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Characteristics of tobacco and snus use among young Finnish male conscripts and personnel of the Finnish Defence Forces

Maria Danielsson

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Supervisors	Professor Tuula Vasankari, MD, PhD Finnish Lung Health Association, Filha, Helsinki, Finland Department of Pulmonary Diseases and Clinical Allergology, University of Turku, Turku, Finland Adjunct professor Liisa Pylkkänen, MD, PhD Department of Oncology, University of Turku Turku, Finland
Pre-examiners	Professor emerita Arja Rimpelä, MD, PhD, M.Sc University of Tampere, Tampere, Finland Professor emeritus Harri Vainio, MD, PhD Director general (emeritus), Finnish Institute of Occupational Health, Helsinki, Finland
Custos	Professor Kari Reijula, MD, PhD Department of Public Health University of Helsinki, Helsinki, Finland
Opponent	Professor Pekka Puska, MD, PhD Finnish Institute for Health and Welfare, Helsinki, Finland

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"An ounce of prevention is worth a pound of cure"

Benjamin Franklin (1706-1790)

To Vesa, Kasper, Aron, and my parents

ABSTRACT

The health hazards of smoking are well recognised. However, the harmful effects of nicotine and the Swedish type of smokeless tobacco (snus) are less familiar. Snus possesses high bioavailability, as nicotine and other harmful chemicals are readily absorbed through the mucous membrane of the oral cavity. This exposes the user to the development of nicotine addiction and increased morbidity if used regularly.

This thesis is based on a study conducted as part of the project 'Promotion of a Tobacco-Free Environment in the Finnish Defence Forces (FDF)', which aimed to reduce nicotine and tobacco use among personnel and conscripts. The specific objective was to investigate the prevalence and characteristics of snus and cigarette use among male conscripts. In particular, the daily exposure to snus among daily users and the factors associated with the willingness to quit snus use and smoking were explored. The two-question nicotine dependence test for smokers, the Heaviness of Smoking Index (HSI), was modified to estimate the level of snus dependence. Additionally, a personnel survey was conducted twice, in 2014 and 2021, to evaluate the prevalence and habits of tobacco and nicotine use among FDF personnel.

The conscript study was conducted as a questionnaire survey during the years 2014–2016 in three of the 17 military units, administered during the first week of service alongside the general health inspection to primarily reflect tobacco habits from civilian life. In total, 4 706 male conscripts were included in the study. The response rate varied from 54% to 97%. The prevalence of snus and cigarette use was higher than expected based on national population-based studies. Over a third (35%) of the conscripts included in the study used snus, and 38% smoked either daily or occasionally. Almost a fifth were daily snus users, and a quarter were daily smokers. Sixteen per cent were daily dual users. Only 2.5% reported using electronic cigarettes.

As expected, an association between smoking prevalence and educational background was found. A similar association was not observed among snus users. However, the daily total exposure time to snus was lower among respondents with an upper secondary education. An earlier starting age of snus use or smoking was a risk factor for higher total exposure time and regular use. On average, daily snus users had started using snus at the age of 16, consumed ten portions per day, and kept the snus in their mouth for over six hours per day. Daily smokers had usually started smoking a year earlier, at the age of 15, and smoked ten cigarettes per day.

The harmful health effects of smoking were well recognised, unlike those of snus use. Only a fifth of the respondents perceived snus as very harmful to health. The perception of snus as harmful to health and the strong addictive effect of smoking were associated with an increased willingness to quit. Moreover, earlier quit attempts increased the willingness to quit snus use and smoking. A simple two-question dependence test for snus users, based on the two-question nicotine dependence test for smokers, was modelled. The dependence profile was very similar for daily snus users and smokers. Approximately half showed low dependence, while 40% demonstrated moderate or strong dependence.

Smokeless tobacco and nicotine products have become increasingly common among the younger population, and the threshold for experimenting with them trying them has decreased. The results indicated that a later onset of use may reduce the probability of becoming a regular user. Increasing awareness of the harmfulness and addictiveness of snus and cigarettes from early adolescence is warranted to achieve optimal preventive effects. Furthermore, active and individually tailored cessation support is needed. To date, a comparable and easily applicable test for snus users, similar to the one available for smokers, has not been developed. The modified two-question nicotine dependence test for snus users could prove useful for healthcare professionals in everyday practice after proper validation.

Among FDF personnel, daily smoking decreased significantly from 14% in 2014 to 6% in 2020, while daily snus use increased from 8% to 11%. The highest prevalence of snus use was observed among military personnel working with conscripts. Approximately a quarter of the participants used snus with a nicotine content of 11–20 mg/g, while 30% used snus with a nicotine content of 21–30 mg/g. Preferred cessation support included nicotine replacement therapy or medication provided by the employer. However, many users had not received advice to quit from healthcare professionals, underscoring the need for proactive, personalised cessation interventions.

Smokeless tobacco and nicotine products have become increasingly common among young people, who now experiment with them more readily than before. A later onset of use appears to lower the risk of progressing to regular use. Therefore, raising awareness of the harms and addictive potential of snus and cigarettes from early adolescence is critical for prevention. In addition, tailored cessation support is needed to assist users in quitting. The adapted two-question dependence test for snus users, once validated, could provide healthcare professionals with a simple and practical tool for everyday practice. Occupational health services, in particular, offer an important opportunity to promote health and workability by providing counselling, cessation support, and targeted programmes to reduce tobacco and nicotine use.

SAMMANFATTNING

Hälsoriskerna med rökning är välkända men de skadliga effekterna av nikotin och snus är ej lika bekanta. Snus har en hög biotillgänglighet eftersom nikotinet och de andra skadliga kemikalier lätt absorberas från slemhinnan i munhålan. Detta ökar risken för nikotinberoende och ökad sjuklighet vid regelbunden användning.

Denna avhandling bygger på en studie som genomfördes som en del av projektet ”Främjande av en tobaksfri miljö i Finlands Försvarsmakt, vars målsättning var att minska nikotin- och tobaksanvändningen bland personal och beväring. Det specifika syftet med denna avhandling var att undersöka prevalensen och särdragen av tobaksanvändningen hos snusare och rökare bland manliga beväringar. Den dagliga exponeringstiden för snusning, samt utvärderade faktorer förknippade med viljan att sluta snusa och röka undersöktes specifikt. Det två-frågors nikotinberoendetestet för rökare (Heaviness of Smoking Index, HSI) modifierades för att uppskatta graden av snusberoende. Dessutom genomfördes en personalundersökning två gånger under åren 2014 och 2020 med syftet att utvärdera förekomsten, användningsvanorna och attityden av tobaksförbrukning.

Studien genomfördes som en enkätundersökning under åren 2014–2016 i tre av försvarets 17 truppförband under den första tjänstgöringsveckan samtidigt med den allmänna hälsoinspektionen. Totalt inkluderades 4706 manliga beväringar i studien. Den totala svarsfrekvensen varierade från 54 % till 97%.

Prevalensen för snusanvändning och rökning var högre än förväntat baserat på nationella befolkningsbaserade studier. Drygt en tredjedel (35 %) av kohorten använde snus och 38 % rökte antingen dagligen eller sporadiskt. Nästan en femtedel snusade dagligen och en fjärdedel rökte dagligen. Sexton procent använde dagligen både snus och cigaretter. Endast 2,5 % rökte elektroniska cigaretter.

Som väntat fann man ett samband mellan rökprevalensen och utbildningsnivån. Ett motsvarande samband observerades inte bland snusare, men den dagliga totala exponeringstiden för snus var lägre bland beväringar med gymnasieutbildning. Tidigare startålder för snusning eller rökning verkar höja risken för en längre total exponeringstid och för regelbunden användning. I genomsnitt hade dagliga snusade över sex timmar per dag. Dagliga rökare hade vanligtvis börjat röka ett år tidigare, vid 15 års ålder, och rökte 10 cigaretter per dag.

Endast en femtedel av de tillfrågade upplevde snus som mycket hälsovådligt, till skillnad från rökning vars risker var allmänt kända. Uppfattningen om snus som hälsoskadligt och tobaksröken som mycket beroendeframkallande associerades med en ökad vilja att sluta röka. Tidigare avvärjningsförsök ökade också viljan att sluta snusa och röka. Beroendeprofilen var mycket lika för både dagliga snusare och rökare på basis av det modifierade två-frågors nikotinberoendetestet för snusare. Cirka hälften uppvisade lågt beroende och 40 % uppvisade måttligt eller starkt beroende.

Användning av snus- och nikotinpåsar har blivit oroväckande vanligt bland den yngre befolkningen. Därtill har tröskeln för att prova dessa produkter blivit lägre än tidigare. Resultaten visade att en senare debut av tobak och nikotinprodukter minskar sannolikheten för regelbunden användning. Ökad kunskap om tobaks- och nikotinprodukters skadlighet och beroendepotential bör inledas tidigt, gärna redan i lågstadiet. Aktivt och individuellt anpassat stöd för att sluta är också nödvändigt. Det modifierade två-frågors nikotinberoendetestet för snusare kan efter validering utgöra ett enkelt och praktiskt verktyg för hälso- och sjukvården.

Daglig rökning bland personalen i Försvarsmakten minskade avsevärt från 14 % år 2014 till 6 % år 2020, medan daglig snusanvändning ökade från 8 % till 11 %. Den högsta prevalensen av snusanvändning observerades bland militär personal som arbetade med värnpliktiga. Cirka en fjärdedel av deltagarna använde snus med en nikotinhalt på 11–20 mg/g, och 30 % använde snus med en nikotinhalt på 21–30 mg/g. De mest önskade stödformerna för att sluta var nikotinersättning eller läkemedel som tillhandahölls av arbetsgivaren. En betydande del av både rökare och snusanvändare hade inte blivit uppmanade av hälso- och sjukvårdspersonal att sluta.

Snus- och nikotinpåsar har blivit allt vanligare bland unga, som nu provar dem lättare än tidigare. Senare debut minskar sannolikheten för regelbunden användning. Därför är det viktigt att tidigt öka kunskapen om snus och cigaretters skadlighet och beroendepotential. Individuellt anpassat stöd för att sluta är nödvändigt. Det modifierade två-frågors nikotinberoendetestet för snusare kan, efter validering, ge vårdpersonal ett enkelt och praktiskt verktyg för daglig användning. Arbetshälsovården erbjuder särskilt en viktig möjlighet att främja hälsa och arbetsförmåga genom rådgivning, stöd vid avvänjning och riktade program för att minska användningen av tobaks- och nikotinprodukter.

TIIVISTELMÄ

Tupakoinnin terveyshaitat tunnetaan hyvin, mutta sen sijaan nikotiinin ja nuuskan haittavaikutukset ovat vähemmän tunnettuja. Nuuskan nikotiinilla on korkea biologinen hyötyosuus, koska nikotiini ja muut haitalliset kemikaalit imeytyvät tehokkaasti suun limakalvojen kautta verenkiertoon. Säännöllinen nuuskan käyttö altistaa nikotiiniriippuvuuden kehittymiselle ja lisää sairastuvuutta.

Tämä väitöskirja perustuu tutkimukseen, joka tehtiin osana ”Tupakoimattomuuden edistäminen Puolustusvoimissa” -hanketta, jonka tavoitteena oli vähentää nikotiini- ja tupakkatuotteiden käyttöä henkilöstön ja varusmiesten keskuudessa. Väitöskirjan tavoitteena oli selvittää nuorten miesten nuuskan ja tupakan käytön yleisyyttä. Lisäksi selvitettiin säännöllisesti nuuskaa käyttävien päivittäistä kokonaisaltistusaikaa ja analysoitiin nuuskan ja tupakan käytön lopettamishalukkuuteen liittyviä tekijöitä. Tupakoitsijoiden nikotiiniriippuvuuden arviointiin kehitetty kahden kysymyksen testi (Heaviness of Smoking Index, HSI) muokattiin nuuskan käytön riippuvuuden arviointiin. Henkilöstölle tehtiin kysely vuosina 2014 ja 2021 tupakka- ja nikotiinituotteiden käytön yleisyyden ja tottumusten selvittämiseksi.

Varusmiestutkimus toteutettiin kyselytutkimuksena vuosina 2014–2016 kolmessa varuskunnassa. Kysely toteutettiin palveluksen ensimmäisen viikon aikana terveystarkastuksen yhteydessä, jotta tulokset kuvastaisivat pääasiassa siviilielämän aikaisia tupakka- ja nikotiinitottumuksia. Tutkimukseen osallistui yhteensä 4 706 miespuolista varusmiestä ja kolmen osatutkimuksen vastausprosentti vaihteli 54 prosentista 97 prosenttiin.

Nuuskaaminen ja tupakointi oli lähes yhtä yleistä ja yleisempää kuin aiemmissa väestöpohjaisissa tutkimuksissa oli oletettu. Yli kolmannes (35 %) kaikista tutkimukseen osallistuneista varusmiehistä käytti nuuskaa ja 38 % tupakoi joko päivittäin tai satunnaisesti. Lähes viidesosa oli päivittäisiä nuuskaajia ja neljäsosa päivittäisiä tupakoitsijoita. Kuusitoista prosenttia käytti molempia tuotteita päivittäin. Vain 2,5 % vastaajista käytti sähkötupakkaa.

Odotutetusti tupakoinnin yleisyys ja koulutustausta olivat yhteydessä toisiinsa, mutta vastaavaa yhteyttä ei havaittu nuuskaajilla. Päivittäinen kokonaisaltistusaika nuuskalle oli kuitenkin selvästi lyhyempi ylemmän toisen asteen koulutuksen saaneella. Nuuskan käytön tai tupakoinnin varhainen aloittamisikä oli yhteydessä myöhempään säännölliseen käyttöön ja suurempaan kokonaisaltistusaikaan. Keskimäärin päivittäiset nuuskaajat olivat aloittaneet nuuskan käytön keskimäärin 16-vuotiaana, käyttivät kymmenen nuuska-annosta päivässä ja pitivät nuuskaa suussa yli kuusi tuntia päivässä. Tupakoitsijat olivat aloittaneet tupakoinnin keskimäärin vuotta aikaisemmin, 15-vuotiaana ja polttivat keskimäärin 10 savuketta päivässä.

Tupakoinnin terveyshaitat tunnettiin hyvin, toisin kuin nuuskan käytön terveysriskit. Vain viidesosa vastaajista piti nuuskaa erittäin haitallisena. Nuuskan terveydelle haitalliseksi ja tupakoinnin erittäin riippuvuutta aiheuttavaksi mieltäminen lisäsivät lopettamishalukkuutta. Myös aiemmat lopettamisyritykset olivat yhteydessä lisääntyneeseen lopettamishalukkuuteen. Tupakoitsijoiden nikotiiniriippuvuuden arviointiin kehitetty kahden kysymyksen testi muokattiin nuuskan käytön arviointiin. Tulokset osoittivat riippuvuusprofiilin olevan hyvin samanlainen päivittäisillä nuuskan käyttäjillä ja tupakoitsijoilla. Noin puolet käyttäjistä osoitti matalaa riippuvuutta ja 40 % kohtalaista tai vahvaa riippuvuutta.

Nuuskan ja nikotiinipussien käyttö on yleistynyt huolestuttavasti nuorilla ja nuorilla aikuisilla. Kynnys kokeilla näitä tuotteita on madaltunut. Tulokset osoittavat, että myöhemmin aloitettu käyttö saattaa pienentää riskiä säännölliselle nuuskan ja tupakan käytölle. Myös tiedon lisääminen tupakka- ja nikotiinituotteiden haitoista tarpeeksi varhain, mielellään jo alakouluikäisille, on suositeltavaa ennaltaehkäisyn tehostamiseksi. Lisäksi tarvitaan aktiivista ja yksilöllisesti kohdennettua lopettamistukea. Tähän asti nuuskan käytön arviointiin ei ole ollut vastaavaa yksinkertaista testiä kuin tupakoitsijoille. Muokattu kahden kysymyksen nikotiiniriippuvuustesti voi tulevaisuudessa tarjota helppokäyttöisen työkalun terveydenhuollon ammattilaisille nuuskaajien riippuvuuden arvioimisessa, mutta testi pitää ensin validoida.

Puolustusvoimien henkilöstön päivittäinen tupakointi väheni merkittävästi 14 prosentista vuonna 2014 kuuteen prosenttiin vuonna 2020, kun taas päivittäinen nuuskan käyttö kasvoi kahdeksasta prosentista yhdenteentoista prosenttiin. Nuuskan käyttö oli yleisintä varusmiesten kanssa työskentelevän henkilökunnan keskuudessa. Noin neljäsosa vastaajista käytti nuuskaa, jonka nikotiinipitoisuus oli 11–20 mg/g ja 30 % käytti nuuskaa, jonka nikotiinipitoisuus oli 21–30 mg/g. Suosituimmat lopettamistukimuodot olivat nikotiinikorvaushoito ja työnantajan tarjoama lääkkeellinen hoito. Huomattava osa niin tupakoitsijoista kuin nuuskan käyttäjistä ei ollut saanut terveydenhuollon ammattilaiselta kehotusta lopettaa.

Nuuskan ja nikotiinipussien käyttö on yleistynyt nuorilla, jotka kokeilevat niitä aiempaa herkemmin. Myöhemmin aloitettu käyttö näyttää pienentävän riskiä siirtyä säännölliseen käyttöön, joten tupakka- ja nikotiinituotteiden haitoista ja riippuvuudesta tiedottaminen varhaisesta iästä alkaen on keskeistä ehkäisyssä. Lisäksi tarvitaan yksilöllisesti kohdennettua lopettamistukea. Muokattu kahden kysymyksen nikotiiniriippuvuustesti voi validoinnin jälkeen tarjota terveydenhuollon ammattilaisille helppokäyttöisen työkalun nuuskan käyttäjien arviointiin. Työterveyshuolto tarjoaa tärkeän mahdollisuuden edistää terveyttä ja työkykyä tarjoamalla neuvontaa, lopettamistukea ja kohdennettuja ohjelmia tupakka- ja nikotiinituotteiden käytön vähentämiseksi.

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LIST OF ABBREVIATIONS

CNS	Central nervous system
E-cigarettes	Electronic cigarettes
EU	European Union
EVALI	E-cigarette or vaping use-associated lung injury
FDF	The Finnish Defence Forces
HDI	Human Development Index
HSI	Heaviness of Smoking Index
nAChRs	Nicotinic acetylcholine receptors
NRT	Nicotine replacement therapy
PAH	Polycyclic aromatic hydrocarbon
RAY	Raha-automaattiyhdistys (the Finnish Slot Machine Association)
THL	Terveyden ja hyvinvoinnin laitos (Finnish Institute for Health and Welfare)
THC	Tetrahydrocannabinol
TSNA	Tobacco specific nitrosamines
US	United States
VAT	Value added tax
VOC	Volatile organic compound
WHO	World Health Organization

LIST OF ORIGINAL PUBLICATIONS

This dissertation is based on the following original articles:

I **Danielsson M, Lammi A, Siitonen S, Ollgren J, Pylkkänen L, Vasankari T.** Alarming development of dual snus and cigarette usage among young Finnish males. BMC Public Health. 2019;19(1):1249. https://doi.org/10.1186/s12889-019-7519-1

II **Danielsson M, Tanner T, Patinen P, Birkhed D, Anttonen V, Lammi A, Siitonen S, Ollgren J, Pylkkänen L, Vasankari T.** Prevalence, duration of exposure and predicting factors for snus use among young Finnish men: a cross-sectional study. BMJ Open 2021;0:e050502. doi:10.1136/ bmjopen-2021-050502.

III **Danielsson, M., Lammi, A., Siitonen, S., Ollgren J., Pylkkänen L., Vasankari T.** Factors predicting willingness to quit snus and cigarette use among young males. *Sci Rep* **13**, 15126 (2023). https://doi.org/10.1038/s41598-023-42233-8

IV **Danielsson M, Lammi A, Siitonen S., Ruohola J-P., Ollgren J, Pylkkänen L, Vasankari T.** Use of nicotine products and withdrawal support among the personnel of the Finnish Defence Forces. BMJ Mil Health 2025. Accession Number: 40175152 DOI: 10.1136/military-2024-002924.

The publications are referred to in the text by their roman numerals.

1 INTRODUCTION

Nicotine is one of the most addictive substances legally sold and distributed worldwide. The farming, manufacturing, and trade of nicotine and tobacco products impose a significant economic and environmental burden on society, while predisposing users to impaired health and diminished workability.

Governmental tobacco control interventions and policies have successfully reduced smoking in countries with a very high Human Development Index (HDI). However, the tobacco industry has introduced novel and alternative nicotine products with increasing intensity. While tobacco smoking remains the most dangerous form of nicotine use, it is indisputable that all tobacco and nicotine products pose significant health risks when exposure is substantial and regular. Although the harmful effects of smoking are well documented, the health risks associated with other nicotine products are less widely recognised. Indeed, several countries have adopted harm reduction policies, promoting alternative nicotine products as tools for smoking cessation.

Finland has successfully reduced smoking prevalence over recent decades without adopting a harm reduction approach. Over the past ten years, however, the use of snus and, more recently, nicotine pouches have increased, particularly among adolescents and young adults. This trend is concerning, as these products contain high levels of nicotine and can rapidly cause addiction. The perception of snus as relatively harmless has evolved over time, despite limited awareness of its negative effects on health and performance, particularly in sporting contexts. While athletes rarely smoke due to the well-known health risks, snus use is often associated with sports teams [1-3].

The recent rise of nicotine pouch use represents a new phenomenon, and reliable prevalence data remain scarce. Other forms of smokeless tobacco are excluded from this thesis due to their negligible use in Finland. Historically, the use of e-cigarettes, non-combustible cigarettes, and water pipes has been marginal in Finland; however, interest in these products has increased alarmingly among adolescents and young adults. The use of the emerging nicotine products may continue to grow. In response, Finland has progressively expanded the Tobacco Act to cover a broader range of nicotine and tobacco products, with the ultimate goal of eliminating their use by 2030. Consequently, a harm reduction policy is not advocated in Finland [4].

Tobacco use has long held a social and cultural presence within the military environment [5, 6]. In Finland, the concept of a 'cigarette-length break' ("tupakan mittainen tauko") was once commonplace. However, significant efforts have been undertaken to improve the physical, social, and mental fitness of conscripts. In

2007, the Finnish Defence Forces (FDF) adopted the slogan "Finland's largest fitness school" to reflect this commitment. By 2010, a working committee appointed by the Minister of Defence had identified the harmful cultural link between tobacco use and military life, recommending increased anti-smoking interventions [5, 7]. In response, a four-year, multi-professional project was launched in 2013 to enhance awareness of the health risks posed by tobacco and nicotine products and their detrimental effects on performance [8].

This project initiated a three-year study to investigate tobacco use patterns among conscripts, and the present thesis is based on its findings. The project, entitled 'Promotion of a Tobacco-Free Environment in the FDF' (Tupakoimattomuuden edistäminen Puolustusvoimissa), was a collaborative effort involving the Finnish Defence Forces, the Finnish Lung Health Association, and the Cancer Society of Finland, conducted from 2013 to 2016. Funding was provided by the Finnish Slot Machine Association (Raha-automaattiyhdistys, RAY) and Maanpuolustuksen kannatussäätiö. The project targeted both conscripts and personnel, introducing a tobacco-free unit model that combined environmental adjustments, leadership initiatives, and healthcare support to encourage cessation and promote a tobacco-free lifestyle. Its key objectives included reducing tobacco use by 20%, fostering less permissive attitudes towards nicotine products, clarifying internal guidelines, enhancing awareness of health risks, and strengthening cessation support services.

The physiological mechanisms underlying substance use disorders and nicotine-induced health impairments are consistent across all nicotine products. Nicotine itself is toxic in high doses and contributes to increased morbidity through several mechanisms. Furthermore, tobacco products contain additives that elevate addiction risk and possess carcinogenic properties. Promoting health through preventative measures and motivating individuals to quit nicotine use remains a highly effective public health strategy. Understanding the distinct characteristics of the tobacco epidemic is essential for success.

This thesis investigates tobacco and nicotine use in young Finnish male conscripts, a demographic representative of the broader population of young adult males. The research pursued four primary objectives: to determine the prevalence of tobacco and nicotine use, to quantify usage levels, to identify predictive factors influencing use, and to assess factors that motivate cessation. Additionally, we developed a simplified, two-question nicotine dependence test for snus users, modelled on the Heaviness of Smoking Index (HSI), to provide healthcare professionals with a practical assessment tool.

As part of the 'Promotion of a Tobacco-Free Environment in the FDF' project, we also conducted two personnel surveys. These studies followed a clinical approach, aiming to identify nicotine use characteristics and design effective cessation support pathways based on the findings.

2 REVIEW OF THE LITERATURE

2.1 The history of tobacco

The history of the tobacco plant Nicotiana goes back over 12 000 years ago to pre-Colombian America long before the Spanish conquistadors brought the tobacco plant to Europe in the 16th century [9]. The Europeans brought it to India in the 16th century [10]. Tobacco was used in the Americas for ceremonial purposes and functioned as a form of currency. The native Americans also used tobacco in traditional medicine as a painkiller and antiseptic for cuts and wounds, but also for treating colds, when mixed with different herbs. It was also used as a whitening toothpaste when mixed with lime or chalk. Snuffing the tobacco smoke through the nostrils caused loss of consciousness and it is speculated that it was therefore used as anaesthetics. However, reliable data is limited [9].

The French ambassador Jean Nicot was convinced of the beneficial properties of the tobacco plant, and he successfully treated skin ulcers and infections, lymphadenitis and even leprosy by applying the bruised leaves topically. The tobacco plant was later named Nicotiane after Jean Nicot [9]. In the enthusiasm over this miracle plant, not much attention was paid to its potential harm. It was used as a panacea, a universal remedy, most commonly in the form of a decoction, an ointment, a powder or a syrup [11]. The manufacturing and trade of the tobacco plant were lucrative and fuelled the slave trade [12].

In the 19th century, after the isolation of nicotine, the medical world became aware of the dangerous alkaloids and mistrust towards use increased. More effort was taken to measure doses [9, 13]. In 1967 Grace G. Stuart analysed case reports published between 1785 and 1860 and identified the following successful uses of tobacco: Tobacco administered externally was used to treat poisonous bites, hysteria, pain, gout, skin infections and ulcers, stimulation of the respiratory system and laryngeal spasm. Tobacco administered per rectum relieved constipation and haemorrhoidal bleeding. Tobacco administered by mouth was used when a patient suffered from strangulated hernia, fever caused by malaria or when inducing vomiting was needed. Tobacco administered by inhalation had an effect on symptoms caused by nasal polyps [11]. By the mid-20th century, the knowledge of the harmful effects of tobacco had increased through medical research and the medical use of tobacco was terminated [9, 13].

However, as we know, the use of tobacco for pleasure did not stop. On the contrary, during the industrialisation era, the use of tobacco as a stimulant

increased manyfold. The advertising by the tobacco companies was alluring, even immoral [14, 15]. A historical moment was the publication of the Smoking and Health -report in 1964 led by U.S Surgeon General Luther Terry in which tobacco smoke was linked to several deleterious health effects including lung and laryngeal cancer, chronic bronchitis and emphysema, cardiovascular diseases and reproductive health. The role of nicotine dependence was also recognised. The working group concluded that the greater the amount of cigarettes smoked daily the higher the death rate [16]. Soon after the US Congress passed the Federal Cigarette Labelling and Advertising Act of 1965, which required the tobacco companies to include warning labels on the packages. However, it took forty more years until the World Health Organization (WHO) successfully rallied 168 countries to sign the Framework Convention on Tobacco Control (FCTC) in 2003 which entered into force in 2005 [17]. The FCTC has since made a significant impact worldwide on the policy and regulating process [18]. However, the advertising by the tobacco companies has not stopped, merely changed to more subtle covert marketing strategies in response to tightened tobacco control policies. New users are tempted by introducing novel tobacco products, often flavoured and introduced as healthier options, by using product placements and celebrities in TV series, cinematography, social media and team sports [15, 19].

Tobacco is smoked as rolled cigars and cigarettes or in waterpipes (i.e. hookah or shisha), chewed, sniffed, or put in the sulcus of the upper lip. A novel form of use is electronic or non-combusted cigarettes. Nicotine pouches have recently become a popular alternative for snus.

2.2 Epidemiology of tobacco and nicotine use

Globally 28.9% (26.4% cigarettes) of males and 5.2% (4.6% cigarettes) of females were current tobacco smokers in 2020. However, 36.7% of males and 7.8% of females were current users of any tobacco product including smokeless tobacco [20]. The majority of users live in low or low-middle-income countries. 82% of users live in South-East Asia [21, 22]. In Finland the use of other forms of smokeless tobacco than snus and nicotine pouches is rare and hence the evaluation of these other smokeless tobacco products are excluded from the thesis [23].

The prevalence of tobacco use and using habits are influenced by age, sex, ethnicity, socioeconomic, educational and cultural factors as well as current social trends. Smoking is more common among males and respondents with lower socioeconomic and educational background [24, 25]. The military service has been historically considered a tobacco-friendly environment [6]. Similar

data regarding smokeless tobacco or snus use is limited. There are, however, a few studies that implicate that a similar association between lower education and snus use was not as evident as smoking. Snus use has increased among the younger population and is equally common regardless of educational background according to a report from the Norwegian Institute of Public Health (2019) [26]. However, the results from the Finnish School Health Promotion Studies suggest that there is an association between socioeconomic factors and snus use, although weaker, compared to smoking [23, 27].

2.2.1 The prevalence of smoking cigarettes and vaping e-cigarettes

In 2019 approximately 18% of the population over 15 years in the European Union (EU) reported daily smoking. Smoking was most common in Bulgaria, Greece, Latvia, Germany and Croatia (in downward order, 29% -> 22%) and least common in Sweden, Finland, Luxemburg, Portugal and Denmark (in upward order, 6.4 -> 11.7%) [20, 28]. According to the Tobacco statistics 2023 by National Institute for Health and Welfare the prevalence of smoking in Finland has more than halved in twenty years from 28% to 12% among working age males and from 18% to 11% among working age women. The decrease has been even more drastic among adolescents and under 20-year-old young adults being a third from ten years ago. Figure 1 shows that the current prevalence of daily smoking is nearly identical between sexes: 6% of males and 4% of females. However, while educational disparities remain, there has been a positive progress in narrowing these gaps. Only 2% of students in upper secondary school were daily smokers compared to 14% attending vocational school [23].

The use of electronic cigarettes (e-cigarettes) is growing alarmingly among adolescents, as highlighted by the Global Youth Tobacco Survey [17]. Among Swedish ninth graders, a quarter had tried e-cigarettes and 12% had experimented with waterpipe at least once [29]. In Finland, vaping has more than doubled in just a few years. In 2021 3% of males and 1 % of females aged 14-20 reported daily e-cigarette use, but by 2023, these figures had increased to 6% and 5%, respectively [23] (Figure 1).

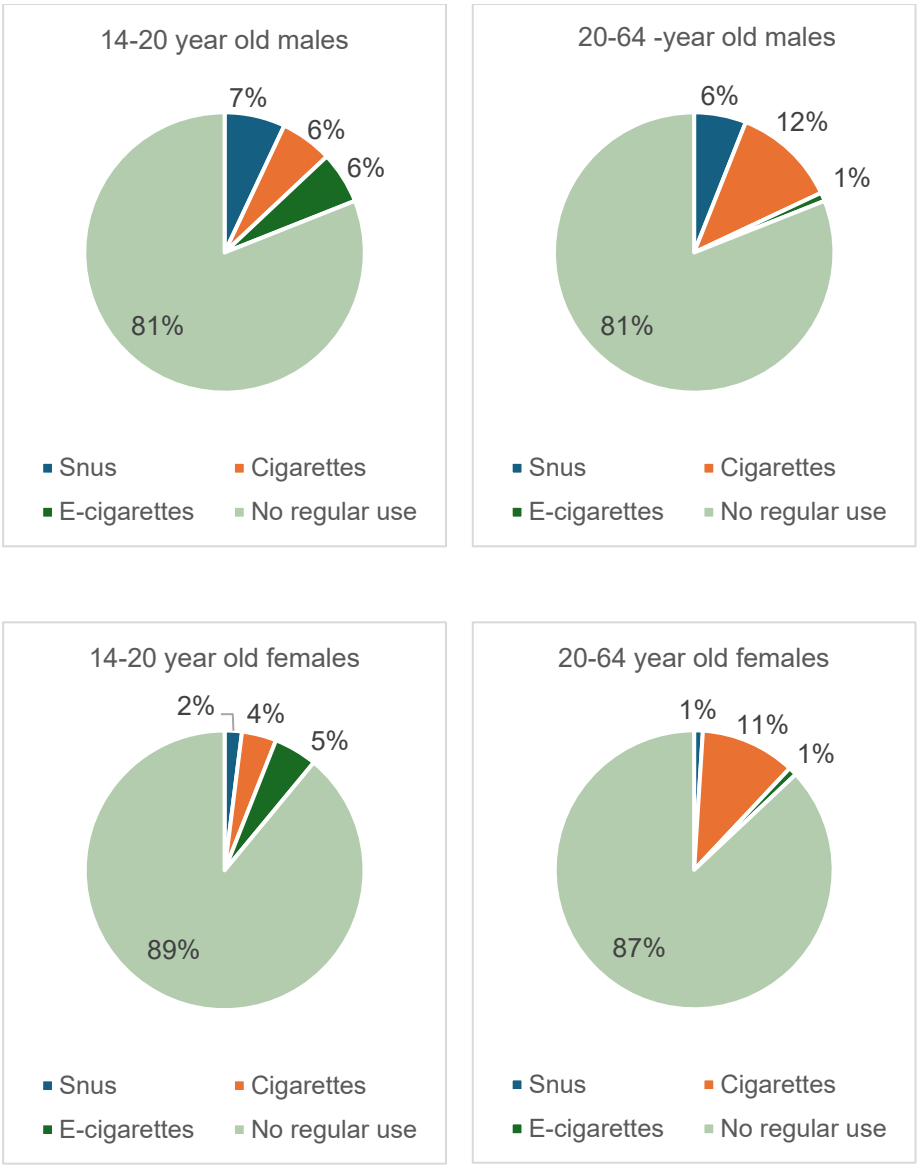

Figure 1 Prevalence of daily smoking, snus and e-cigarette use among adolescent and working age adult Finnish males and females in 2023 and 2022 respectively. Adapted from the data of Tobacco statistics 2023, Finnish Institute for Health and Welfare [23].

Despite this trend among youth, the use of e-cigarettes, non-combustible cigarettes and waterpipe remains marginal among Finland's working age population. In 2022, only 1% of males and females aged 20-64 vaped [23]. Similar patterns are observed in Swedish and Norwegian data [30, 31].

2.2.2 The prevalence of snus use

The popularity of the Swedish type of moist oral tobacco called snus has grown among adolescents and young adults in the Nordic countries and the United States (US). It seems that snus, and lately also nicotine pouches have replaced smoking to some extent in this age group [32]. American snus is still the most popular in the US, but Swedish snus has increased its market share during the last decade [33-36]. Approximately 4.5% of males but only 0.3% of females reported current use of smokeless tobacco [37]. The EU banned oral tobacco in 1992, with Sweden granted exemptions for snus [38]. However, cross-border sales remain prohibited. Reports suggest tobacco companies target foreign markets, with strong snus products, especially for Finland, widely advertised online and illicit trade common [39].

Snus use is most common in Sweden and Norway. These countries have a long history of snus use, which is why the tobacco culture differs somewhat from the neighbouring countries. Tobacco statistics show that smoking prevalence in Sweden and Norway is low but current tobacco use is high: 29.8% of males and 18.2% of women use any tobacco product at least occasionally [20]. According to Swedish statistics approximately 19% of 16-29-year-old males used snus daily and 7% occasionally (a total of 26%) in 2021. Of women 9% were daily users and 6% were occasional users (a total of 15%) [40]. In 2021 31% of 16-34-year-old Norwegian males reported daily snus use and only 6% were occasional users. Altogether 37% used snus either daily or occasionally. Respectively 14.5% of Norwegian women were daily users and 6% occasional users. [41]. In 2021 11.4% of Danish youth use smokeless tobacco, mainly snus or nicotine pouches, which is an increase of 2.3% from 2020. The use of chewing tobacco was rare (0.5% daily and 05% occasionally). Almost 27% had tried smokeless tobacco. However, many of these respondents had difficulties differentiating snus from nicotine poaches, which may affect the prevalence statistics. Approximately 6% of 15-29-year-old Danish males and 2% of females used snus daily. Respectively, almost 4 % and 3% use snus occasionally [42, 43]. Corresponding data is not available from Iceland. However, over 18-year-olds report low use [44]. In Finland, snus use is most prevalent among males aged 20–34. In 2022, 11 % of males in this age group reported daily snus use, while 20% reported current use (daily or occasional). Among women, only 1-2% reported current use, with the majority also being aged 20-34 [23] (Figure 3). According to the Adolescent Health and Lifestyle Survey of 2019, the readiness to try and use snus has grown among adolescents during the last decade. The majority (86%) had received or bought snus from a friend and 9% had acquired snus through social media [45] (Figure 2).

The EU banned oral tobacco in 1992, with Sweden granted exemption for snus. However, cross-border sales remain prohibited. Reports suggest tobacco companies target foreign markets, with strong snus products, especially for Finland, widely advertised online and illicit trade common.

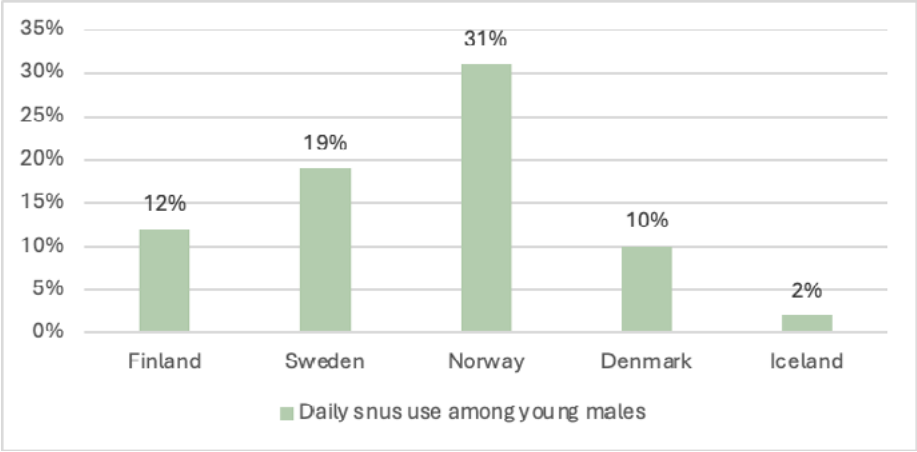

Figure 2 Prevalence of daily snus use among young Scandinavian males. Source of data: Finland 20-32 year-olds, Finnish Institute for Health and Welfare, 2020 [44]; Sweden 16-29 year-olds Public Health Agency of Sweden, 2021 [40]; Norway 16-34 year-olds Statistics Norway, 2021 [41]; Denmark 15-24 year-olds, Danish Health Authority, 2021 [42]; Iceland 18 +, year-olds, Finnish Institute for Health and Welfare, 2020 [44].

2.2.3 The use of nicotine pouches

The sale of tobacco-free nicotine pouches, also called nicotine snus, lack a congruent EU-wide regulation. [44]. However, several countries have recently incorporated nicotine pouch use into tobacco legislation. The new Finnish Tobacco Act adopted in May 2025, permits the sale of nicotine pouches containing up to 16.6 mg/g, restricted to mentol and mint flavours. [46]. In Sweden, Norway and Iceland strong nicotine pouches are sold as consumer goods. The sale of nicotine pouches was increased during the COVID-19 pandemic in response to supply shortage of snus. According to the Finnish customs report a record amount of illegally bought cans of strong nicotine pouches was confiscated in 2020, which may signal increased interest in use [39]. The control of smuggling strong nicotine pouches across the open EU-borders is difficult [47].

Reliable data on the prevalence of nicotine pouch use in Finland is limited. The 2023 School Health Promotion Study introduced questions about nicotine pouch use for the first time. The results revealed that approximately 1.6% of

boys in upper secondary education and 5.0% in vocational school were daily users. Additionally, 5.4% of boys in upper secondary education and 15.8% in vocational school were occasional users [48].

In Sweden, the Novus- report by the A Non-Smoking Generation -organisation indicate a significant rise in nicotine pouch use. Between 2019 and 2021, the prevalence among 14-18-year-olds increased from 7% to 16%. Further, the Swedish C.A.N-report from 2022 show increased readiness to use nicotine pouches. Of second graders in upper secondary school 39% of males and 42% of females had tried nicotine pouches. Approximately 22% of both males and females reported use within 30 days. Almost 60% of males and a quarter of females had used snus prior to trying nicotine pouches [49]. According to the report from the Danish Health Authority (2022) 4% of adolescents and young adults (age 15-29 years) used nicotine pouches daily and 3% occasionally in 2021. Approximately 6% of males and 2% of females used nicotine pouches occasionally [43].

The use of nicotine pouches in Great Britain has become more popular especially among younger and middle-aged males who use other nicotine products although the use is still rare. Only 0.25% of the adult population reported use of nicotine pouches. However, the prevalence doubled from 2021 to 2022 [50]. An increased market of nicotine pouches in USA has been detected as well. As in Great Britain, the use of nicotine pouches was more common among respondents who used other nicotine products. Almost 6% had ever tried pouches. Ever use was associated with lower education and previous use of smokeless tobacco products and previous quit attempt with traditional methods. 17% reported interest of use. The interest of use was higher among smokers, who planned to quit within 6 months [51].

2.2.4 The prevalence of tobacco and nicotine use in the Finnish Defence Forces

The prevalence of snus and cigarettes has been previously studied among male conscripts during the beginning of their military service. However, none of these studies has studied the possible changes of use during the military service. The use of other form of tobacco product was not asked. Mattila et al. (2012) studied the association between tobacco habits and physical activity among conscripts during the study period from 1999 to 2010. Ten out of 28 units were randomly selected. Exclusive snus use increased from 5% to 7% and dual use of snus and cigarettes increased from 12% to 13%. Smoking decreased from 42% to 34% during the follow-up period [2]. In 2012 Hamari et al. investigated the tobacco habits of conscript that had attended military service in Northern Finland during the years 2008-2009. In this study group

approximately 16% were daily snus users, 19% were daily smokers and 7 % were dual users. Occasional smokers were twice more likely to be daily snus users compared to daily smokers [52].The prevalence was a little higher in a study that investigated the occurrence of dental caries among conscripts in twelve units located in different parts of Finland. Tanner et al. (2014) reported than 39% smoked daily and 9% used snus daily. Approximately 11% were dual users of snus and cigarettes [53].

There are no previous studies investigating the tobacco habits of the personnel in the Finnish Defence Forces (FDF) nor from personnel deployed or volunteered abroad for crisis management tasks in Finland. Comparing tobacco use among the military personnel in other countries is difficult because of very different structure of the armed forces and conscription as well as cultural differences. Of the Nordic countries only Finland have retained a systematic and efficient universal conscription and an equivalent personnel. In Norway approximately 15% of all males and females liable for call-up are drafted [54, 55]. In Denmark males are mandated to serve for four months if they are called up under a randomized selection mechanism [56, 57].

Sweden ended the compulsory military service in 2010 and as a consequence the amount of personnel was reduced to a minimum. Sweden reactivated the conscript system in 2017. However, the amount of annual conscripts and subsequently the amount of personnel is reverted gradually over a longer period of time [58]. Conscription registers in Sweden, Norway and Denmark provide some data regarding the tobacco habits of conscripts [58].

Data regarding tobacco habits of the personnel of the armed forces in these countries are scarce. A small questionnaire survey (n=52) was conducted among a group of conscripts and specialist officers at one of the Armed Forces' Live Regiments in Sweden in 2014. According to this study 46% used tobacco, and of users 71% used tobacco daily. Of all tobacco users 50% used snus and 33% smoked and 17 % were dual users [59].

The use of tobacco products among the military personnel in the United States armed forces is high even though the smoking prevalence has declined over the past decades. In 2011 almost half (49%) reported use of any nicotine product. In 2018 almost 40% used tobacco in some form, which is double compared to the prevalence of the general population in the US. Half (51%) of the military personnel smoked in 1980. In 2011 the prevalence had dropped to 25% and in 2018 further to 18%. Approximately 13% used smokeless tobacco in 2011 and the prevalence was the same in 2018 [60-62]. Deployment to active operational areas is common among the military personnel in NATO member countries. Several studies have shown an association between deployment and increased smoking rates and risk for other substance use disorders [63-65]. Norway and Denmark, as members of the North Atlantic Treaty Organization

(NATO), actively deploy units to conflict zones [55, 56]. With Finland and Sweden recently joining NATO, they too will be expected to fulfil similar obligations in the coming years.

2.3 Content and characteristics of nicotine and tobacco products

2.3.1 Nicotine

Nicotine is a natural alkaloid defence chemical that occurs in several varieties of the Solanaceous plants. The tobacco plant contains high concentrations of nicotine, 0.3-0.5 % of nicotine by dry weight. However, a much lower quantity of nicotine can also be found in tomatoes, aubergines, potatoes, sweet peppers and coca plants for example [66]. Natural nicotine contains over 99% of the stereoisomer S-nicotine. However, nicotine can also be synthetically manufactured, and this form is commonly used in e-cigarette liquids and nicotine pouches. Synthetic nicotine exists in two different stereoisomers, S-nicotine and R-nicotine in equal amounts. A rising concern is that the health effects of R-nicotine are poorly understood [67-69].

Nicotine comes in unprotonated free-base, monoprotonated and diprotonated forms. The unprotonated nicotine is readily absorbed through the oral membrane. Changing the pH over 6 toward an alkaline state will also change the protonation status to unprotonated nicotine. Usually, this is achieved by adding carbonates or bicarbonates [70, 71].

Nicotine is a neurotoxin mimicking the transmitter acetylcholine and can be lethal by causing respiratory failure and cardiac arrest through stimulation of the parasympathetic nervous system [72, 73]. It is therefore included in many insecticides. The human lethal dose of an adult is estimated to be 50-100 mg of nicotine ingested or absorbed, which is equivalent to five cigarettes. In lower concentrations, nicotine acts as a stimulant [66, 73]. Exposure to strong nicotine pouches, snus or liquid nicotine has increased rapidly causing intoxication symptoms in adults. Common symptoms are nausea, vomiting, headache, stomach cramps and tremor. High doses can result in arrhythmia and convulsions [72, 74]. Doses as small as half a teaspoon or splashes of liquid nicotine on the skin can cause illness or even death among children. The lethal dose of nicotine in children is estimated to be between 1 and 13 mg per kilogram (mg/kg) of body weight. Severe toxic reactions have been reported in children with doses as low as 2 mg [75, 76]. Careless handling of snus and nicotine pouches, nicotine gum and such expose animals to high quantities of nicotine, which can be fatal. For example, the median lethal dose in dogs is 9.2-12mg/kg [77, 78].

2.3.2 Combustible cigarettes and cigars

Both combustible cigarettes and cigars consist of chopped dry tobacco leaves, which are smoked by lighting the end of the roll. However, cigarettes are rolled in paper and cigars in a tobacco leaf. Cigarettes are usually uniform in size, contain chemical additives and the smoke is inhaled into the lungs through a filter. The amount of tobacco does not exceed 1 gram of each cigarette and is smoked within 10 minutes.

Cigars are traditionally meant to be puffed without inhaling the smoke. The reason for this is that the alkaline unprotonated nicotine, with a pH of 6.2-8.0, generates a higher amount of available nicotine, which is effectively absorbed through the mucosa in the oral cavity resulting in a satisfying effect without inhaling the smoke. The cigars can be subdivided according to size into large cigars, cigarillos and little cigars. Large cigars can be up to 20 cm long and it may take 1-2 hours to smoke them. They typically contain 5-20 grams of tobacco. Smaller cigarillos are a little bigger than cigarettes and contain 3 grams of tobacco. Little cigars contain approximately 1 gram of tobacco and are the same size as cigarettes. They often come portion-packed and may contain filters [79].

Smoking causes approximately 6 million deaths every year worldwide of which 600 000 persons die of second-hand smoke. Nicotine is highly toxic if digested. The tobacco smoke contains over 9000 chemicals, of which over 60 are carcinogenic. Among these, tobacco-specific nitrosamines (TSNA), polycyclic aromatic hydrocarbons (PAH), aromatic amines, benzene, aldehydes and ethylene oxide are the most dangerous [79-82]. The cigar smoke contains much higher nitrate concentrations than cigarette smoke, which increases the amount of TSNA [79, 83].

2.3.3 Snus

Smokeless tobacco is a type of nicotine-containing tobacco product that is not smoked nor burned. The commonest smokeless tobacco used in Northern Europe is the Swedish type of smokeless tobacco called snus, which is often portion-packed. Therefore, this thesis does not comprehend other forms of smokeless tobacco products. Snus is placed in the sulcus under the upper lip in the mouth in close contact with the oral mucosa. The mucosal membrane enables efficient and continuous absorption of nicotine and other chemical compounds into the bloodstream. The nicotine intake can therefore be high. [84-87]. Snus contains over twenty carcinogens and toxins including tobacco-specific nitrosamines (TSNA) and volatile nitrosamines, volatile aldehydes, and nickel compounds. The health hazards of snus cannot be disregarded [83, 88, 89]. Regular snus users are exposed to higher levels of nicotine and TSNA

than cigarette smokers [87]. A wide range of flavours lowers the threshold to start use, especially among youth and young adults [90].

The chemical characteristics of snus vary depending on the manufacturer, brand and strength of snus. The concentration of nicotine, unprotonated nicotine and minor alkaloids, the pH, and the amount of TSNA varies the most. Northern European snus generally contains less highly cancerogenic TSNA due to a fermentation process prohibiting bacterial growth, than snus manufactured in the United States. Additives like humectants, alkaline agents and flavouring are used to improve taste and increase the shelf life [91].

2.3.3.1 The nicotine content of snus

The strength of snus is somewhat complicated to determine because several factors affect the final concentration of nicotine in the bloodstream. The content of nicotine and additives, and the weight of snus portions varies according to brand, which makes comparison and estimation of the strength difficult. Many other factors than the amount of nicotine, such as the humidity, pH, flavour and individual differences resonate with the perceived strength and the level of nicotine in the blood [70, 85].

The strength of snus is not regulated by law. Reliable statistical data regarding the strength of snus that is used in Scandinavia can only be obtained from Norwegian statistics. The popularity of strong snus has increased significantly in Norway during the last 10 years. Strong snus containing over 20 mg/g of nicotine covered almost 80 % of the market share according to Norwegian statistics. The content of portion-packed snus has changed accordingly: In 2005 one pouch of snus contained on average 8.6 mg nicotine and in 2015 it had increased to 12.5mg [26, 44]. In Sweden the most sold snus brands in 2021 contained 7-14 mg/g nicotine according to unofficial reports. The pH of the product is seldom mentioned.

The nicotine absorption of snus is regulated through several different mechanisms. For example, the absorption rate can be enhanced by elevating the pH of snus thus increasing the amount of readily available unprotonated nicotine [70, 85].

One portion usually weighs between 1-3 g. The following unofficial categorisation according to the nicotine content is often used to determine the strength of snus: normal snus < 10mg/g, strong ca. 14mg/g, very strong ca. 20 mg/g and super strong ca. 40 mg/g. However, an official international classification is lacking. Traditional snus has typically a pH range of 5.87-9.10 and contains 0.08-16mg/g unprotonated free nicotine. Standard snus has usually a pH of 8.0-8.7. Snus classified as extremely strong can contain nicotine over 40mg/g mg and have a pH of 9-9.7.

2.3.3.2 The total amount of exposure to nicotine in snus users

The total amount of exposure to nicotine in snus depends on the nicotine content, chemical qualities affecting the absorption rate of the nicotine, the size of the snus poaches, the number of snus poaches used per day and the length that the snus is kept in the mouth.

Tobacco and nicotine products placed in touch with the oral mucosa provide effective and continuous uptake until the substance is removed. The uptake rate of the chemicals is regulated by several factors of which the pH has a significant role. In addition, local blood flow, size and the wettability of the product and the nicotine content modulate the absorption [85]. The amount of nicotine absorbed through the oral mucosa into the blood varies usually between 22-44% [92-94]. According to Pickworth et al. (2014) [85], high-end alkaline snus resulted on average in a peak nicotine plasma increase of 19.6 ng/mL, which is usually measured after smoking one cigarette. Studies show that approx. 60 to 90% of the nicotine is released from the snus over time. [95]

The total amount of exposure to nicotine in snus users is difficult to estimate because the content of the chemical compounds and package size of snus varies, as discussed in the previous sections. The data regarding the characteristics of snus use and exposure time is scarce. Digard et al. (2009) [96] concluded that Swedish males consumed on average 12 snus portions per day and kept the one portion of snus in their mouth for almost an hour. The average daily total exposure time to snus was estimated to be 13.0 hours per day. Females kept the snus portion in their mouth for a little over half an hour and used 10 portions per day, which resulted in a daily exposure time of almost eight hours per day. Interestingly, the self-reported number of loose snus portions used per day was almost 50% less than the measured amount for both sexes.

Cotinine, a nicotine metabolite, is commonly used and accepted as an indicator of nicotine exposure. Several nicotine dependence tests have been validated by using measurements of cotinine concentration in body fluids. Cotinine can be measured from the saliva, from serum and urine. However, individual differences in nicotine metabolism may affect the outcome. There is a possibility of overestimation of cotinine levels among smokeless tobacco users because the saliva containing nicotine is swallowed and processed through first-pass metabolism in the liver. [97, 98].

2.3.4 Nicotine pouches

The nicotine pouches contain nicotine derived from tobacco leaves or synthetic nicotine, food-grade fillers, water, salt and flavouring [67, 99]. As in snus, the alkalinity varies between 6.6-10.1, which affects the uptake [70, 85]. They were

originally invented to be used as NRT. The nicotine pouches used for NRT contain up to 4mg/g of nicotine and are sold as over-the-counter products.

A growing concern is the increased popularity of strong and very strong nicotine pouches which are used the same way as snus pouches. The customer can choose between a wide range of flavours if ordered online or bought from abroad illegally. The strength of nicotine pouches varies from 4-50mg/g [100]. They tend to have a higher pH and a greater percentage of unprotonated nicotine compared to snus: The pH ranges from 6.86-10.1 and contains 7.7-99.2% of unprotonated free nicotine [70]. In 2019 the Finnish customs confiscated a record amount of strong nicotine pouches exceeding the legal amount of nicotine. The strongest products contained more than 50 mg/g of nicotine [101].

If verified, the Tobacco Act amendment will limit nicotine pouches to 16.6mg per pouch and allow only menthol and mint flavours [46]. Health authorities have expressed concerns regarding the availability of excessively strong nicotine products and the allowance of menthol and mint. Their concern is that these measures may undermine efforts to discourage the use of smokeless tobacco use [102]. Nicotine pouches are often attractively packaged or designed to appeal a specific target group. The advertising often points out the benefits of choosing nicotine pouches over other tobacco products, which could mislead the consumer to think that these products have a lower health risk despite of lack of evidence [103].

2.3.5 Electronic cigarettes

Electronic cigarettes commonly also called e-cigarettes, vapes, e-cigs, Juul, tank system and mods, contains an electronic heat source, which creates an aerosol of the liquid used in the delivery system that is inhaled. The devices are usually chargeable. The liquid contains glycerine and propylene glycol originally developed as food additives. If preferred, a liquid containing nicotine may be chosen. Hence not all vapes contain nicotine [104]. According to the EU regulation, a maximum strength of 20mg/ml of nicotine is allowed. The EU-directive revision from 2015 prohibits the marketing of e-cigarettes and the trade of flavoured e-liquids [105]. However, flavoured food additives are used in countries with prohibition. Outside EU, flavoured e-liquid is popular and comes in approximately 7 000 different flavours making vaping appealing. In addition, vaping is cheaper than smoking cigarettes [106]. E-cigarettes can be used to deliver other drugs such as marihuana [104].

E-cigarette liquids contain a high quantity (60-90%) of unprotonated easily absorbed nicotine and correlate with the total nicotine content. The pH of e-cigarette liquids ranges from 5.1-9.1 [107]. Carcinogenic and toxic chemicals found in these liquids include N-nitrosamines, volatile aldehydes, acrolein,

volatile organic compounds (VOC) such as toluene and benzene, polycyclic aromatic hydrocarbons (PAH), cadmium, nickel, tin, lead and other heavy metals. Diacetyl and diethylene glycol are toxic when inhaled and have been linked to lung diseases [104, 108, 109].

E-cigarettes were developed in China in 2003, but gained popularity only after entering the US market in 2007 [106]. Long-term health hazards of e-cigarettes are difficult to estimate because the development of the devices and liquids has been fast, and the follow-up time of use is not sufficient. However, many studies implicate, that the use of e-cigarettes may increase the total use of nicotine which predisposes to the development of substance use disorder and morbidity caused by extensive use of nicotine [106]. Synthetic nicotine commonly used in e-cigarette liquids contains 50/50 of the S-nicotine and R-nicotine [67]. In addition, nicotine in liquid form is highly toxic. The increased use of e-cigarettes has led to severe outcomes among small children and pets [75, 78].

2.3.6 Other nicotine products

Non-combusted cigarettes, also referred to as "heat-not-burn tobacco products" or "heated tobacco products", consist of a heating source and tobacco. The tobacco can be wrapped in paper. The tobacco is heated in a lower temperature than cigarettes creating an aerosol that is inhaled, much like in e-cigarettes [110].

The waterpipe, also called hookah or shisha, was invented in India in the 16th century in an attempt to reduce the potential harm of the tobacco smoke[111]. Flavouring is common, which makes the use inviting. Smoking is often conducted in a social setting, in which the smoking tube is passed around. The smoke is passed through a water cistern before inhalation. However, this mechanism does not filter the toxic chemicals, carcinogens and heavy metals released by the burning tobacco. The health hazards are very similar to that of combustible cigarettes [112]. The harmful effect is multiplied by the prolonged use characteristic of the use of waterpipe. One hour of smoking is equivalent to 4-20 combustible cigarettes.

An alternative to tobacco is the use of steam stones, which release steam that is inhaled. The health effects of steam stones are unknown. Herbal mixtures not containing tobacco are often marketed as a healthier choice even though harmful compounds are released during the burning process. The waterpipe is usually heated with charcoal, which releases a high amount of carbon monoxide and polyaromatic hydrocarbons (PAH) among other cancerogenic compounds [113]. Electronic non-combustible waterpipes have emerged on the market. However, for now, there is no known literature reviewing the health hazards of the use of e-waterpipes [114].

2.4 The impact of nicotine and tobacco products on health

2.4.1 Nicotine

Nicotine, the common factor of all nicotine and tobacco products, is highly addictive and is the primary compound responsible for causing and contributing to morbidity among regular users. It stimulates the nicotinic cholinergic receptors, increasing signalling molecules within the central nervous system and throughout the body. The harmful health outcomes depend on the total exposure to nicotine, both in the short-term and long-term [72, 115].

Nicotine is rapidly delivered into the body, reaching the systemic circulation within seconds. Regular use is a major risk factor for atherosclerosis and cardiovascular diseases, triggered by several mechanisms. Endothelial dysfunction is the first manifestation of vascular disease, as inflammation in the blood vessel walls weakens endothelial function. Nicotine contracts peripheral circulation and increases cardiac output by activating the sympathetic nervous system, leading to higher blood pressure and elevated heart rate. It also reduces insulin sensitivity through chronic adrenergic onset and metabolic response to chronic stress [116, 117]. Changes in blood rheology, vasoconstriction, vascular epithelial damage, and effects on collagen metabolism and keratinocyte function likely contribute to skin ageing [118].

The impaired microcirculation affects wound healing and increases the risk of fractures and other injuries, including noise-induced hearing damage, such as that caused by ammunition. Regular use of nicotine products significantly increases the risk of complications during and after surgery. It also predisposes to frostbites of the fingers and toes, which is a significant risk during military training [116]. Vasoconstriction, vascular changes and oxidative stress may cause erectile dysfunction and reduce the quality of sperm [119-121]. Nicotine use is also associated with decreased fertility among females by disrupting ovulation and hormonal balance, damaging eggs and reproductive tissues and increasing miscarriage risk [122, 123](Figure 3).

Neurological and cognitive symptoms associated with nicotine use are often related to withdrawal, resulting from neuroadaptation. Regular users frequently experience sleep disorders, nervousness, irritability and weakened resilience. The body craves nicotine to feel normal, yet studies have shown an alteration in cognitive functions and mental health. The developing brain is particularly vulnerable, making nicotine exposure during pregnancy, early childhood and adolescence especially harmful. Nicotine exposure in the womb can harm the developing foetal brain by disrupting brain cell growth, wiring, and neurotransmitter systems, leading to learning, behavioural, and attention

problems later in life [26, 123, 124]. Adolescence is a sensitive period for the development of the limbic and dopamine systems, and animal studies suggest that nicotine exposure during this time may alter appetitive behaviours [125] (Figure 3).

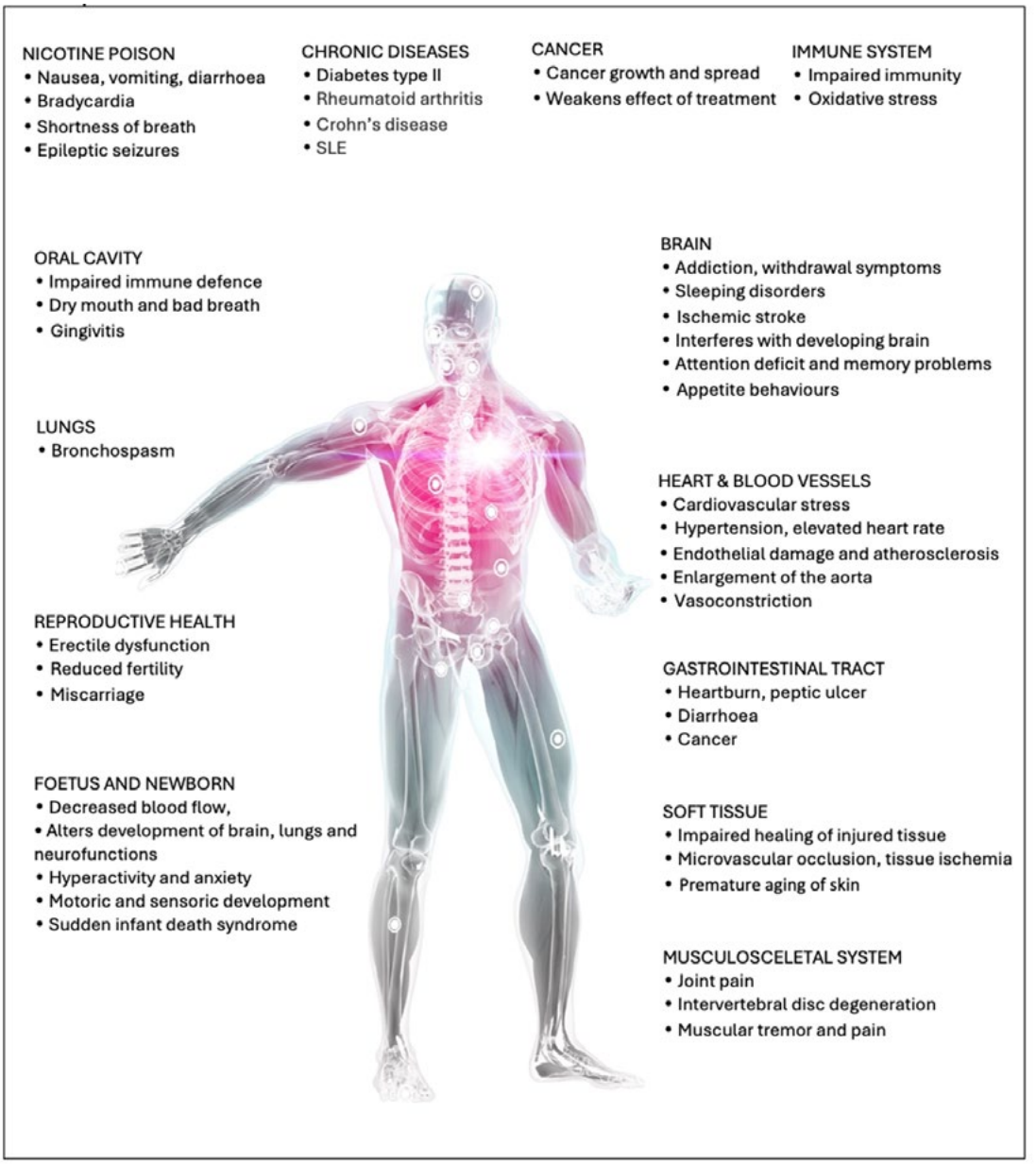

Figure 3 The harmful effect of nicotine on the body. Source for graphic: FDF, Free from nicotine products -micro short film.

Regular use of nicotine also affects the immune system through various mechanisms. Immunological studies suggest that nicotine alters the function of macrophages and T-cell mediated responses, leading to compromised protective inflammatory response and enhanced tumour growth [126-129]. Experimental studies indicate that nicotine may promote cancer growth through various signalling cascades, increasing oxidative stress and inducing metabolic changes in cells. Nicotine and its metabolites activate growth signals and inhibit apoptosis of cancer cells in vitro, while also enhancing the movement and spread of cancer cells [130]. Nicotine use has also been shown to worsen the effectiveness of cancer treatment by disrupting the pharmacokinetics of anticancer drugs [131]. Individual differences, the disease type, inflammatory and autoimmunological mechanisms, and the route and amount of exposure all affect the immune response [26].

Nicotine alters the chemoreflex that regulates breathing by reducing the sensitivity of nicotine receptors, a mechanism suspected to cause sudden infant death syndrome (SIDS) in infants of smoking mothers [132].

Interestingly, nicotine has been associated with decreased intensity or severity of Parkinson´s disease, ulcerative colitis, some forms of Alzheimer´s disease and even a severe form of sepsis and endotoxemia by reducing unbeneficial autoimmune responses [129, 133-135]. Medical research is still exploring the full extent of nicotine's role in these diseases, and while there is some evidence to suggest it may reduce the severity of certain conditions, the risks of nicotine addiction and other harmful effects should not be overlooked.

2.4.2 Tobacco smoke

Combustible cigarettes increase morbidity significantly. Smoking induces systemic low-grade inflammation, atherogenic dyslipidaemia and hyper-coagulability [136, 137]. The risk of dying from cardiovascular disease is five times higher in smokers under 50 years compared to non-smokers. [24, 72, 138].

Tobacco smoke contains an abundant number of carcinogens, including a high amount of TSNA and PAH as discussed previously on page 20, section 2.3.1. The chemicals weaken the immune system, and the DNA is damaged by the toxins. According to current knowledge, smoking predisposes the development of at least oral and lung cancer, cancer in the gastrointestinal tract, breast and cervical cancer, kidney and bladder cancer, prostate cancer and acute myeloid leukaemia [24, 72].

Smoking is the main cause of chronic obstructive pulmonary disease (COPD), which is caused by prolonged inflammation and damage to the lungs and airways. Approximately 3.23 million deaths worldwide are caused by COPD and smoking is the main cause in 9 out of 10 cases. Smoking increases the risk

for the development and progression of periodontal diseases ten-fold. Low-grade inflammation induced by smoking weakens the defence system in the oral cavity by affecting the mucosa, gingiva, crevicular fluids and saliva [139, 140].

Smoking has been associated with both acute infections such as respiratory infections and bacterial meningitis, and chronic systemic inflammatory diseases like rheumatoid arthritis, Crohn's disease, psoriasis, atopic dermatitis, lichen, acne and systemic lupus erythematosus. [118, 129, 133, 141]. Smoking is also a well-known risk factor for pustulosis palmoplantaris [118].

Prolonged exposure to tobacco smoke has many negative effects on the reproductive health of women, men and the child. Smoking is a well-known risk factor for erectile dysfunction caused by endothelial dysfunction, reduction of nitric oxide availability and increased oxidative stress [120]. Smoking impairs the function of sex glands and sperm production even in young males [142, 143]. Regular exposure to tobacco smoke reduces the function of the placenta, inhibits the growth of the foetus resulting in low birth weight and increases the risk of pregnancy complications and premature delivery. The newborn baby has an increased risk for sudden infant death syndrome [72]. The use of tobacco products may lower the fertility of both males and females. The chemicals in tobacco smoke may accelerate egg cell loss and bring menopause forward an average of two years [144].

2.4.3 Snus and non-medical nicotine pouches

Solid data show an increased risk for cancer and overall morbidity among regular smokeless tobacco users. However, smokeless tobacco includes a wide range of finely ground or processed tobacco products, that are chewed, snorted into the nose, placed in the oral cavity, dissolved in the mouth or heated through a device. The content of the tobacco product varies from pure dried leaves to processed tobacco that contains several harmful or carcinogenic chemicals. The number of tobacco-specific nitrosamines and other dangerous chemicals varies by product. The majority of research data concerning other smokeless tobacco products has been conducted in countries where the use of snu and non-medical nicotine pouches are rare [83, 145]. Snus manufacturers have therefore made efforts to suggest that snus is less harmful to health. However, reliable data, collected over several decades, show that also snus increases the morbidity and mortality of regular users. Non-medical nicotine pouches are novel products and data regarding the health effects is scarce. As discussed previously, the use of other smokeless tobacco products than snus and non-medical nicotine pouches is rare in Finland. Therefore, this chapter discusses mainly the health hazards of snus.

The health hazards of snus and nicotine pouches are the same as for nicotine in general. Typically, nicotine exposure is high in both products as discussed in section 2.3.2, which increases the risk for tobacco and nicotine-induced diseases. For example, the increase in blood pressure in both women and men is dose-dependent [26, 146]. Prenatal exposure to snus has been associated with higher blood pressure and altered heart rate variability in preschool children [147]. In addition, snus contains several carcinogenic and toxic chemicals described earlier in section 2.3.2. [72, 89, 148]. Snus is also highly addictive. The exposure time to snus is often long because each snus portion is kept in the mouth on average up to an hour and the absorption of the chemicals is continuous [85, 92, 96].

Regular use of snus causes changes in the oral mucosa. Keratosis and other lesions are common. The gingival recession may cause tooth sensitivity and root surface caries. Many users also suffer from bad breath and yellow teeth [86, 139, 149, 150]. There is evidence that snus use increases the risk for oesophageal and pancreatic cancer and possibly stomach and rectum cancer and weakens the treatment results of cancer. Globally smokeless tobacco is associated with increased risk for cancer in the oral cavity and pharynx [83, 151]. However, the association between snus use and increased risk of cancer in the oral cavity and pharynx is unambiguous because incidents are low in Sweden and Finland. Snus use combined with smoking increases the risk of cancer in the oral cavity [26, 151-154].

Several studies conducted mainly in Sweden suggest that the risk for type II diabetes and metabolic syndrome is elevated if the use exceeds 4 cans per week among men. It is uncertain if lower regular use increases the risk. Nicotine reduces insulin sensitivity through chronic adrenergic onset and metabolic response to chronic stress, but chronic inflammatory processes may contribute [155]. Further, snus use may increases the risk of obesity [26]. The risk for pregnancy complications, premature birth, low birth weight, stillbirth, and oral cleft malformation may be elevated [26, 156, 157]. The risk for erectile dysfunction is elevated caused by nicotine-induced vasoconstriction and oxidative stress [119, 125]. However, studies regarding erectile dysfunction caused by snus use are limited.

Regular snus use increases the mortality rate after a heart attack. Quitting snus use doubled the probability of survival [26, 146, 158-160]. The risk of acquiring and dying from a stroke is increased among regular snus users compared to non-users [26, 161, 162].

Research has shown that nicotine products administered orally, especially those requiring hand contact (e.g., nicotine pouches and snus), can increase infection risk. This is due to the potential transfer of pathogens from the hands

to the mouth, which facilitates the spread of infectious agents. Additionally, during the COVID-19 pandemic, studies suggested that users of smokeless tobacco products like snus might have an increased susceptibility to COVID-19. Some factors include repeated hand-to-mouth movements and the potential effects of nicotine on the immune response, including impaired mucosal defence and inflammatory response [163, 164].

2.4.4 E-cigarettes and non-combustible cigarettes

Distributing nicotine through devices, that do not generate smoke, is often considered as a less harmful choice and means of harm reduction. However, e-cigarettes and non-combustible cigarettes emit toxins including *polycyclic aromatic hydrocarbons* (PAH), volatile organic compounds (VOC), carbon monoxide (CO) and insoluble metals [109, 165].

The levels of oxidizing chemicals in e-cigarette vapour are much lower than in cigarette smoke, but differences between devices make it difficult to assess individual risks. Oxidizing chemicals can damage cell membranes, cause inflammation, and contribute to cardiovascular diseases. Nanoparticles and metal particles released from heating e-cigarette devices pose potential health risks, even though their concentrations are lower than in cigarettes [165]. For the time being, insufficient data regarding potential harm to health in long-term use hinders the evaluation of health hazards [166].

We do know that nicotine itself has several harmful effects on health, and it predisposes to the involvement of a substance use disorder [104]. The most common subjective health effects are throat and mouth irritation, headache, cough, and nausea [167, 168]. Vaping interferes with and reduces normal lung function [109]. E-cigarettes have also been associated with erectile dysfunction due to endothelial damage caused by vasoconstriction and oxidative stress [121]. In addition, cases of e-cigarette or vaping use-associated lung injury (EVALI) of previously healthy users have been linked to the use of tetrahydrocannabinol (THC)-containing products and vitamin-E acetate [169, 170].

2.4.5 Co-occurrence of tobacco use and chemical exposure as occupational health hazards

Tobacco products can significantly amplify the risk of work-related illnesses when workers are exposed to workplace chemicals. It is crucial to emphasize the importance of recalling detailed information about working conditions and practising proper hand hygiene.

In addition to environmental factors, genetic factors and diseases such as chronic inflammation also influence the development of cancer. The most

significant risk factors for cancer are tobacco and alcohol, which also enhance each other's effects and likely the effects of other carcinogens as well [171].

An illustrative case study described in Duodecim (2004) [172] highlighted a peculiar incident where a worker, who used polytetrafluoroethylene (PTFE, Teflon) spray to lubricate robot surfaces, developed a condition known as polymer fever due to smoking. While PTFE is typically safe to handle, the heat from the burning cigarette led to the thermal decomposition of the PTFE. Consequently, the compounds were transferred from the worker's unprotected and unclean hands to their mouth and, eventually, the system.

Studies have demonstrated that smoking significantly heightens the risk of cancer among workers exposed to various hazardous substances at work, including but not limited to aluminium, arsenic, asbestos, formaldehyde, lead dust, radon, sulfuric acid fog, nickel, silicate, silicate fibres, and crystalline silicon dioxide [173-176].

Furthermore, workers handling firearms face increased health risks due to lead dust exposure. Standard bullets often contain lead and lead primers, which, upon ignition, release lead particles into the air. Without proper ventilation, lead dust may settle on shooters' hands and clothing. Inhaling the dust or transferring lead particles to the system via contaminated hands poses significant health hazards. Tobacco users are particularly susceptible to lead exposure through contaminated hands. To mitigate these risks, it is imperative to adopt safe practices such as outdoor shooting, meticulous hand hygiene, and refraining from tobacco use during shooting sessions [177].

2.5 Pathophysiology of the development of substance use disorder

Nicotine and acetylcholine are structurally related and therefore bind to the nicotinic acetylcholine receptor (nAChRs). Both molecules contain a cationic nitrogen and hydrogen bond acceptor (Figure 5).

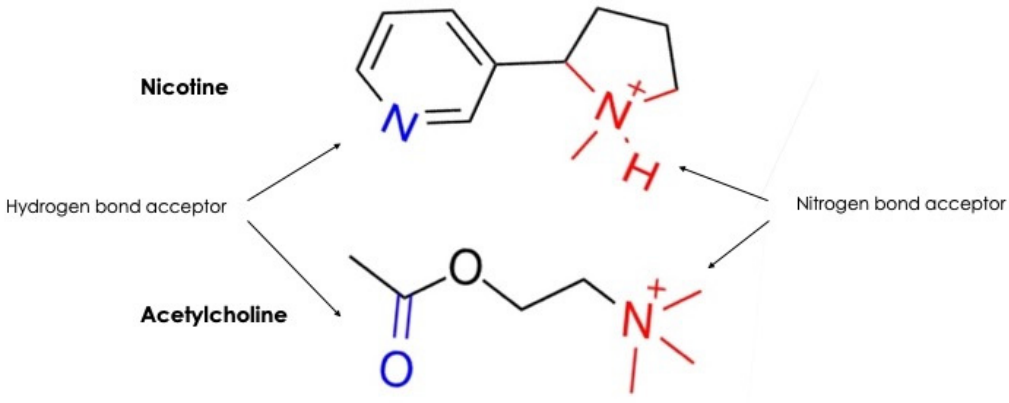

Figure 4 The molecular structure of nicotine and acetylcholine

2.5.1 Chemistry and neuropathology of nicotine

Nicotine is a highly addictive alkaloid neurotoxin extracted from tobacco plants, but it can also be manufactured synthetically [178]. All tobacco products such as cigarettes, non-combusted cigarettes, cigars, smokeless tobacco, hookah tobacco and most e-cigarettes contain nicotine [72].

Nicotine addiction is a complex disorder that involves multiple molecular mechanisms and is affected by genetic factors. The long-lasting nature of addiction is the result of repeated exposure to nicotine which induces the remodelling of synaptic connections in the brain [179, 180]. Nicotine is structurally related to the neurotransmitter acetylcholine, and it interacts with the nicotinic acetylcholine receptors (nAChRs) found throughout the body (Figure 4).

Presynaptic activation of nAChRs stimulates the release of several neurotransmitters from the neurons in the central nervous system (CNS) including acetylcholine, dopamine, norepinephrine, serotonin, glutamate, and γ-aminobutyrate (GABA). A large number of behaviours and brain functions are modulated by nicotine through this system. The effects depend on the location in the CNS and the structure of the receptor [178]. Studies suggest that the serotonergic (5-HT) system of the brain triggered by presynaptic

activation of nAChRs mediates many of nicotine´s behavioural effects [181]. The hypothalamus synthesises orexins (hypocretins) that regulate appetite, sleep and arousal, and addiction and reward. Nicotine has been shown to affect the same functions [182]. The endocannabinoid system modulates the motivation and reward process in the brain. Nicotine-induced dopamine release in the hypothalamic nucleus accumbens has a rewarding and addictive effect. In addition, several neurochemical systems contribute to the addictive effects of nicotine. Continuous exposure to nicotine makes changes in the acetylcholine receptors which leads to neuroadaptation that sustains the reinforcing effects of tobacco usage. [180, 183, 184] (Figure 5).

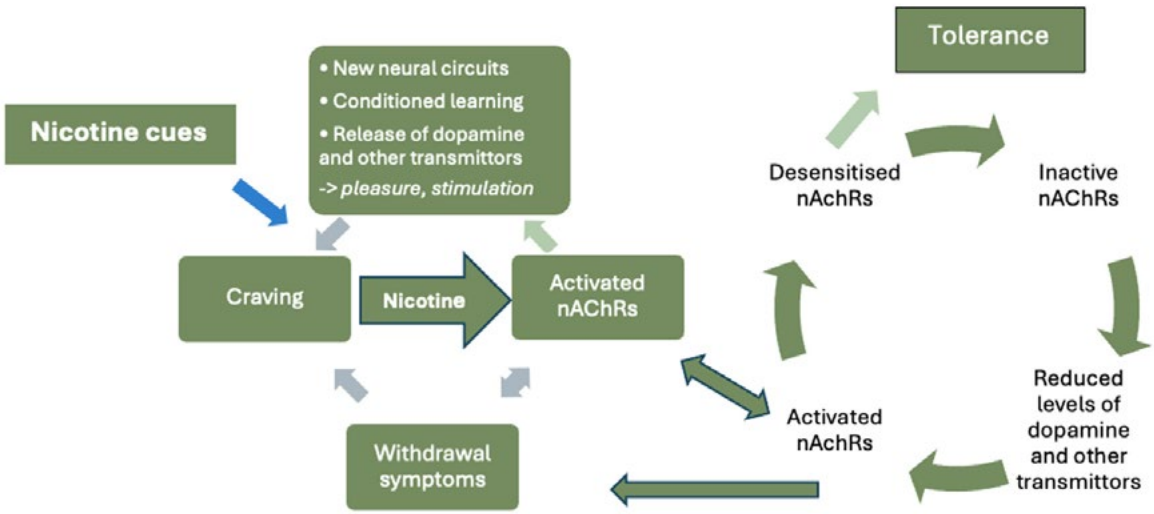

Figure 5 Nicotine induced neuroadaptation and behavioural changes that are triggered by nicotine cues. Adapted from Benowitz 1999: Nicotine addiction [180].

Nicotine-induced neuroadaptations as described above, play a crucial role in the development of addiction, and withdrawal symptoms (Figure 6). The brain adapts to dopamine release by downregulating the number of dopamine receptors that are stimulated. As a result, the rain's set point for pleasure changes. A continuous supply of the addictive substance is needed not to feel pleasure but to feel normal [180, 184].

Acetylcholine, dopamine, glutamate, γ-aminobutyric acid, and endocannabinoid signalling systems are subjected to studies that endeavour for treatment of nicotine dependence-induced withdrawal syndrome [80, 184].

2.5.1.1 Withdrawal symptoms

Withdrawal symptoms, which induce physiological, psychological, behavioural and social reactions are developed when the nicotine level decreases in the blood. Approximately 80% of quitters suffer from withdrawal symptoms, but only 15% experience severe withdrawal symptoms. Age, gender, resilience, and the level of dependence resonate with the perception of withdrawal symptoms [138, 185].

The most common symptoms are irritability, anxiety, sleeping disorders, malaise, impatience, craving for tobacco and nicotine, restlessness, attention deficiency, headache, development of craving for sweet food and increased appetite [138]. The mechanism is explained earlier in this section. Withdrawal symptoms begin usually between 2-12 hours after quitting the use of tobacco products. Physiological withdrawal symptoms usually refract in a few weeks. Many quitters perceive the psychological and social withdrawal symptoms as the hardest to defeat [138] (Figure 6).

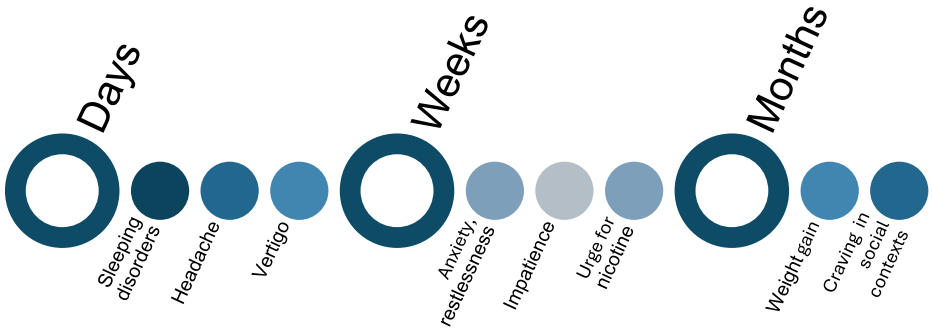

Figure 6 Average duration of the most challenging phase of withdrawal symptoms after quitting use of nicotine product. Source of data: Current care guidelines, Duodecim [138]

According to the learning theory, the response to a stimulus is learned, in which case the smoking situation includes conditioned stimuli to which the person responds by smoking, even if the level of nicotine in the blood does not require it. The content or type of stimulant is less important than a smoker's own expectations of stimulus-triggered tobacco cravings. Therefore, certain situations in which the smoker has previously smoked can act as stimuli. Typical examples are after a meal, when using alcohol or in certain social contexts such as during a work break or when meeting friends [185].

The craving for nicotine varies depending on the menstrual cycle and is the greatest during the luteal phase (the time between ovulation and menstruation) and lowest during the follicular phase (the time between the first day of menstruation and ovulation), which could be taken into consideration when planning the withdrawal programme [186].

2.5.2 The role of additives in tobacco and nicotine products

Tobacco products contain thousands of chemicals including many carcinogens and toxins. The addictiveness and appeal of tobacco products are enhanced by additives found in tobacco products. It is noteworthy to recognise the role of additives in the development of substance use disorders as current pharmacotherapies often result in a low success rate of quitting use.

Cigarette smoke for example contains several neurologically active compounds such as acetaldehyde, minor tobacco alkaloids and MAO inhibitors harman and norharmands [80]. Rose et al. showed in 2010 that test subjects preferred denicotinized tobacco smoke over intravenous nicotine. [187]

Snus contains several neurologically active ingredients, including minor tobacco alkaloids. Ammonium- and sodium carbonates are commonly used to regulate the rate of absorption and hence the strength of the product by maintaining a specific pH balance [70, 91]. In addition, a large selection of spices, oils and flavours increases the appeal of use as described in section 2.5 [91]. Flavoured snus, such as menthol or liquorish, were favoured by youth and young adult users according to Norwegian and Danish data [44].

It is important to understand the neurobiological changes that occur in response to exposure to nicotine and additives to develop effective pharmacotherapy for the treatment of nicotine addiction.

2.5.3 Individual differences and other factors affecting the metabolism of tobacco and nicotine users

Nicotine is metabolised by several different enzymes in the liver, of which the cytochrome P450 CYP 2A6 is the most important. The metabolism is affected by genetic variations of the enzymes, diets, gender, pregnancy, liver and kidney diseases, ethnic differences and pharmacological agents that induce or inhibit the metabolism in the liver. Nicotine weakens for example the effect of insulin and beta-blockers [188, 189]. Polymorphism of CYP1B1 has been associated with an increased risk of breast cancer among women who have been exposed to tobacco smoke [190].

The polycyclic aromatic hydrocarbons (PAH) found in tobacco smoke induce the function of the enzyme P450 CYP 1A2, which is also a central enzyme in drug metabolism. The effect of several psychiatric and antiarrhythmic drugs, theophylline, warfarin and drugs used for treatment of cancer weakens when the elimination rate increases. Inversely, the risk for side effects and even overdose increases when the metabolic rate is normalised from smoking cessation. This is particularly important for products for which the therapeutic width is narrow, such as theophylline and clozapine [189, 191]. The genetic variation can affect the total exposure to nicotine, as fast nicotine metabolisers

tend to smoke more, which may predispose them to smoking-induced diseases. In addition, the effect of pharmacotherapy may be insufficient among these individuals [192].

2.6 Measurements and estimation of nicotine dependence

The adverse health effects of tobacco products are dose-dependent. The risk of developing substance use disorders is affected by genetic predisposition, environmental, cultural and socioeconomic factors, and the amount and duration of exposure to nicotine [193, 194]. The level of addiction and subsequently the treatment methods vary between individuals [195]. A total of five validated instruments have been developed for smokers but only a couple are suitable for snus users.

2.6.1 Evaluation of the nicotine dependence of smokers

The two-question nicotine dependence test for smokers, the Heaviness of Smoking Index (HSI), which was developed by Heatherton et al. (1989) [196] and based on the original six-question Fagerström Test for Nicotine Dependence (FTND), is well-suited for everyday practice to determine the levels, from low-level to very strong dependence [196-198] (Table 1). The dependence is categorised into four levels according to the grading of the following questions: Time to the first cigarette of the day; Number of cigarettes smoked per day.

A new guideline for the recommendation of NRT in Sweden has simplified the estimation model of nicotine dependence for smokers. Only the number of cigarettes used per day is asked and roughly categorized into less than twenty cigarettes per day or more than twenty cigarettes per day. The guideline concludes that the second question regarding the time to the first cigarette taken after waking up can be useful when selecting NRT. The model is partly based on clinical experience in a lack of scientific studies [199].

The Cigarette Dependence Scale (CDS) by J-F. Etter et al. (2003), consists of five or twelve questions (two different versions) with similar psychometric features. The test is suited for evaluating both high and low-level dependence [200].

The Nicotine Dependence Syndrome Scale (NDSS) is a 19-item multidimensional validated questionnaire. The questionnaire assesses five aspects of nicotine dependence: Drive (craving, withdrawal and compulsion to smoke), Priority (The behavioural preference of smoking), Tolerance, Continuity

(the regularity of smoking) and Stereotypy (the rigidity of smoking patterns) [201]. The functionality of NDSS has been tested in a Finnish twin study [202].

Table 1 The two-question nicotine dependence test for smokers (HSI)

Question	Smokers	Points
Time to first cigarette of the day	< 6 minutes	3
	6–30 minutes	2
	31–60 minutes	1
	> 60 minutes	0
Number of cigarettes smoked per day	10 or less	0
	11–20	1
	21–30	2
	>30	3
Total score and interpretation:	0–1 = low nicotine dependence 2 = moderate dependence 3 = strong dependence 4–6 = very dependence	

Source: Adapted from 'Current care guidelines 2018, Duodecim [138]

Hooked on Nicotine Checklist (HONC) is a validated ten-item instrument with a focus on psychometric properties. It is suitable for adolescents and adults, and for smoked and oral tobacco products. HONC is a sensitive measure of early low-level dependence, as it has very good predictive value and even predicts relapse. HONC is available in 19 languages, including Finnish [203].

The Autonomy Over Smoking Scale (AUTOS) is a 12-question measure that assesses withdrawal, psychological dependence, and craving. It can be used for both adolescents and adults, and for smoked and oral tobacco. The test is unfortunately not available in any Nordic language [204].

2.6.2 Evaluation of the nicotine dependence of snus users

Boyle et al. (1995) developed a set of 9 and 10 questions to test the dependence of smokeless tobacco users [97]. Later, in 2006, Ebbert et al. introduced a six-question dependence test [205]. At the moment a longer six-question questionnaire is recommended for the evaluation of snus dependence in Finland [206]. In addition, the 10-question Hooked on Nicotine Checklist (HONC), which is also suitable for oral tobacco use, is available in Finnish [203]. However, it is questionable how frequently these tests are used in everyday practice.

The most significant correlation observed among smokeless tobacco users is the link between cotinine levels and the time to the first snus portion of the day [97, 196]. Boyle et al. verified earlier findings indicating that the duration and frequency of smokeless tobacco use are connected to cotinine levels. Additionally, a relationship between cotinine levels and a question assessing intentional swallowing of smokeless tobacco was identified [97]. However, assessing how much this correlation reflects the level of dependence is complicated due to individual metabolic variations and the liver's efficient metabolism. Nowadays, snus and pure nicotine are mainly used in portioned packages, preventing loose snus from being swallowed but allowing snus chemicals to dissolve into saliva.

A simplified evaluation system similar to the two-question dependence test for smokers has not been developed. Associate professor Agneta Hjalmarson at Sahlgrenska Academy, the University of Gothenburg's faculty of education and research in health sciences, and author of "Stödja patienter att sluta röka och snus", believes that it would be possible to divide snus users into high or low consumers respectively, similar to the model described for smokers [199]. She suggests that the evaluation of the level of dependence could be categorised accordingly: The snus can last for less than two days or over three days (private conversation with A. Hjalmarson in 2021).

2.7 Treatment of nicotine substance use disorders

The psychological component plays a key role in withdrawal and remission from use. Strong motivation and understanding of the mechanisms that evoke and maintain the dependence will increase the probability of maintaining a tobacco and nicotine-free life. For example, the craving to smoke is engendered by the expectation of the occurrence of smoking [185]. Therefore, behavioural interventions alone or in combination with pharmacotherapy are effective [207-209].

The *IARC Handbooks of Cancer Prevention Volume 19: Oral Cancer Prevention* [151] provides comprehensive guidelines on identifying risk factors, promoting early detection, and implementing evidence-based interventions to reduce the incidence of oral cancer globally. It serves as an essential resource for shaping public health policies and preventive strategies.

It is highly recommended that an individual withdrawal plan is made based on a discussion on the willingness and readiness to quit, and the level of nicotine dependence because it increases the probability to succeeding and remaining tobacco-free [138]. The process starts with building up a trusting and supportive environment. Discussion regarding the history of tobacco use

and habits, emotions connected to use and quitting, current life situation and concurrent addictions is important. It is recommended to perform a mini-intervention by applying the "five A´s" model: Ask about the use, Advise why quitting would be beneficial, Assess the willingness and attempt to quit, Assist the quit attempt and Arrange follow-up. It is recommended to document the withdrawal plan in the patient record system [138, 210].

Implementing the 5 R-model (relevance, risks, rewards, roadblocks, repetition) which provides tools for a more in-depth motivational conversation and aims at behavioural changes, can provide further assistance to raise the willingness to quit [138, 210]. Adolescents and young adults need tailored, low-threshold support services that take into account the specific characteristics of their age group and their tobacco habits [138, 211].

2.7.1 Non-medical treatment options

The mini-intervention, discussed above can solely evoke the motivation to quit. Continuous individual support and follow-up, and a multi-professional approach increase the success rate [209, 212]. Group support is equally effective as individual support and doubles the success rate for quitting and should therefore be easily available by healthcare providers, in schools and in other educational establishments [211, 213]. Online individual and group support as well as social peer support in the form of asynchronous communication has been shown to be effective [214].

A common challenge is weight gain, on average 3.0-5.5 kg during the first 6-12 months after quitting the use of nicotine products. It affects approximately as many as 80% of quitters. An individually planned weight management control strategy is effective and prevents relapses. Exercise intervention is effective in the long term [210, 215].

Mindfulness training can help quitters control and bypass the urge to smoke or use nicotine products [216, 217]. Hypnotherapy may be helpful for selected patients. However, the evidence is insufficient to determine if hypnotherapy is more effective than other forms of behavioural support [218, 219]. Current or former mental illness or condition, such as psychosis, schizophrenia, personality disorder, dementia, epilepsy, active drug or alcohol abuse and suicidality are usually contraindications for hypnosis [220].

Several studies have shown that exercise alleviates both the craving for nicotine and withdrawal symptoms. The effect is stronger and lasts longer if the intensity of the exercise is moderate or high. The mechanisms underlying this effect are not yet known [221, 222].

2.7.2 Nicotine replacement therapy

NRT includes a wide range of products containing a maximum of 4 mg of nicotine. These products are classified as pharmacotherapy and regulated under the Medicines Act (395/1987). Sale is allowed in pharmacies, shops, kiosks and service stations as over- the counter drugs, which have been granted a retail license [46].

NRT increase the level of nicotine in the blood enough to reduce the withdrawal symptoms without maintaining the dependence [193, 223]. They are effective when applied and used properly, especially for regular smokers using over ten cigarettes per day [138, 223, 224]. Some users may continue the use of NRT for years, in which case the addiction has not been emotionally and psychologically processed [225]. Guidance, evaluation of the level of nicotine addiction, and follow-up by a healthcare professional are recommendable [209]. NRT products have only an official indication for smokers over 18 years of age. However, NRT has been shown to be effective for the treatment of nicotine dependence in general [138, 223].

Snus, nicotine pouches, e-cigarettes and other non-combustible tobacco and nicotine products have been suggested as means of harm reduction. However, they cannot be recommended as they often contain a greater amount of nicotine, lead to frequent use and contain additives which maintain the addiction [26, 226, 227]. According to published literature, these products are not effective in smoking cessation and cannot be recommended for use as such. On the contrary dual use may inhibit successful smoking cessation [228].

2.7.3 Pharmacotherapy

Pharmacotherapy improves cessation results manyfold, especially when combined with behavioural support [229].

Varenicline

Varenicline has been shown to be the most effective therapy for aiding smoking cessation. It is 2.2 times more effective than placebo, 1.3 times more effective than NRT, and 1.4 times more effective than bupropion. Fagerström et al (2010) concluded that varenicline can also help snus users to quit [230, 231].

Varenicline is a nicotine receptor-specific substance that is commonly used to treat tobacco use disorders. It reduces the pleasurable effect of nicotine and the craving for nicotine by blocking the nicotine receptors in the brain and preventing the nicotine from attaching to receptors and hence blocks the effect of nicotine. At the same time, it acts as an agonist by maintaining moderate levels of dopamine to counteract the withdrawal symptoms [232].

Varenicline is well tolerated and is unlikely to be subject to clinically meaningful drug interactions [138]. The most common side-effect is the perception of realistic dreams. The side effects can be avoided by reducing the dosage by half. Varenicline is currently available in Europe, North America, parts of Asia and Oceania.

Cytisine

The generic drug cytisine is similar to varenicline and has been used effectively in Central and Eastern Europe since the 1960´s and in Canada since 2017 for smoking cessation. It is currently authorized only in four EU countries: Bulgaria, Latvia, Lithuania and Poland. From January 2024 it has been available in the United Kingdom as a prescription drug for cessation treatment. [233-235]

Bupropion

Bupropion is equally effective as NRT [236]. The recommended time for therapy is eight weeks [138]. Bupropion is primarily an atypical antidepressant. The effect of reducing the craving for nicotine is established by the inhibition of dopamine and noradrenalin reuptake and by reducing the stimulating effect of nicotine on the nicotinic acetylcholine receptors [237]. Repeated exposure to bupropion does not appear to weaken the effect. Side effects include sleeping disorders, dryness of the oral mucosa and rashes. There is an induced risk of suicide if the patient suffers from depression [138, 238]. Bupropion has several drug interactions and contraindications that should be taken into account when prescribing the treatment [138].

Nortriptyline

Nortriptyline has been shown to be effective in treating nicotine addiction, although the therapy has not acquired an official indication for this. Nortriptyline is an affordable option, and the effect is approximately the same as for bupropion [239].

The recommended treatment period is from eight to twelve weeks. Typical side effects are anticholinergic effects such as dryness of the mouth, obstipation, accommodation disorders and blurred vision. Orthostatic hypotension, palpitations of the heart and tachycardia are also common side effects. Nortriptyline can cause drowsiness and therefore it is recommended to take the drug in the evening [138].s

The effect of bupropion and nortriptyline is not based on the anti-depressants effects. Both drugs are equally effective on depressed and non-

depressed patients. Other anti-depressives and anxiolytics do not have similar effects on nicotine addiction [239, 240].

2.8 A brief overview of tobacco-related issues: policies, economic impact, occupational health risks, and environmental consequences

The steady global decline in smoking prevalence since the mid-70´s is a victorious example of effective and persistent tobacco control strategies and multidimensional collaboration between governments and organisations. However, the focus has been on cigarette use, which has left the use of other tobacco and nicotine products to lesser attention. The shrinking combustible cigarette market and the increased public awareness have forced the tobacco industry to develop and increase sales of alternative tobacco products. Many of these are presented and advertised as means of harm reduction for cigarette dependence. Consumers are invited to initiate or increase the use of nicotine and tobacco products by appealing packages that address selected target groups according to age, gender, and other demographic factors, often using information from social media. Consumers commonly personalise use by choosing among a vast variety of flavours (snus, nicotine poaches, cigarettes, e-cigarettes) and appealing packages. Some products taste like candy and the box is designed accordingly attracting young customers [90, 99].

2.8.1 Tobacco prevention policies and legislation

Tobacco taxation has been harmonized in the EU with the so-called Tobacco Tax Directive (2011/64/EU). The directive defines the taxed tobacco products, the boundary conditions of the tobacco tax structure and the minimum tax levels. According to the Tobacco Tax Directive, the total amount of unit and ad valorem taxes applied by the member states must exceed both the euro-denominated and the percentage minimum tax level. In Finland, the tobacco tax has been increased every year since 2009, except for the years 2009 and 2013. In addition, the VAT rate has increased over the years. [23, 241].

The sale of oral tobacco was banned in the European Economic Community in 1992 and later in the European Union under the Tobacco product directives (2001/37/EC, 2014/40/EU). Countries in the European Economic Area (EEA) must also transpose the EU directives on tobacco products into national law. In the 1990s, Sweden and Norway were granted an exemption on snus sales. However, sales and marketing to EU countries were prohibited [105, 242].

Several reports indicate that tobacco companies are targeting consumers beyond domestic markets. Strong and very strong snus, with a nicotine content of up to fivefold compared to traditional Swedish snus, which are specifically manufactured for the Finnish market, are widely advertised and easily available at online forums and at the borders. Illicit snus trade is common [47, 100, 101].

Within the EU, the minimum age for purchasing tobacco is 18 years, with the exception of Austria and Belgium, where sales are permitted to customers aged 16 years and over [243]. Flavoured cigarettes are prohibited throughout the EU [105], although some users circumvent this restriction by using flavour cards originally intended for dry foods [244]. Finland prohibits additives in all tobacco products. The sale of snus is prohibited in all EU states. However, Sweden has previously been exempted from these prohibitions [245].

In Finland, tobacco marketing is strictly controlled. Packaging must include health warnings and be kept out of direct view of customers [246]. The Tobacco Act was tightened in May 2022, banning flavoured cards or similar products, prohibiting smoking on public beaches and playgrounds to protect children from passive smoking, and to reduce littering and environmental harm, and as of May 2023, requiring plain packaging without brand images and logos [247]. Norway and Denmark have already adopted plain packaging measures; additionally, Sweden's new law mandates that packages display health warnings and content declarations also for tobacco-free nicotine products [29].

On January 1st, 2023, new legislation regulating tobacco-free nicotine products came into force. The legislation mirrors the existing regulations for tobacco products and e-cigarettes by imposing an 18-year minimum age and prohibiting marketing targeted at adolescents and young adults under 25 years [248].

Nicotine pouches were previously sold in Finland as nicotine replacement therapy (NRT) products when containing a maximum of 4 mg of nicotine. From May 2024 the sale of nicotine pouches was reclassified and is now prohibited under the Finnish Tobacco Act. The sale of nicotine pouches containing up to 20mg/g of nicotine and without flavour restrictions was permitted in Finland. However, the Finnish Parliament approved an amendment to the Tobacco Act, which bring nicotine pouches with a maximum nicotine content of 16.6mg/g per pouch under its regulation. The remaining flavours would be menthol and mint [46]. Health authorities have expressed concerns regarding the availability of excessively strong nicotine products and the allowance of menthol and mint. Their concern is that these measures may undermine efforts to discourage the use of smokeless tobacco use [102].

The WHO Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2023-2030 aims for a 40% reduction in tobacco use, including smoked and smokeless tobacco, by the year 2030 relative to

2010 [249]. Finland has set a goal to be nicotine-free by the year 2030 [250, 251]. A worrying trend in very high UN HDI countries is a decline in smoking cessation. Only six countries in the European region are expected to reach the goal. Finland is one of them [20].

2.8.2 The economic burden of smoking

The cost-effectiveness of tobacco control policies and preventive interventions is indisputable. Tobacco use increases morbidity by contributing to both acute and chronic diseases, which can impair performance and workability. The accumulation of health problems and socioeconomic challenges is not uncommon. The costs associated with tobacco-related illnesses and consequent sick leave are substantial for both society and employers [252-255].

The economic burden can be categorised into direct and indirect costs. Direct costs include healthcare expenses, sick leave benefits, disability and survivors' pensions, compensation for fire damage, and the costs associated with tobacco control and prevention. Indirect costs encompass productivity losses due to smoking-related deaths, disability periods, sick leave, and smoking breaks. While most calculations and evaluations focus on smokers, other nicotine and tobacco products, including snus, also have significant adverse health effects.

In the United States, the costs of smoking-related illnesses are estimated to exceed $300 billion annually [255]. In Finland, the annual direct costs of smoking are approximately EUR 295 million, with smoking-attributable income transfers amounting to EUR 330 million, resulting in a total of approximately EUR 630 million. Additionally, the indirect costs of smoking are estimated at EUR 900 million, bringing the total yearly economic burden for society to approximately EUR 1.5 billion [254].

On average, smokers are absent 1.5 to 3 times more often than non-smokers due to recurrent infections, influenza, asthma, chronic bronchitis, and cardiovascular diseases. Furthermore, smoking breaks reduce workplace productivity, with an estimated annual cost of EUR 3,000 per smoking employee for employers[250, 254]. The average annual expenditure on cigarettes per smoker is approximately EUR 2 000 [250].

Preventive measures, such as health screenings to identify early signs of health deterioration, brief interventions, health coaching, educational initiatives, and workplace exercise programmes, have been shown to be cost-effective [254-256]. Preventing the initiation of nicotine use among new users is equally important as providing cessation support and treatment for nicotine addiction. The implementation of effective government policies, such as increasing tobacco taxes, has been proven to reduce tobacco consumption [257].

2.8.3 The occupational health risks of tobacco farming and necessary safety precautions

There are approximately 33 million tobacco farm workers worldwide. Major producers are the US, China, Brazil, and India, but it is cultivated in African and South American countries as well. Currently, tobacco is grown in 12 EU countries, with 99% of production concentrated in Italy, Spain, Poland, Greece, Croatia, France, Hungary and Bulgaria. Germany, Romania, Portugal and Belgium contribute to the remaining 1% through small-scale cultivation. This covers approximately 2% of global production [38, 258]. A small amount of tobacco has been cultivated for personal use in Finland, Sweden and Denmark since the 17th century[259, 260]. Especially in low-income countries tobacco farming is associated with poverty, low labour standards, and human rights violations. Child labour is still a considerable problem in many developing countries. Even in the United States child farmworkers are unprotected by US labour law [261-263].

Tobacco farming exposes the worker to several generally acknowledged occupational health risks of agriculture, such as traumatic injuries, musculoskeletal disorders, hearing impairment, biological and chemical risks, and physiological stress. The use of pesticides is common in crop farming, which also may alter the health of the workers. [264-266]. In addition, workers who plant, cultivate and harvest tobacco are exposed to nicotine. The nicotine from uncured green leaves is easily absorbed through the skin. The risk is especially high in the morning when nicotine is dissolved in dew water or when wet from rain. The working clothes may be saturated with wet tobacco, which increase the area of absorption of the skin [264, 267, 268]. The tobacco may cause rashes when in contact with the skin. Further, tiredness, increased perspiration and salivation, increased heart rate, poor appetite, pallor, whole-body dull pain and insomnia have been associated with tobacco exposure among workers [266]. The Green Tobacco Sickness (GTS), is a known occupational illness [269, 270]. The symptoms usually start at work or several hours after work. Common symptoms are nausea, vomiting, dizziness, headache, abdominal cramps and fluctuation in blood pressure and heart rate [266, 270, 271].

Information on how to reduce the risk of nicotine exposure and increase safety at work is crucial. Employers should provide the workers with adequate protection, such as water-resistant gloves and clothing which is important when working with tobacco plants. Coverage increases the body heat and the risk of severe dehydration. Symptoms normally stop after 24 hours of exposure. However, at the moment there are no studies on the long-term effects for GTS. New workers, may have a higher risk of GTS, because of lower tolerance to nicotine exposure [269]. Children and adolescents are more sensitive to

chemical exposure and may suffer more serious health effects than adults [261, 269].

2.8.4 The environmental burden of the tobacco industry and consumption

Tobacco waste consists of nicotine, toxins and other chemical remnants, and nonbiodegradable filters, snus bags, devices and packaging materials, which is an ecological growing challenge [272, 273].

Tobacco farming covers an area of over four million hectares in 120 countries. Ending tobacco farming would liberate this land for alternative crop farming. The tobacco industry threatens the natural resources of the earth by depleting the soil, enhancing deforestation and climate change. The growing of tobacco leaves requires yearly 5.3-million-hectare land, 22.2 milliards cubic of water and the use of pesticides. The curing of the leaves demands wood, which increases deforestation. Each year approximately 6 500 hectares of forest is felled, and 8 million tons of wood is used. The manufacturing and transportation of tobacco products emit 84 million tons of greenhouse gases each year which is 0.2% of all emissions. The toxic residue and waste pollute the environment. The tobacco production produces 25 million tons of waste each year [258, 273-275].

One cigarette requires 3.7 litres of water, 3.5 grams of fossil fuels and emits 14 gram of greenhouse gases. The compensation for a smoker of 50 packyears requires planting 132 trees and growth for 10 years. The water consumed during this time would be sufficient to secure the basic needs of three persons for 62 years. The additional annual environmental footprint of an average regular red meat-eating (14.4 kg meat/year) smoker (7.3kg tobacco/year) is substantial: a smoker consumes over five times more water and two times more fossil fuels than a red meat eater who does not smoke [274].

2.9 The Finnish Defence Forces (FDF)

2.9.1 The Finnish military service

The FDF is based on a large reserve, which is produced by mandatory military service for all adult males by law [276]. All males are liable for call-ups at the age of 18 years. The military service or the non-military (civil) service must be completed by the age of 30. Voluntary military service for women has been possible since 1995 [277].

Entry into service takes place twice a year, in January and in July, forming yearly two contingents. The length of the military service depends on the training track. The minimum length is 165 days for rank-and-file-duties. Conscripts trained for demanding tasks serve for 255 days. At most, coscripts who are trained to be officers, non-commissioned officers or for the most demanding special duties serve for 347 days. Non-military service lasts 347 days. The auxiliary reserve begins after completing the military or non-military service until the age of 60 years. Refreshing training can be ordered during the reserve [278]. (Figure 7)

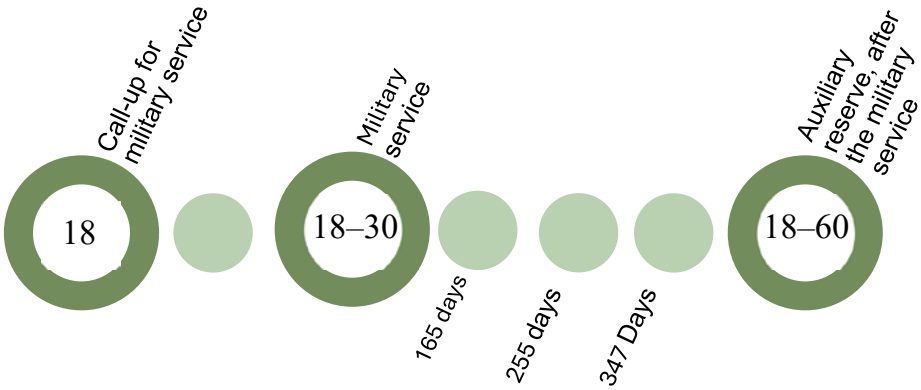

Figure 7 Illustration of the timeline for the mandatory Finnish military system for adult males [278].

Each year approximately 30 000 males are liable for call-ups. With some yearly variation, approximately 73-75% attend military service and a little less than 2% choose non-military service mostly for ethical or religious reasons. Yearly approximately 20% are exempted from the military due to lack of service eligibility caused by health issues, drug abuse or other suitability issues. An additional few per cent are dismissed due to personal reasons, for living abroad or because the individual possesses multiple nationalities [276, 278]. The popularity of women's voluntary military service has grown during the last few years. Until 2016 approximately 400-500 women volunteered yearly. However, after the year 2018 over 1000 women have started military service each year [279].

2.9.2 The Finnish Defence Forces as an employer

The FDF is a significant public employer and provides work for over 12 500 employees in different parts of Finland. In 2021 the mean age of all personnel was 41.7 years [280]. Two-thirds of the employees work in different military

positions and the majority are males (approximately 95%). A previous military service in the FDF is required. A third are civilian employees of which almost half are females. A third of all civilian personnel have an academic degree. Most of the civilian positions are within healthcare, information technology, engineering, administration or communication. The National Defence University provides a university education leading to an academic degree and is responsible for officer education. All employees are required to have a Finnish citizenship [278, 280].

The Centre of Military Medicine is part of the FDF Logistic command and employs almost 400 people. The Centre of Military Medicine provides healthcare for conscripts and personnel, is responsible for training in field medicine and leads military medicine research. There are a total of 18 health centres in different units in Finland [281].

3 AIMS OF THE THESIS

The overall aim of this thesis is to investigate tobacco habits among young adult males and to recognize the specific characteristics of snus and cigarette use, perception of the harmfulness of use, the level of dependence and willingness to quit use. In addition, the change in the prevalence of use of tobacco products and the preferred type of support among the personnel in the Finnish Defence Forces as part of the reporting process of the 'Promotion of a tobacco-free environment in the FDF' –project is evaluated.

The specific aims of the studies included are the following:

I To evaluate the prevalence of cigarettes, snus (Swedish type of smokeless tobacco) and dual use as well as the transition from one tobacco product to another among young adult male conscripts.

II To investigate the duration of daily exposure time to snus among occasional and daily users and its associated predictive factors among young adult male conscripts.

III To investigate the perception of the addictiveness and health risks associated with snus and cigarette use, as well as the factors associated with the willingness to quit both habits among young adult male conscripts. Additionally, the level of nicotine dependence among users is assessed.

IV To evaluate the prevalence and characteristics of daily smoking and snus use, identify predictive factors for quitting, and analyse the nicotine content of snus use among personnel in the Finnish Defence Forces.

The publications are referred to in the text by their roman numerals.

4 MATERIAL AND METHODS

4.1 The target population

The conscript study

Between the years of 2014-2016, a total of 94 314 males were liable for military call-up, of whom 71 883 (76.2%) commenced service (Figure 8). In addition 1 631 females (2.2%) undertook voluntary military service [279, 280]. The study sample was drawn from three military units, comprising 7 035 conscripts representing approximately 10% of all conscripts during the study years. Of these, 6 508 conscripts received the study questionnaire, and 4 706 conscripts (72%) were included in the final study population. A total of 527 conscripts (7.5%) were excluded from the initial study population, including females and conscripts assigned to specialised companies or those exempted from service during the initial weeks of training.

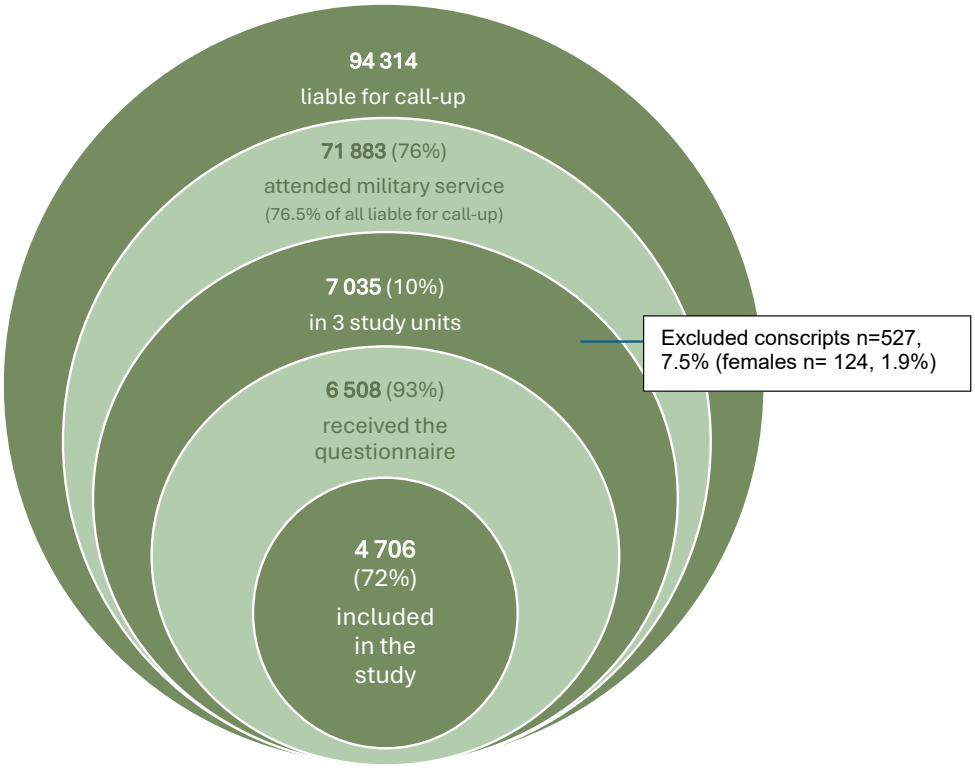

Figure 8 The target population of the conscripts in the years 2014-2016. Source: Statistics Finland [279].

The FDF personnel study

In 2014, the Finnish Defence Forces (FDF) employed 13,513 personnel, decreasing to 12,520 by 2020. Approximately 80% of employees were male, with 73% working in military roles (Table 2).

Table 2 he number and structure of the personnel in the Finnish Defence Forces

	Employees			**Military positions**			**Civilian positions**		
	Total	*Males*	*Females*	**Total**	*Males*	*Females*	**Total**	*Males*	*Females*
2020	12 520	10 176 (81%)	2 344 (19%)	7 808 (62%)	7 399 (95%)	409 (5%)	4 230 (34%)	2 308 (55%)	1922 (45%)
2014	13 513	10 911 (81%)	2 602 (19%)	8 005 (59%)	7 754 (97%)	251 (3%)	5 207 (39%)	2 885 (55%)	2 322 (45%)

Source: Personnel report, FDF [280]

4.2 Sampling

The conscript study

Three out of 16 military units — The Guard Jaeger Regiment, the Karelian Brigade, and the Kainuu Brigade were selected for their diverse geographical representation (Figure 9). The study units represented together 10% (n=7 035, years 2014-2016) of all conscripts (Figure 9). Companies were selected from the military units through random selection. The number of female conscripts or conscripts serving in special forces was too low to be representative of the age group at the population level (n=527, 7.5%)

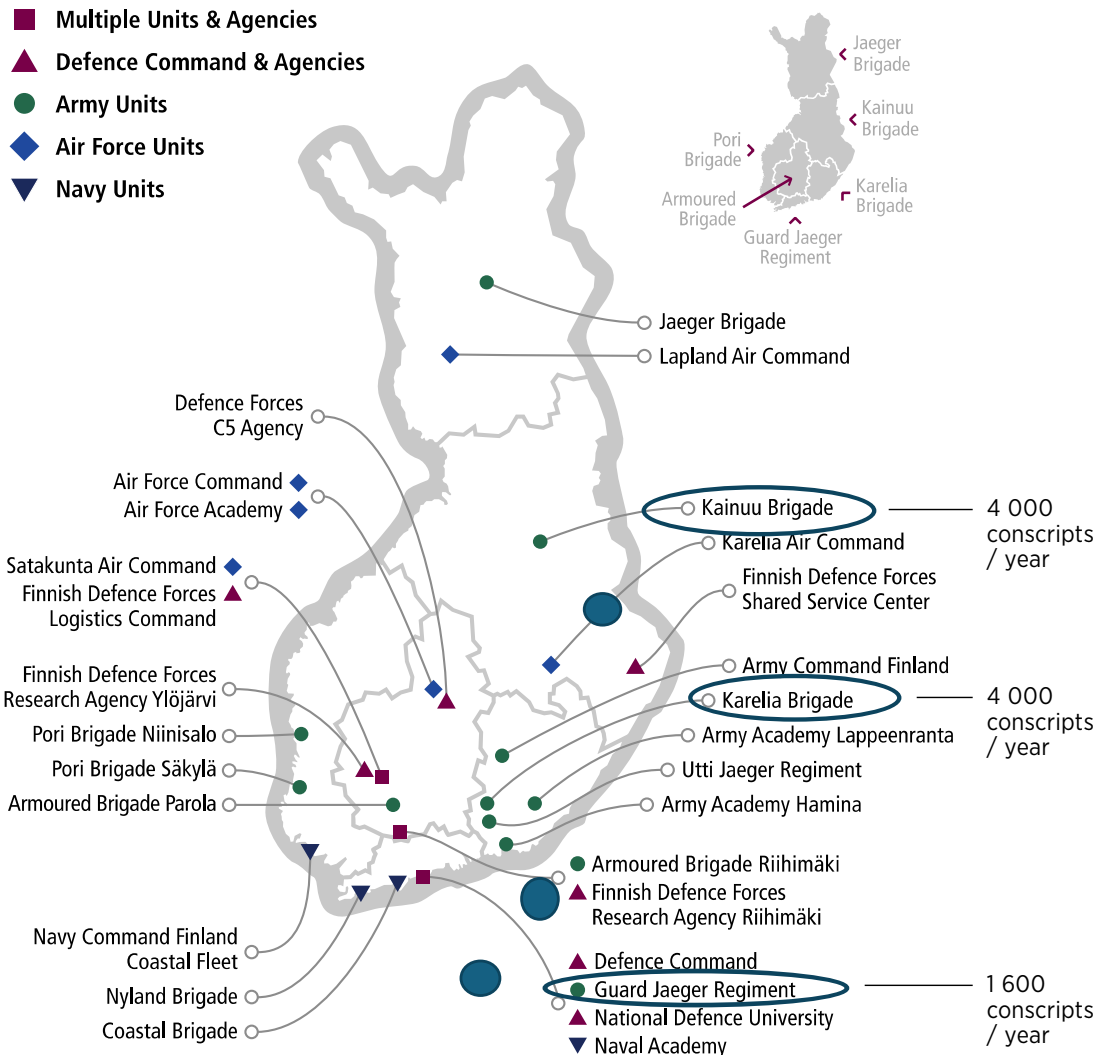

Figure 9 The location of the three study units, The Guard Jaeger Regiment, the Karelian Brigade and the Kainuu Brigade are encircled. Source: Finnish Defence Forces

The FDF personnel study

A total of 2386 out of 13 513 (response rate 18%) and 3373 out of 12 520 (27%) employees answered the personnel survey in 2014 and 2020 respectively (Attachment Form 3). The mean age of the respondents was 42.5 (SD ±11.8) in the year 2014 and 42.1 (SD ±11.1) in the year 2020.

Approximately 20% of the respondents worked in a military position among conscripts (22% in the year 2014 and 20% in the year 2020). The number

of respondents working in civil positions was 44% in the year 2014 and 35% in the year 2020. Approximately 3% of the respondents in the year 2020 were healthcare professionals. This subcategory was not included in the 2014 survey.

Of the respondents, 49% in 2020 and 38% in 2014 had a university degree and approximately a fifth (18%) of the cohort of 2020 and a third (29%) of the cohort of 2014 had other postsecondary education. A third (31% in 2020 and 32% in 2014) of the respondents had a secondary educational background.

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4.3 Data collection

The conscript study

The data for the conscript substudies (studies I-III) was collected as a questionnaire-based survey on paper during the general health inspection in the first week of military service for each contingent (January/July).

The questionnaire (see Attachment Form 1) included 25 questions covering demographics, tobacco habits, attitudes on tobacco use and willingness to quit use. In the year 2016, four additional questions assessed nicotine exposure time and dependence of snus (see Attachment Form 2, questions 26-29). WHO-recommended and validated questions for smoking and snus use were included [282]. Partially the same questions were included from The Adolescent Health and Lifestyle Survey 2011 and School Health Promotion Study 2011 [283, 284]. The questionnaire was piloted in The Guard Jaeger Regiment for the second contingent in 2013. To ensure anonymity, survey responses were coded in a pseudoanonymous form with an eight-digit identifier. The recording of the data was performed manually using a self-developed program that created a database in dBase format, which was later converted to Excel for delivery. Before implementation, path testing was conducted to ensure that all the execution paths of the form's storage functioned correctly and that each input was stored in exactly one database cell (i.e., every value was stored correctly, ensuring that no input was lost, and no data was mistakenly overwritten). The accuracy of

the recorded data was monitored through spot checks at the beginning of the process and during the material batch deliveries. Personal data and research material were kept separate.

In study I (2014), 1 971 male conscripts from two contingents were invited to participate, with 1 916 responding (response rate: 97.2%). The mean age was 19.4 years (± 1.1 years). Female participants (n=53, 2.7% of the respondents) were excluded from the analysis.

Study II (2016) comprised the contingents of the year 2016. Of 2 355 male conscripts with 1 280 responses (54% response rate) and a mean age of 19.5 years (± 1.3 years); female participants (n=34, 2.6%) were excluded.

Study III (2014-2016) surveyed 6 508 male conscripts including 4 706 males (72% response rate) with a mean age of 19.4 (± 1.2). Due to small numbers (n=124, 1.9% response rate and mean age 20.2, ± 2.4), female prevalence was analysed separately and excluded from the main analyses. (Table 3)

Table 3 The yearly male cohort and response rate for the sub-studies I-III (years 2014-2016).

	Study I	**Study II**	**Study III**
Year	**2014**	**2016**	**2014-2016**
Invited male conscripts (N)	1 971	2 355	6 508
Male participants (N)	1 916	1 280	4 706
Response rate (males)	97%	54%	72%
Females (N)	42	34	124

Pseudoanonymisation and personal data recording

The personal data retrieved from the surveys was coded in a pseudoanonymous form using an eight-digit identifier. The research material was processed without identifying data and only research numbers of the participants were used in connection with the processing of the material. The following logic of the eight-digit identifier (e.g. 11141001) was used: the first number describes if it is the first or the second follow-up query. The next three digits describe the contingent (e.g. 114 = 1/14), the fifth number describes the research unit (e.g. 11141001, 1 = The Guard Jaeger Regiment) and three the last digits are the respondent's research number. In addition, A commercial service provider was chosen to provide the transfer of paper-based data into an electronic database. The recording of the data was performed manually using a self-developed program that created a database in dBase format, which was later converted to Excel for delivery. The program replicated the layout and flow of the original

forms and included limit value checks for all inputs. Before implementation, path testing was conducted to ensure that all the execution paths of the form's storage functioned correctly and that each input was stored in exactly one database cell (i.e., every value was stored correctly, ensuring that no input was lost and no data was mistakenly overwritten). No duplicate entries were made. The accuracy of the recorded data was monitored through spot checks at the beginning of the process and during the material batch deliveries. In similar works where formal quality control measures were applied, the error rate for this recording method has typically ranged between 0.2 and 0.5 parts per thousand.

The FDF personnel study

The FDF personnel surveys (study IV) utilised an electronic questionnaire in the years 2014 and 2020 (see Attachment Form 3). The 2014 survey compromised 56 questions, while the 2020 version contained 62 questions, covering workplace demographics, tobacco habits, attitudes toward use and willingness to quit. The 2020 survey included six additional questions specifically on snus use.

The personnel surveys were anonymous and distributed via the FDF intranet "Torni". Hence no person register was created. To respond, an Internet link was available in which directed the respondent to answer the survey through the Surveypal survey tool managed by Filha. In 2020, upon opening the survey, the Deputy Chief of Staff, Personnel of the FDF sent a letter to the personnel, encouraging them to respond to the survey. Additionally, a banner was placed on the homepage of the FDF intranet (Torni), featuring promotional text and a link to the survey. A member of the research group sent a reminder email to units with very low response rate, urging them to share the survey link with their personnel.

4.4 Variables

The conscript study

The primary variables in the conscript studies (study I-III) were related to the use of cigarettes, snus use, and electronic cigarettes (Attachment Form 1). Participants self-reported their current and past use of tobacco products. Use status was categorised as *daily*, *occasional*, former, or *never* users. Daily use was defined as using a product every day, while occasional use referred to less frequent but ongoing use. Former users were those who had used a product previously but not at the time of survey completion. Respondents who indicated,

"I have never smoked or used snus on a daily basis" were classified as never users. Prevalence was measured as both absolute numbers (n) and proportions (%), representing the percentage of conscripts reporting use at the time of data collection. Due to low frequency of use, respondents who smoked self-rolled cigarettes, cigars or pipes were grouped with manufactured cigarette users in a single cigarette-smoking category.

Dual use of cigarettes and snus was determined by the concurrent daily and/or occasional use of both products. Participants were categorised into four groups: *daily users*, *occasional users*, *former users* and *dual users*. Transition between product categories were assessed by comparing the number of current users to those who had recently quit use.

The duration of cigarette smoking and snus use was calculated by subtracting the reported age at initiation from the participant's current age. Responses indicating age of initiation younger than nine years were excluded. For further analysis, the duration of use was measured in years.

Educational attainment was categorised into three levels: basic education (corresponding to 9 years of compulsory schooling; vocational education; and upper secondary education.

Study II (2016) introduced additional variables to explore snus use in more detail (Attachment Form 2). Participants reported the total number of years of snus use, the age at initiation regular use, the average number of daily snus portions, the typical use time per portion, and their perceptions of the health effects of snus. The reported duration of use per portion was categorised as: *less than 30 minutes*, *30–59 minutes*, *one hour or more*, *two hours or more*, and *three hours or more*. Perceived harmfulness of snus use was rated on a five-point scale: *not at all harmful*, *hardly harmful*, *neither harmful nor harmful*, or *very harmful*.

Mean daily exposure time to snus was estimated by multiplying the average number of daily portions by the lower and upper bounds of the categorised usage time intervals: *0–30*, *31–60*, *61–120*, *121* or more minutes per portion. Responses concerning the age at which regular tobacco use commenced were limited to those indicating initiation at nine years or older.

Study III (years 2014-2026) further examined quitting behaviours, perceived harmfulness and addictiveness, willingness to quit, and received recommendations to quit smoking or snus use. Variables included Previous quitting attempts: *none, one, two or more*; Perceived harmfulness of cigarettes/ snus: rated on a four-point scale (1 = not at all harmful, 4 = very harmful; Perceived addictiveness: rated on a three-point scale (1 being = not at all addictive, 3 = very addictive); Willingness to quit: *no intention, intention to quit within six months, or intention to quit after six months*; Quitting advice received in the past 12 months from *a doctor, nurse, healthcare professional,*

dentist, pharmacist, a family member, or *someone else*. The duration of snus use was calculated by subtracting the reported age of initiation from the conscripts current age

Estimation of the level of nicotine dependence

The validated two-question dependence test, the HSI, was used to estimate the level of nicotine dependence among smokers. The two items include the questions *time to the first snus portion of the day* and *the number of snus portions used per day*. The HSI categorise nicotine dependence into four categories: low 0–1 points, moderate 2 points, strong 3 points, and very strong 4–6 points [197].

A two-question dependence test, developed for this study and analogous to the HSI was used to estimate the level of nicotine dependence among snus users (Table 9). The score for the time to the first snus portion of the day was the same as in HSI: The first snus portion placed in the mouth within 6 minutes scored 3 points*; within 6–30 minutes*, 2 points*; within 31–60 minutes*, 1 point; and *after 60 minutes*, 0 points.

For scoring *the number of snus portions used per day* three categories were used (Table 9): 1–7 portions per day 0 points, 8–12 portions 1 point and more than 13 portions 2 points. This categorisation of snus use was adapted from the corresponding question in the six-question nicotine dependence test for snus users used in Finland [206]: To ensure a sufficient cumulative number of responses in each category the third point was omitted from the scoring as opposed to the HSI.

Based on these two questions, *time to first snus portion of the day* and *number of snus portions used per day*, nicotine dependence was categorised as follows: low dependence 0–1 points, moderate dependence 2 points, strong dependence 3 points, and very strong dependence 4–5 points. In 2014, these two questions for snus users were not included in the first questionnaire; consequently, the first of the two (1/II) contingent in 2014 was excluded from the dependence analyses. Sensitivity analyses confirmed that this exclusion did not affect the results.

The FDF personnel study

The primary outcomes of the personnel study were the prevalence of snus use, cigarette smoking, and e-cigarette vaping, as well as factors predicting attempts to quit smoking or using snus. The prevalence of use for cigarettes, e-cigarettes and snus use was assessed using the same categorisation system

as described previously in the conscript studies. Additionally, the 2020 survey included questions regarding the use of nicotine pouches.

The 2020 questionnaire (Attachment Form 3) collected more detailed information on snus and nicotine pouch use among regular users. This including the estimated nicotine content of the products used and the total daily exposure time to nicotine. The questionnaire also explored preferences for cessation support and whether participants had received advice to quit tobacco or nicotine products within the preceding 12 months.

The nicotine content of snus was categorised into the following intervals: *1–10 mg/g, 11–20 mg/g, 21–30 mg/g, 31–40 mg/g, over 40 mg/g, and I do not know* (the latter available only in 2020). Preferences for withdrawal support were classified into: *personal meetings with a healthcare professional, nicotine replacement therapy (NRT) or medication provided by the employer, mobile support, group support, support from family* or *friends, or no support needed.* Advice received to quit within the past 12 months was categorised according to the source: *a doctor, healthcare professional, dentist, dental hygienist, pharmacist, employer, family,* or *none of the aforementioned* (only in 2020). Given the timeliness and higher response rate of the 2020 survey, the primary results of the personnel study based on data collected on that year.

4.5 Statistical methods

Complete case analysis (listwise deletion) was employed in cross-tabulation calculations to address missing data by excluding participants with any incomplete information.

Statistical analyses in studies I-III involved the Chi-Square and Fisher's Exact Test to evaluate categorical variable associations (studies I-IV). The Mantel-Haenszel Trend Test for ordinal and the Gamma coefficient for ordinal variable correlation and the Marginal Homogeneity Test [285-287] was used for row/column proportion comparisons (studies I-III).

Studies II and III applied Multiple imputation by chained equations (MICE) to address missing data [288, 289]. Multiple imputation assumed that the data's missingness was missing at random (MAR). The median test was used for comparing snus-use characteristics, and Spearman's rho correlation to assess the relationship between the snus-use duration and quantity. An interval regression model was employed to analyse factors influencing daily snus exposure time. The Wald test was used in the regression models to examine the association between the independent predictor variables and the dependent criterion variable.

Study III incorporated ordinal regression analysis to model willingness to quit using proportional odds regression. Univariate analyses were performed with a p-value threshold of 0.2 for inclusion in the multivariate model. Variables selection was conducted using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Nicotine dependence estimation involved sensitivity analysis, excluding the year 2014 data and implementing multiple imputations (study III). The relative risk ratio (RRR) was used as the risk measure in the regression models (study IV).

All statistical analyses were performed using t SPSS (version 23.0, SPSS, Inc., Chicago, IL) and Stata (version 16.1). All methods were performed in accordance with the relevant guidelines and regulations.

5 ETHICAL CONSIDERATIONS

The study among conscripts was conducted as a survey, and therefore, the conscripts were not subjected to examinations or tests that could compromise their integrity. Data containing health information was not processed, except for information regarding nicotine product use. The study protocol was evaluated by the Medical Ethics Committee of the Helsinki and Uusimaa Hospital District, which issued a favourable opinion (Number 148/13/03/00/2013). With permission from the committee, four additional questions were added for the 2016 contingents. The Finnish Defence Forces (FDF) granted permission to conduct the study.

Participation in the survey was voluntary. Each recruit received written and verbal information about the survey before providing informed consent by signing a consent form. A numerical code was created to allow data analysis and combination without compromising respondent integrity. The data were anonymised by a third party before disclosure to the researchers and processed in compliance with the EU General Data Protection Regulation (EU 2016/679).

Conducting a survey almost immediately after enlistment can pose ethical challenges regarding the perceived voluntariness of consent. A military environment, which may feel unfamiliar and authoritarian to young recruits, could create pressure to comply with optional guidelines. Additionally, conscripts are required to complete other mandatory inquiries related to service performance and eligibility, which may make it difficult for them to assess their willingness to participate in the survey. This factor may have contributed to the unusually high response rate, particularly in 2014, compared to typical population-level surveys.

Upon reflection, the research group concluded that the benefits of the study outweighed the potential influence of the authority-conscription relationship on voluntary participation. The survey data provided valuable insights into smoking and snus use patterns in this age group, without including sensitive information. Furthermore, investigating attitudes toward tobacco and nicotine product use supported future intervention planning.

The personnel survey was conducted as part of the project 'Promotion of a Tobacco-Free Environment in the FDF.' Participation was voluntary and anonymous, with no personal data registry created. The FDF granted permission to conduct the surveys and approved the inclusion of selected results in this thesis. Ethical committee approval was not required for the personnel surveys.

6 RESULTS

6.1 Snus and cigarette use among conscripts (studies I, III)

Of the male participants 39 % (n=741) smoked and 34% (n=634) used snus either daily or occasionally in the year 2014. The proportion of daily tobacco product users was greater among smokers: 26 % (n=489) were daily smokers and 14 % (n=267) were daily snus users (Study I).

Table 4 show very similar results. The prevalence for female conscripts was calculated but excluded from further analysis because of small cohort. Smoking was more common compared to snus use among females. A total of 24% of females smoked cigarettes and 7% used snus. Of the female participants 13% were daily smokers and 4% were daily snus users (Study III). The use of e-cigarettes was uncommon, approximately 2.5% of respondents used e-cigarettes, and therefore their use was not further evaluated in any of the studies.

Table 4 The prevalence of snus use and smoking among young Finnish males and females during the years 2014-2016 (Study III)

		Daily user	Occasional user	Former user	Non-user
Males N=4706 Mean age 19.4, SD ± 1.2	Snus[1]	784 (17%)	864 (18%)	286 (6%)	2726 (58%)
	Cigarettes[2]	1172 (25%)	627 (13%)	420 (9%)	2455 (52%)
Females N=122 Mean age 20.2, SD ± 2.4	Snus[3]	5 (4%)	4 (3%)	3 (2%)	110 (89%)
	Cigarettes[4]	16 (13%)	13 (11%)	11 (9%)	83 (67%)

[1] Information missing for 46 cases (1%,) [2] Information missing for 32 cases, 0.7%.
[3] missing 2, 1.6%, [4] missing 1, 0.8%

6.1.1 Dual use of snus and cigarettes

Nearly one-fifth (21%, n=402) of snus users and smokers were daily or occasional dual users. Among daily snus users 17% (n=45/267) also smoked daily, while and of daily smokers 9% (n=45/489) of daily smokers reported daily snus use. Additionally, 28% (n=74/267) of daily snus users smoked occasionally,

and correspondingly 41% (n=201/489) of daily smokers occasional used snus (Study I).

The findings from the larger cohort (study III) were consistent: 11% (n=128) were daily dual users, while 28% (n=229) of daily snus users smoked occasionally, and 42% (n=491) of daily smokers occasionally used snus.

6.1.2 Transition between snus use and smoking after quitting

Transition between snus use and cigarette smoking, as well as vice versa, were commonly observed (Study I). Slightly over one-third (35%, n=56) of former daily smokers reported current daily use of snus, while 43% (n=52) of former snus users had become daily smokers. Conversely, 20% (n=31) of former smokers had quit both smoking and snus use, and a 26% (n=31) of former snus users had quit smoking, resulting in abstinence from both products.

This pattern was further confirmed in a larger sample presented in Figure 10 (Study III). Among former smokers, 53% had transitioned to daily snus use, while 48% of former snus users had started smoking. Additionally, approximately one-third had successfully quit both snus use (37%) and smoking 29%. Gamma coefficient = -0.32 shows moderate monotonic inverse relationship between transition from snus use to smoking and vice versa ($p < 0.001$).

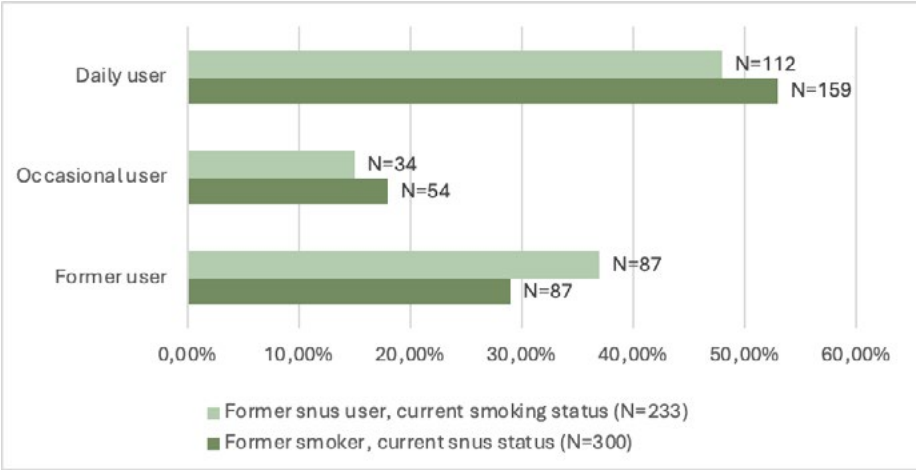

Figure 10 Transition from snus use to smoking among daily and occasional users and contrariwise or quitting both snus use and smoking, years 2014-2016, (n=4706, study III).

6.1.3 Snus and cigarette use according to the educational background

A strong correlation was observed between educational level and smoking ($p<0.001$). Smoking was most prevalent among respondents with only a basic comprehensive education (57%, n=113) and least common among those with an upper secondary education (10%, n=96). Respondents with a vocational education fell between these groups, with 39% (n=282) reporting smoking. In contrast, there was only weak evidence of a correlation between snus use and educational background ($p=0.690$) (Study I).

Figure 11 presents consistent findings: 16% of respondents with an upper secondary education and 18% of those with either vocational or comprehensive education reported using snus. No significant correlation was found between snus use and educational background based on the linear-by-linear association test ($p=0.135$). However, the association between smoking and educational background remained strong ($p<0.001$) (Study III).

It is worth noting that approximately 90% of the respondents had either a vocational or upper secondary education, resulting in a relatively small number of participants with only a basic education. Despite this limitation, the statistical analyses confirmed the robustness of the results.

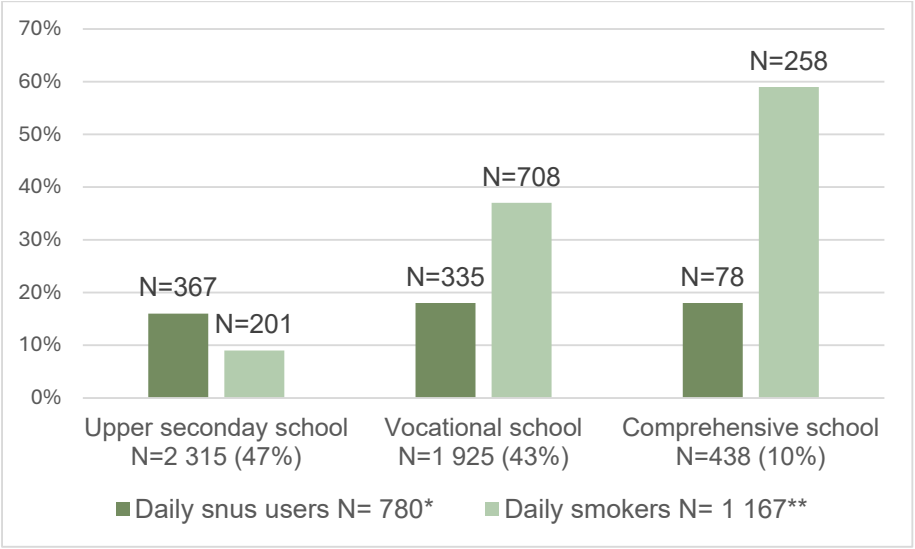

Figure 11 Daily use of snus and cigarettes by the education, years 2014-2016, (N=4706). Missing information for * n=4, ** n=5.

6.2 Exposure time to snus and cigarettes (study II)

6.2.1 Starting age, duration of use, and amount of daily use

The 2016 questionnaire included additional variables that allowed for the calculation of exposure time to snus and cigarettes. The cohort consisted of 1,280 male conscripts. The analysis revealed clear differences between daily and occasional snus users in terms of starting age, duration of use, and the average daily consumption of snus portions and cigarettes. The p-values were calculated using the Median test.

As shown in Table 5, the median starting age for snus use was 16 years among daily users and 17 years among occasional users (median test $p<0.001$). Daily snus users consumed an average of 10 portions per day, whereas occasional users consumed only three portions per day on average ($p<0.001$). The median duration of snus use was three years for daily users and two years for occasional users ($p<0.001$).

Table 5 Measures for snus use; starting age, duration of use, and portions per day in the year 2016*

	Snus[1] *n*=451					
	Daily			**Occasional**		
	N	**Median (mean)**	**range**	***N***	**Median (mean)**	**range**
Starting age (mean years)	218	16 (16.2)	12-20	100	17 (17.3)	14–27
Duration of use (mean years)	215	3 (3.2)	0–7	95	2 (2.4)	0–8
Amount of use (mean snus portions per day)	217	10 (9.6)	2–23	157	3 (4.4)	0–20

* Multiple imputation assumed that the data's missingness was missing at random (MAR). The association persisted, and the result did not significantly change, except for the age of the respondent, which did not affect the outcome.

Table 6 demonstrates that the median starting age of smoking was 15 years among daily smokers and 17 years among occasional smokers (median test $p<0.001$). Daily smokers had nearly two years longer history of smoking than occasional smokers (median 5 years vs 3 years) ($p<0.001$). The median number of daily cigarettes was ten among daily smokers and one among occasional smokers ($p<0.001$).

Table 6 Measures for cigarette use; starting age, duration of use, and amount per day *

	Cigarettes[2] *n*=403					
	Daily			**Occasional**		
	N	**Median (mean)**	**range**	***N***	**Median (mean)**	**range**
Starting age *(mean years)*	267	15 (14.7)	10–20	136	17 (16.6)	10–22
Duration of use *(mean years)*	270	5 (4.9)	0–15	136	3 (2.9)	0–10
Amount of use *(mean cigarettes per day)*	333	10 (12.6)	2–47	150	1 (1.9)	0–30

* Multiple imputation assumed that the data's missingness was missing at random (MAR). The association persisted, and the result did not significantly change, except for the age of the respondent, which did not affect the outcome. Adapted from Danielsson et al. (2021) [290].

6.2.2 Duration of snus kept in the mouth

Figure 12 illustrates that daily snus users kept the portions in their mouths for a longer duration compared to occasional users. The majority of daily users (61%) reported a daily usage time of 31 to 60 minutes. The specific number of portions used during each usage period was not assessed and therefore remains unknown.

Only 30% of daily users reported keeping snus in their mouths for 30 minutes or less. In contrast, approximately half of the occasional users (52%) kept snus in their mouths for a maximum of 30 minutes, while 43% reported usage times between 31 and 60 minutes.

The difference in exposure time between daily and occasional users was statistically significant ($p<0.001$). Additionally, a positive linear correlation was observed between the number of snus portions used and the duration of use, as indicated by Spearman's Rho (0.4, $p<0.001$).

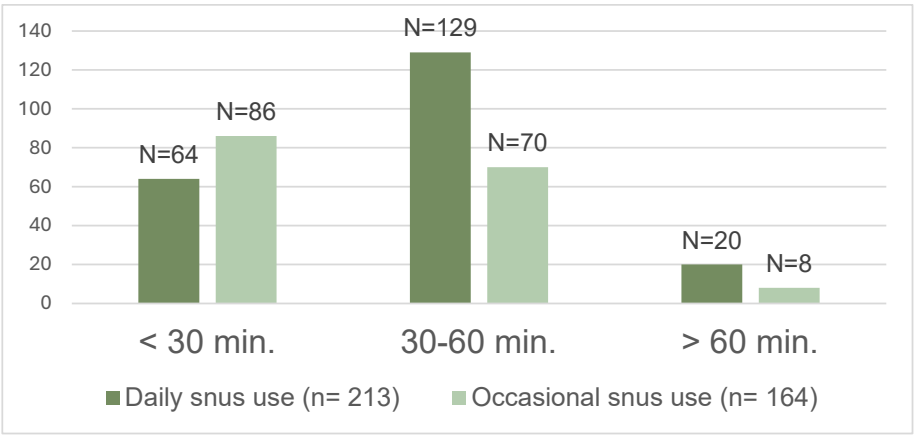

Figure 12 The duration of usage for daily and occasional snus users.

6.2.3 Total exposure time to snus

The mean daily exposure time to snus was six hours and 12 minutes per day among daily users and two hours and 19 minutes per day (on the days when snus was used) among occasional users (Figure 13).

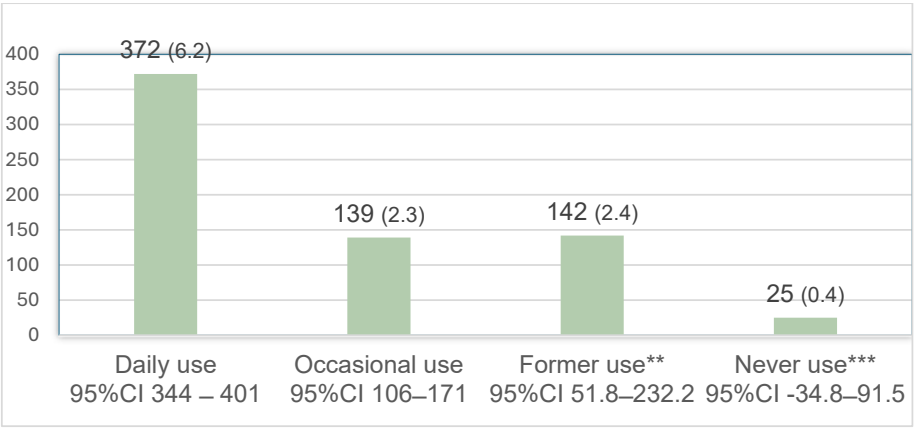

Figure 13 Total daily exposure time in minutes (hours) to snus in relation to use status (N=271*). **Answer for questions: The number of snus portions used per day and the average using time per one portion. Total exposure time to snus = snus portions/day x the time in minutes that the snus portion was kept in the mouth. **Previous snus use, recently quitted. ***3.2% (24/740) used 1–5 portions/day when reporting themselves never users/never regularly used, and the rest reported 0 portions.*

6.2.4 Predictive factors of total exposure time to snus

The correlation between the duration of snus use and the daily total exposure time was strong, as indicated by the Wald test of confidence interval. On average, the total exposure time increased by 45 minutes per day for each additional year of use ($p<0.001$).

An inverse correlation was observed between the respondent's age and exposure time: with each additional year of age, daily snus use decreased by 25 minutes.

Educational background also influenced total exposure time. Respondents with an upper secondary education had a significantly shorter daily exposure time—141 minutes less—compared to those with a basic comprehensive education ($p=0.036$, Wald test). However, no significant difference was found for respondents with a vocational education (-36 minutes, $p=0.556$) after adjusting for age and tobacco use history.

Occasional smoking was associated with a more than one-hour increase in daily snus exposure time ($p=0.054$, Wald test). In contrast, daily smokers were less likely to use snus compared to non-smokers ($p=0.033$).

Finally, respondents who perceived snus as harmful to health had a significantly lower total daily exposure time, with an average reduction of 85 minutes ($p=0.025$) (see Table 7).

Table 7 Linear regression analysis of factors affecting the total time of snus use per day in 2016

Predictive factor	Effect of daily total exposure time in minutes (95%CI in minutes)	p-value***
Duration of snus use*	46 (29 – 643)	<0.001
Age of respondent**	-25 (-47 – -3)	0.026
Comprehensive school	0	
Vocational school	-36 (-155 – 84)	0.556
Upper secondary education	-141 (-272 – -9)	0.036
Never regularly smoked	0	
Daily smoker	-78 (-150 – -6)	0.033
Occasional smoker	72 (-1 – 145)	0.054
Former smoker	45 (-26 – 117)	0.211
Snus perceived as harmless	0	
Perceived neither as harmless nor harmful	-59 (-135 – 16)	0.123
Perceived as very harmful	-85 (-159 – -11)	0.025

The number of participants: n=308. Negative effect in minutes refers to factors decreasing the total use time. Positive effect in minutes refers to factors increasing it compared with the reference (0 minutes). *Each additional year of snus use increased the daily total exposure time by46 minutes. **Each additional year of the respondent's age decreased the daily total exposure time by25 minutes. Snus use was less common among the older respondents. ***p-value provided by Wald-test. Adapted from Danielsson et al. (2021) [290].

6.3 Perceptions on snus use and smoking on health (study III)

Study III included all participants from the years 2014-2016. A total of 4 706 males (response rate: 72%), representing 5 % of all males (n= 94 314) liable for call-up, along with 124 female respondents. The mean age was 19.4 years (SD ± 1.2) for males and 20.2 (SD ± 2.4) for females.

6.3.1 Perceptions of the harmfulness of snus use and smoking on health

The majority of participants (58%, n=2,600) perceived snus as harmful on health; however, only 21% (n=956) considered it very harmful. Approximately one-third (33%, n=1,466) perceived snus as neither harmful nor harmless, while 9% (n=414) regarded it as harmless.

In comparison, nearly 90% of participants perceived smoking as harmful, with 45% (n=2,012) considering it harmful and 43% (n=1,959) viewing it as very harmful. A small proportion (11%, n=476) considered smoking to be neither harmful nor harmless, and only 2% (n=62) perceived it as harmless (see Table 8).

Table 8 Perceptions on harmfulness of snus use and smoking on health

	Very	Clearly	Neither harmful nor harmless	Hardly	Not at all
Snus use (n= 4480)	21%	37%	33%	8%	1%
Smoking (n=4509)	43%	45%	11%	1%	1%

6.3.2 Perceptions of the addictiveness of snus use and smoking

Nearly two-thirds (65%, n=2,872) of respondents considered snus to be addictive, with 29% (n=1,279) perceiving it as very addictive and 36% (n=1,593) as clearly addictive. In contrast, 26% (n=1,159) regarded snus as neither addictive nor non-addictive, while 10% (n=429) believed it was not addictive at all.

Smoking was more consistently recognised as addictive. Almost 80% of respondents perceived smoking as addictive, with 38% (n=1,715) considering it very addictive and 41% (n=1,824) clearly addictive. Meanwhile, 16% (n=722) regarded smoking as neither addictive nor non-addictive, and 5% (n=238) believed smoking was not addictive at all (see Table 9).

Table 9 Perceptions on addictiveness of snus use and smoking

	Very	Clearly	Neither addictive nor not addictive	Hardly	Not at all
Snus use (n=4460)	29%	36%	26%	7%	2%
Smoking (n=4499)	38%	41%	16%	4%	1%

6.4 Willingness to quit use (study III)

Almost half (45%) of daily snus users and half of daily smokers (49%) expressed willingness to quit use. P-values below are provided by Wald-test of confidence interval.

6.4.1 Predictive factors affecting the willingness to quit snus use

In the univariate analysis, the willingness to quit snus use was positively associated with the perceived harmfulness of use (clearly harmful: OR 3.19, 95% CI 2.09–4.86, p<0.001), previous quit attempts (two or more attempts: OR 4.17, 95% CI 2.88–6.05, p<0.001), and receiving advice to quit from a healthcare professional, dentist, pharmacist, family member, or another individual (OR 1.54, 95% CI 1.07–2.21, p=0.019).

Table 8 shows that, in the final multivariate model a significant positive correlation remained between the perceived harmfulness of use and the willingness to quit (clearly harmful: OR 3.09, 95% CI 1.94–4.93, p<0.001). Previous quit attempts showed a strong correlation with willingness to quit: one quit attempt within the past six months increased the odds of quitting nearly threefold (OR 2.67, 95% CI 1.81–3.94, p<0.001), while two or more previous attempts increased the odds almost fourfold (OR 3.65, 95% CI 2.44–5.40, p<0.001). However, receiving advice to quit increased the odds by only 25% (OR 1.25, 95% CI 0.90–1.99) when all confounding factors were accounted for. Neither the duration of snus use nor the respondent's educational background was significantly associated with the willingness to quit (p>0.2). P-value provided by Wald-test of confidence interval.

Table 10 The final multivariate logistic regression model for daily snus users' willingness to quit snus use

Variable		**Multivariate analysis**			
		N (%)	OR	95% CI	P-value
Perceived harmfulness of use	Not at all	148 (21%)	1		
	Neither harmless nor harmful	313 (43%)	**1.72**	1.09 – 2.72	0.021
	Clearly harmful	260 (36%)	**3.09**	1.94 – 4.93	< 0.001
	Total	721			
Quit attempts of use	No attempts	379 (54%)	1		
	One	165 (24%)	**2.67**	1.81 – 3.94	< 0.001
	2 or more	158 (23%)	**3.63**	2.44 – 5.40	< 0.001
	Total	702			
Perceived addictiveness of snus	Not at all	66 (9%)			
	Neither addictive nor not addictive	193 (27%)			
	Very addictive	465 (64%)			
	Total	724			
Received advice to quit snus use	No	156	1		
	Yes	514	1.25	0.90 – 1.99	0.145
	Total	670			

*Relative order of the outcome values used in the regression: not willing to quit; willing to quit after six months; willing to quit within six months. N=daily snus users. OR Multivariate analysis: information missing for 105/628 cases. * Excluding the first cohort of two cohorts in 2014.*

6.4.2 Predictive factors affecting the willingness to quit smoking

Earlier quit attempts (OR 2.71, 95% CI 2.08–3.54), the perception of smoking as harmful (clearly harmful: OR 3.68, 95% CI 2.68–5.05) and addictive (very addictive: OR 1.88, 95% CI 1.07–3.32), along with advice to quit from a healthcare professional, dentist, pharmacist, family member, or another individual (OR 1.83, 95% CI 1.34–2.61), were associated with a greater willingness to quit smoking in the univariate analysis. In contrast, a higher level of dependence showed an inverse association with the willingness to quit.

In the final multivariate model (Table 9), one quit attempt within the past six months more than doubled the likelihood of being willing to quit (OR 2.34, 95% CI 1.77–3.10), while two or more previous attempts increased the probability more than threefold (OR 3.22, 95% CI 2.32–4.49). Receiving advice to quit smoking raised the probability by 65% (OR 1.65, 95% CI 1.17–2.32).

A strong (OR 0.63, 95% CI 0.44–0.89) or very strong (OR 0.43, 95% CI 0.26–0.71) level of dependence was inversely correlated with the willingness to quit. The perception of cigarettes as addictive indicated a positive trend for willingness to quit smoking (OR 1.74, 95% CI 0.93–3.26). However, educational level, dual use of snus and cigarettes, smoking duration, and perceived harmfulness of smoking did not show a significant association with the willingness to quit in the multivariate analysis ($p > 0.2$). P-value provided by Wald-test of confidence interval.

Table 11 A multivariate logistic regression analysis for daily smokers' willingness to quit smoking

Variable		**Multivariate analysis**			
		N (%)	OR	95% CI	P-value
Perceived harmfulness of use	Not at all	37 (3%)	1		
	Neither harmless nor harmful	223 (21%)	1.43	0.59 – 3.41	0.427
	Clearly harmful	822 (76%)	2.28	0.98 – 5.32	0.057
	Total	1 082			
Quit attempts of use	No attempts	561 (53%)	1		
	One	317 (30%)	**2.34**	1.77 – 3.10	<0.001
	2 or more	190 (18%)	**3.22**	2.32 – 4.49	<0.001
	Total	1 068			
Perceived addictiveness of smoking	Not at all addictive	48 (4%)	1		
	Neither addictive nor not addictive	192 (18%)	**0.99**	0.50 – 1.95	0.971
	Very addictive	844 (78%)	**1.74**	0.93 – 3.26	0.086
Received advice to quit smoking	No	189	**1**		
	Yes	895	**1.65**	1.17 – 2.32	0.004
	Total	1084			
Level of cigarette dependence	No/low dependence	541 (49%)	1		
	Moderate	261 (24%)	**0.99**	0.74 – 1.33	0.947
	Strong	205 (19%)	**0.63**	0.44 – 0.89	0.008
	Very strong	88 (8%)	**0.43**	0.26 – 0.71	0.001
	Total	1 095			

Relative order of the outcome values used in the regression: not willing to quit; willing to quit after six months; willing to quit within six months. N=daily smokers. OR Multivariate analysis: information missing for 51/1044 cases.

6.5 The level of nicotine dependence among snus users and smokers (study III)

6.5.1 The two-question nicotine dependence test for snus users and smokers

Table 10 presents the nicotine dependence levels among daily male smokers and snus users (N=767), assessed using the HSI nicotine dependence test for smokers and a modified two-question nicotine dependence test for snus users. The method is detailed in section 4.3.4.1: Outcome variables.

Table 12 The modified two-question nicotine dependence test for smokers and snus users

	Smokers	**Snus users**	**Points**
Time to first cigarette / snus portion of the day	< 6 minutes	< 6 minutes	3
	6–30 minutes	6–30 minutes	2
	31–60 minutes	31–60 minutes	1
	> 60 minutes	> 60 minutes	0
Number of cigarettes or snus portions used per day*	10 or less	1-7	0
	11–20	8-12	1
	21–30	>12	2
	>30	–	3
Total score and interpretation	0–1 = low nicotine dependence 2 = moderate dependence 3 = strong dependence 4–6 = very dependence		

** A three-category coding for snus users based on the six-question nicotine dependence test was used because only 17% of snus users used over 12 snus portions per day. [206].*
Source: Study III

Daily snus users (N=767) used on average 7 snus portions (±SD 5.6), while daily smokers (N= 1 161) smoked on average 10 cigarettes per day (±SD 7.8). As shown in Figure 16, only a small number of daily users exceeded 12 portions of snus or 20 cigarettes per day.

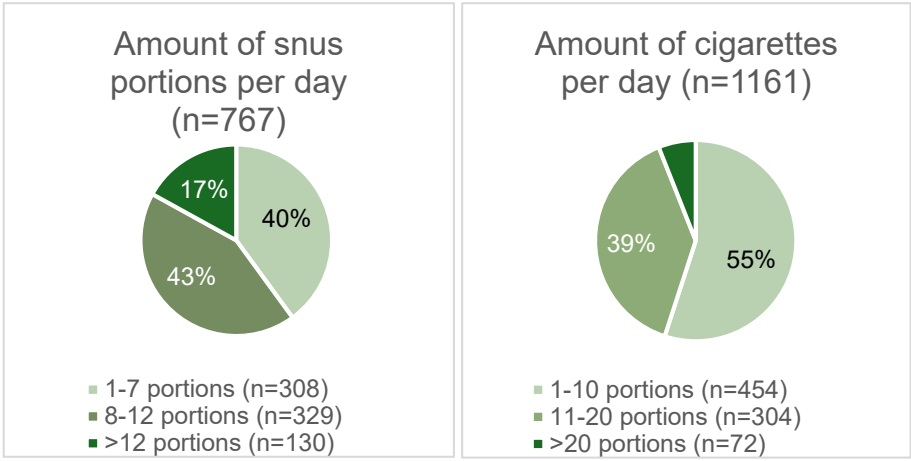

Figure 14 Daily amount of snus portions and cigarettes among daily users.

6.5.2 The level of nicotine dependence among snus users and smokers

As illustrated in Figure 17, the nicotine dependence levels among snus users closely mirrored those of smokers. In both groups, half of the users exhibited low dependence, while 40% demonstrated moderate or strong dependence. Approximately 10% of daily users in each group showed very strong nicotine dependence. These findings are based on 773 daily snus users and 1 168 daily smokers.

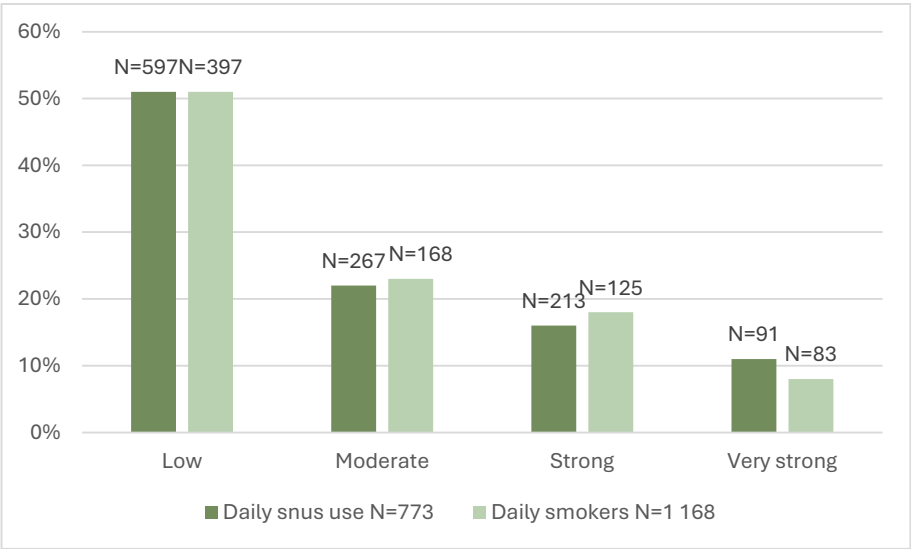

Figure 15 The level of dependence among daily smokers and snus users. *Missing values of daily snus users n=11/784. Missing values of smokers n= 4/1 172.*

6.6 The FDF personnel survey of 2020 (Study IV)

6.6.1 The prevalence of daily smoking, snus use and vaping among the FDF personnel

The prevalence of snus use, smoking and vaping of e-cigarettes was measured twice, in the year 2014 (N=2385, response rate 18%) and the year 2020 (N=3 373, response rate 27%). Daily smoking declined from 14% (N= 343) to 6 % (N=208, while smoking remained stable (8%, N=188 and 7%, n=224) respectively. Vaping decreased from 5% (N=11) to <1 % (N= 19). However, daily snus use increased from 8% (N=181) to 11% (N=370), with occasional use remaining at 5% (N=123 in 2014; N=165 in 2020) (Figure 19).

In 2020, 14% of males (n=349), 1% of females(n=10), and 16% of respondents with undisclosed gender (n=11) reported daily snus use. Daily smoking rates were 6% for males (n=162), 5% for females (n=40) and 9% for undisclosed gender (n=6).

Figure 18 shows that between 2014 and 2020, daily smoking rates significantly decreased, while daily snus use increased, as evidenced by non-overlapping 95% confidence intervals. during the same period, also supported by non-overlapping 95% confidence intervals.

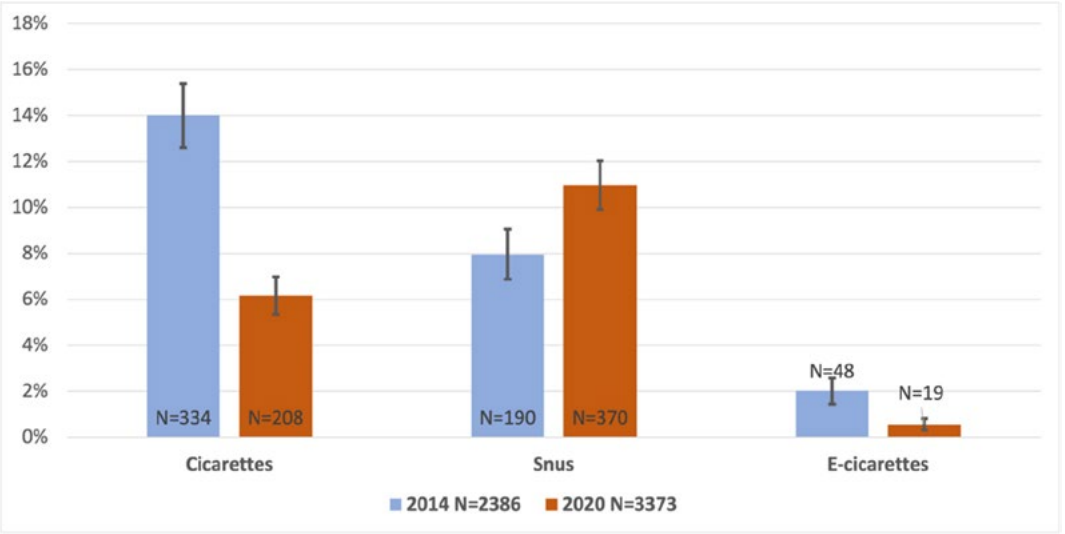

Figure 16 The change in prevalence of daily smoking and daily use of snus and e-cigarettes among the personnel of FDF in the years 2014 and 2020.

Prevalence of tobacco use by education

As shown in figure 19, the prevalence of daily smoking was lowest among respondents with a university and upper secondary education and highest among those with comprehensive or vocational school education. Snus use, in contrast, was most common among respondents with an upper secondary education and least prevalent among those with a postsecondary education. Regardless of educational background, the use of e-cigarettes remained consistently low.

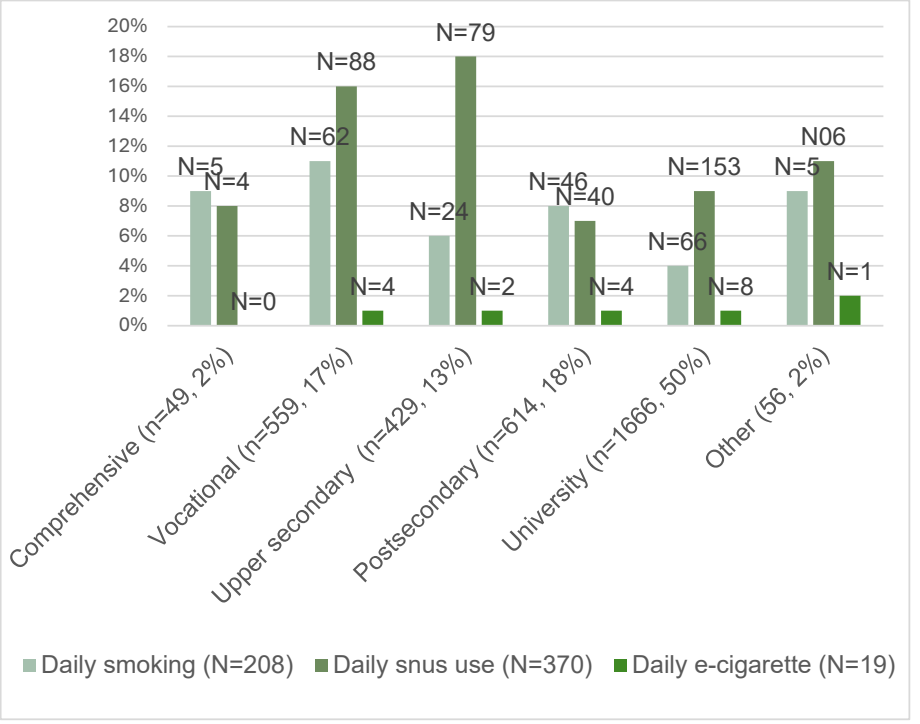

Figure 17 The number of daily smokers, snus users and e-cigarette users by educational background among the personnel of Finnish Defence Forces in the year 2020 (n=3 373).

6.6.2 Characteristics of snus and cigarette use among the FDF personnel

Table 11 presents detailed patterns of nicotine use among daily snus users and smokers. Among daily snus users (n=370), the average daily consumption was 12 snus pouches (±SD 6.2), with usage consistent across all seven days of the week. On average, one snus portion was kept in the mouth for 41 minutes (±SD 38.4). Notably, 44% (234/535) of respondents reported keeping snus in their

mouth for nearly their entire waking hours. The average weekly usage was 15 pouches (±SD 17.3), with an average snus use duration of 10 years.

Regarding smoking habits, in 2020 daily smokers reported smoking an average of 14 manufactured cigarettes (±SD 6.1, n=172), 13 self-rolled cigarettes (±SD 8.6, n=22), or 7 cigars (±SD 8.7, n=57) per day. Pipe smoking was rare, with only 4 respondents indicating pipe tobacco use. The average smoking duration was nearly 20 years. Half of all smokers, both daily and occasional (216/432), expressed a current desire to quit smoking.

Table 13 The parameters for daily snus and cigarette use, year 2020

Total N= 3 373	**Daily snus users (N= 370)**	**Daily smokers (N=208)**
Daily amount of snus portions / cigarettes used	11.9, ±SD 6.2 (N=367)	14 (N=172)
Duration of use	10.4 years, ±SD 8.3 (N=368)	19.7 years, ±SD 11.4
Average time of snus portions kept in the mouth	40.6 min., ±SD 38.4 (N=363)	-

The nicotine content of snus used by daily and occasional users

Figure 20 illustrates the distribution of nicotine content preferences among snus users in 2020. Among respondents (N=397), approximately one-tenth reported using regular snus with a nicotine content of less than 10 mg/g. Slightly more than a quarter opted for strong snus containing 11–20 mg/g of nicotine, while one-third used very strong snus with a nicotine content of 21–30 mg/g. Additionally, 4% reported using snus with a nicotine concentration of 31–40 mg/g. A small fraction (2%) consumed extremely strong snus with more than 40 mg/g of nicotine. Notably, 26% (N=138) of the respondents were unaware of the nicotine content in the snus they used.

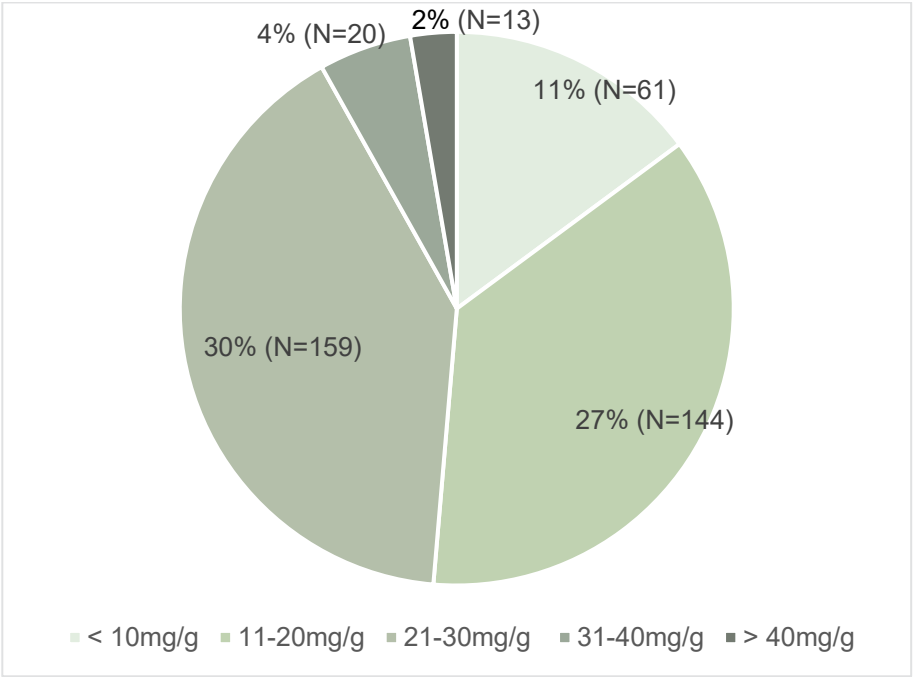

Figure 18 Strength of snus used by the personnel according to the survey of 2020 (N=397). Missing information for n=138.

6.6.3 Factors influencing cessation of smoking and snus use

Predictive factors for quitting smoking or snus use

The multivariate analysis of the 2020 data revealed several factors associated with quitting smoking. Female gender, higher educational attainment, civil status, non-military work roles, and a previous history of attempting to quit snus use were all positively linked to smoking cessation. In contrast, factors associated with quitting snus use included female gender, older age, a previous history of quitting smoking, and a civil work position. Notably, educational level did not significantly influence the likelihood of quitting snus use.

Preferred withdrawal support

Figure 21 shows that in the year 2020, half of the respondents indicated they did not require any specific support to quit tobacco use. However, a significant proportion of both groups—37% of snus users and 41% of smokers—expressed that nicotine replacement therapy or withdrawal medication provided by their employer would be helpful. Among smokers, the second most preferred form

of support was encouragement from family or friends (14%), whereas only 3% of snus users shared this preference. Personal meetings with a healthcare professional were the third most popular option for smokers (9%), while only 4% of snus users favoured this approach. Group support was similarly favoured by both smokers (6%) and snus users (5%), and mobile-based support was the least popular option, with only 2% of respondents considering it beneficial.

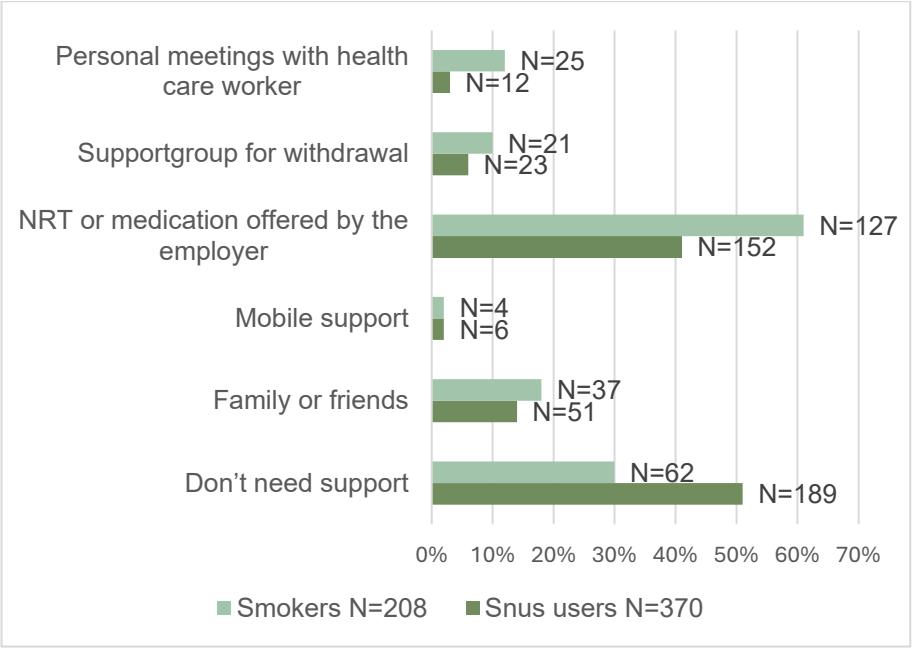

Figure 19 The preferred type of support among daily smokers and snus users.

Received advice to quit use in the last 12 months

Figure 22 illustrates that nearly half of all smokers and snus users reported that they had never received advice to quit from anyone. Family members were the most common source of cessation advice, with 33% of smokers and 37% of snus users receiving encouragement from a relative. Dental hygienists had advised a fifth of smokers (19%) to quit, compared to only 5% of snus users. Advice from dentists was less frequent, with fewer than 10% of respondents in both groups reporting such guidance. Nurses had encouraged nearly a fifth of smokers (17%) and a tenth of snus users (12%) to quit. Doctors were more likely to advise smokers (14%) than snus users (6%), while pharmacists were the least common source of cessation advice, with only 3% of smokers and less than 1% of snus users receiving their guidance.

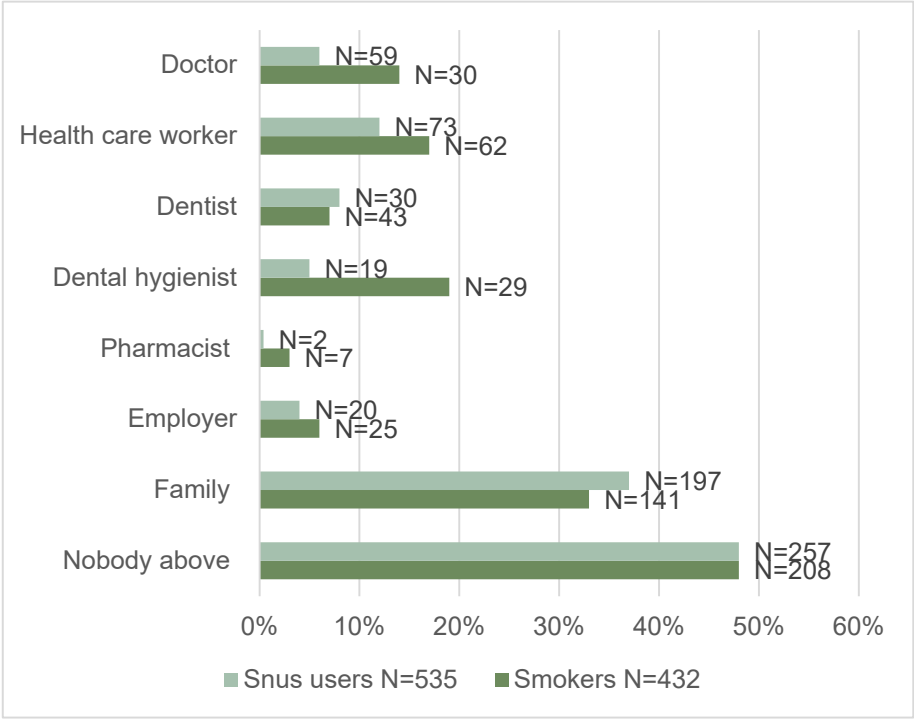

Figure 20 Received advice to quit use in the last 12 months reported by daily and occasional snus users and smokers.

7 DISCUSSION

7.1 Main findings

One of the main findings from our conscript study was the high prevalence of snus use, which approached that of smoking. Daily snus users had a significant total exposure time to snus, with longer exposure time associated with an earlier starting age and longer duration of use.

Moreover, those who perceived snus use as harmful to health and had previously attempted to quit were more likely to express a willingness to quit snus use. Similarly, those who had made earlier quit attempts and received advice to quit were more motivated to quit smoking. Interestingly, our analysis revealed similarities in the dependence profile of both smokers and snus users, as assessed by the HSI [291] for smokers and our modified nicotine dependence test for snus users.

The 2020 survey conducted among the Finnish Defence Forces (FDF) personnel showed a substantial decline in both smoking prevalence and e-cigarette use compared to the 2014 survey. Nearly 60% of snus users reported a preference for high or very high nicotine-content snus. Notably, almost half of both smokers and snus users had not received any advice to quit use withing the past year.

7.2 Prevalence of snus and tobacco use among conscripts

7.2.1 Prevalence of snus and tobacco use among young adults

In our study conducted in 2014 (study I), we observed a substantial prevalence of snus use. At that time, one-third of the respondents used snus at least occasionally, and 14% were daily users. These findings are consistent with a 2012 conscript study in Northern Finland where 16% of participants reported daily snus use and 40% were occasional users [52]. The 2014 statistics from Sweden showed that nearly 30% of males aged 16-29 used snus, with 17% being daily users. In Norway, about a third of males aged 16-24 used snus, and 23% were daily snus users.

A striking finding was that the prevalence of both snus usage and smoking was significantly higher in our study compared to the Finnish national health surveys. Daily smoking was nearly 1.5 times higher, and snus use was three

times more common than the rates reported in the 2015 Adolescent Health and Lifestyle Survey among 18-year-old males [292]. Additionally, daily smoking in our study was more than double the rate reported among 15-24-year-old males in the 2014 Health Behaviour and Health among the Finnish Adult Population survey. Snus usage was not included as a variable in that study [293]. According to the Finnish Adolescent Health and Lifestyle survey the readiness to experiment and use snus has increased since 2010 [45]. The availability of data on snus consumption patterns in Europe outside Scandinavia remains limited, likely due to the prohibition on the sale and marketing of snus within the EU.

Only a small percentage of conscripts reported either daily or occasional use of e-cigarettes, making it impractical to conduct further analysis regarding the characteristics of e-cigarette use. Similarly, the use of cigars or self-rolled cigarettes was exceptionally rare. These findings align with those from population-based studies in Finland [23]. However, it is worth noting that recent trends have shown a rise in e-cigarette use among adolescents and young adults [17, 23, 45], accompanied by an increased willingness to experiment with non-cigarette tobacco products in Europe and the USA [45, 294, 295].

7.2.2 Dual use and transition between snus and cigarettes

In our study a fifth of the conscripts reported simultaneous use of snus and cigarettes and a tenth were daily dual users (study I). A third of daily snus users smoked occasionally and 40% of daily smokers used snus occasionally. This confirms the finding of Hamari et al. (2012) who showed that dual use of cigarettes and snus was common among conscripts in Northern Finland: a third of occasional smokers were daily snus users and two thirds of daily smokers were occasional snus users [52]. The increase of dual use was also noted in the 2015 Adolescent Health and Lifestyle Survey among 18-year-old males [292]. Ruokolainen et al. (2024) showed that increase of snus use and dual use was prominent among young adult males [296].

We discovered that the transition from smoking to snus use and vice versa was common. Over a third of former smokers were daily snus users and 40% of former snus users reported current smoking. A common objective in many countries has been a harm reduction policy to decrease smoking prevalence by encouraging the use of alternative tobacco products such as snus. Our findings do not support the assumption that snus use would decrease the smoking prevalence. Similar observations have been made in Norway, where the smoking prevalence has declined but overall tobacco use has declined less due to sharp increase of snus use [297, 298]. Analysis retrieved from a large

population-based study in Norway (HUNT) [299] showed that snus use and dual use of snus and cigarettes among 13-19-year-old males doubled the risk of smoking and the risk to continue snus use as young adults was three-fold. A brief report published in 2023 showed that the transition from cigarette smoking to smokeless tobacco was uncommon in USA, but those who do change to smokeless tobacco tend to become dual users rather than exclusive smokeless tobacco users [300] .

7.2.3 The association between education and use of tobacco products

The commonly held assumption that lower educational attainment is associated with higher smoking prevalence [24, 25, 301] was also seen in our study. However, this association was missing among daily snus users. The prevalence of snus use was nearly the same for respondents with comprehensive, vocational or upper secondary education. These findings align with Danish statistics among adolescents, were daily snus use rates showed little variation between students attending different educational paths [43]. In Norway no discernible difference in snus use across educational groups has been seen. Over recent years, there have been an overall increase in snus use across all educational backgrounds [31]. In Study II we noted that the total exposure time to snus was lowest among respondents with upper secondary education, which indicates that higher education may have a protective effect from heavy use.

According to the Finnish School Health Promotion studies the association between socioeconomic factors and snus use is observable although weaker compared to smoking [23, 27]. Sæther et al. (2021) suggested that common risk factors, such as socioeconomic factors, academic adjustments, and use of cannabis, are lower among snus users compared to smokers [302].

7.3 High total exposure time to nicotine in snus users

The total daily exposure time to snus in our cohort was over six hours per day among regular users, half of the average 14 hour exposure time reported for Swedish male snus users [96]. The article did not specify the nicotine content of the snus used by the participants. However, mild snus is traditionally favoured in Sweden, whereas Finnish users tend to prefer stronger varieties, which could explain the difference [100, 303, 304]. Data on total exposure time to snus from other countries is limited, though comparable figures exist for snus pouch consumption in the neighbouring counties. On average regular snus users in Sweden and Norway use 12 snus pouches per day, similar to the

amount reported in our study [26, 298] [96, 303]. In Denmark, daily use rarely exceeds 10 pouches [43] [83].

The development of a substance use disorder is a complex with repeated exposure playing a crucial role [180, 184]. The capacity to tolerate nicotine is a matter of repeated exposure and the subsequent development of tolerance due to neuroadaptation, which increases susceptibility to nicotine addiction. Notably, snus possesses a high bioavailability of its chemicals, absorption occurs continuously throughout the time that snus is kept in the mouth [84-87]. Regular and extended usage is driven by nicotine dependence, subsequently heightens the likelihood of health-related complications accumulating over time [26, 305]. Therefore, the daily total exposure time to nicotine is noteworthy.

7.4 Quit attempts and willingness to quit snus and cigarette use

The analysis of our study (study II) showed that half of the daily smokers and snus users expressed a desire to quit. This aligns with data from the national tobacco statistics of 2014 [306], where 50% of males aged 15-24 wished to quit smoking. Among this group, 69% had already attempted to quit. However, this study did not inquire about the willingness or previous attempts to quit snus use.

A smoker makes on average three to four quit attempts before succeeding [138]. Similarly, snus users may need to try several times before quitting, especially considering that some studies indicate that snus and dual use may cause even stronger addiction than smoking [307, 308]. Additionally, current snus use may prevent successful smoking cessation [228]. Study III showed that earlier quit attempts were associated with increased willingness to quit use for both snus users and smokers, supporting the assumption that the readiness to quit increases with each quit attempt [309, 310].

Our findings suggest that the health hazards of smoking were well recognised, but only 60 % considered snus harmful. A Swedish report from 2021 revealed that both adolescents and adults underestimate the serious health risks of nicotine. This perception lowers the threshold to try new smokeless tobacco and nicotine products, reinforcing the need for awareness campaigns and education [311]. Previous research has shown that health literacy increases the willingness to quit smoking [312, 313]. Perceptions and attitudes influence the choices and behaviours individuals engage in [314]. Many young people view newer nicotine products as safer, easier to hide, and healthier compared to traditional cigarettes [315, 316]. This highlights the importance of providing adequate information on the risks of snus, particularly for adolescents. Encouragingly, snus users who perceived snus as harmful were

more likely to express a willingness to quit. However, a similar association was not found among smokers, which is unsurprising given that most smokers were already aware of the health risks of smoking. Instead, the belief that smoking is highly addictive was associated with an increased willingness to quit. Further, smokers who had received advice to quit by a doctor, nurse, healthcare professional, dentist, pharmacist, a family member, or someone else were more likely to express a willingness to quit smoking, reinforcing the important role of healthcare personnel and close relatives in smoking cessation.

Guidelines for treating nicotine dependence emphasise personalised support that takes into consideration the age and tobacco habits of the adolescents or young adults [138, 317]. Our findings implicated that a somewhat different approach is recommendable when encouraging smokers and snus users to quit. Snus users may benefit from basic health promotion focused on raising awareness that snus and nicotine are harmful and highly addictive, whereas smokers could respond better to tailored support addressing dependence, as their awareness on health hazards is already high. Recognising this need, Finland has initiated a joint governmental strategy for preventive actions and treatment of nicotine addiction in [251, 318].

7.5 The modified two-question dependence test show similar dependence profile for snus users and smokers

To our knowledge an easily applicable test for measuring nicotine dependence among snus users has not been developed. In Sweden usually only the daily or weekly amount of snus portions used is asked [199]. Our questionnaire did not address all six questions of the official test for nicotine dependence used in Finland [206]. Instead, we included two questions, analogously to the nicotine dependence test for smokers, the HSI, [196], addressing the time for placing the first snus portion into mouth after waking up and the daily amount of snus portions used. Previous studies with a similar approach could not be identified in the scientific literature.

The level of dependence for both snus users and smokers followed a very similar dependence profile. Our modified two-question nicotine dependence test is promising but needs to be validated further using cotinine measures. However, if proven usable, this test could be a practical tool for evaluating and treating nicotine dependence of snus users in everyday practise.

7.6 The tobacco habits of the FDF personnel

7.6.1 The prevalence of cigarette and snus use

The comparison between the personnel surveys conducted in 2014 and 2020 showed that the prevalence of daily smoking has significantly decreased over recent years in the FDF. In 2014, the smoking prevalence among the FDF personnel was similar to that of the general Finnish population at 14% and 16%, respectively [306]. By 2020, this rate had more than halved to 6%, which was notably lower than the 12% observed among the general population[23, 319]. This decrease aligns with trends seen in Sweden and Norway, where smoking prevalence in 2020 was approximately 6% and 8%, respectively [23, 40, 41, 319]. Nearly one-third of the participants reported having previously smoked, indicating that the majority of those who quit smoking did not switch to using snus or e-cigarettes.

Conversely, a moderate increase was seen in the use of snus. Among FDF personnel, snus use rose from 8% in 2014 to 11% in 2020. This rise may be partly due to a shift from smoking to snus use. A similar increase has been observed in the general Finnish population, particularly among young adult males [296]. In 2020, 7% of Finnish males aged 20-64 years reported daily snus use, with the rate increasing to 12% among those aged 20-34 years. Snus use among Finnish females remained low across all age groups (1-2%) [23, 319]. This trend mirrors patterns in Norway and Sweden. In Norway, daily snus use in 2020 was approximately 20% for males and 5% for females, with the highest prevalence (around 30%) among males aged 25-35 years. In Sweden, snus use has a long-standing history, reflected in stable usage rates: 16% of the population were daily users in 2020, with 18% of males and 5% of females [26, 41]. The prevalence of snus use has doubled among females in the past ten years [40, 320]. Snus use is less common in Denmark compared to other Scandinavian countries, with daily usage estimated to range between 1% and 5% among the adult population [44].

Additionally, the prevalence of daily e-cigarette use among FDF personnel decreased from 5% in 2014 to 1% in 2020, aligning with the 1% rate among Finnish adults aged 20-64 [23, 319]. In Sweden, about 2% of the adult population used e-cigarettes in 2022, with 0.5% being daily users, predominantly among young females [30].

7.6.2 The content of nicotine and number of snus portions used among the FDF personnel

According to the 2020 personnel survey, participants reported using an average of 12 snus pouches per day. Our conscript study showed an average consumption of snus ten times a day, which aligns with daily snus use in Norway (ten times) [26, 320] and Sweden (11-13 times) [96, 320]. Participants kept snus in the mouth for approximately 38 minutes, similar to the findings from the conscript study. International data on exposure time of snus is limited, but in the study by Digard et al. (2009) Swedish males kept snus in their mouth for an average of one hour [96].

The majority (57%) of snus users showed a preference for snus with a nicotine content ranging from 11–30 mg/l, commonly addressed as strong or very strong snus. The preference for nicotine concentration resembles the usage patterns in Norway, although it leans towards a stronger preference than what is typically seen in Sweden [26, 303]. When nicotine content is high, addiction likely develops more quickly and becomes stronger.

7.6.3 Predictive factors for quitting smoking and snus use

Our data of year 2020 showed that demographic and occupational characteristics influence the likelihood of quitting, highlighting the need for targeted cessation support programs. Smoking prevalence was notably higher among military personnel working closely with conscripts, who also showed a lower likelihood of quitting these habits. Given the influential role of military personnel as leaders and role models for conscripts, it is crucial to address tobacco use to promote healthier behaviours within the military community. Historically, tobacco use has been more prevalent in the military environment compared to the general public, although research on the tobacco habits of military personnel in Finland and the Nordic countries is limited [2, 52, 53, 321-324]. Of note, several studies have also shown an association between deployment and increased tobacco use and risk for other substance use disorders [63-65, 322].

Users with a history of successful quitting attempts are more likely to possess the skills and confidence needed to quit again, demonstrating higher self-efficacy in cessation. Higher educational attainment is consistently linked to greater health literacy and better access to resources that facilitate quitting [313, 325]. Civilian workers in military settings, as opposed to those in direct military roles, might experience less stress and have more stable routines, which can aid in quitting effort. Not working directly with conscripts may reduce exposure to social smoking norms prevalent in conscript environments [326]

7.6.4 Preferred interventions for tobacco cessation

To develop effective withdrawal support strategies, we surveyed participants to understand their preferences. The survey revealed that daily smokers were more receptive to receiving support compared to snus users. Both groups preferred employer assistance for purchasing nicotine replacement therapy or medication for nicotine dependence. Surprisingly, few participants expressed interest in personal support from healthcare professionals or participation in support groups. However, smokers were more open to these forms of personal support than snus users, likely due to their greater awareness of the health hazards. Earlier research indicates that snus users and smokers approach quitting differently. Snus users often perceive snus as less harmful, making them less likely to seek quitting support. In contrast, smokers are more aware of the health risks associated with smoking and are more inclined to use cessation aids like nicotine replacement therapy and professional advice [327-329].

According to the personnel study, almost half of both smokers and snus users had not received any advice to quit within the last year. A striking finding was that only a fifth of smokers and a tenth of snus users received cessation advice from healthcare professionals. This may be due to healthcare providers prioritising other health issues, perceiving snus as less harmful, lacking adequate training or confidence, or facing systemic barriers such as insufficient integration of cessation programs and reimbursement challenges. Additionally, patient attitudes and cultural norms towards tobacco use can influence the likelihood of receiving cessation advice [330-332].

Healthcare professionals have substantial opportunities to improve patient outcomes. Research consistently indicates that simply asking subjects about their tobacco use can significantly impact quitting rates. Implementing brief interventions and, if necessary, recommending nicotine replacement therapy (NRT) or medications can dramatically increase the likelihood of cessation. These strategies should be more widely promoted and integrated into routine healthcare practice to support tobacco users in quitting [209, 212].

7.7 Generalisability of the results

The results obtained from the conscript studies in this thesis can be generalised to average Finnish males at this age group as they mainly reflect the tobacco behaviours and attitudes of young males in civilian life prior to conscription. Research regarding the characteristics of snus use in this age group is scarce which is why this material makes a valuable contribution to tobacco research in general. Notably, the results exclude males exempted from military service, a group that is distinct due to the specific reasons for their exemption. While

this limits full population coverage, the findings may still be considered broadly representative of the age group, as the behaviours captured reflect pre-service civilian patterns. It is also likely that at least some of those exempted—particularly individuals with mental health or substance use issues—use tobacco products, suggesting that the overall prevalence in the total population may be even higher. The findings on the prevalence of nicotine and tobacco use among female conscripts cannot be regarded to represent the female tobacco culture in general because of the small and selected cohort.

The Defence Forces provide employment for over 13 000 Finns, of which over a third are civilians. Thus, the personnel study may offer insights into the tobacco culture of the broader working-age population, despite the specific setting.

Healthcare providers rarely inquired about the use of nicotine products other than smoking and seldom provided advice to quit. While these findings are concerning, it is important to note that they cannot be generalised to represent the entire Finnish health care providers.

7.8 Strengths and limitations of the studies

7.8.1 Strengths of the thesis

The surveys were conducted simultaneously with the health inspection which enabled a high overall response rate of 72%. However, the response rate was highest for the cohort of 2014, 97.2% and decreased to 69% in 2015 and 54% in 2016. This was most likely due to the fact that the health personnel at chosen army units became less motivated in conducting the survey as years passed. The response rate in population-based surveys of this target group tend to be substantially lower, between 30-50% and the categorisation of the surveys may not address young adult males as their tobacco habits may significantly differ from older working age adults [23, 45, 319].

Conducting the surveys during the first week of service allowed investigation of tobacco use and habits that primarily reflect civilian life before military influence.

Few studies have examined total nicotine exposure in snus users or assessed the level of dependence among regular users. Even fewer studies have investigated the willingness to quit snus use and factors associated with it. There are no previous studies on the strength of snus used among working age adults (study IV). Overall, the results obtained may contribute to providing qualitative information that helps health care professionals to plan intervention models and withdrawal support.

As part of this thesis, an innovative, but a preliminary two-question dependence test for snus users was developed. This dependence test provided interesting results that could be investigated more in detail and validated in further studies.

The personnel study (study IV) is the first of its kind to comprehensively analyse nicotine use among the personnel in the Finnish Defence Forces using two subsequent questionnaires. Overall, this kind of detailed information from any country is very limited, which increases the value of the data presented. However, extensive research on tobacco habits among the military personnel has been made in the USA by the Department of Defense, Veterans Affairs, and NIH on smoking and smokeless tobacco. Prevalence statistics has been published on Japanese and South Korean active- duty soldiers and previously also among Norwegians and Swedish military personnel. A survey was performed at the beginning of the project and another after full implementation. Some improvements, particularly the decrease in smoking, can be attributed to this initiative.

7.8.2 Limitations of the thesis

Our conscript studies have some limitations. First of all, approximately 25% of young adult males liable for military service are exempted. Therefore, the results are not fully representative for the entire population, although it is assumable that the use of tobacco products is even greater among exempted individuals some of whom are suffering from substance use disorders and severe mental health issues [333, 334]. Female conscripts were not included in the analysis because the cohort was small. In addition, it is possible that females, who attended voluntary military service may represent a selected group of females [335].

Secondly, the reliance on self-reported data may compromise the validity of questionnaire-based studies. However, research generally indicates that self-reported smoking data tends to be reliable [336, 337].

Thirdly, the questionnaire was modified twice, which reduces comparability across all results. First modification was made to the 2/II cohort in 2014 after we got the primary results from 1/II 2014 cohort, which showed that snus use was surprisingly common. Therefore, a few additional snus specific questions were added to the questionnaire, which allowed us to evaluate later the level of dependence for snus users. The second modification was made for the cohort of 2016 when questions addressing the total exposure time to snus were added to the questionnaire. These modifications were, however, considered necessary to adapt the questionnaires in response to emerging observations.

Fourthly, the questionnaire did not include questions regarding the concentration of nicotine or the weight of the snus that was used. Therefore, it was not possible in this study to make an estimation of the total nicotine exposure for snus users. Although we do not have access to official data several sources implicate that strong snus containing over 20mg/g is commonly used in Finland [39, 100].

Fifthly, a limitation regarding the preliminary two-question dependence test for snus users was the lack of possibility to validate it with cotinine measurements. Further, the questionnaire used in the conscript surveys did not cover all questions from the validated Boyles test or the THL snus addiction assessment test.

It should be noted that time has passed since the data was collected, and changes in usage patterns, such as the introduction of nicotine pouches, may have occurred. However, the data remains valid as it reflects the trends and behaviours relevant to the study period. There has been a significant increase in the use of nicotine pouches in the last three years in Finland. However, this trend was not visible in 2020 when the last survey was conducted and therefore the use of nicotine pouches has not been reported here. Snus and snus pouches are closely related tobacco products that share similarities in content and usage but differ in their form and presentation.

The personnel study was carried out electronically through the intranet, primarily reaching personnel engaged in computer-based tasks and excluding those predominantly working in the field. This approach might have introduced bias into the results. Even though the number of participants (2 386 persons in year 2014, and 3 373 in year 2020) can be considered sufficient to provide reliable data for analyses, the response rates were low, i.e., 18% and 27%, respectively. The gender distribution and the educational background of the respondents in both cohorts were very similar to those of the employees of the FDF in general. However, the low response rate may have introduced selection bias in the data.

8 CONCLUSIONS

The findings of this thesis demonstrate that the prevalence of snus and cigarette use among male conscripts is almost equally common, with rates exceeding those anticipated based on national population-based studies.

Commencement of snus use at an earlier age was associated with more frequent, regular use and a greater total lifetime exposure time. While snus was perceived as less harmful to health than smoking, its addictive nature was widely recognised. These findings underscore the importance of introducing educational interventions regarding the health hazards and addictiveness of nicotine and tobacco products during early adolescence, at the latest.

A greater willingness to quit snus use was positively associated with the perception of health-related risks, whereas an increased willingness to quit smoking was more strongly linked to the recognition of smoking's addictive nature. Moreover, the presence of two or more prior quit attempts correlated with a higher willingness to cease both snus use and smoking. This knowledge offers valuable guidance for the development of tailored cessation interventions.

The nicotine dependence profiles of snus users closely aligned with those of smokers, as measured by the modified two-question dependence test for snus users. This simplified, two-question assessment tool, developed during the project, may serve as a practical resource in clinical settings, although its reliability requires further validation.

The personnel study revealed a significant reduction in smoking prevalence alongside a moderate increase in snus use, reflecting broader national and regional patterns in tobacco consumption. High-nicotine snus products were found to be particularly favoured among regular users. Notably, a considerable proportion of both smokers and snus users reported having received no advice to quit. A smokeless and nicotine-free environment plays a vital role in supporting cessation and, more broadly, in fostering a culture of tobacco- and nicotine-free living. This objective was central to the project 'Promotion of a Tobacco-Free Environment in the Finnish Defence Forces (FDF)'.

Occupational health services represent a pivotal, yet underutilised, resource for promoting nicotine-free lifestyles. By embedding cessation tools into routine health assessments, providing bespoke interventions, and fostering supportive environments, these services can play a central role in facilitating long-term cessation efforts.

9 PUBLIC HEALTH IMPLICATIONS AND FUTURE PERSPECTIVES

This thesis offers a comprehensive overview of the epidemiology and characteristics of various tobacco and nicotine products, as well as on perceptions of snus and the willingness to quit snus use among young men in an area with limited prior research. The findings contribute to a deeper understanding of the current tobacco use trends among young adults and offer valuable insight into preferred snus usage patterns identified in the personnel study.

These insights highlight the need for healthcare organisations to take an active role in training health care professionals and implementing both effective cessation support strategies as well as preventive guidance for a broader variety of tobacco and nicotine product use. Occupational health care services provide a valuable opportunity to support these efforts, as they work in close collaboration with employers. This cooperation enables the integration of health-promoting and workability-enhancing measures directly into occupational health care contracts. Improving health care professionals' understanding of attitudes, health risks and the addictiveness of these products can enhance their ability to motivate users to quit and discourage initiation. It is also essential to identify and reinforce the factors that encourage tobacco- and nicotine-free lifestyles. For instance, environmental concerns related to tobacco cultivation may serve as a motivational factor.

The Finnish Defence Forces provide a unique framework for influencing health behaviour as a structured institution where conscripts' personal choices are limited [5, 338]. The majority of conscripts are aged 18–19 years. The health-promoting potential of conscription is further emphasised by the opportunity to reach approximately 75% of males at a critical stage of life, when lifestyle habits are being formed and are likely to persist through adulthood. It is essential to implement measures that support healthy lifestyles among military personnel and highlight their role as positive role models in their capacities as trainers and supervisors. This is most effectively achieved by fostering nicotine-free environment in the workplace and by facilitating the health care services available to both conscripts and personnel. The Finnish Defence Forces have been proactive in advocating for a nicotine-free environment and have actively endorsed the implementation of support programs within the FDF, overseen by healthcare professionals. Occupational health care has played a pivotal role in the well-being of the FDF personnel.

The themes and findings identified in this thesis provide a valuable foundation for further research. Although the modified two-question nicotine dependence test for snus users requires validation, it has the potential to be used in clinical practice once its reliability and accuracy have been confirmed.

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APPENDICES

Form 1 Conscript study, study questionnaire for the year 2014

FORM 1. ***Number: XXXXXX*** ***Date:***

A survey on tobacco habits among conscripts

1. How old are you?
   _____ years

2. What is your gender?
   i. male
   ii. female

3. Where do you live permanently?
   _____

4. How long is your military service?
   i. 165 days
   ii. 255 days
   iii. 347 days
   iv. I don't know

5. What is your level of education?
   i. high school
   ii. vocational education
   iii. upper-secondary

6. How many cigarettes or cigars have you smoked during your entire life? How many times have you smoked tobacco in a pipe during your entire life?
   i. none / never
   ii. just one / just once
   iii. 2-50 / times
   iv. over 50 / times

7. Do you currently smoke (cigarettes, cigars or tobacco in a pipe)?
   i. yes, every day
   ii. sometimes
   iii. I have quit
   iv. I have never smoked on a regular basis

8. Have you ever tried snus? How many times up until now?
   i. never
   ii. just once
   iii. 2-50
   iv. over 50

9. Do you use snus now?
   i. yes, every day
   ii. sometimes
   iii. I'm trying to quit or have quit
   iv. I have never used snuff on a regular basis

10. How many of the following products do you use every day? Fill in each blank. Put in 0 if you do not smoke at all.
    i. manufactured cigarettes _____ a day
    ii. cigarettes you roll yourself _____ a day
    iii. snus _____ times a day
    iv. electronic cigarette _____ times a day

11. If you smoke cigarettes or use snus, how long have you been using these products?
    i. smoked _____ years
    ii. used snus _____ years

12. Do regular personnel smoke in the presence of conscripts?
    i. yes, every day
    ii. yes, sometimes
    iii. no
    iv. I don't know

13. Do regular personnel use snus when conscripts are present?
    i. yes, every day
    ii. yes, sometimes
    iii. no
    iv. I don't know

14. If you currently smoke, would you like to quit?
    i. Yes
    ii. No

15. If you currently use snus, would you like to quit?
    i. Yes
    ii. No

16. If you smoke and/or use snus, what type of support would help you the MOST to quit smoking/using snus?
    i. peer support online (for e.g. Facebook groups, discussion forums, nurse online)
    ii. a one-on-one meeting with a health care professional
    iii. support group meetings
    iv. information and training on the effects of smoking / using snuff
    v. the support of friends and family
    vi. some other type of support
    vii. I do not need support to stop smoking / using snus

17. If you smoke or/and use snus, has one of the persons listed below recommended in the past twelve months that you quit smoking / using snus?

a doctor	yes	no
a nurse or health care professional at work	yes	no
your dentist	yes	no
a pharmacist	yes	no
a family member	yes	no
someone else	yes	no

18. How many times have you stopped smoking in the past six months?
    i. I have never smoked regularly
    ii. I have not smoked in the past six months
    iii. not once
    iv. yes, once
    v. yes, twice or more

19. How many times have you stopped using snus in the past six months?
    i. I have never used snuff regularly
    ii. I have not used snuff in the past six months
    iii. not once
    iv. yes, once
    v. yes, twice or more

20. If you want to quit smoking, do you intend to quit in the near future?
    i. I don't smoke
    ii. I don't want to quit smoking
    iii. I will not try quitting smoking in the near future
    iv. yes, in the coming 30 days
    v. yes, sometime in the next 2-6 months
    vi. yes, sometime in the next 7-12 months
    vii. yes, in over a year's time

21. If you want to stop using snus, do you intend to stop in the near future?
    i. I don't use snus
    ii. I don't want to stop using snus
    iii. I will not attempt to stop using snus in the near future.
    iv. yes, in the coming 30 days
    v. yes, sometime in the next 2-6 months
    vi. yes, sometime in the next 7-12 months
    vii. yes, in over a year's time

22. If you do smoke, how quickly within minutes will you have your first cigarette after waking up?
    i. in less than 6 minutes
    ii. 6-30 minutes
    iii. 31-60 minutes
    iv. over 60 minutes

23. If you do use snus, how quickly within minutes will you use snus after waking up?
    i. in less than 6 minutes
    ii. 6-30 minutes
    iii. 31-60 minutes
    iv. over 60 minutes

24. What is your opinion on smoking and using snus?

	Not at all	Hardly	Neither good or bad	Clearly	Very damaging
How damaging to your health is smoking?	1	2	3	4	5
How damaging to your health is snus?	1	2	3	4	5
How addictive are cigarettes?	1	2	3	4	5
How addictive is snus?	1	2	3	4	5

25. What is your experience of the following situations?

	Not at all	Seldom	Sometimes	Often	Always
May conscripts smoke when they are performing their military service?	1	2	3	4	5
May regular personnel smoke during working hours?	1	2	3	4	5
Do people smoke in military service / during working hours?	1	2	3	4	5
May conscripts use snus when they are performing their military service?	1	2	3	4	5
May regular personnel use snus during working hours?	1	2	3	4	5
Is snus used during military service / working hours?	1	2	3	4	5
Have there been situations where smoking has been an advantage while in the army (e.g. during breaks)?	1	2	3	4	5
Have there been situations where using snus has been an advantage while in the army (e.g. during breaks)?	1	2	3	4	5

THANK YOU FOR COMPLETING THE SURVEY!

Form 2 Conscript study, study questionnaire for the years 2015-2026

FORM 2. ***Number: XXXXXX*** ***Date:***

A survey on tobacco habits among conscripts

1. How old are you?
   _____ years

2. What is your gender?
   i. male
   ii. female

3. Where do you live permanently?
   _____

4. How long is your military service?
   i. 165 days
   ii. 255 days
   iii. 347 days
   iv. I don't know

5. What is your level of education?
   i. comprehensive education
   ii. vocational education
   iii. upper-secondary education

6. How many cigarettes or cigars have you smoked during your entire life? How many times have you smoked tobacco in a pipe during your entire life?
   i. none / never
   ii. just one / just once
   iii. 2-50 / times
   iv. over 50 / times

7. Do you currently smoke (cigarettes, cigars or tobacco in a pipe)?
   i. yes, every day
   ii. sometimes
   iii. I have quit
   iv. I have never smoked on a regular basis

8. Have you ever tried snus? How many times up until now?
   i. never
   ii. just once
   iii. 2-50
   iv. over 50

9. Do you use snus now?
   i. yes, every day
   ii. sometimes
   iii. I'm trying to quit or have quit
   iv. I have never used snus on a regular basis

10. How many of the following products do you use every day? Fill in each blank. Put in 0 if you do not smoke at all.
    i. manufactured cigarettes _____ a day
    ii. cigarettes you roll yourself _____ a day
    iii. snus _____ times a day
    iv. electronic cigarette _____ times a day

11. If you smoke cigarettes or use snus, how long have you been using these products?
    i. smoked _____ years
    ii. used snus _____ years

12. Do regular personnel smoke in the presence of conscripts?
    i. yes, every day
    ii. yes, sometimes
    iii. no
    iv. I don't know

13. Do regular personnel use snus when conscripts are present?
    i. yes, every day
    ii. yes, sometimes
    iii. no
    iv. I don't know

14. If you currently smoke, would you like to quit?
    i. Yes
    ii. No

15. If you currently use snus, would you like to quit?
    i. yes
    ii. no

16. If you smoke and/or use snus, what type of support would help you the MOST to quit smoking/using snus?
    i. peer support online (for e.g. Facebook groups, discussion forums, nurse online)
    ii. a one-on-one meeting with a health care professional
    iii. support group meetings
    iv. information and training on the effects of smoking / using snus
    v. the support of friends and family
    vi. some other type of support
    vii. I do not need support to stop smoking / using snus

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a nurse or health care professional at work	yes	no
your dentist	yes	no
a pharmacist	yes	no
a family member	yes	no
someone else	yes	no

18. How many times have you stopped smoking in the past six months?
    i. I have never smoked regularly
    ii. I have not smoked in the past six months
    iii. not once
    iv. yes, once
    v. yes, twice or more

19. How many times have you stopped using snus in the past six months?
    i. I have never used snus regularly
    ii. I have not used snus in the past six months
    iii. not once
    iv. yes, once
    v. yes, twice or more

20. If you want to quit smoking, do you intend to quit in the near future?
    i. I don't smoke
    ii. I don't want to quit smoking
    iii. I will not try quitting smoking in the near future
    iv. yes, in the coming 3
    v. 0 days
    vi. yes, sometime in the next 2-6 months
    vii. yes, sometime in the next 7-12 months
    viii. yes, in over a year's time

21. If you want to stop using snus, do you intend to stop in the near future?
    i. I don't use snus
    ii. I don't want to stop using snus
    iii. I will not attempt to stop using snus in the near future.
    iv. yes, in the coming 30 days
    v. yes, sometime in the next 2-6 months
    vi. yes, sometime in the next 7-12 months
    vii. yes, in over a year's time

22. If you do smoke, how quickly within minutes will you have your first cigarette after waking up?
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    ii. 6-30 minutes
    iii. 31-60 minutes
    iv. over 60 minutes

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    ii. 6-30 minutes
    iii. 31-60 minutes
    iv. over 60 minutes

24. What is your opinion on smoking and using snus?

	Not at all	Hardly	Neither good nor bad	Clearly	Very damaging
How harmful to your health is smoking?	1	2	3	4	5
How harmful to your health is snus?	1	2	3	4	5
How addictive are cigarettes?	1	2	3	4	5
How addictive is snus?	1	2	3	4	5

25. What is your experience of the following situations?

	Not at all	Seldom	Sometimes	Often	Always
May conscripts smoke when they are performing their military service?	1	2	3	4	5
May regular personnel smoke during working hours?	1	2	3	4	5
Do people smoke in military service / during working hours?	1	2	3	4	5
May conscripts use snus when they are performing their military service?	1	2	3	4	5
May regular personnel use snus during working hours?	1	2	3	4	5
Is snus used during military service / working hours?	1	2	3	4	5
Have there been situations where smoking has been an advantage while in the army (e.g. during breaks)?	1	2	3	4	5
Have there been situations where using snus has been an advantage while in the army (e.g.	1	2	3	4	5

during breaks)?					

26. Did you use snus before you entered military service?
    i. yes
    ii. no

27. At what age did you start regular /daily snus consumption?
    _____ years

28. How many doses/pouches of snus do you use when you use snus?
    i. _____ times per day

29. For how long do you keep snus in your mouth each time you use snus?

    i. <30min
    ii. 30-59min
    iii. 1 hour or more
    iv. 2 hours or more
    v. 3 hours or more

THANK YOU FOR COMPLETING THE SURVEY!

Form 3 Study questionnaire for the personnel study 2020

A Survey on the Use of Tobacco and Nicotine Products among Defence Forces Personnel in 2020 (electronic branching survey)

1. How old are you?
   _____ years

2. What is your gender?
   i. male
   ii. female
   iii. other /prefer not to say

3. In which unit are you currently serving? (answering is optional): *Dropdown menu options:*
   i. Defence Command, Defence Forces C4 Agency, Defence Forces Service Centre, Defence Forces Intelligence Agency, Defence Forces Research Agency, National Defence University, Navy Command, Coastal Fleet, Coastal Brigade, Nyland Brigade, Naval Academy, Defence Forces Logistics Command, Defence Forces Logistics Centre, 1st Logistics Regiment, 2nd Logistics Regiment, 3rd Logistics Regiment, Centre for Military Medicine, Explosives Centre, Air Force Command, Karelia Air Command, Lapland Air Command, Satakunta Air Command, Air Force Academy, Army Command, Jaeger Brigade, Guard Jaeger Regiment, Kainuu Brigade, Karelia Brigade, Armoured Brigade, Pori Brigade, Utti Jaeger Regiment, Army Academy, Other

4. What is your current position
   i. in military duties working with conscripts
   ii. in military duties, NOT working with conscripts
   iii. in civian duties
   iv. in health care

5. What is your level of education?
   i. comprehensive education
   ii. vocational education
   iii. upper-secondary education
   iv. institute-level education
   v. higher education (university or equivalent)
   vi. other, what?

6. Do you currently smoke (cigarettes, cigars or tobacco in a pipe)?
   i. yes, every day
   ii. sometimes
   iii. I have quit
   iv. I have never smoked on a regular basis

7. How much do you smoke on average per day? *Please indicate all types of tobacco you smoke*
   i. manufactured cigarettes ___a day
   ii. self-rolled cigarettes ___a day
   iii. pipe_____ a day
   iv. cigars_____ a day

8. How much do you smoke on average per week? *Please indicate all types of tobacco you smoke*
   i. manufactured cig. ____a week
   ii. self-rolled cig. _____ a week
   iii. pipe_____ a week
   iv. cigars_____ a week

9. For how long have you smoked (in years)?

10. Would you like to quit smoking?
    i. yes
    ii. no

11. What type of support would most likely help you quit smoking? You may choose more than one option.
    i. Personal meetings with a health care professional
    ii. Employer-provided nicotine replacement products or prescription medication
    iii. Mobile support
    iv. A quit-smoking group during working hours
    v. Support from family or friends
    vi. Other type of support, what?
    vii. I do not need support to quit smoking

12. Have any of the following people advised you to quit smoking during the past year (12 months)? You may choose more than one option.

    i. Doctor
    ii. Public health nurse or occupational health nurse
    iii. Dentist

iv. Dental hygienist
v. Pharmacy staff
vi. Employer
vii. Family member
viii. Someone else, who? _____
ix. None of the above have advised me to quit during the past 12 months

13. If you want to quit smoking, do you intend to quit in the near future?
    i. I don't want to quit smoking
    ii. I will not try quitting smoking in the near future
    iii. yes, in the near future

14. How quickly within minutes will you have your first cigarette after waking up?
    i. in less than 6 minutes
    ii. 6-30 minutes
    iii. 31-60 minutes
    iv. over 60 minutes

15. Have you ever made a serious attempt to quit smoking and gone without smoking for at least 24 hours?
    i. yes
    ii. no

16. If you have tried to quit smoking during the past four years, have you used any of the following cessation support methods?
    i. Nicotine replacement products (nicotine gum, patch, lozenge, sublingual tablet, inhaler, or spray)
    ii. Prescription medication intended for smoking cessation
    iii. Prescription medication or nicotine replacement therapy for cessation provided by the Defence Forces
    iv. Advice or counselling from health care services
    v. I have not used any of the above cessation support methods

17. How many years ago did you last smoke? _____ years ago

18. Do you currently use snus
    i. yes, every day
    ii. sometimes
    iii. I have quit
    iv. I have never used snus on a regular basis

19. How many times a day do you use snus? _____ a day

20. How many snus pouches do you use in total per day*?* _____ a day

21. How many snus pouches do you use in total per week*?* _____ per week

22. How many snus pouches do you use in total per week*?* _____ a day

23. For how long have you used snus (years)? _____ years

24. How soon after waking up will you have your first snus pouch?
    i. in less than 6 minutes
    ii. 6-30 minutes
    iii. 31-60 minutes
    iv. over 60 minutes'

25. Do you keep snus in your mouth most of the time when you are awake?
    i. yes
    ii. no

26. Do you intentionally swallow saliva mixed with snus
    i. yes
    ii. no

27. How many minutes do you keep a snus pouch in your mouth? _____ minutes

28. Do you use snus while sick in bed*?*
    i. yes
    ii. no

29. How much nicotine does the snus you use contain
    i. 1–10 mg/g
    ii. 11–20 mg/g
    iii. 21–30 mg/g
    iv. 31–40 mg/g
    v. yli 40 mg/g
    vi. I don´t know

30. Would you like to quit snus use?
    i. yes
    ii. no

31. What type of support would most likely help you quit snus use? You may choose one or more. Personal meetings with a health care professional
    ii. Employer-provided nicotine replacement products or prescription medication
    iii. Mobile support
    iv. A quit-smoking group during working hours
    v. Support from family or friends
    vi. Other type of support, what? _____
    vii. I do not need support to quitting snus use

32. Have any of the following people advised you to quit snus use during the past year (12 months)? You may choose more than one option.

    i. Doctor
    ii. Public health nurse or occupational health nurse
    iii. Dentist
    iv. Dental hygienist
    v. Pharmacy staff
    vi. Employer
    vii. Family member
    viii. Someone else, who? _____
    ix. None of the above have advised me to quit during the past 12 months

33. If you want to quit using snus, do you intend to quit in the near future?
    i. I don't want to quit using snus
    ii. I will not try quitting using snus in the near future
    iii. yes, in the near future

34. If you have tried to quit using snus in the past four years, have you used any of the following aids to support quitting? (You may choose more than one answer)
    i. Nicotine replacement therapy products (nicotine gum, patch, lozenge, sublingual tablet, inhaler, or spray)
    ii. Prescription medication intended for quitting
    iii. Prescription medication or nicotine replacement therapy for quitting paid for by the armed forces
    iv. Advice or guidance provided by healthcare professionals
    v. I have not used any of the above aids to quit

35. How many years ago did you last use snus? _____ years ago

36. Do you currently vape electronic cigarettes (e-cigarettes)?
    i. yes, every day
    ii. sometimes
    iii. I have quit
    iv. I have never vaped on a regular basis

37. How many times a day do you vape on average? _____ times a day

38. How many times a week do you vape on average? _____ times a week

39. Do you use e-liquid containing nicotine in your e-cigarette?
    i. yes, daily
    ii. occasionally
    iii. never

40. For how long have you vaped (years)? _____ years

41. Would you currently like to quit vaping?
    i. yes
    ii. no

42. What type of support would most likely help you quit vaping? You may choose more than one option.
    i. Personal meetings with a health care professional
    ii. Employer-provided nicotine replacement products or prescription medication
    iii. Mobile support
    iv. A quit-smoking group during working hours
    v. Support from family or friends
    vi. Other type of support, what? _____
    vii. I do not need support to quit vaping

43. Have any of the following people advised you to quit smoking during the past year (12 months)? You may choose more than one option.

    i. Doctor
    ii. Public health nurse or occupational health nurse
    iii. Dentist
    iv. Dental hygienist
    v. Pharmacy staff
    vi. Employer
    vii. Family member
    viii. Someone else, who? _____
    ix. None of the above have advised me to quit during the past 12 months

44. If you want to quit vaping, do you intend to quit in the near future?

i. I don't want to quit vaping
ii. I will not try quitting vaping in the near future
iii. yes, in the near future

45. How quickly within minutes will you have your first vape after waking up?
    i. in less than 6 minutes
    ii. 6-30 minutes
    iii. 31-60 minutes
    iv. over 60 minutes

46. If you have tried to quit vaping during the past four years, have you used any of the following cessation support methods?
    i. Nicotine replacement products (nicotine gum, patch, lozenge, sublingual tablet, inhaler, or spray)
    ii. Prescription medication intended for smoking cessation
    iii. Prescription medication or nicotine replacement therapy for cessation provided by the Defence Forces
    iv. Advice or counselling from health care services
    v. I have not used any of the above cessation support methods

47. How many years ago did you last vape?

    ____ years ago