HWLs. Fixed options made sense when tested qualitatively on a new group of individuals, and were well received in the actual pilot. We also included a measure of HWL trustworthiness, but as the results were identical for all HWLs, we did not include this measurement in the main data collection.

For the outcome measures in Paper 3, we applied a variant of risk perception variables that asked more directly about perception from the HWL, and defining the risk as being from daily snus use: "*When you see the snus product on the picture, what are your thoughts about the health risks from daily snus use*?". Thus, we amended the most common format of risk perception measures from the SLT literature by adding a concrete time frame of use, that being daily use. We designed the measure to target their perceptions while they looked at the product picture, as one single exposure unlikely would alter risk perception. We did not apply the other recommendations of Kaufman, Persoskie, Twesten, and Bromberg (2018) such as specifying the type of health hazard, because of the nature of the HWL risk messages being general ("*snus is damaging to your health*"). Neither did we specify the person the risk was relevant for (personal or general) (Sjöberg, 2003), because of the broad sample criteria: we wanted to recruit people using and not using snus, which made it challenging to design outcome measures that would be equally relevant for all participants. As for our intention measure in Study 3, it was designed like similar measures in SLT HWL literature, in addition to including a concrete time frame (6 months perspective) as recommended by Kaufman et al. (2018).

Dropouts. In Paper 2, Study 1 (with 11 items) and Paper 3 (13 items) the completion rates were high, around 95%, implying that almost everyone who started the survey also completed it. However, for Study 2, Paper 2, the results were quite different. In the latter half

of post-measures in Study 2, which was about specific health hazards, 60% dropped out. We cannot know the reason for why people dropped out of this study, because the invitation was spread on social media, and we did not have direct contact with the participants. This particular survey was however longer than the other two surveys (over 70 items), and those who dropped out may have been less interested in the topic or experienced the burden of answering as greater than those who completed the survey (Galesic, 2006). The specific health hazard list was long and repeated four times in total (pre- and post for short- and long term hazards).

In Study 2 of Paper 2, both dropouts and completers scored similarly on risk perception pre-manipulation, but we could not check demographics because it was measured at the end of the survey. The treatment of missing data is described in the next section.

Statistical analyses. All analyses were done with IBM SPSS version 23 for Paper 2, and version 25 for Paper 3. Statistical assumptions were checked before analyses and adjusted for if they were severely violated.

For the two studies in Paper 2, we did an overall ANOVA first and followed it up with simple contrast analyses, or complex contrast analyses in cases where the conditions were combined (e.g., the two "*can*" conditions vs the one "*will*" condition). We tested the hypotheses by checking how post-measures differed between HWLs. As for Paper 3, we used a mixed model with time as within-subject factor and HWL as between-subject factor and checked the interaction effect between time*label. The hypotheses in Paper 3 were tested directly with planned comparisons.

Cases with missing data were removed from the analyses by IBM SPSS through standard listwise deletion, which means that if a value is missing, the whole case is removed from the analysis. This technique is usually considered to be adequate if data is missing

completely at random, and when the number of missing values is moderate since the method reduces the sample size (Peeters, Zondervan-Zwijnenburg, Vink, & van de Schoot, 2015). Thus, with most of our studies having a high completion rate, this technique was considered adequate. However, for Study 2 in Paper 2, from the post-measures for specific health hazards and forward, the dropout rate was higher. In this case, the dropouts increased after the rating of pre- and post- general risk perception, and with those analyses being done separately, the general risk measures were not impaired from the dropouts. Because of the dropout rate and applied technique for analysis, the last part of Study 2 should be interpreted with caution.

Ethics. Data for both of the empirical studies were collected in an anonymized form, and the projects were exempt from evaluation by the Regional Committee for Medical Research Ethics (REK). The demographic variables were broad and general, and we did not collect any information that could identify the participants. Paper 2 was assessed and found exempt by an Ethics committee member, while Paper 3 was approved by a local ethics committee at the Department for Psychology, UiT The Arctic University of Norway, which was not around when Paper 2 was produced and assessed.

When collecting data through social media such as Facebook, the researcher is not in direct contact with participants, and potential participants. Therefore, it is important to be clear about ethics and respect for privacy in the invitation (Gelinas et al., 2017). To fulfill this criterion, we prioritized going through ethical considerations before launching the surveys. The first page of our surveys explained the topic for the study, that there was no correct answer to the questions asked, age criterion was being over 16 years old, and participants had to know the Norwegian language. It also stated that the survey collected anonymous data, that we did not collect IP-addresses, or information that in any way, directly or indirectly, could identify the participants. By clicking the “Next”-button, participants agreed to enroll in the study, but they were free to end the survey any time they decided to.

The invitation links were distributed on websites with large groups of people (e.g., high school web sites) and through Facebook groups. Participants were encouraged to share the invitation further on, but any questions and comments should go directly to the researcher and not be discussed on the invitation link. This last line was added in the data collection for Paper 3, after experiences from the data collection in Paper 2.

Data was only available for people working with the studies, namely the co-authors on each of the studies. At the closure, both studies referred to an official Norwegian website about health and snus use, in case participants felt like knowing more about snus risks after being part of the study. For those who were randomized to the generated RR HWLs in Study 3, it was explained that the HWLs were designed for the study only and not approved for use on snus packages and that the current EU HWL was the approved version. Paper 2 was published in an open-access journal, and data published along with it as is encouraged for enhancing transparent research. The same procedure is planned for Paper 3, at acceptance.

Summary of papers

Paper I: A systematic review and content analysis of warning labels on smokeless tobacco products: International evidence

We reviewed international evidence of cognitive effects from HWLs on non-combustible smokeless tobacco products (not including e-cigarettes). The review was preregistered in PROSPERO International prospective register of systematic reviews prior, and we followed guidelines from Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA). Through the search *smokeless tobacco, chewing tobacco, snus,* and *snuff* combined with *warning*, label*, or pack** in four online databases we found 808 records, which were reduced to twelve articles: five with self-reported exposure to HWLs, five with experimental exposure, and two combining both types. The main part of the studies was from the USA (6) and Canada (2), and the rest from India (4).

All studies applied cognitive outcome measures (e.g., recall, awareness, thinking of health risks, believability, risk perception, product appeal). SLT users had noticed HWLs more often than non-users, but non-users had more effect from being exposed to it. Six studies included cognitive outcome measures related to behavior (e.g., willingness to try SLT, cessation attempts, likelihood of future use, replace cigarettes with SLT) and found some effects from the HWLs. Similarly to cigarette HWLs, graphic HWLs were often found to affect outcome measures such as awareness, risk perception, product appeal and use intentions more than textual HWLs did, but not in all cases.

Next, we systematized and analyzed the content in textual HWLs applied within-studies and found that the most frequently applied health hazard was cancer, oral health, and addiction. Oral health was also the topic viewed as the most credible in one study. Health risks were evenly framed as possible and absolute, but a direct comparison of effects could

not be done because of the methodology of the studies. Four studies focused on the effects of relative risk HWLs. The RR HWLs were assessed as less believable than standard HWLs, generated lower risk perception from snus, and increased willingness to try SLT for tobacco users when combined with a standard textual HWL but not when combined with a graphic HWL.

Paper II: Textual health warning labels on snus (Swedish moist snuff): Do they affect risk perception?

The effects of SLT HWLs have not been studied in Norway, where the number of snus users recently exceeded the number of smokers. The EU requires that SLT packages carry textual HWLs, which also includes packages in Norway. In 2016, "*can*" was removed from the current SLT HWL "*This tobacco product (can) damages your health*". We tested how the two described HWLs and one earlier version claiming that snus "*causes cancer*" affected risk perception in two studies, one with measures after HWL exposure (N = 196), and one with pre and post measures (N = 467).

Neither the HWL stating "*causes cancer*" or strengthening "*This tobacco product (can) damages your health and is addictive"* by removing "*can*" generated differences in short-time (1 year) risk perception compared to a control group. The removal of "*can*" did increase long-term (10 years) risk perception in Study 1, however, the same results did not appear in the pre-post design of Study 2, were risk perception increased regardless of HWL (including the control group). Further, participants chose "*causes cancer"* and "*damages your health"* as most alarming when compared and ranked next to each other.

Paper III: Health warning labels describing snus as less harmful than smoking: the effects on perceptions of risk

As our systematic review showed that there were few studies on relative risk HWLs, we conducted a study to examine this topic. Two relative risk HWLs were constructed based on estimates from an expert panel in a study by Levy et al. (2004): *"Snus is less damaging to your health than smoking*" and *"Snus is 90% less damaging to your health than smoking*". Participants (N = 254) were randomized to one of four conditions: the two relative risk HWLs, an HWL based on the current EU version, or a control condition with the text "snus" only and no HWL. Risk perception from using snus and cigarettes was measured pre and post HWL exposure. Intentions to use snus was included in exploratory analyses.

Perception of risks from snus use and its relative risk to smoking decreased the most in the control (no HWL) and the *90% less* conditions, when they were compared to the EU-based HWL. When the general relative risk HWL was compared to the EU-based HWL, the relative perceived risk was similar for both conditions, but the snus risk was higher for the latter HWL. Both perceptions of snus risks alone and its relative risk to cigarettes decreased more for the *90% less* HWL than for the general relative risk HWL. Thus, the EU-based HWL maintained stable risk perception levels from pre to post, while the control (no HWL) and the two relative risk HWLs adjusted perceptions more in line with expert opinions. The *90% less* HWL was particularly effective in reducing the risk perception from snus.

Discussion

SLT differs from cigarettes in legal regulations, user group characteristics, and health risks, which implies that HWLs can and perhaps should reflect these differences. We collected, systematized and reviewed the sparse literature of effects from SLT HWLs, which is an important field because of the increasing use of snus in Norway. Snus is an SLT product commonly used in Norway, but how Norwegians perceive common HWLs on snus has not been studied before. In two experimental studies, we found that altering the textual content of snus HWLs may have effects on the perception of risk, which is a factor relevant to behavior change. However, intentions to use snus did not differ in our study.

In our review based on literature retrieved in 2017, we found twelve studies on effects from SLT HWLs, and a couple more have been published since then, including ours (Nilsen, Friborg, Teigen, & Svartdal, 2018). One main finding in our review of international evidence (Nilsen, Wiium, & Svartdal, 2019), was that graphic SLT HWLs had a somewhat stronger effect on for example attention and thoughts about health risks, similar to the findings for cigarette HWLs (Hammond, 2011) and U.S. SLT HWLs (Levy et al., 2016). This specific finding is important but perhaps not surprising, as general mechanisms may be similar for cigarettes and SLT. If graphics are perceived to be livelier and more concrete compared to plain text, it makes sense that this effect is independent of the product studied. Construal level theory (Trope & Liberman, 2010) may help explain some of the enhanced effects of graphic HWLs, which are low-level construal, more concrete representations of health hazards compared to HWLs abstracted through words. Importantly, our review includes SLT in general, and with snus being amongst the products with the lowest health risks, the conclusions from the review are not necessarily representative for snus.

None of the SLT HWL studies we found were from Scandinavia, and none focused on the EU HWLs. Therefore, examining how Norwegians perceive the current snus HWL is

relevant. The current EU HWL is a high-construal message describing an abstract outcome: health damages in general. In Paper 2, our main finding was that there were some but minor differences in perception of risk from the former versus the current EU HWL. Verbal alterations from *can damage* to *damages* your health did strengthen long-term risk perception, but perhaps not enough to have practical implications on behavior. Recall that the connection between heightened risk perception and behavior is small (Sheeran et al., 2014). Thus, the EU might get some backup for their expectation that this change would strengthen the risk message, but not by a lot, according to our results. Importantly, our study was conducted after the coming HWL change was announced in Norwegian media, and some people in our sample might have known about it beforehand. This factor could have biased their perceptions and contributed to reduced effects of the new label. Our study design was however based on a one-time exposure to an HWL, and risk perception will unlikely change after one single exposure.

On a more general note, the moderated statement that using snus *can damage your health* is perhaps more realistic than an absolute *damages your health*-warning. Not everyone who uses snus will experience health problems from the use, and an overstated warning could weaken the public's trust in official health information. Stating that the product can damage *several people* could be more precise. From a philosophical perspective, the *can*-statement may be a better fit with respect to an individual's autonomy, while the absolute statement may have a more paternalistic expression.

We also found that the general risk perception increased for all labels in Paper 2, regardless of HWL content including the control. This effect may have been caused by the participants rating several specific risks before the post general risk measures. When the participants compared all the HWLs at the end of the survey, most people chose the *Causes cancer-warning* as the most alarming statement, but the same result that was not supported in the between-group manipulation. However, this particular measure was done at the end of Study

2, which had a rather large dropout rate, and the results should not be interpreted as representative. In sum, our null findings in Paper 2 can be a product of the HWLs being perceived as quite similar, or be related to elements of the study design such as the one-time exposure or the length of the survey.

Another focus of Paper 2 was the comparison of risk perception of people using versus not using snus, and experts versus laymen. We found that those who used snus estimated the risks to be lower than those who did not use snus. This may have been an effect of underlying attitudes, which we did not measure. For example, more positive attitudes among snus users may have lowered their perception of risk from the product and vice versa for non-users. Indeed, according to self-perception theory (Bem, 1972), this may be the case, as individuals may infer attitudes from observing their own behavior. Another finding was that experts had the overall lowest estimates of risks from snus. This may be an illustration of how experts and laymen judge risks differently, with experts having a technical approach, and laymen including other factors as well (Slovic, 1987). One could argue that snus users have perceptions more in line with experts, and perhaps more realistic perceptions, which could be the case – but as problematized by Slovic (1987), the experts may have answered the questions differently than laymen. A practical implication of this finding is with risk perception for non-users being very high, how much more could an HWL increase their risk perception? On the other hand, with snus users having lower risk perception, should the HWL be strengthened? Perhaps one would like to maintain the moderate risk message if the reduced risks from snus are to appeal to smokers. This is again a topic related to the harm reduction perspective, which is discussed more closely below.

As for Paper 3, we focused on the aspect that makes SLT HWLs deviate from cigarette HWLs, which is the comparative, harm reductive perspective. Our systematic review showed that research on RR HWLs was another shortcoming in the literature. Prior evidence

suggests that some versions of RR HWLs do adjust relative risk perception from snus and cigarettes more in line with expert opinions (Callery et al., 2011), and we found the same result in our study (Nilsen, Halkjelsvik, & Svartdal, 2019). Describing the comparative risk in concrete percentages rather than general terms reduced risk perception the most, which may be an effect of CLT, in that concrete information triggers low-construal psychological distance. However, this may also merely be a consequence of the large size of the difference (90%), perhaps surprising people with being that large. Therefore, this study should be followed up with a variation of the percentages. Also, the 90% less statement is about reduced total mortality risk, thus, saying that snus is 90% less *health damaging* may be imprecise. The study should be followed up with varied concrete-abstract health damages such as gum disease vs. cancer. Finally, the relative risk may not offer the clearest and most transparent format of risk information (Gigerenzer et al., 2010). Tailored risk information in the format of absolute risk could be an interesting expansion of the SLT HWL literature.

The HWLs applied in Paper 2 vs. Paper 3 have quite different characteristics. Paper 2 focuses on the common format of SLT HWLs, statements that compare the risks of using snus (or SLT) to not using it. The risk of, for example, gum damages would increase for snus users compared to non-users. HWLs comparing snus and smoking are not applied in tobacco control, as best we know, and one reason for this is probably the lack of knowledge about effects from such comparisons. Therefore, our Paper 3 focuses on this understudied subject, which may be controversial for some. Stating that snus is 90% less harmful than smoking is a strong statement, but this is what some experts have agreed, and it is of interest to see how the public assess risk from this particular statement (which also has been adopted in several news articles), and whether reading it affects intentions to use snus. If, for example, reading the 90% less HWL had produced strong use intentions in none-smokers, this would have been an

unwanted effect. As for our study, we found some effects on adjusting risk perception, but none on intentions, although low power might have been an issue.

A concern is that the public may dichotomize product harmfulness when SLT is portrayed in relative terms such as "*less harmful*" (Savitz et al., 2006), and conclude that switching to snus is a mean to avoid adverse health consequences (Kaufman et al., 2016). While using snus is associated with health risks, the overall mortality rate and risks for some health hazards (e.g., lung related) are very much reduced compared to smoking (SCENIHR, 2008). If autonomy and informed choice are meant to be leading ethical guidelines in the modern society, individuals have the right to know that a product is less harmful, even if the full risk message is complex and may be misunderstood by some (Kozlowski, 2002). For example, the U.S. warning "*No tobacco product is safe"* is by some considered so unspecific that it violates people's right to know at least something about the difference in risk profiles (Kozlowski & Edwards, 2005). Still, mechanisms and effects of relative risk HWLs are barely studied in the area of smokeless tobacco (Hammond, 2011; Levy et al., 2016), a harm reduction strategy may seem premature - if the end goal is zero tobacco consumption. However, if one moderates paternalism by enhancing freedom of choice as is suggested in the nudge theory (Thaler & Sunstein, 2003), one could share the relative risk information, but at the same time encourage people towards the least harmful behavior. A thorough ethical analysis that results in a recommendation about whether a harm reduction policy (and RR HWLs) should or should not be applied, goes beyond the scope of this thesis. The existing literature shows that experts disagree on the matter of harm reduction. We conclude that comparative information in HWLs can adjust risk perception more in line with some scientific opinions. Whether or not this type of risk information should be applied, depends on the current political stand and the role of HWLs in tobacco control as a whole.

In sum, the EU strengthening the risk message on SLT HWLs inspired the topic of this thesis, and we questioned whether changing a verb alone really affects risk perception. We found that it may, but not by a lot. Another finding was that people perceive risks from snus to be very high in the first place. If HWLs are designed to warn against a hazard from a product, what are the practical implications when risk perception from snus is already that high, and very high also when compared to cigarettes? As discussed in the introduction, if the goal is to reduce risky behavior such as the use of snus, there are other relevant theories with different focuses than risk and hazards. For example, attitudes, in how much a person likes or dislikes snus can matter, as well as focusing on other reasons for using snus, like psychosocial factors or positive effects from the use. Health behavior models have been changing the focus to other measures than fear appeal, while the FCTC regulations are perhaps more focused on health risks. HWLs are just a part of a larger tobacco control program, and mass media campaigns using for example humor are also conducted (Helsedirektoratet, 2018). As a final comment, the findings from our studies may be generalizable to related fields, for example, HWLs on other products, or for perceptions of headlines and short text messages.

Limitations

Our studies were designed to check how HWLs are assessed and understood at the time of exposure. Thus, the results cannot speak for how the effects will endure over a longer period, for example after seeing the labels continuously in a real-life situation. Neither do we measure variables relevant for behavior, except the exploratory inclusion of use intentions in Paper 3, in which there was no change after exposure to any of the HWLs. Risk perception is still expected to be somewhat related to behavior change (Sheeran et al., 2014). Implications from these kinds of studies design should be interpreted with that in mind. The inclusion of SLT in general in the review weakens the conclusions for snus alone, although the tendencies may still be of relevance for future studies. Due to our broad sample criteria, we did not specify the risk target

in our risk perception variables, something that is recommended to strengthen the measurement of risk (Kaufman et al., 2018). Therefore, our results are probably more similar to general than personal risk perception, thus somewhat higher than it would have been in a personally relevant measure (Sjöberg, 2003). This challenge could have been reduced by narrowing the sample to smokers or non-tobacco users only, which would have made it easier to tailor the outcome measures to one target group.

Future research

With the literature for SLT HWLs being very sparse, many approaches can enrich the field. In a recent meeting about the future for tobacco HWLs in general, the researchers summarized the need for developing theoretical approaches, study designs, objective measures, expanded population base, broadened tobacco products, and focus on policies (Thrasher et al., 2018).

The most common design of studies in this field is either recall or exposure to HWLs and one-time measurement of responses. More studies should aim to apply a longitudinal design, preferably with repeated exposure to HWLs in natural settings. Also, there is a lack of studies on actual behavioral responses to HWL exposure, beyond intentions, especially for SLT studies. As for methodological approaches, applying objective measures such as eye-tracking or fMRI could contribute to this research field which mainly applies self-report as outcome measures.

The effects of comparative information about snus and smoking in HWLs should be studied both in the form of RR and AR and as combinations of these two. The comparative information could have a different effect when placed on cigarette packages versus snus packages. A study assessing how smokers and non-smokers perceive comparative information about snus and smoking on cigarette vs. snus packages would be interesting. Individual

characteristics other than tobacco use can influences how people process risk information, for example, health literacy (Hoover et al. 2018) which could be controlled for in future studies.

Finally, the research could be extended by including health information beyond mere warnings, perhaps by looking into theories from social psychology and health behavior models.

Conclusion

In sum, the literature on effects from SLT HWLs is sparse, but the studies indicate that HWLs may affect factors relevant to behavior change. This thesis has focused on changes in the textual content of HWLs, which may have some, but minor effects on risk perception. Comparative risk information shows potential in adjusting perceptions of risk more in line with expert opinions, which can contribute to increasing the attractivity of snus compared to cigarettes, however, making snus more attractive can benefit smokers but potentially harm non-tobacco users. Therefore, ethical considerations must be made before including comparative information in snus HWLs.

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Paper 1

A systematic review and content analysis of effects of warning labels on smokeless tobacco products: International evidence

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Abstract

The aim of this article is to analyze the textual content applied in studies on health warning labels for smokeless tobacco products, and to review international evidence of these labels effect on outcome measures related to cognition and behavior. Articles were extracted through systematic searches in four online databases during February 2017, with the search terms: smokeless tobacco, chewing tobacco, snus, and snuff combined with warning*, label*, or pack*. Twelve articles met the inclusion criteria. Five studied effects from self-reported exposure, five studies exposed participants to warning labels within-study, and two used a combination. One study was purely qualitative. The studies originated from the USA (6), India (4), and Canada (2). We conducted a content analysis to map the topic and content of textual warning labels that were applied within-studies, and found that cancer and oral diseases were the most common health hazards. Graphic warnings were found to have a stronger effect on some outcome measures when compared to text warnings, similar to results from comparative cigarette studies. Studies on relative risk messages indicated that they affected tobacco user subgroups differently, and that their effect changed when they were combined with other health warnings. The literature on effects of warning labels on smokeless tobacco is sparse, and needs expansion.

Keywords: Smokeless tobacco, Warning labels, Tobacco control, Systematic review, Content analysis, International evidence

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A Systematic Review and Content Analysis of Warning Labels on Smokeless Tobacco Products: International Evidence

Smokeless tobacco (SLT) are different forms of tobacco that can be chewed or sniffed (U.S Food and Drug Administration, 2018). Using the common European SLT subtype Swedish moist snuff (snus) is by some experts regarded as less harmful than smoking cigarettes (Levy et al., 2004), but is still associated with other health risks, such as adverse pregnancy outcomes, diabetes type 2, and increased risk of death after myocardial infarction or stroke (Norwegian Institute of Public Health, 2014). Marketing snus as a safer alternative to cigarettes has been debated. Some believe that encouraging SLT as a means for harm reduction can be beneficial to public health, while others are reluctant to promote the use of any form of tobacco (Gartner, Hall, Chapman, & Freeman, 2007).

Both snus and Asian chewing tobacco (betel quid and areca nut) are considered carcinogenic to humans (IARC, 2012). The South-East Asia Region has several different SLT types of which some have high levels of tobacco-specific nitrosamines (National Cancer Institute and Centers for Disease Control and Prevention, 2014). The common SLT type areca nut/betel nut affects the endocrine and immune system, which can lead to several adverse health damages (Garg, Chaturvedi, & Gupta, 2014). Prevalence of SLT use is increasing in some countries, such as Norway (Norwegian Institute of Public Health, 2014) and the USA (Centers for Disease Control and Prevention, 2016), and is especially high in India and Bangladesh (World Health Organization, 2015).

How does the public perceive the health hazards of SLT? Only one in five American smokers believed snus was less harmful than smoking when asked directly, but the proportion exceeded 50 % when measured indirectly (Popova & Ling, 2013). As for Norwegian smokers, one in five believed health risks from snus were “far lower” compared to cigarettes (Lund, 2012), which is in accordance with some scientific evidence (Levy et al., 2004). The same

respondents reported a higher willingness to try snus as a means to quit cigarettes (Lund, 2012). Another study found that the majority of Norwegian smokers thought risks for oral cancer, cardiovascular disease, and stomach cancer were equal or higher for snus compared to cigarettes, but fewer rated the risk of lung cancer as higher for snus (Lund & Scheffels, 2014). About half of both young and adult Indian and Bangladeshi users chose their SLT subtype based on beliefs of it being less harmful than other types (Mutti et al., 2016).

Health warning labels (HWL) can inform users and potential users about risks associated with tobacco products. Effects of HWLs on SLT products may differ from those on cigarettes because of the diverse health risks from the tobacco products, and because some SLT products are less harmful to health relative to smoking. HWLs sometimes focus on this relation, e.g. as "*This product is not a safe alternative to smoking cigarettes*". The European Union removed cancer warnings (EUR-LEX, 1992) from snus products in 2011 (EUR-LEX, 2001). The conclusions in the 2012 IARC statement supports a cancer warning for SLT in general, but there is limited evidence specifically for snus. The cancer warning has so far not been reintroduced on EU snus products, although the warning was strengthened by removing "can" from "damages your health" (EUR-LEX, 2014). In the USA, a warning about mouth cancer is one of four required labels for SLT products (U.S Food and Drug Administration, 2010). However, the U.S. also allows forms of SLT that are more carcinogenic than the EU ones. The other three American warnings concern mouth disease, tooth loss, and addiction, in addition to a statement that SLT is "not a safe alternative to cigarettes". Indian governments require the text "WARNING: Tobacco causes mouth cancer" along with an illustration of oral cancer (Government of India. Ministry of Health & Family Welfare, 2014), replacing an earlier graphic of a scorpion.

The current review extends previous work on effects of U.S. smokeless tobacco control policies (Levy, Mays, Boyle, Tam, & Chaloupka, 2016) by broadening the inclusion

criteria to all nationalities, and supplementing with a content analysis of the textual HWLs applied in studies. In their review, Levy and colleagues (2016) identified nine American studies on SLT HWLs and concluded that graphic warnings were more effective than mere textual warnings, findings that were similar to those for cigarette packages (Hammond, 2011). More specifically, large graphic warnings increased health knowledge, risk perception, and smoking cessation. In the current review, we aim to assess the effects of HWLs in international studies of qualitative, observational and experimental design, and to examine the content of HWLs applied in within-study exposure studies. Both effects on measures related to cognition and behavior were relevant for our search, and we examined specific effects for subgroups, such as users/non-users, gender, age, and socioeconomic status.

Methods

The protocol was preregistered in PROSPERO International prospective register of systematic reviews (National Institute for Health Research, 2017) in May 2016, under the registration number 42016050409. The review structure follows guidelines from Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) (Online Resource 1).

Inclusion Criteria

For our literature base, the inclusion criteria were: 1) empirical studies, 2) either or both qualitative and quantitative designs, 3) interventions that used HWLs or health risk information on SLT products, mere textual, graphics or a combination, 4) examination of effects from either self-reported or within-study exposure to HWLs on SLT product packages (not in e.g. advertisements), 5) outcome measures that separated SLT effects in combined cigarette/SLT studies, 6) outcome measures that were either cognitive (e.g., attention, recall, perception) or related to behavior (e.g., intentions to use or quit SLT), 7) written in the English language, and 8) all populations. Literature reviews, comments, and case studies were excluded, as were studies on e-cigarettes.

Search Strategy

We identified articles through searches in four electronic databases: PsycINFO, MEDLINE, EMBASE, and Scopus. The EMBASE and grey literature searches deviated from the registered Prospero protocol, but were added to make sure all relevant studies were included.

The first author did the literature search together with a librarian. In line with the PRISMA guidelines, we present the full search strategy applied in one of the databases (Table 1). We also hand-searched the reference lists of all included articles for additional studies. Supplemental searches in grey literature[1] such as governmental reports, theses, and student projects did not reveal previously unidentified work. Neither did scanning through all Cochrane reviews about tobacco (N = 101).

Table 1. Complete search strategy in MEDLINE.

1	Tobacco, Smokeless/
2	smokeless tobacco.ti,ab.
3	snus*.mp.
4	snuff*.mp.
5	chewing tobacco.mp.
6	or/1-5
7	product packaging/ or product labeling/
8	warning*.mp.
9	(pack* or label*).mp.
10	or/7-9
11	6 and 10

Study Selection

Two authors separately extracted relevant articles from the search results and compared lists afterwards. Studies were selected through reading titles and abstracts, and discrepancies were solved through a closer examination of how compatible the articles were with the inclusion criteria. The third author was included when necessary.

Quality Assessment

Two authors assessed risks of bias independently. We examined the articles for any competing interests (such as funding by the tobacco industry) and made any findings explicit. The CONSORT quality checklist for randomized control trials was applied to both experimental and quasi-experimental studies (The CONSORT group, 2017). For cross-sectional observational studies, we applied the STROBE checklist (STROBE, 2017). The most important notes from the quality assessment are described in the overview of our included studies (Online Resource 2).

Synthesis of Results

Results from studies on self-reported exposure to HWLs were summarized and compared. For the within-study exposure studies, we conducted a content analysis to sum up frequencies of textual content in HWLs. Next, we looked into whether there were any systematic tendencies in how different types and content of warning labels affected outcome measures. We looked for differences between countries, users/non-users of SLT, gender, age, and socio-economic status.

Results

Figure 1 (PRISMA Flow diagram) illustrates the study selection process in which 28 of 808 articles were retrieved for full-text. Five of these were excluded because the results were not split for SLT and cigarettes, nine because they studied effects from HWLs placed in advertisements or other places than on the products themselves, and two because of other

design-related factors. Most of the 12 included studies were conducted in 2011 and later. Five of the studies displayed SLT product pictures with HWLs to participants, five measured effects from self-reported exposure to SLT products with HWLs, and two were combinations. See Table 2 for the content of textual HWLs applied within-study, and Online Resource 2 for a summary of each of the article's origin, SLT subtype, design, sample, measures, main findings, and notes on quality.

On a general note, all studies applied self-reported outcome measures only, which means that participants read and answered questions related to the HWLs. None of the studies used objective measures, like e.g. eye-tracking or functional magnetic resonance imaging (fMRI), which is a limitation of the literature base. Seven studies exposed participants to HWLs within-study, and the remaining studies asked participants to recall HWLs and answer questions. Recall in this type of studies can be biased, in that people may for example remember the HWLs wrongly or mix it up with HWLs on other products (e.g. cigarettes). Thus, in such recall studies, the validity can be weakened as one may not know exactly what the outcome measure captures.

Another limitation of the exposure studies in this literature base, is that none of the studies measure repeated or longitudinal exposure to HWLs. In real life, people are exposed to HWLs frequently at least if they buy and use tobacco. Therefore, the effect of HWLs can change through time, and that effect is perhaps the most relevant one, more than the effect from a one-time exposure. However, a longitudinal design would demand more complicated study designs, but could be managed through e.g. repeated smart phone reminders.

Content of the Textual HWLs

Seven studies exposed participants to HWLs within-study, e.g. as "This product causes mouth cancer". A summary of the textual warnings these studies applied can be found in Table 3.

Thematically, the most frequent health risks were cancer and oral cancer, mouth diseases, tooth loss, and addiction. Eight of the health risks were phrased as possible (“can”, “may”), while nine were absolute (“is”, “causes”). Such verbal differences may affect outcome measures. For example, the Canadian users commented that “can” was too hypothetical and weak (Health Canada, 2003). In a non-health related context, statements of “can” created expectations of a highly severe outcome being possible, probable or uncertain to happen, whereas “will” was perceived as something low to medium in severity being probable, possible or certain (Teigen & Filkuková, 2013). A direct comparison is however not feasible based on the current review material. For example, Mutti and colleagues (2015) applied absolute terms on several HWLs unlike most others, but their results were split on format (textual/symbolic/graphic), not on textual content. Thus, a comparison of those results cannot be made.

Table 2. Content of textual warning labels in exposure studies (n = 7)

Authors	HWL type	Warning text	Topic
Brubaker & Mitby, 1990	HW	Warning: This product may cause mouth cancer	Oral cancer
	HW	Warning: This product may cause gum disease and tooth loss	Gum disease, tooth loss
	RR	Warning: This product is not a safe alternative to cigarettes	Not safe
Health Canada, 2003	HW	Use of this product can cause cancer	Cancer
	HW	This product contains cancer-causing agents	Carcinogenic
	HW	This product causes mouth diseases	Mouth disease
	HW	This product may be harmful	Harmful
	RR	This product is not a safe alternative to cigarettes	Not safe
	AD	This product may be addictive	Addiction
	AD	This product is highly addictive	Addiction
Oswal et al, 2011	HW	Tobacco causes cancer	Cancer
Callery et al, 2011	HW	This product contains cancer-causing chemicals	Carcinogen
	HW	You're chewing your way to tooth decay	Tooth loss
	HW	This product can cause heart attacks	Cardiac
	RR	Using ST is less harmful than smoking cigarettes	Less harmful
	AD	Don't get trapped. Smokeless tobacco is addictive	Addiction
Adkison et al, 2014	HW	Warning: This product can cause mouth cancer	Oral cancer
Mutti et al, 2015	HW	Tobacco causes oral cancer. Tobacco kills.	Oral cancer
	HW	Tobacco causes mouth disease. Tobacco kills.	Mouth disease
	HW	Tobacco causes heart disease. Tobacco kills.	Cardiac
	HW	Tobacco kills 2500 Indians every day. Tobacco kills.	Death
	AD	Tobacco is highly addictive. Tobacco kills.	Addiction
Rodu et al, 2016	HW	This product can cause mouth cancer	Oral cancer
	HW	This product can cause gum disease and tooth loss	Gum disease, tooth loss
	RR	This product is not a safe alternative to cigarettes	Not safe
	RR	No tobacco product is safe, but this product presents lower risks to health than cigarettes	Less harmful
	RR	No tobacco product is safe, but this product presents substantially lower risks to health than cigarettes	Much less harmful
	AD	Smokeless tobacco is addictive	Addiction

Note. HW = health warning, AD = addiction warning, RR = relative risk message

Effects on Cognitive Outcome Measures

All of the 12 studies measured effects on some cognitive outcome measures, such as recall, awareness, and perceived risk. These results are summarized in the below section.

American and Canadian studies. Recall appeared to be unrelated to the textual HWL content in the oldest American study, as neither of the HWLs were remembered more often than others (Brubaker & Mitby, 1990). A qualitative Canadian report also found low recall of textual HWLs when interviewing SLT-users (Health Canada, 2003). These Canadian users differed in whether they found HWLs effective, some users reported that it increased awareness while others took no notice of them. Among American youth, 40.3% had noticed an HWL most of the time or always when seeing an SLT product (Johnson, Wu, Coleman, & Choiniere, 2014). Young SLT users reported higher exposure to HWLs than their non-user counterparts (66.6% vs. 34.7%), but more of the non-users reported that seeing an SLT warning made them think of health risks "a lot" compared to users (28% vs. 13.4%). SLT users also had lower odds of perceiving greater harm from tobacco use (odds ratio [*OR*] = 0.3) (Johnson et al., 2014).

As for adult American SLT users, 77.5% reported exposure to current text-only warnings, of which 73.9% reported thinking of health risks (Agaku, Singh, Rolle, & Ayo-Yusuf, 2016). Recall of HWL exposure was associated with higher perceived harmfulness from SLT, compared to people who did not recall being exposed to HWLs (*OR* = 2.16), but not with perceived addiction. There was no association between self-reported exposure to HWLs the past 30 days and being curious about SLT products for young people who were non-users of tobacco (Portnoy, Wu, Tworek, Chen, & Borek, 2014). HWLs targeting health risks had higher odds of being seen as believable compared to HWLs claiming that snus is less harmful to health compared to cigarettes (Rodu, Plurphanswat, Hughes, & Fagerstrom, 2016). This finding is described in more detail later. In sum, users report having noticed

HWLs more often than non-users, which makes sense, as they would have higher exposure frequency of products. However, non-users report more effects from exposure.

Participants chose graphic warnings as the HWL type that would make people consider health risks more over textual HWLs (63.6% vs. 5.4%), increase perceived risks (28.3% vs. 4.8%), attract the most attention (47% vs. 18.8%), and was seen as least attractive to a user (61.3% vs. 6.8%) in an American study (Adkison, Bansal-Travers, Smith, O'Connor, & Hyland, 2014). The Canadians found that seeing a graphic HWL produced lower odds of positive product appeal compared to those seeing a text HWL (*OR* = 0.33), and lower odds of estimating realistic relative risk from SLT/cigarettes compared to those seeing a product without an HWL (*OR* = 0.51) (Callery, Hammond, O'Connor, & Fong, 2011).

Indian studies. Four of the studies were conducted on Indian populations. Few women of low socio-economic status had noticed symbolic HWLs (10.76%) or symbolic HWLs accompanied with text (3.84%) (Majmudar, Mishra, Kulkarni, Dusane, & Shastri, 2015). Graphic HWLs were noticed more often than symbolic and textual ones among the general population (68.8% vs 45.5%), while the symbolic “scorpion” was often misunderstood, and rarely associated with cancer (Oswal, Raute, Pednekar, & Gupta, 2011). A perceived advantage of the graphics was however that they made risk information available for illiterate tobacco users, but the graphic design should be more precise than the scorpion. Graphics were also perceived as more effective in increasing awareness over symbolic and textual versions (Mutti et al., 2015). Effectiveness of HWLs on cognitive measures, such as noticing the HWLs (34.3% vs. 28.1%) and thinking of SLT risks (15% vs. 17.5%) did not differ when measured pre- and post- implementation of graphic HWLs in India (Gravely et al., 2016). However, SLT quitters were more likely to be aware that SLT packages had HWLs after the change (77.8% vs. 86.8%).

Effects on Outcome Measures Related to Behavior

Six studies included outcome measures related to behavioral outcome, e.g. intentions to try, use or buy SLT. The findings are summarized below.

American and Canadian studies. Three of the studies originated from the USA. Seeing an HWL on an SLT product had no effect on willingness to try SLT (Brubaker & Mitby, 1990). Of the 77.5% American SLT users that reported exposure to warnings, 17.1% had stopped using SLT on more than one occasion (Agaku et al., 2016). Males had lower odds of stopping SLT use because of HWLs, compared to females (*OR* = 0.27). Seeing health risk messages were associated with a lower likelihood to try and buy snus, compared to relative risk messages (Rodu et al., 2016). One Canadian study found that compared to the textual HWLs, seeing the graphic HWLs decreased smokers' willingness to try SLT and likelihood of future use (*OR* = 0.39), while seeing an HWL with relative risk information for snus/cigarettes was associated with a higher likelihood of future use (*OR* = 2.04), and higher willingness to attempt replacing cigarettes with SLT (*OR* = 1.47) (Callery et al., 2011).

Indian studies. In the Indian studies, adults perceived textual HWLs as overall least effective when compared to symbolic HWLs (b = −0.36), graphics (b = −2.22) and testimonials (b = −1.68) The same pattern was seen for youth (symbolic HWLs (b = −0.30), graphics (b = −2.59) and testimonial versions (b = −2.13) (Mutti et al., 2015). The analyses in this study are somewhat unclear. The authors state that the effect of message theme was analyzed with logistic regression models, but in the results section, they say generalized linear regression. Their results were however reported as b, not odds ratio. As for the fourth Indian study, the implementation of graphics in India did not lead to changes in intentions or attempts to quit when measured pre and post implementation (Gravely et al., 2016).

Effects of Relative Risk HWLs

Four studies looked into effects from RR HWLs as either "SLT is not a safe alternative to cigarettes", or "No tobacco product is safe, but this product presents (substantially) lower risks to health than cigarettes".

As the content of the HWLs was unrelated to recall frequency, there was no difference between recall of the "not safe" HWL and that of standard health warnings (Brubaker & Mitby, 1990). The Canadian SLT users found "not safe" to be the most unclear HWL, partly because they thought SLT was a safer option at least for some people, as passive smoking was eliminated. Some even believed this HWL meant that cigarettes were safer (Health Canada, 2003).

"Not safe" was perceived as more believable than the two proposed RR HWLs "No tobacco product is safe, but this product presents (substantially) lower risks to health than cigarettes", in a study sponsored by Swedish Match (Rodu et al., 2016). This finding was stable across all tobacco usage groups. Smokers who saw "lower risk" or "substantially lower risk" reported lower harm from snus (*OR* = 0.51 and *OR* = 0.33) and were more willing to use (*OR* = 1.80 and *OR* = 2.07) and buy it (*OR* = 3.50 and *OR* = 4.0). The pattern was similar for SLT users, reporting lower harm from snus (*OR* = 0.39 for "lower risk"), higher likelihood to use (*OR* = 2.04 for "substantially lower") and motivation to buy it (*OR* = 1.92 and *OR* = 2.15). Never users and triers viewing "substantially lower risks" were more likely to buy snus (*OR* = 1.88) (Rodu et al., 2016).

Adding the RR information "Using smokeless tobacco is less harmful than smoking cigarettes" to a graphic HWL produced lower willingness to try SLT (53.8%) than the combinations RR + textual HWL (74.2%) and RR + no HWL (73%) (Callery et al., 2011).

Discussion

The material is sparse, but there are indications that graphic HWLs may in some cases evoke more reactions than textual HWLs, e.g. on attracting attention, evoking thoughts about health risks, and decreasing willingness to try SLT. This tendency is supported by similar studies on HWLs in advertisements (Popova & Ling, 2014; Stark, Kim, Miller, & Borgida, 2008), and in comparative studies on cigarette HWLs (Hammond, 2011). However, considering that graphics increased unrealistic beliefs about the relative risk between SLT and cigarettes (Callery et al., 2011), their effect should be closely examined in future studies. For example, one study suggests that graphics should avoid being too disgusting, as people may get "turned off" by the graphic content, and react by avoiding looking at them (Health Canada, 2003).

In India, adult SLT-users who were exposed to graphic HWLs perceived them as more effective than symbolic or textual ones (Mutti et al., 2015), although effect measures did not differ before and after the implementation of graphic HWLs in 2011 (Gravely et al., 2016). Perhaps applying tobacco control programs to increase awareness and understanding of HWLs (Majmudar et al., 2015) could potentially improve the absent change in effect after implementation. Nevertheless, the fact that SLT quitters were more aware of the presence of HWLs on SLT packages after the change to pictorials in India (Gravely et al., 2016), may indicate an effect after all. Along with the symbolic scorpion being misunderstood, some of the graphic HWLs were unclear, and not identified as illustrations of health hazards (Oswal et al., 2011). Thus, having additional focus groups assessing the design of graphic HWLs may be beneficial to ascertain the content of these labels.

The qualitative Canadian study found that mouth and throat risks were perceived as the most credible topics in SLT HWLs (Health Canada, 2003). Our content analysis shows that these also are the most frequent health hazards of HWLs applied within-study, with oral cancer and oral diseases being among the most frequent.

There were some misunderstandings about the RR HWL "not a safe alternative to cigarettes". Some recommend avoiding information about relative risk to cigarettes in HWLs altogether, as it may make people believe SLT products are safer (Health Canada, 2003). Although the "(substantially) lower risk" HWL made tobacco users more willing to try snus, it also made non-users more likely to buy it (Rodu et al., 2016). This brings us back to the debate about SLT as a harm reduction product. If the desired effect of HWLs is to encourage smokers to change to SLT, applying the suggested RR HWLs could be advantageous. On the other hand, the RR HWLs may lead to recruitment from non-user populations. Perhaps HWLs could convey information targeting both smokers and non-users of SLT.

Limitations

There are limitations to this review. A main weakness is that there are few studies available, and the existing ones have diverse origins, designs, and populations. Thus, conclusions should be drawn with care. In addition, we might have missed some material in our searches for grey literature, as not all of it could be examined, and studies in other languages than English were not included.

Conclusions

The literature on effects of SLT HWLs is sparse, and the conclusions of this review is therefore limited. The most common warnings applied in the studies were related to cancer, oral health and addiction. Graphic warning labels may be more effective on some outcome measures, such as attention and willingness to try SLT. Another strength of graphic HWLs is the potential to communicate health information to people who are illiterate. However, the graphics should be customized and tested before being implemented. Moreover, including relative risk information that compares snus with smoking in HWLs is debated, and there are very few studies on effects from such HWLs.

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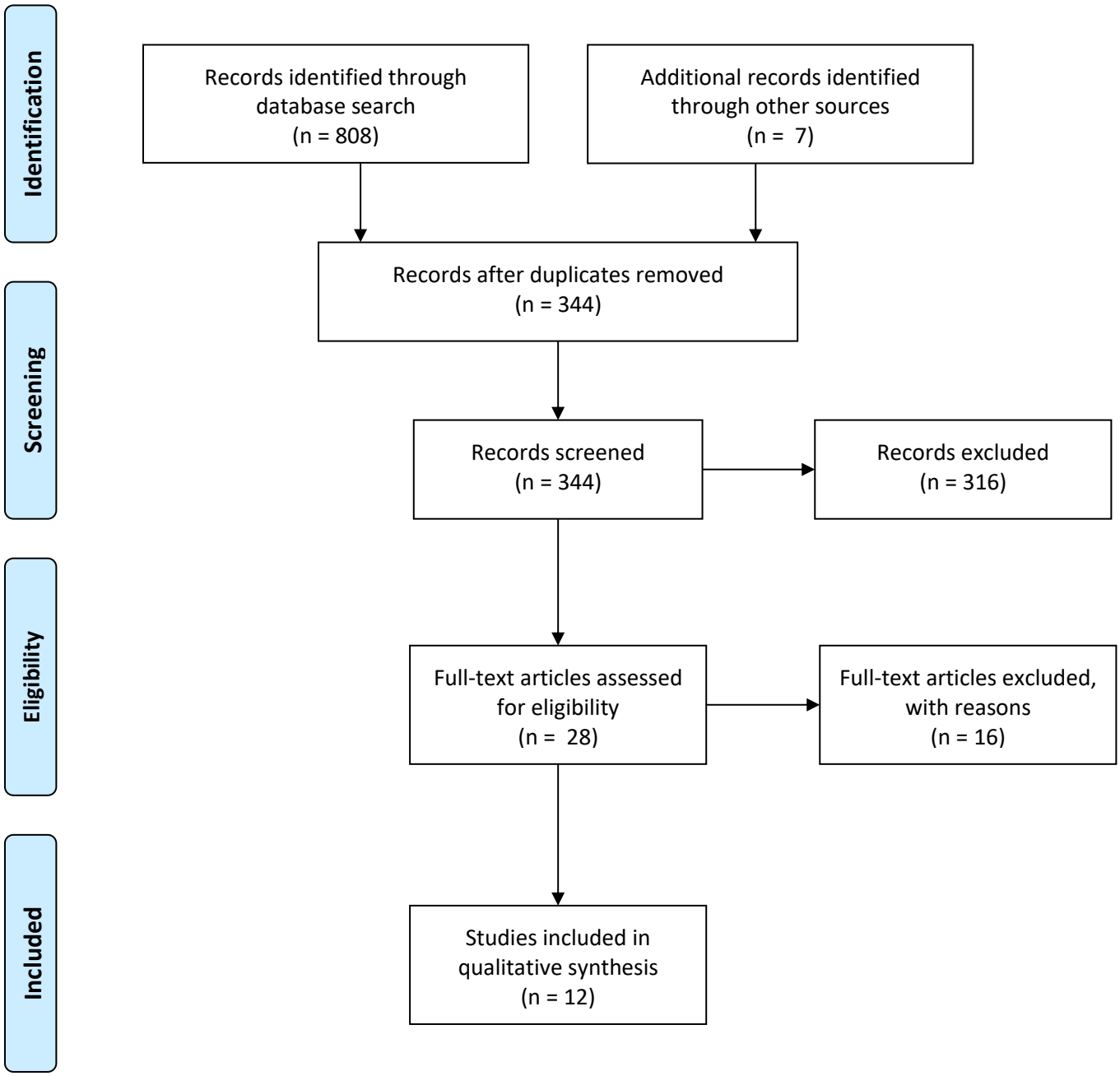
Fig. 1 PRISMA flow diagram of study selection process



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4-5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	7
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8-9
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Table 2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	15-16
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	17

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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Study	Journal	Country	SLT subtype	Design	N	Population	Age	male (%)	HWL exposure	HWL format	HWL content	Control	Relevant measures	Main findings	Quality notes
Brubaker & Mitby, 1990	Addict Behav	USA	Chewing tobacco and oral snuff	Experimental	192	Students, not regular SLT users	14 - 18 (M = 15.68)	44.8	Exposure	Text	Health warning, relative risk	Product with no warning	Willingness to try, recall	43.4 % recalled seeing a warning, and 32.2 % of these remembered the content. Recall was unrelated to content of the label. Warnings had no effect on likelihood of future use.	Lacks illustrative example of SLT product used in the study. Measure of previous experience with SLT not defined. Source of funding not reported.
Health Canada Tobacco Control Programme, 2003	Gov. report	Canada	Chewing tobacco, nasal and oral snuff	Focus group	22	SLT users	16-60	91	Self-report and exposure	Text	Health warning, relative risk	N/A	Recall, approval, personal impact	Low recall and personal impact of HWLs. General approval of HWLs, but for others.	Source of funding not reported.
Oswal et al, 2011	Asian Pacific J Cancer Prev	India	N/A	Focus group and field survey	615	All adults	18+	N/A	Self-report and exposure	Symbolic "scorpion" or graphic w/text	Health warning	N/A	Notice HWLs, message communicated through HWL, need for having HWLs and in which format.	Pictures were preferred to text HWL, but it must be clear and representative. Pictorial HWL were noticed more often among all educational levels. Most people chose mouth cancer as the most informative pictorial HWL. The scorpion was often misunderstood.	Lacks N for focus groups. Source of funding not reported.
Callery et al, 2011	Nicotine Tob Res	Canada	Snus, snuff and tablet	Experimental	611	Cigarette smokers	18 - 30 (M = 24.8)	46.5	Exposure	Text or graphic w/text	Health warning, relative risk	Product with no warning	Appeal, likelihood of future use, willingness to try SLT, relative health risk beliefs	Graphic HWLs increased false RR beliefs, and reduced appeal, likelihood of future use and willingness to try. RR HWL had no effect on appeal or willingness to try (exc. as cessation aid), but increased correct RR beliefs and	No remarks.
Johnson et al, 2014	AM J Prev Med	USA	Chewing tobacco, snuff, dip and snus	Cross-sectional	23 817	Middle and high school students	N/A	N/A	Self-report	Text	Health warning, relative risk	N/A	Current use of SLT, exposure and response to warning labels, perception of product harm	Users reported higher exposure to HWLs than non-users (66.6 % vs 34.7 %), but they also responded less to HWLs (13.4 % vs 28 %) and perceived lower harmfulness from SLT use. Females generally perceived greater	No remarks.
Adkison et al, 2014	Harm Reduct J	USA	Snus, snuff, strips and pellets	Cross-sectional with intervention	1000	All	14 - 65	49.9	Exposure	Text or graphic w/text	Health warning	N/A	Risk perception, appeal, attractiveness, want to be seen using	Graphic HWLs made more people consider health risks, attracted most attention and was chosen as least attractive to a user. Text HWLs were chosen as most appealing to peers and the type one would want to be seen using	No remarks.
Portnoy et al, 2014	AM J Prev Med	USA	Chewing tobacco, snuff and dip	Cross-sectional	15,484	Never-users, middle and high school students	N/A	46.7	Self-report	N/A	N/A	N/A	Curiosity about SLT, past 30 days exposure to health warnings on SLT products	Exposure to HWLs the past 30 days was not associated with being curious about SLT products.	Measure of exposure to HWLs not fully written out.
Majmudar et al, 2015	Indian J Med Paediatr Oncol	India	Chewing tobacco, betel leaves or masheri	Cross-sectional with intervention	279	Female SLT-users, low socioeconomic status	N/A	0	Self-report	Text or symbolic "scorpio"	Health warning	N/A	Notice HWLs	More women reported noticing pictorial warnings post-intervention.	Measures not written out.
Mutti et al, 2015	Tob Control	India and Bangladesh	General SLT	Cross-sectional with intervention	2083	Youth and adults	16 - 80 (M = 37.3)	52.2	Exposure	Text or graphic w/text	Three pictorial versions: Graphic, symbolic and testimonial	N/A	Risk perception, prevent usage, encourage quitting, effect assessment	Both youth and adults perceived pictorial HWLs as more effective than text only, and pure graphic HWLs more so than symbolic and testimonial ones.	No remarks.
Rodu et al, 2016	Nicotine Tob Res	USA	Snus	Cross-sectional with intervention	12 553	All	18 - 45+	57	Exposure	Text	Health warning, relative risk	N/A	Believability, harmfulness, motivation to use, intention to buy	Current HWLs more believable than RR HWLs. Users reported higher likelihood to buy and use snus from RR HWLs, and triers/nonusers reported higher motivation to buy snus.	Sponsored by Swedish Match.
Agaku et al, 2016	Prev Med	USA	Chewing tobacco, snuff, dip, snus or dissolvable tobacco products.	Cross-sectional	1626	Past 30-days SLT users	18 - 65+	93.7	Self-report	Text	Health warning, relative risk	N/A	Thinking about health risks, stopped use because of warning, perception of harmfulness and addictiveness	77.5 % reported exposure to warning. Of these 73.9 % reported thinking of health risks, and 17.1 % had stopped using SLT at more than one occasion. Exposure was associated with perceived harmfulness but not addictiveness.	Source of funding not reported.
Gravely et al, 2016	BMC Public Health	India	Chewing tobacco, areca nut, gutka, betel quid, dry snuff, paste or toothpowder.	Cross-sectional, pre and post HWL policy change from symbolic to	4733	SLT-users	15 - 55+ (M = 41.8)	56.3	Self-report	Symbolic "scorpion" and graphic w/text	Health warning	N/A	Awareness, HWL salience, cognitive and behavioral reactions	No differences on any outcome measures from pre- to post-policy for the total sample. SLT quitters were more often aware that SLT packages had HWLs post-policy.	No remarks.

Paper 2

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RESEARCH ARTICLE Open Access

Textual health warning labels on snus (Swedish moist snuff): do they affect risk perception?

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Abstract

Background: To strengthen the risk message on snus warning labels, the European Union in 2016 removed *"can"* from the warning *"This tobacco product (can) damages your health and is addictive."* We tested how these and other textual warnings affect risk perception.

Methods: Snus-using and non-using Norwegians aged 16–72 participated in two online survey experiments. Participants in Study 1 ($N = 196$) were randomized to read one of four warning labels. Outcome variables included ratings of likelihood of health damage from snus and perceived severity of such damages. Study 2 ($N = 423$) used similar outcome measures but added a baseline measure allowing for a pre-post comparison, as well as a control group receiving no warning label. Data were analysed using ANOVA and non-parametric tests.

Results: Study 1 indicated that removing *"can"* from the EU warning increased long-term risk perception, but adding *"causes cancer"* had no effect on risk perception. In Study 2, risk perception increased from pre to post, regardless of label manipulation. *"Causes cancer"* and *"damages your health"* were indicated as most alarming when participants compared and ranked all warnings.

Conclusions: Adding *"causes cancer"* or removing *"can"* from *"damages your health"* did not strengthen short-time (1 year) risk perception, but the latter increased long-term (10 years) risk perception in Study 1. In the pre-post design in Study 2, risk perception increased regardless of warning label.

Keywords: Smokeless tobacco, Swedish moist snuff, Snus, Warning labels, Risk perception, Tobacco control

Background

The use of snus (a moist oral smokeless tobacco product) has been increasing in Norway, especially among young people aged 16–24. The number of daily and occasional young users increased from 9% of males and 2% of females in 2003 to 33% and 23% in 2013 [1], an increase considered as "almost an epidemic" by the Norwegian Institute of Public Health [1]. This report concluded that snus is associated with several health risks, such as lesions of the oral cavity, adverse pregnancy outcomes, and some forms of cancer. Although snus is considered as less harmful compared to smoking [2], the risks associated with snus use should be communicated to users and potential new users. One way of informing the public is by the use of product warning labels.

Whereas the effect of warning labels for smoked tobacco has been thoroughly researched, comparable studies on smokeless tobacco (SLT) are scarce [3]. The literature for snus specifically is even more limited. Hence, the present summary includes SLT labels in general, and implications for snus warnings should be interpreted carefully, as health risks from snus differ from other SLT products. Mere *textual warnings* seem to be noticed and remembered, but their effect on intentions to use SLT is small [4]. In this study, around 40% of the adolescents exposed to textual warnings recalled seeing a warning label, and of these one in three remembered the content of the warning. Males remembered the warnings somewhat better than females, which is reasonable as males tried or purchased such products

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more frequently than women did. However, remembering warnings did not reduce future intentions of using SLT. MacKinnon and Fenaughty [5] found that heavy SLT users remembered written warnings better than non-users, possibly due to repeated exposure. In a 2016 study [6], about four in five users remembered exposure to textual warning labels, and recall was closely associated with self-reported thoughts about health risks and perceived harmfulness of SLT. Still, less than one in five said warning labels had stopped them from using SLT on some occasion.

In comparison, *graphical warnings* seem to have a greater effect in capturing attention and motivating smokers to quit [7]. One study [8] found that pictorial versions evoked more concerns about health risks compared to mere textual ones, and pictorial versions were judged as least attractive to SLT users whereas textual warnings were seen as more appealing for peers (i.e., the kind of package a peer would want to be seen using). In contrast, another study found no increase in risk perception in a sample of non-users who were shown graphic cancer warnings on snus products [9]. It is worth noting that the baseline risk perception in this sample was high, possibly preventing a further increase (ceiling effect).

Whereas graphical warning labels are mandatory for smoked tobacco in the European Union (EU), the requirement for snus products is limited to textual warnings. In 2003, EU removed the warning "*causes cancer*" [10] from snus products, and replaced it with the more general warning: "*This tobacco product can damage your health and is addictive*" [11]. It can be assumed that the previous "*causes cancer*" warning was more alarming than the more general claim "*damages your health,*" but to our knowledge there is no evidence supporting this expectation. In May 2016 the warning message was strengthened by removing the modal verb "*can*" [12], following an EU-directive adopted in 2014 [13].

Whereas the EU-expectation of a strengthened risk message by removing *can* gained support in focus group interviews among SLT users [14], the effect of removing *can* may be more complex. Specifically, Teigen and Filkuková [15] found that statements including *can* were associated with an outcome being possible, but uncertain, whereas *will*-statements were perceived as referring to more probable or certain outcomes. Moreover, *can* evoked expectations of high magnitude effects, whereas *will* denoted low to medium effects [15]. According to this line of reasoning, removing *can* might reduce severity perceptions but increase expected likelihood of health damage from snus.

In light of these findings, we examined risk perception from snus warning labels in Norway. Although the verbs *can* and *will* are frequently used on warning labels, we could not identify any studies comparing possible effects of this difference. As the EU changed these particular verbs on snus warnings in 2016, it is of interest to examine whether they differentially affect risk perception. Specifically, we examined the following hypotheses:

H1: In line with the EU-directive 2014/40/EU, removing *can* from *damages your health* will strengthen the risk message.
H2: Removing *can* from *damages your health* should decrease severity expectations, but increase likelihood perception, in line with Teigen and Filkuková [15].
H3: As the *can*/*will* labels target general health only, a warning explicitly stating that snus *will* severely damage health and *cause cancer* (i.e., the EU warning before 2003) should generate stronger risk expectation than either of the other labels.

Risk perception from textual warning labels on snus products was tested in two separate studies. In Study 1, participants read one of four warning labels and then responded to risk perception measures. Study 2 added a baseline for outcome measures, a control group seeing a snus product with no warning, and an expert panel responding to the same measures. As most of the warning labels also include an assertion about ease of addiction (see Table 1), we added a rating related to ease of addiction. Both studies were conducted before the modal verb *can* was removed from the snus warning message "*This tobacco product (can) damage your health and is addictive*" [13].

Study 1

Participants

The total sample was 196 participants (151 female, 6 did not indicate gender), age 16–64 years ($M = 34.14$, $SD = 10.70$). Participants were recruited through snowballing in social media (www.facebook.com), January 2016. All completed an online questionnaire (www.qualtrics.com) following electronic informed consent. Participants not understanding Norwegian language or being < 16 years of age were excluded. There were no incentives for participation.

Materials and procedure

Participants were randomly assigned to read one of four warning labels on a brand-neutral snus product, thus making the text scenario realistic. Figure 1 presents an example,[1] and Table 1 summarizes the textual warnings. The questionnaire then asked about expected severity of health damages following use of snus, likelihood for such health damages after one and ten years, and perceived ease of addiction. Demographic data and self-reported use of snus were also collected.

Table 1 Textual content of warning labels

EU implementation	Abbr.	Warning label
1. ➔ 2003	Cancer	"This tobacco product severely damages your health. Causes cancer."
2. Not applied	Can-can	"This tobacco product can damage your health and be addictive."
3. 2003–2016	Can-is	"This tobacco product can damage your health and is addictive."
4. 2016 ➔	Will-is	"This tobacco product damages your health and is addictive."

The experiment was exempt from evaluation by the Regional Committee for Medical Research Ethics, as advised by an Ethics committee member. We followed guidelines from the Data Protection Official for Research [16]. All information was recorded anonymously. A debrief explained which manipulations participants had been given, and which warning label that is applied today. Resources to official guidelines about snus and health risks were made available.

Outcome measures

Perceived severity of health damage associated with the text message was assessed with the question: 'In your opinion, how severe are the health damages referred to on the warning label?' (7-point scale, 1-'very small' to 7-'very serious'). Perceived likelihood of health damage following 1 and 10 years of snus usage was measured as: 'Of 100 persons using snus regularly for 1 (10) years – how many do you think are victim to such health damages?' (7 ordinal categories, 0–5, 6–10, 11–15, 16–20, 21–25, 26–30, > 30). Expectations of addiction were assessed by the following question: 'In your opinion, how many weeks does it take to become addicted to snus?' (7 ordinal categories, 0–5, 6–10, 11–15, 16–20, 21–25, 26–30, > 30).

Fig. 1 Example of snus product with a textual warning label[1]. 'Løssnus' means loose snus (non-pouched)

Demographic variables were gender, age, level of education, and snus habits (never, quit or discontinued or former, tried but no regular use, sometimes, regular use).

Statistical analyses

For H1 and H3, *severity* and *likelihood of health damage* were averaged to *Risk1* (short term) and *Risk10* (long term) risk perception [9]. The hypotheses were tested by planned comparisons [17] given the specific predictions. For H2, as the severity estimates did not satisfy the normality requirement, the predicted differences between the three outcome measures *severity*, *likelihood at 1 year*, and *10 years* were assessed using a Mann-Whitney U test. First, we checked whether gender, age, snus use, and addiction beliefs affected our outcome measures through a repeated measures ANOVA with label as between-group factor, and Risk1 and 10 as within-group factor. IBM SPSS version 23 was used for all analyses. The statistical power of an ANOVA with four groups (n's = 55, 47, 44, and 49) was 85% (given $p = .05$) to detect an effect size of 0.255 (based on group means 4, 4, 4, and 5 yielding a between-groups SD of .43, divided by their common within-group SD of 1.70).

Results

Descriptive statistics are presented in Table 2. There were no significant differences in demographics (age, gender, education, snus use) between experimental conditions. The ANOVA indicated no gender differences ($M_{Females} = 4.40$ vs. $M_{Males} = 3.80$), $F(1, 178) = 2.703$, $p = .102$, partial $\eta^2 = .015$, but snus-users rated risks significantly lower than non-users ($M_{Users} = 3.7$ vs. $M_{Non\text{-}users} = 4.55$), $F(1, 178) = 6.868$, $p = .010$, partial $\eta^2 = .037$. Risk increased along with age, in both short- ($r(188) = .24$, $p = .001$) and long-term ($r(186) = .15$, $p = .042$), and with estimates of ease of addiction, ($r(188) = .16$, $p = .025$).

H1: EU can vs. will

To test the EU expectation that removing *can* from *damages your health* increases risk perception, we compared the outcome measures *Risk 1* and *10* for the two combined *can* labels (2 and 3 in Table 1) vs. *will* (4 in Table 1). For *Risk 1*, a contrast analysis of the mean scores between these labels did not indicate a significant difference ($M_{Can} = 3.75$ vs. $M_{Will} = 4.00$), $t(192) = -1.058$, $p = .291$. The corresponding contrast for *Risk10* scores

Table 2 Study 1: Demographics for participants in each experimental condition. The textual content of warning labels is described in Table 2

Demographic	Cancer (*N* = 55)	Can-can (*N* = 47)	Can-is (*N* = 45)	Will-is (*N* = 49)
Age Mean (SD)	33.40 (9.69)	33.41 (9.51)	34.26 (11.04)	35.22 (12.71)
Gender				
Female	44	40	30	37
Male	9	6	14	10
Missing	2	1	1	2
Education				
High school or less	12	14	11	14
Some college	10	7	15	7
Bachelor's degree or more	31	24	17	25
Other		1	1	1
Missing	2	1	1	2
Snus habits				
Never	22	21	18	24
Tried or quit	11	12	12	8
Sometimes or regularly	20	13	14	15
Missing	2	1	1	2

Note. SD Standard Deviation

demonstrated higher scores for *will* compared to *can* (M_{Can} = 4.37 vs. M_{Will} = 4.94), $t(190) = -2.135$, $p = .034$. These results thus partly supported the EU hypothesis, as removing *can* was associated with a higher risk perception estimates in the long-term (10 years) but not in the short-term (1 year).

H2: Complex can vs. will

This hypothesis states that *can* labels evoke expectations of higher severity and lower likelihood, whereas a reversed pattern is expected for *will*. To test this, we conducted a non-parametric Mann-Whitney U test for non-normally distributed data, with combined *can* vs. *will* labels as conditions (see above). Neither *severity* (U = 2635, $z = 1.678$, $p = .093$), *likelihood 1* ($U = 2424$, $z = .752$, $p = .452$) or *10 years* ($U = 2606$, $z = 1.899$, $p = .058$) were significantly different over the conditions.The mean and median ranks are shown in Table 3. Hence, these results did not support H2.

H3: Cancer vs. general health

To test the expectation that an explicit cancer warning is more alarming than the general health versions, we compared the outcome measures *Risk 1* and *10* for the *causes cancer* label (1 in Table 1) vs. *general health* (all other labels). For *Risk 1* and *Risk 10*, contrast analyses of

Table 3 Study 1: Risk perception between *can* and *will* labels

	Severity	Likelihood 1 year	Likelihood 10 years
Can			
Mean (SD)	4.37 (1.57)	3.14 (2.13)	4.37 (1.99)
Median (IQR)	4 (2)	2 (4)	4 (3)
Will			
Mean (SD)	4.82 (1.62)	3.24 (1.89)	5.06 (1.67)
Median (IQR)	5 (2)	3 (3)	5 (3)

Note. SD Standard Deviation. *IQR* Interquartile Range
Measured on 7-point scales ascending from (1) 'Very small' to (7) 'Very high' for *severity*, and 0–5, 6–10, 11–15, 16–20, 21–25, 26–30, > 30 victims to health damage for *likelihood*

the mean scores between these conditions did not indicate significant differences, *Risk 1* (M_{Cancer} = 4.03 vs. M_{Health} 3.84), $t(192) = -.770$, $p = .442$, and *Risk 10* (M_{Cancer} = 4.8 vs. M_{Health} = 4.56), $t(190) = -1.049$, $p = .295$, respectively. Hence, these results do not support H3.

In sum, the present data did not support the idea that *can* vs. *will* labels affect likelihood or severity perceptions differentially [15], nor that adding *causes cancer* has a stronger effect than general health warnings. However, the results render some support to the EU idea that removing *can* increases risk perception, but only for long-term estimates.

Study 2

Study 2 added a pre-measure of the outcome variables, increasing the possibility of identifying changes in risk perception levels caused by warning labels. In Study 2 we focused on H1 (removing *can* from *damages your health* strengthens the risk message), and H3 (snus *will* severely damage health and *cause cancer* generates stronger risk expectation than either of the other labels). Also, we added a control group that read the label "Snus" without any warning to examine the effect of repeated risk assessments per se. Eight experts from the tobacco group in the Norwegian Directorate of Health also answered the pre-questionnaire without the warning manipulation, serving as an expert panel for comparison with laymen's risk perception.

In contrast to Study 1, Study 2 asked participants to rate a number of specific short and long time health hazards following the general risk measures. These estimates can function both as testing knowledge of hazards from snus use, but also as a primer actively reminding participants of possible health hazards. A likely effect of this procedure is that participants demonstrate an overall increased risk perception at post-test. Importantly, if warning labels serve their purpose, their effect should be enhanced by this procedure.

Recruitment procedure, data collection, exclusion criteria, ethical considerations and debriefing were identical to Study 1. No compensation for participation was

offered. Participants were recruited through the official Facebook profile of the Department of Psychology, UiT The Arctic University of Norway ($n = 78$), slutta.no, a site for people intending to quit using smoke or snus ($n = 85$), snowballing on the Facebook profile ($n = 220$), and through an internet learning platform for two local high schools ($n = 123$) in February 2016. Eight tobacco experts at the Norwegian Directorate for Health also answered the pre-questionnaire.

Data collection started with a baseline measure of risk perception from snus, both for general health and cancer risk. Next, participants were randomized to read one of five warning labels (four being the same as in Study 1, plus a control group). Following presentation of the labels, participants responded to the same questions as in the baseline.

Participants

A total of 515 respondents started the survey, 423[2] completed it_2. Table 4 presents descriptive statistics for the participants who completed the $survey_3$. One respondent reported max values on all measures and was excluded from the analyses.

Outcome measures

General health was operationalized as 'In your opinion, how harmful is snus to general health?', and *cancer* as 'In your opinion, to what extent does snus cause cancer?' Both were answered on a 9-point scale ranging from 'not at all' to 'extremely', and were averaged into a common variable named *Risk perception* corresponding to Popova and Ling [9]. *Specific health hazards 1 year (short-term)* and *30 years (long-term)* listed twelve health hazards from snus use (oral cavity, gaining weight, obesity, diabetes, pregnancy complications, increased heart rate and blood pressure, increased risk of dying from stroke and cardiac arrest, and for developing oral, oesophagus or pancreas cancer). All hazards were extracted from a national report on actual hazards from snus [1]. Estimates were given on a rating scale to the statement "I believe short-term/long-term regular snus use may lead to (12 hazards)" (1: 'not at all'; 5: 'extremely'). Finally, participants were presented with all four warning labels and asked to rate which one was the most alarming. *Demographic questions* were identical to Study 1. Snus use were coded into 1) non-users: never tried, quit, tried but no regular use, and 2) users: sometimes, regular but trying to quit, and regular users.

Design and statistical analyses

Initial analyses were performed to assess the effect on *risk perception* of gender, age, snus use and addiction beliefs. Next, ANOVAs[3] were used to test planned comparisons [17].When testing H1 and H3, the between-subjects factor was the five different warning labels with *time* as the within-subject (pre-post) factor. The statistical power of a repeated ANOVA with five groups (n's = 73, 100, 82, 64 and 104) was 17% (given $p = .05$ and pre-post $r = .71$) to detect an effect size of 0.068 (given pre-test means 5.68, 5.90, 5.96, 5.

Table 4 Study 2: Demographics for participants in each experimental condition

Demographic	Control ($N = 104$)	Cancer ($N = 64$)	Can-can ($N = 73$)	Can-is ($N = 100$)	Will-is ($N = 82$)
Age Mean (SD)	33.65 (12.41)	30.42 (12.70)	31.28 (12.98)	34.15 (14.13)	34.05 (12.42)
Gender					
Female	48	35	34	47	35
Male	18	14	20	27	24
Missing	66	15	19	26	23
Education					
High school or less	14	19	16	23	19
Some college	8	10	7	9	9
Bachelor's degree or higher	41	16	25	37	31
Other	3	3	4	5	1
Missing	38	16	21	26	22
Snus habits					
Never	25	18	25	38	26
Tried or quit	16	12	11	9	15
Sometimes or regularly	25	18	18	27	18
Missing	38	16	19	26	23

Note. SD Standard Deviation

89, 5.89 and post-test means 5.72, 6.22, 5.97, 6.03, 6.03 yielding a between group SD = 0.13 divided by their common within-group SD of 1.84).

Results

The overall ANOVA indicated that females regarded snus use as more risky than males ($M_{Females}$ = 6.5 vs. M_{Males} = 4.9), $F(1, 277) = 33.426$, $p = .000$, partial $\eta^2 = .108$, and snus-users regarded snus as less risky compared to non-users (M_{Users} = 4.5 vs. $M_{Non\text{-}users}$ = 6.8), $F(1, 277) = 84.030$, $p = .000$, partial $\eta^2 = .233$. Also, risk perception tended to increase with increasing age, $r(299) = .17$, $p = .004$ and with estimates of ease of addiction, $r(422) = .29$, $p = .000$. As none of these factors interacted significantly with the outcome measures or with label manipulations, they were not included in the analyses reported below.

H1: EU can vs. will

The ANOVA demonstrated a significant main effect of time on *Risk perception*, increasing from pre to post, (M_{Pre} = 5.87 vs. M_{Post} = 7.13), $F(1, 418) = 391.46$, $p = .000$, partial $\eta^2 = .484$. Levels of risk perception are presented in Table 5. H1, that the *will* label affects risk perception more than the combined *can* labels, was not supported by a contrast analysis of post measures, (M_{Can} = 6.00 vs. M_{Will} = 6.03), $F(1, 418) = .751$, $p = .387$.

H3: Cancer vs. general health

Similarly, H3 (*causes cancer* generates higher risk estimates compared to the other labels combined), was not supported, (M_{Cancer} = 6.22 vs. M_{Others} = 6.01), $F(1, 418) = 1.101$, $p = .315$. An overall comparison between all warning labels vs. no warning (control group) indicated no difference, (M_{Others} = 6.06 vs. $M_{Control}$ = 5.72), $F(1, 418) = 0.004$, $p = .947$.

When presented all warning labels simultaneously, a majority chose the *causes cancer* warning as most alarming (73%), followed by the *will* warning (17%). Other warnings were < 2%.

Table 5 Study 2: Mean (SD) for general risk perception before and after seeing warning labels. Measured on 9-point scales ascending from (1) 'Not at all' to (9) 'Extremely'

	Pre	Post
Expert panel	3.38 (1.03)	–
Control	5.68 (1.93)	5.72 (2.05)
Causes cancer	5.90 (2.21)	6.22 (2.24)
Can-can	5.96 (2.11)	5.97 (2.21)
Can-is	5.89 (1.91)	6.03 (1.99)
Will-is	5.89 (1.96)	6.03 (2.15)

Note. SD Standard Deviation

Laymen vs. experts

At baseline, experts perceived the general risk as lower than participants, ($M_{Experts}$ = 3.38 vs. M_{Laymen} = 5.86), $F(1, 428) = 12.178$, $p = .001$, partial $\eta^2 = .028$.

Specific health hazards

The baseline sum score of specific health hazards were significantly lower for short-time vs. long-time ratings of snus use, (M_{Short} = 33.12 vs. M_{Long} = 41.10), $F(1, 419) = 476.80$, $p = .000$. The correlation between *Risk perception* and the summed hazards ranged between r = .57–.62, indicating that 62–68% of the variance in risk estimates are determined by other factors than perceived health hazards from snus. The tendency was more pronounced among snus-users than non-users, r_{Users} = .76–.81 vs. $r_{Non\text{-}users}$ = .58–.63.

Discussion

Two experiments examined risk perception from textual snus warning labels among Norwegian respondents. In Study 1, the new EU-warning (*damages your health*) tended to induce higher long-term (10 years) risk perceptions compared to the former warning moderated by *can*, but these labels did not differ in short-time (1 year) risk estimates. A hypothesis that *can* warnings are associated with more extreme risk perception whereas *will* warnings trigger less serious and more common damages was not supported, neither was the assumption that *causes cancer* generates higher risk perception compared to general health warnings. In Study 2, different text labels did not demonstrate any effect on outcome measures, as risk perception increased similarly over all conditions. In the simultaneous rating of all labels, *will* was perceived as more alarming than *can*. In sum, apart from the fact that these results render some support to the EU's expectation that removing *can* enhances long-term risk estimates, the effects of textual warnings seem to be negligible.

If the strengthened EU label affects long-term risk perception only, its effect on prevention of snus use among young people may be questioned. The fact that the studies reported here do not demonstrate effects of warning labels in short-time risk estimates, indicates that textual warnings do not affect the main target population well. Focusing on short-time negative consequences rather than serious, long-time consequences might be expected to work more effectively in prevention. From this perspective it is of interest that reading a list of specific and concrete health hazards associated with snus use (Study 2) increased risk estimates significantly. This result indicates that a focus on specific hazards may activate increased awareness about those hazards, which in turn increases risk perception.

The fact that increased risk perception occurred without any differential effects of textual labels in Study 2 may indicate that the repeated hazard estimation questions masked the textual warning manipulations. However, we believe that repeated hazard questions effectively worked as a priming procedure, activating possible negative consequences of snus use and thereby enhancing potential effects of textual warnings. As differential effects of textual warning messages did not appear, we interpret this as even stronger evidence that textual warnings do not affect risk perception. This conclusion agrees with the findings by Popova and Ling [9], who found that snus warning labels, even graphic warnings, did not increase risk perception in non-smokers. As they found positive effects of labels for moist snuff and e-cigarettes, it may be asked if snus warning messages at all affect risk perception.

The tendency for users to rate harmfulness of risks as lower than non-users agrees with the findings of Øverland et al. [18]. They also reported that 41% of Norwegian adolescents rated the harmfulness of snus as equal to or higher compared to cigarettes. This agrees with the fact that our expert panel rated most health risks as lower than the laymen, especially compared to non-users. One explanation for this difference may be that experts are viewing risk in a public health perspective, whereas laymen operate with a personal reference perspective.

Limitations

The results of Study 2 must be interpreted with some caution, as the statistical power was very low. Given the very small effect size, we cannot expect that increasing the sample size would make much difference as the effect of this intervention would still be minor.

Participants were recruited from social media through e.g. interest groups such as quit intenders, and from high school students. This implies that our sample may be different from the general population, and results should be interpreted with this limitation in mind. Also, the same argument goes for the limited 8-member expert panel, as they may not be representative of all tobacco experts.

A study including risks from other, comparison topics (e.g. smoking, driving, eating chocolate) would have served to place risk ratings of snus usage in perspective. Still, participants in our studies apparently agreed on the risks from snus when judged in isolation. Further, the study could have measured behavioural outcome as well, such as intentions to use or quit snus. Our study only measured risk perception directly after having read a warning label, and did not examine how the different labels might have affected risk perception over time.

Conclusions

Study 1 found that removing the modal verb *can* from *damages your health* in snus warning labels may affect long-term risk perception, but no heightened risk perception from *causes cancer*. Study 2 did not reveal any differences between labels, but risk perception increased in all conditions, probably due to answering the specific hazard ratings.

Endnotes

[1]Photo of snus product: Rebecca Ravneberg, Norwegian Directorate for Health. The textual warning message on the product is altered across experimental conditions.

[2]The sample size for post general risk outcome measures were 423. However, the sample size decreased to 252 for the post specific hazards measures. As descriptive measures were collected at the end of the questionnaire, the sample characteristics only describes those who finished the survey.

[3]The randomization worked well as the demographics and pre-test outcome variables $F(1, 515) = .730$, $p = .572$, partial $\eta^2 = .006$ showed no significant differences between the groups. Dropouts did not differ in general risk perception pre-manipulation, compared to those who completed the survey, as shown in a one-way ANOVA with completion/non-completion as predictor $F(1, 515) = 1.901$, $p = .169$, partial $\eta^2 = .004$.

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Availability of data and materials

The two datasets are published alongside the article.

Author's contributions

All authors were involved in designing the studies. CVN and FS carried out the main analyses, in compliance with OF and KHT. All authors contributed to the writing, revision and approval of the final manuscript.

Ethics approval and consent to participate

The experiments were exempt from the Regional Committee for Medical Research Ethics, as advised by a Committee member. We followed ethical guidelines from the Data Protection Official for Research [17]. Participants gave their consent by clicking the survey link after reading about the purpose of the project, anonymized data collection, and voluntary participation.

Competing interests

The authors declare that they have no competing interests.

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Paper 3

Health warning labels describing snus as less harmful than smoking: Effects on perceptions of risk

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Abstract

Background

Using snus (Swedish moist snuff) is less harmful than smoking, but health warning labels (HWLs) on snus products usually do not reflect this relation. There are few studies on effects of comparative risk information in snus warning labels, and some scientists and politicians are concerned that such a focus may increase snus use among non-tobacco users. The purpose of this experiment is to examine whether risk perceptions differ after exposure to non-comparative vs. comparative risk information in snus warning labels.

Methods

A total of 254 Norwegians aged 19-69 were randomly allocated to one of four HWL conditions: non-comparative EU-based ("*Snus is damaging to your health*"), Control (the text "*Snus*" only), General Relative Risk ("*Snus is less damaging to your health than smoking*") or Percentage Relative Risk ("*Snus is 90% less damaging to your health than smoking*"). The two latter comparative HWLs were based on expert opinions. Perceptions of risk from snus use and smoking were measured before (pre) and during (post) exposure to the HWL. Changes from pre- to post in 1) perceptions of risk from snus use alone, and 2) perceptions of relative risk from snus use versus smoking, were tested in repeated measures ANOVAs, with current snus and cigarette use as covariates.

Results

Both the perceived risks from snus use and its perceived relative risk to smoking decreased more in the Control and the Percentage HWL condition than in the EU-based HWL condition. When comparing the General Relative Risk and the EU-based HWL, a similar difference was found for the relative perceived risk, but not for the separate measure of snus risk. Both the

snus risk and relative risk perception decreased more for the Percentage than for the General Relative Risk HWL.

Conclusions

The non-comparative EU-based HWL claiming that "*Snus is health damaging*" maintains a high level of perceived risk from snus use, while no HWL and the suggested comparative HWLs adjust perceptions of risk more in line with expert opinions. An HWL describing snus as 90% less harmful than smoking was particularly effective.

Keywords: Snus, smoking, health warning labels, comparative information, relative risk

Background

Snus (Swedish moist snuff) is sometimes proposed as a tobacco harm reduction product. One expert panel estimated that using snus reduces the relative risk of total mortality by 90% compared to smoking cigarettes (1). Still, using snus is addictive and some studies find snus use to be associated with health risks such as cancer (2), adverse pregnancy outcomes, diabetes type 2, and oral health damages (3). Proposing snus as a harm reduced alternative is therefore debated (4). Some emphasize its potential as a smoking cessation aid (5), while others question whether snus actually facilitates smoking cessation and raise a concern about the growing snus consumption in young non-smokers (6).

In Norway, where smoking in public places has been prohibited since 2013 (7), the number of daily snus users exceeded the number of daily smokers in 2017 (8). People under 34 years old make up the largest group of snus users both for men (ca 30%) and women (ca 10%). One study of male Norwegian snus users found that the number of snus users deriving from never smokers increased from 16 to 25% in the years 2003-2015, while the largest proportion of users were former or current smokers (9). This finding may indicate some support to the concern (4, 10) that some of the new snus users derive from never smokers who might never have started smoking in the first place.

When estimating the relative risks from snus and cigarettes, the public tends to exaggerate risks from snus compared to expert opinions. For example, in an observational study over 16 years on risk perception of snus and cigarette smoking among Norwegians (16-79 years old), daily use of cigarettes were rated as 6.48 on a scale where 7 was "*very harmful*," whereas daily use of snus scored 5.14 (11). The estimates were stable for the whole period. In contrast,

the expert panel in the study by Levy et al. concluded that the total mortality of snus was around 5 – 10% of the risks from smoking (1).

Using health warning labels (HWLs) on product packaging is one strategy for increasing risk perception in users and potential users. HWLs are a part of the tobacco control measures described in the World Health Organizations Framework Convention on Tobacco Control (12), was developed to reduce the harms from tobacco. Cigarette packages are subject to stronger regulations compared to smokeless tobacco products (SLT), (e.g., to carry larger, graphic HWLs), which may reduce initiation and increase smoking cessation more than textual HWLs (13, 14). Tobacco regulations for SLT products typically include smaller, textual warnings (15), such as the current European Union (EU) snus HWL: "*This tobacco product damages your health and is addictive"* (16). Note, however, that the sale of snus is prohibited in the EU, with the exception of the EU-member Sweden and the non-EU member Norway through the European Economic Area Agreement (17).

Given the smaller risk from SLT compared to cigarettes and their potential as an alternative to smoking, some argue that product information should reflect the relative risk (18). Tobacco alternatives such as snus may be perceived as more favorable when compared to cigarettes than when presented alone because cigarettes are a product that most people know is very harmful (19). Therefore, health information about the comparative risks from tobacco products should be science-based and carefully designed to convey a realistic risk message (20). However, there are few studies addressing this topic, and we need a better understanding of how such comparisons between products affect risk perception and behavior (19, 21, 22).

To our knowledge, only four studies have exposed participants to HWLs that compare risks from SLT (e-cigarettes excluded) and cigarettes, such as: "*This product is not a safe alternative to cigarettes*". Messages comparing risks are referred to as «health warning labels» because of the shared format with standard HWLs, although the information strictly speaking concerns reduced risks. For example, in a study on perception of textual HWLs among American high school students who were not regular SLT users, the HWLs tested, including the relative risk HWL "*not a safe alternative*", did not affect intentions to use SLT in the future (23). This particular HWL was consistently perceived as confusing and uninformative in interviews with Canadian consumers of SLT, cigars, and pipe products (24). Young Canadian smokers exposed to the HWL "*Using ST is less harmful than smoking cigarettes*" more often had beliefs that corresponded with the realistic relative risk between SLT vs. smoking. They also had higher likelihood of reporting future use of SLT, and higher willingness to try SLT as a cessation aid (25). However, the HWL did not influence product appeal. Note that this particular HWL was designed for experimental purposes, and is not applied on SLT packages in Canada.

In a study sponsored by the snus manufacturer Swedish Match, participants were exposed to one of four current US HWLs, and two relative risk HWLs: "*No tobacco product is safe, but this product presents lower risks to health than cigarettes*", and one underlining that the risk from snus was: "*substantially lower*". These two were compared to an HWL stating that snus is "*not a safe alternative to smoking*". Tobacco users perceived snus as less harmful and reported that they were more likely to use and buy snus after seeing the two relative risk HWLs. For people who had tried or never used snus, seeing "*substantially lower risk*" was associated with lower risk perception from snus, and reporting higher likelihood for buying (but not for using) snus (26).

One study assessed effects of relative risk information on actual snus use, although as a one-time provision of more extensive information, instead of exposure to a brief HWL (27). In this randomized trial, nicotine lozenge, snus or snus combined with relative risk information were tested as means for smoking cessation, and cessation rates were found to be similar for all groups, with under 1.5% of the group participants staying abstinent for the whole year. The amount of snus used during cessation did not differ between the snus-only and the snus + relative risk information group.

The current study

The aim of the present study is to test how different textual content in SLT HWLs affect risk perception, in particular from HWLs comparing risks from snus and cigarettes. We are interested in the potential effect of the HWLs on perceptions of risk from snus use, and on the relative perceptions of risk between snus and cigarettes.

Hypotheses 1a and b (H1a and H1b): The current non-comparative EU HWL states that snus "*damages your health and is addictive*", a statement that is likely to produce an overestimation of the risks from snus use. We hypothesized that seeing a snus product with an HWL based on the current EU HWL would increase risk perception of snus use compared to seeing a control condition with no HWL (H1a), and that the relative perception of risk from snus use versus smoking would become lower in favor of snus use after exposure to the EU HWL compared to the control condition (H1b). Note that we chose to remove the "[…] *and is addictive*" statement from the EU HWL to make it similar to the below relative risk HWLs.

Hypotheses 2a and b (H2a and H2b): The first comparative HWL is a general claim that "*Snus is less damaging to your health than smoking*", which we expected to adjust perceptions of risk to be more in line with tobacco experts than would exposure to the EU-based HWL. Specifically, when compared to the EU-based HWL, this General Relative Risk HWL (General RR) was expected to decrease perception of risk from snus (H2a), and to increase the difference between perceptions of risk from snus and smoking, such that the relative ratings are more in favor of snus use (H2b).[1]

Hypotheses 3a and b (H3a and H3b): The second comparative HWL specifies that "*Snus is 90% less damaging to your health than smoking*", in line with Levy et al. (1). As hypothesized for the General RR condition, we expected risk perception from snus to decrease more in this Percentage Relative Risk (Percentage RR) HWL condition than for the EU-based HWL (H3a), and that the difference in relative risk would change more in favor of snus use in the Percentage RR condition than in the EU-based HWL condition (H3b).

Hypotheses 4a and b (H4a and H4b): As the public tend to have unrealistically high estimates of risks from snus (11), the 90% difference in the Percentage RR would likely be larger than most people would expect, and may therefore have a greater impact on perceptions than the General RR. Thus, the Percentage RR was expected to decrease risk ratings of snus more than

[1] Note that an increase in the (absolute) difference between snus use and smoking is reflected in a decrease in our relative score (snus risk minus smoking risk) where lower scores means relatively less risk for snus use compared with smoking.

the General RR (H4a), and to produce a stronger change in the relative perception of risk (H4b)[2]

As intentions tend to be hard to affect (28) and our main focus was risk perception, we tested the effect of the HWLs on intentions to use tobacco exploratively and did not include these measures in the hypotheses or in the power calculation.

Methods

Participants

We collected the data in March 2019. Of the 267 people who entered the survey, 254 completed it (95% completion rate, 69.3% females; age span 19-69, *M* = 36.39, *SD* = 11.92). Participants were required to be Norwegian speaking and over 16 years old. The survey invitation was initially shared in large Facebook groups for Norwegian universities and for www.slutta.no, a collection of official Norwegian resources about tobacco cessation. People were encouraged to share the invitation link. There was no payment for participation.

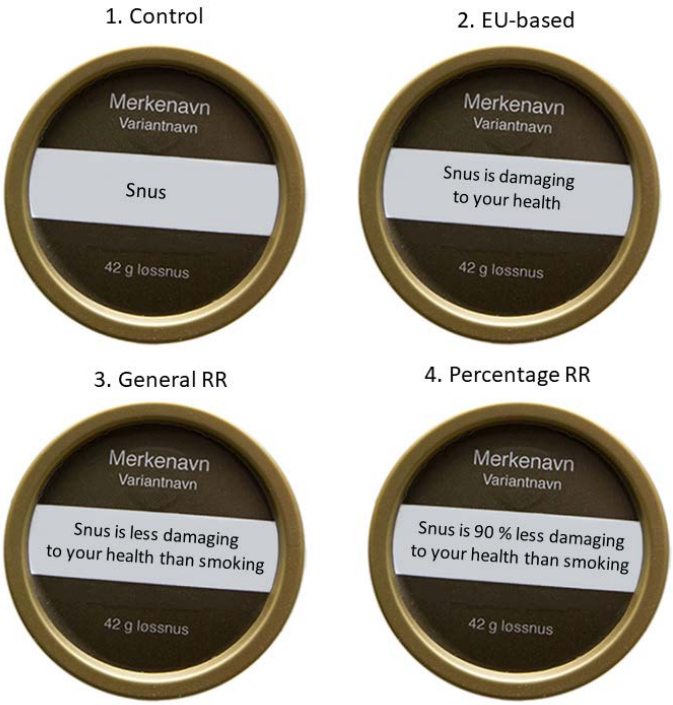
Procedure

Participants were instructed not to discuss details of the study on the Facebook invitation page, to avoid affecting how other people answered the questions. Participants were

[2] For the sake of completeness, we decided a priori to include the analyses of Hypothesis 4b, but this hypothesis was not preregistered.

randomized to one of four conditions with different textual content on a snus package model: 1) Control (no risk message), 2) EU-based HWL, 3) General Relative Risk HWL (General RR) and 4) Percentage Relative Risk HWL (Percentage RR). The four HWLs (translated from Norwegian) are presented in Figure 1. Risk perception and use intentions for both snus use and smoking were measured before (pre) and during (post) exposure to an HWL. Participants could view the picture of the snus package as long as they preferred while making the post-exposure ratings. It was not possible to go back to previous pages in the survey. The finishing page of the survey explained that the relative risk HWLs were constructed for the study purpose and that the EU HWL was the approved version. Official resources with information about health risks from snus and smoking were made available. Demographics and current tobacco use were measured before the pre-exposure risk ratings. The hypotheses were preregistered at Open Science Framework preregistration (embargoed link for peer review only) https://tinyurl.com/y4kbm24a as: «*Comparative information in health warning labels on snus products*»

Fig. 1. Health warning labels in the four conditions



Measures

Descriptive variables were age, gender, education, snus use and smoking status. The measures of snus use and smoking status were categorized into non-users (never tried, quit, tried but no regular use) and users (sometimes or regularly).

We measured baseline risk perception from snus use and smoking in two separate questions: "*Based on your current knowledge, how health damaging do you believe daily use of snus/smoking cigarettes is*?", and we included questions about intention to use tobacco for exploratory analyses: "*How likely are you to use snus/smoke cigarettes in the next six months?*" (1 Not at all – 10 Extremely).

In the ratings following exposure to an HWL we measured risk perception from snus use and smoking again: "*When you see the snus package above, what are your thoughts about the health risks from daily use of snus*?" (1 Not risky at all – 10 Extremely risky) and "*What are your thoughts about the health risks from daily smoking of cigarettes*?" (1 Not risky at all – 10 Extremely risky). Post-exposure questions about intentions to smoke or use snus were identical to the baseline questions.

Sample size

We conducted a within-subject pilot study where 40 respondents rated outcome measures from six HWLs (including the three in this study). The outcome measures in the pilot were designed to capture what the participants thought the HWLs were meant to convey. The differences in risk perception between two of the relative risk HWLs were about Cohen's d = 0.6. Because positive findings in pilot studies tend to give too high effect sizes (29), and because we made alterations in the outcome measures, we expected effect sizes of about 0.3. When including baseline ratings in the experimental design and assuming a correlation between pre and post measurement of $r = 0.5$, we would need around 50 persons in each condition for a power of 0.8 (p-value threshold of .05). Thus, a total of 200 persons were needed in the present study. The data collection was closed when all groups had attained at least 50 participants.

Statistical analysis

Each of the hypotheses were tested in separate repeated measures analysis of variance (ANOVA) with HWLs as between-group factor, pre versus post exposure as a within-group

factor, and current snus use and smoking habits as covariates[3]. In accordance with the pre-registered hypotheses, we only report inferential statistics for the interaction between the HWL conditions and the pre- to post exposure measurements. This interaction represents the difference between the conditions in the change from pre- to post exposure. For the hypotheses concerning relative risk perception from snus use versus smoking, we constructed a new variable by subtracting the smoking rating from the snus rating. Note that the analyses could have been based on a single large model, with planned contrasts, but we found the present pairwise approach more transparent, and the separate models are also less restrictive than a full model. All tests were conducted with IBM SPSS 25.

Results

Descriptive statistics of demographic variables according to experimental condition are presented in Table 1. Means and standard deviations for risk perception ratings pre- and post HWL exposure are presented in Table 2. We did not significance test baseline differences in line with recommendations (30).

[3] Only the main effects of the tobacco use covariates were specified in the preregistration, but the interactions between covariates and within-subject factors are always included in the repeated General Linear Model function in IBM SPSS.

Table 1. Demographics for each experimental condition

Demographic Variable	Control (n = 50)	EU-based (n = 69)	General RR (n = 73)	Percentage RR (n = 75)
Age Mean (SD)	33.50 (11.45)	37.18 (11.01)	36.61 (12.08)	37.41 (12.69)
Gender (%)				
Female	36 (72)	44 (63.8)	47 (64.4)	58 (77.3)
Male	14 (28)	23 (33.3)	26 (35.6)	17 (22.7)
Missing	0 (0)	2 (2.9)	0 (0)	0 (0)
Education (%)				
High school or less	23 (46)	19 (27.5)	28 (38.3)	32 (42.7)
Higher education	27 (54)	49 (71)	45 (61.6)	43 (57.3)
Missing	0 (0)	1 (1.4)	0 (0)	0 (0)
Snus habits (%)				
Never, tried or quit	24 (48)	34 (49.3)	42 (57.5)	34 (45.3)
Sometimes or regularly	25 (50)	34 (49.3)	31 (42.5)	41 (54.7)
Missing	1 (2)	1 (1.4)	0 (0)	0 (0)
Smoking habits (%)				
Never, tried or quit	40 (80)	61 (88.4)	66 (90.4)	64 (85.3)
Sometimes or regularly	9 (18)	8 (11.6)	6 (8.2)	11 (14.7)
Missing	1 (2)	0 (0)	1 (1.4)	0 (0)

Note. SD = Standard Deviation.

Table 2. Mean (standard deviations) for risk perception before and after exposure to warning labels

	Snus risk perception		Relative risk snus/smoking	
	Pre	Post	Pre	Post
Control	6.38 (2.20)	3.65 (2.79)	-3.14 (2.06)	-4.79 (3.34)
EU	5.58 (2.18)	5.33 (2.40)	-3.66 (2.24)	-3.55 (2.34)
General RR	6.22 (2.48)	5.32 (2.38)	-3.07 (2.42)	-3.90 (2.46)
Percentage RR	5.87 (2.42)	3.86 (2.02)	-3.32 (2.26)	-5.54 (2.20)

Note. Responses were made on 10-point risk scales from (1) 'Not at all' to (10) 'Extremely"; Relative risk was calculated as snus rating minus smoking rating.

Changes in risk perception after HWL exposure

The original means for risk perception from snus pre- and post-exposure are displayed in Fig. 2, and relative risk means in Fig. 3. Three of the four preregistered hypotheses about changes in perception of risk from snus were supported (H1a H3a, H4a, but not H2a), as were all of the hypotheses about changes in relative risk (H1b, H2b, H3b, and H4b).

In the comparison of the EU-based HWL and the Control condition, there was only a slight change for the EU HWL (M_{Pre} = 5.64 vs. M_{Post} = 5.33) versus a marked decrease for the control condition (M_{Pre} = 6.33 vs. M_{Post} = 3.65). This interaction was statistically significant, $F(1, 110) = 25.04$, $p < .001$, $\eta_p^2 = .19$. Thus, in relative terms, the EU HWL showed an increase in risk perception over the control condition (if the control can be considered as the counterfactual outcome), confirming H1a although in a slightly different way than we expected. Similarly, H1b was confirmed, as exposure to the EU-based HWL maintained relative risk levels from pre to post (M_{Pre} = -3.62 vs. M_{Post} = -3.55), while the control

condition decreased the relative risk ratings of snus use (M_{Pre} = -3.17 vs. M_{Post} = -4.79), F(1, 110) = 15.49, p < .001, η_p^2 = .12.

In the next hypothesis (H2a), we expected the General RR to decrease perception of risk more than the EU HWL, but there was no clear interaction effect, F(1, 133) = 2.24, p = .122, η_p^2 = .02. However, seeing the General RR (M_{Pre} = -3.13 vs. M_{Post} = -3.97) produced a slightly stronger decrease in the *relative* risk ratings in comparison to seeing the EU HWL (H2b) (M_{Pre} = -3.62 vs. M_{post} = -3.55), F(1, 133) = 7.64, p = .007, η_p^2 = .05.

The expectation that the Percentage RR would decrease perception of risk more than the EU-based HWL (H3a) was supported, as the EU version decreased less than half a point (M_{Pre} = 5.64 vs. M_{Post} = 5.33) whereas the Percentage RR decreased more than two points (M_{Pre} = 5.92 vs. M_{Post} = 3.86). This interaction effect was statistically significant, F(1, 136) = 23.24, p < .001, η_p^2 = .15. Thus, concrete relative risk information in the HWL lowered risk estimates from snus more than the EU-based version did.

Also the relative risk scores decreased more in the Percentage RR (M_{Pre} = -3.32 vs. M_{Post} = -5.52) than in the EU-based HWL (M_{Pre} = 3.62 vs. M_{Post} = -3.55), F(1, 135) = 47.85, p < .001, η_p^2 = 26. This supported our hypotesis H3b. The differences in change were the largest in this comparison, with the Percentage RR HWL producing a marked drop in relative risk ratings compared to the EU-based HWL.

The Percentage RR with concrete information about the relative risk were expected to decrease risk ratings from snus use more than the General RR (H4a). This hypothesis was supported, F(1, 141) = 13.21, p < .001, η_p^2 = .09. The General RR decreased ratings with

almost one point (M_{Pre} = 6.25 vs. M_{Post} = 5.32) whereas the Percentage RR decreased over two points (M_{Pre} = 5.92 vs. M_{Post} = 3.86). Similarly, the Percentage RR (M_{Pre} = -3.32 vs. M_{Post} = -5.52) decreased the relative risk scores more than the General RR did (M_{Pre} = -3.13 vs. M_{Post} = -3.97), $F(1, 140) = 15.90$, $p < .001$, $\eta_p^2 = 10$.

Fig. 2. Original means for risk perception from snus pre- and post HWL exposure

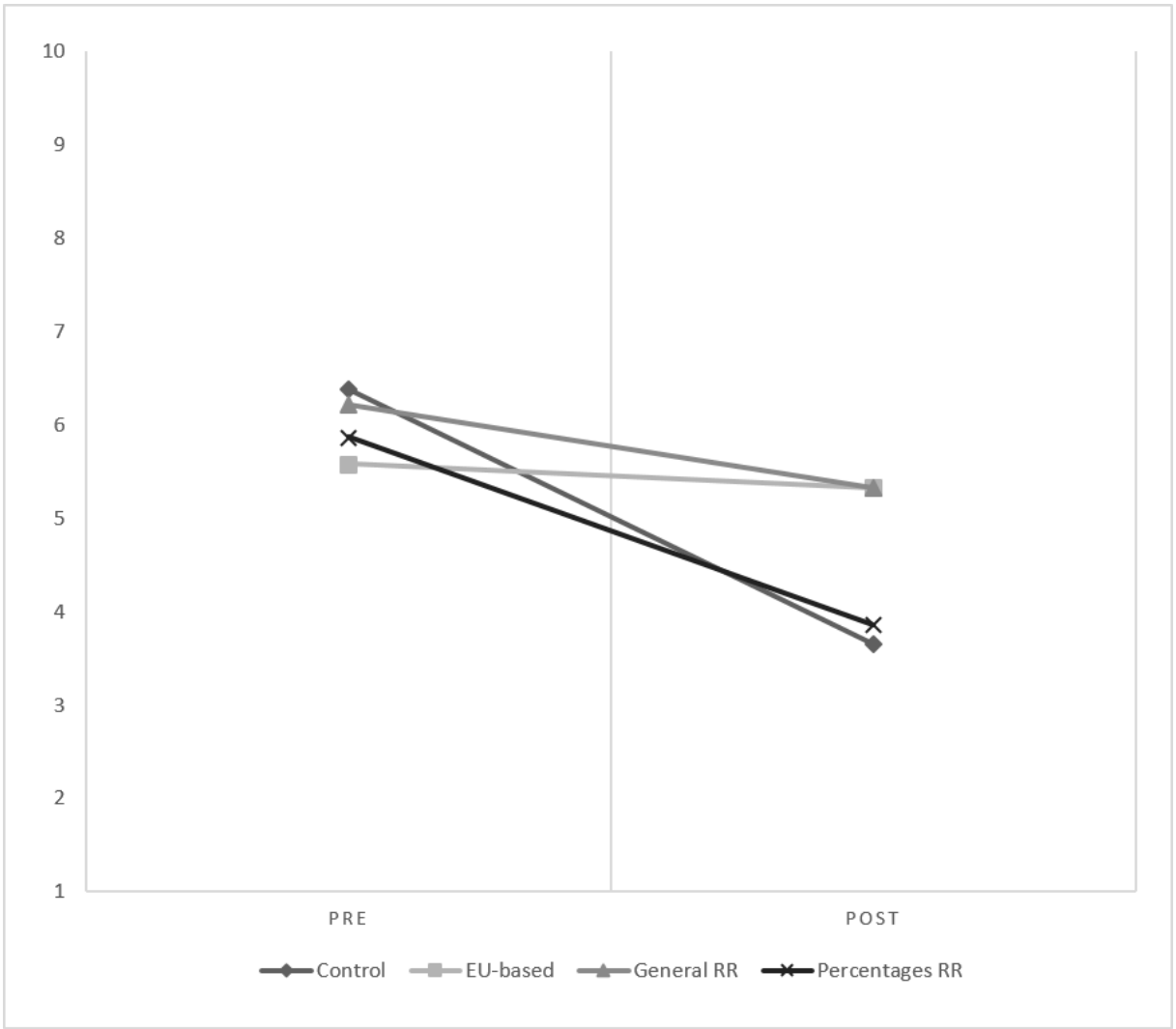
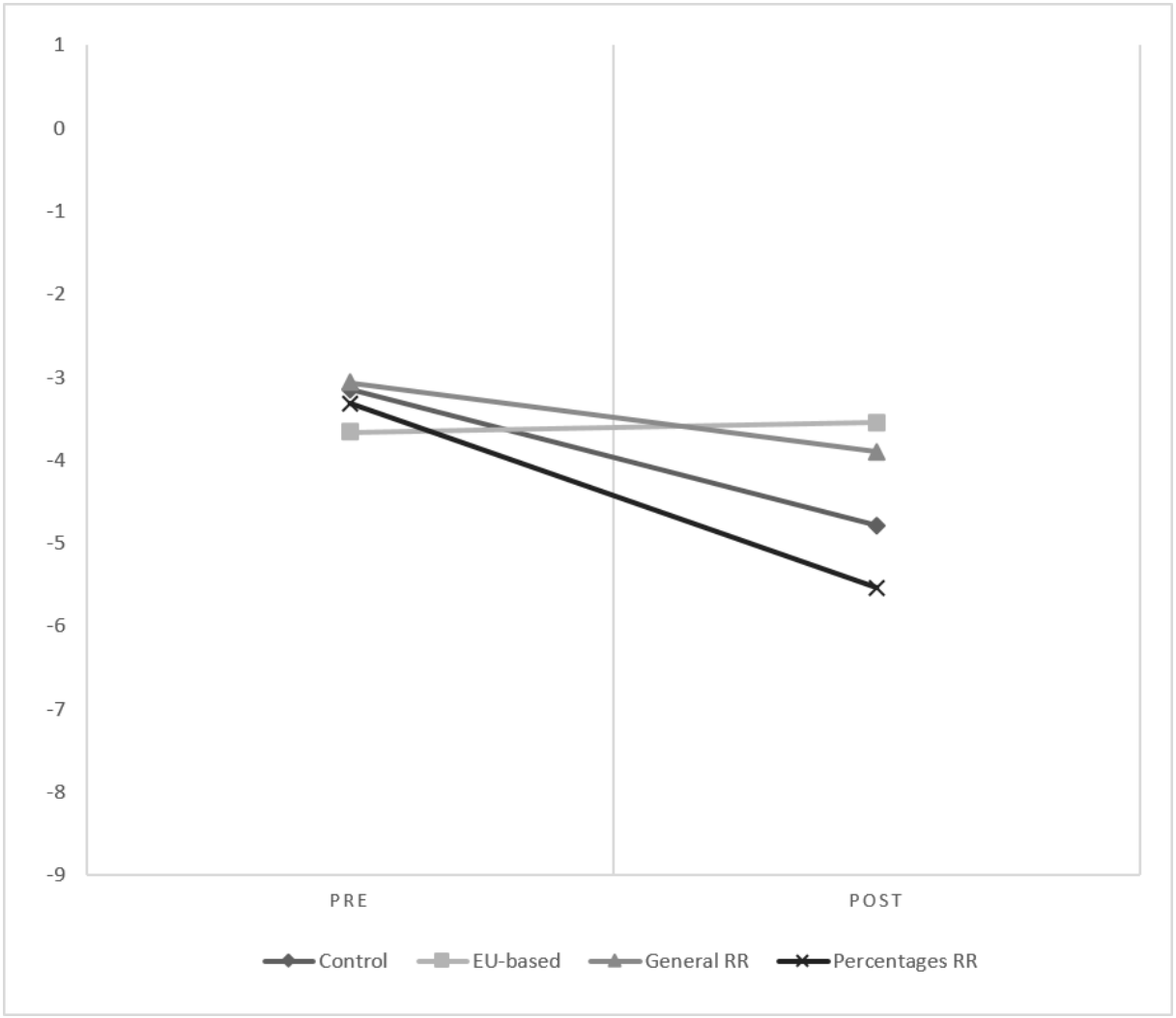


Fig. 3. Original means for relative risk perception from snus/smoking pre- and post HWL exposure



Intentions to use snus

Effects of seeing an HWL on intention to use snus were explored for all HWLs in one model. We did not test intentions to smoke because there were too few smokers in the sample. There was no interaction effect between pre- and post-measurement and the HWLs in terms of intentions to use snus, $F(3, 252) = .40$, $p = .75$, $\eta_p^2 = .01$, but already using snus was associated with having stronger future intentions to use snus (around 8.5 on the scale from 1 to 10) than not using snus (around 1.5 on the scale), $F(1, 252) = 698.57$, $p = .000$, $\eta_p^2 = .76$.

Discussion

Norwegian participants recruited through social media were randomized to see one of four HWLs, and rated risk perceptions of tobacco use pre- and post HWL exposure. All but one of the preregistered hypotheses were supported. In comparison to the non-comparative EU-based warning, the other relative risk HWLs as well as the control groups no-risk message lowered the perception of risk from snus and changed the risk ratings in favor of snus use (lowering the relative risk from snus use compared to smoking). These results conform to expectations, as we hypothesized that the EU-based HWL would produce higher perception of risk from snus than the RR HWLs because it is an absolute statement focusing on the harm of snus, with no reference to more harmful tobacco products that could have provided perspective.

The control group should be expected to demonstrate no change from pre to post, as this group was not exposed to any HWL but saw a snus product with the text “Snus” only. Still, the post-measures of perception of risk from snus decreased the most in the control group. This result may indicate that the textual HWLs increase risk perception, and that not having HWLs on snus products may communicate that snus implies no risk. Furthermore, even the RR HWLs produced higher risk perception compared to the control, indicating that RR information increases risk estimates somewhat more than having no HWL.

The predicted difference between the EU-based HWL and the General RR HWL was not supported. Although there was a slight tendency in the expected direction as EU maintained high risk estimates from snus while the General RR HWL decreased it, the changes were fairly similar for these two HWLs. The General RR HWL is a quite imprecise claim that snus

is "*less damaging to your health*" than smoking. "*Less*" is an abstract term with a broad range, and in this study it did not appear to activate an expectation of large differences. However, *relative* risk perception differed for the EU-based and General RR HWLs, with the latter HWL increasing the relative estimate differences more, as expected. A similar general claim HWL **"***Using ST is less harmful than smoking cigarettes*" was found to lower relative risk estimates when tested on young Canadians (25).

As expected, a concrete percentage format for the relative risk had a stronger effect than the general statement on lowering the perception of risk from snus, and in increasing the difference between snus use and smoking such that the relative perceptions of risk were more in line with the opinions of the expert panel (1). Rodu et al. (26) also found that risk perception from snus was typically lower for their RR HWLs than for the other HWLs. A possible explanation for our result is that with risks from snus generally being exaggerated when compared to cigarettes (11), reading a statement that snus is 90% less health damaging can have a strong impact. Popova and Ling (31) found that more people rated snus use as less harmful than cigarettes when the risks were measured and compared indirectly from two separate questions rather than directly from one single question (51.6% versus 22.1%). Thus, the indirect relative risk measure we applied using two separate questions, may have reduced some of the overrating of risks from snus that could have been generated from one single item, and potentially produced more realistic risk ratings

Intentions to use snus did not vary between HWLs, but it is likely that we did not have sufficient power to test effects on intentions. If intentions in fact remained stable, this could be a desirable quality of the HWLs. The sample consisted mainly of non-smokers, and their interest in using snus did not increase, even though their risk perceptions changed in favor of

snus. Other literature indicate that there is an association between heightened risk perception and behavior (28), and some studies have found effects from relative risk information on behavioral variables, e.g. (25, 26), while other studies have not (27).

Limitations

There are limitations to our study. First, females are overrepresented in the sample, possibly limiting the generalizability of findings. Furthermore, there were slight differences in the phrasings of the pre and post risk measures. The risk estimate differences we found were produced from a one-time exposure to an online picture of a snus product with an HWL, and may not be generalizable to real-life exposure or have a long-term impact. Participants were asked to rate their perceived risk while looking at the HWL, but this perception may change when the HWL is no longer present. Furthermore, the short time between pre and post measures may have primed the perceptions and affected the results. We used self-reported measures, which can be biased if participants moderate their answers to be more socially favorable, as described by the social desirability bias (32). In addition, the awareness of being part of a study may affect the answers, known as the Hawthorne effect (33) . Finally, as our recruitment was done via an open invitation link on Facebook, we do not have information about those who saw the invitation but chose not to respond. This implies that we do not know how representative our sample is for the general population.

Future studies

A logical extension of these findings is to follow up with studies on snus HWLs with information about relative risk, absolute risk, and a combination of these risk formats. The health hazards could be varied as general (health) or specific (blood pressure, diabetes), the severity from low (gum recession) to high (cancer), and the time frame from immediate/short

to a distant future. Similar studies should be repeated with smokers, in neighboring countries such as Sweden and Finland, and among the Sami people.

Conclusion

Relative risk information in snus HWLs reduces perceived risk from snus use and adjusts relative perceptions of risk between snus and smoking such that perceptions are more in line with expert opinions. At least in the case of products that differ greatly in risk, a message that frames relative risk in terms of percentages can be considerably more potent than a general relative risk claim.

Abbreviations

ANOVA: Analysis of variance

EU: European Union

HWL: Health Warning Label

RR: Relative Risk

WHO: World Health Organization

Declarations

Ethics approval and consent to participate

The study was approved by the local ethics committee at the Department for psychology, UiT The Arctic University of Tromsø. Participants were anonymous as we did not collect any

identifying data, or IP-addresses. The invitation explained that participation was voluntary, and that one could leave the survey at any chosen time.

Consent for publication

Participants consented to their data (with age and education removed) being published in an online data repository.

Availability of data and materials

The dataset supporting the conclusions of this article will be made available in the UiT Open Research Data repository, along with publication of the manuscript.

Competing interests

No competing interests

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Authors' contribution

CVN, TBH and FS designed the study and analyzed the data. CVN did the main writing of the manuscript, with TBH and FS contributing. All authors read and approved the final manuscript.

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Not applicable

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