



Tobacco Use Behaviors for Swedish Snus and US Smokeless Tobacco

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Contents

	Page
Executive Summary	1
1 Introduction	6
1.1 Background	6
1.2 Literature search and methods	8
2 Temporal, Geographic and Demographic Patterns of Smokeless Tobacco Use.	10
2.1 Scandinavia	10
2.1.1 Current and Historical Temporal Trends of Swedish Snus	10
2.1.2 Geographic variations in snus use	12
2.1.3 Age and gender	12
2.1.4 Socioeconomic and occupational variations in snus	14
2.1.5 Other individual level characteristics related to snus	15
2.1.6 Exposure estimates: frequency, amount and duration of snus	15
2.2 United States	17
2.2.1 Temporal trends	18
2.2.2 Geographic variations in smokeless tobacco use	19
2.2.3 Age and gender	20
2.2.4 Race/ethnicity	21
2.2.5 Socioeconomic and occupational variations in smokeless tobacco use	22
2.2.6 Other individual level characteristics related to smokeless tobacco use	23
2.2.7 Exposure estimates: frequency, amount and duration of smokeless tobacco use	23
2.3 Summary and Conclusions	23
3 Relationship of Smokeless Tobacco to Smoking	25
3.1 Population-level transitioning between tobacco products	26
3.1.1 Scandinavia	26
3.1.2 United States	27
3.2 Individual-level transitioning between tobacco products: Gateway and transitioning from smokeless tobacco to cigarettes	27
3.2.1 Scandinavia	28
3.2.2 United States	31
3.3 Transitioning from cigarettes to smokeless tobacco and smoking cessation	35
3.3.1 Scandinavia	36
3.3.2 United States	41
3.4 Snus/Smokeless Tobacco Initiation	45
3.4.1 Scandinavia	45
3.4.2 United States	46
3.5 Dual Use	47
3.5.1 Scandinavia	47
3.5.2 United States	52
4 Summary and Conclusions	57

List of Tables

- Table 1: Recent Patterns of Snus Use in Sweden (Digard et al. 2009) (means)
 Table 2: Prevalence of Current (30-day) STP Use by US Region

List of Figures

- Figure 1: Temporal Trends in the Prevalence of Snus Use in Sweden
 Figure 2: Prevalence of Daily Snus Use by Swedish Males
 Figure 3: Prospective Follow-Up of Tobacco Use Among Adolescents
 Figure 4: Temporal Trends in the Prevalence of STP Use (30-day) from US National Surveys
 Figure 5: Current (30-day) Use of STP Among Youths by US States
 Figure 6: Current (30-day) Use of STP Among by Gender and Age
 Figure 7: Tobacco Use Trends Among Males in Sweden

List of Appendices

- Appendix A: The Prevalence of Snus Use in Scandinavia
 Appendix B: Regional variation in Snus use within Sweden and Norway
 Appendix C: Age of Snus Users in Scandinavia
 Appendix D: Socioeconomic Status (as measured by employment, occupation, education or income) and Snus Use in Scandinavia
 Appendix E: Individual-level Characteristics Associated with STP use
 Appendix F: Patterns of Snus Use in Scandinavia
 Appendix G: US National Surveys
 Appendix H: Gender Differences in STP Use in the United States (Mixed Ages)
 Appendix I: Race/Ethnicity of STP Users in the United States
 Appendix J: Socioeconomic Differences in STP use in the United States
 Appendix K: Snus Use among the Military in Scandinavia
 Appendix L: STP Use among US Military Personnel
 Appendix M: Other Individual Level Characteristics Related to Snus Use
 Appendix N: Patterns of STP Use in the United States

Executive Summary

This report examines the relationship between the use of smokeless tobacco products (STP), including Swedish snus, and smoking in Sweden and other Scandinavian countries, and the United States. Traditional Swedish snus is an oral moist snuff product that is air cured, finely ground and heat treated. It is widely used in Scandinavian countries, particularly Sweden where for several generations it has been an entrenched part of the culture. Swedish snus is not as well known among tobacco users in the United States, who use a variety of smokeless tobacco products (STP), including dry snuff and chewing tobacco. These products are produced differently from snus, and are not considered chemically equivalent.

The term STP includes a broad range of products that vary considerably with regard to usage patterns, chemical composition, and content of potential toxicants. There are differences in risk associated with use of different STP, and according to the 2009 WHO Tobacco Product Regulation report it would be “scientifically inappropriate to consider smokeless tobacco as a single product for purposes of estimating risk or setting policies” (WHO 2009). Thus, it is essential to use a consistent terminology and clear definition of STP when addressing patterns of use; however, this report does not compare the chemical composition and components of US STP. ENVIRON International Corporation (ENVIRON) previously prepared a report for Swedish Match that summarized the chemical characteristics, toxicological, and epidemiological data on traditional Swedish snus (ENVIRON, March 2010), which has been updated (ENVIRON, 2013).

Individual and population harm reduction is a fundamental element of the 2009 US Family Smoking Prevention and Tobacco Control Act (also known as the Tobacco Control Act), Section 911, Modified Risk Tobacco Products, requires the Food and Drug Administration (FDA) to establish a process for determining whether a product will significantly reduce harm and the risk of tobacco-related disease. The FDA released a draft guidance report for a Modified Risk Tobacco Product Application in March 2012 (FDA 2012). The guidance provides extensive information about the types of scientific studies and analyses FDA recommends that applicants should consider including evidence of a significant reduction in harm and in the risk of tobacco-related disease to individual tobacco users and the benefit to the population as a whole, taking into account both users of tobacco products and non-tobacco users. The report does not attempt to assess the application of quantitative harm reduction models. Nor does the report address the marketing or public perceptions of snus or other STP.

This report presents a comprehensive examination of the current scientific literature on the usage patterns of Swedish snus in Scandinavian countries and of smokeless tobacco generally in the United States. We, further discuss the interconnected issues of harm reduction as it relates to snus/smokeless tobacco use, including gateway to cigarette smoking, smoking cessation and tobacco use initiation. These topics are part of the Swedish experience with tobacco use, including population characteristics and historical and contemporary patterns of tobacco use of Swedish tobacco users. Population data and smokeless tobacco use patterns are also examined for the US.

There is much research on use of STP in the US, and that research is not specific to Swedish snus. Many US-based research articles use the term STP to refer to both snuff and chewing tobacco compared to the predominance of a single smokeless tobacco product.

Chapter 2 contains two subsections. The first subsection discusses the patterns of snus in Sweden and other Scandinavian countries ([Section 2.1](#)).

Daily snus use is reported by 19% of adult males and 4% of adult females in Sweden. Occasional use is reported by an additional 6% of males and 4% of females. Snus use is also common in Norway (use by 15 to 20% of adult males), and to a lesser extent in Finland. There were substantial increases in snus use in Sweden and Norway since the 1960s, but use rates have remained relatively stable since about year 2000.

[Section 2.2](#) describes the patterns of smokeless tobacco use in the United States.

In the US, combining data for all forms of STP, current use (daily and occasional) is reported by approximately 7% of males and less than 1% of females. Similar to the trend in Sweden, the prevalence of use of smokeless tobacco has remained stable since year 2000, as have the rates of smoking. There is a geographic element to STP use in the US; smokeless tobacco products are more commonly used by those living in the southern and mid-western states. Use is also typically higher among those living in rural, less densely populated areas, and STP use is most common among white Americans and American Indians compared to other racial/ethnic groups. US military personnel represent a subpopulation with higher STP use than the general population.

Chapter 3 contains numerous subsections that present a summary of the available and more recent research on the relationship between smokeless tobacco (snus in Scandinavia, others forms in the US) and cigarette smoking: gateway, cessation, snus/smokeless tobacco initiation, and dual use patterns, organized by Scandinavia first and then the data from the US.

Gateway: Following a review of longitudinal and cross-sectional studies conducted on snus use in Sweden and other Scandinavian countries, there is little evidence that prior snus use leads to daily cigarette smoking among adults. These studies show that snus use is associated with a reduced risk of becoming or continuing to be a regular cigarette smoker, (compared to those who start using tobacco as smokers or non-tobacco users), that is, there is an inverse association between snus use and cigarette smoking initiation. Longitudinal studies provide evidence of transitioning from cigarettes to snus as compared to switching from snus use to cigarette smoking. Review of studies among adolescents in Sweden, Norway and Finland showed that baseline snus use was not a precursor to exclusive cigarette smoking; that is, tobacco initiation with snus or current snus use was not a predictor of future cigarette smoking. According to the 2007 SCENIHR report, “the Swedish data, with its prospective and long-term follow-up do not lend much support to the theory that smokeless tobacco (i.e. Swedish snus) is a gateway to future smoking.” Several additional studies published since the SCENIHR report have supported this same conclusion

A review of the US studies suggests mixed findings that prior smokeless tobacco may be associated with, and may lead to, subsequent cigarette smoking among adults. Though a majority of the study authors concluded that there was evidence of gateway, one well-conducted study in which non-gateway use was found to be more common than gateway use highlighted the importance of determining temporality in studies of tobacco gateway, noting that studies that examine for correlation only are inadequate. A majority of the studies in adolescent and young adults found an increased risk of cigarette use among those who reported prior STP use; however, it is important to note that tobacco habits are often not set amongst adolescents. In addition, several studies highlight the importance of including psychosocial and behavioral variables that may affect smoking initiation. In studies that suggested an association between STP and future cigarette smoking, when factors such as access to tobacco, family smoking habits, cultural bans on smoking, and alcohol use were considered, the strength of the association diminished. As mentioned earlier, one of the recurring limitations in evaluating these studies are the various methods in estimating the risk of initiating cigarette smoking, such as study design variations, study population, and methods of predicting smoking variables. For example, in evaluating gateway patterns, a few studies collected information on the age of tobacco initiation, investigated the initial and subsequent weekly use and/or employed the use of national surveys for analysis. Recurring limitations in the US studies are study design variations and small and non-representative study populations, especially in youth studies.

Transitioning and Cessation: the clinical trials in which snus use was specifically used for smoking cessation support resulted in a success rate roughly equivalent to other NRTs. The data from Scandinavian cohorts should not be interpreted that use of snus is a necessary or sufficient condition for smoking cessation. However, the available studies indicate that snus use has been used more often than NRTs by Scandinavian males as an aid for smoking cessation, and being a former smoker is common among snus users. These data have consistently shown that male snus users are more likely to quit smoking than smokers who do not use snus. The data also indicate that some smokers initiate use of snus specifically to aid in smoking cessation, and successfully quit smoking. The 2007 SCENIHR report concluded that “observational data from Sweden indicate that snus has been used more often than pharmaceutical nicotine products by some men as an aid to stop smoking. The data are consistent in demonstrating these male snus users are more likely to quit smoking than non-users.” Since then, there have been clinical trials and two meta-analyses in Norway on the use of snus as a smoking cessation tool that support this conclusion.

There were no clinical trials conducted among adolescent tobacco users. The gradual transitioning from smoking to snus observed in adults was not as apparent among adolescents. The experimentation with snus and smoking was common through teenage years, without an inclination towards a tobacco type, although boys were more likely to be snus users and girls were more likely to be cigarette smokers as young adults. Several authors discussed the importance of psychosocial contributions to smoking cessation and how this may impact an individuals' decision to quitting tobacco.

There are fewer available studies in the US. While some of the clinical trials and observational studies provide evidence that smokers who use STP daily are prone to quit smoking, other evidence show that tobacco users were more likely to transition from STP to cigarette smoking than vice versa, and smokers who used STPs were not more likely to quit smoking. The studies conducted among adolescents and young adults do not provide evidence of STP use as a cessation aid. This may be due in part to the low prevalence of smokeless tobacco use in the US, which is evident in the limited number of studies that address smokeless tobacco use behaviors. There is a need for more longitudinal studies that adequately address the temporality of smokeless tobacco use in relation to cigarette smoking, as well as co-factors that contribute to this relationship.

Initiation: In Sweden and Norway, uptake of snus occurred across all age categories compared to cigarette uptake which appeared to occur more frequently at a younger age. In addition, tobacco initiation was shown to be gender-dependent; males were more likely to initiate snus while females more likely to initiate cigarette smoking. Studies in Sweden and Norway have shown that snus initiation was more prevalent among former cigarette smokers than among non-tobacco users.

Smokeless tobacco initiation in the US was even lower than rates of snus initiation in Scandinavia. Tobacco users in the US were more likely to initiate with cigarettes, and at a younger age than for STP initiation.

Dual Use: Recent cross-sectional studies in Sweden and Norway have reported the prevalence of dual use from 2% to approximately 10%, depending on whether the criteria are daily dual use, or occasional use of one of the tobacco types. Factors associated with dual tobacco use included being male and those with low education. Some evidence suggests slightly lower overall tobacco use among the dual users. One study reported that pouched snus users had a slightly higher prevalence of cigarette smoking compared to users of loose snus. Taken together, among adults and adolescents, the range of dual use appears to be less than 10% in the Swedish population of snus users. Dual use appears to mark a transient period in tobacco use. Among adult tobacco users, baseline dual users were most likely to transition to snus use or remain dual users; whereas among adolescents, some dual users did transition to smoking. Some evidence suggests slightly lower overall tobacco use among the dual tobacco users.

In the US, the rates of dual tobacco use appear to be in the range of <1 to 3%, but may be higher among those in the military, in certain US regions, among males, and by age (adolescents and young adults appear to have higher rates of dual use). Overall, studies reported low rates of switching between tobacco products. Among adults, dual users were most likely to transition to cigarette smoking than smokeless tobacco use. Prospective studies on dual use patterns among adolescents are limited. Cross-sectional studies among adolescents showed that dual users were inclined to use snus or smoke cigarette either daily or occasionally. The evidence suggests that in the US, daily dual users consume fewer cigarettes than exclusive smokers, but some uncertainty exists as to whether dual users have lower rates of tobacco consumption

In summary, there is conclusive evidence of switching from smoking to snus use at both the population and individual levels in Sweden. Switching from cigarettes to snus is more common than switching from snus to cigarettes in Sweden. Also, STPs have been used as a smoking reduction and cessation aid by individuals in Sweden; the data are less clear in the US

1 Introduction

This report examines the relationship between the use of smokeless tobacco products (STP), including Swedish snus, and smoking in Sweden and other Scandinavian countries, and the United States. The report cites the scientific literature examining the Swedish experience with tobacco use, including population characteristics and historical and contemporary patterns of tobacco use of Swedish tobacco users. For these topics, population data and smokeless tobacco use, are also examined for the US.

1.1 Background

Traditional Swedish snus is an oral moist snuff product that is air cured, finely ground and heat treated. It is widely used in Scandinavian countries, particularly Sweden where for several generations it has been an entrenched part of the culture. Swedish snus is not as well known among tobacco users in the United States, who use a variety of smokeless tobacco products (STP), including dry snuff and chewing tobacco. These products are produced differently from snus, and are not considered chemically equivalent.

According to the manufacturing organization European Smokeless Tobacco Council, “snus” is defined as a product for oral use “traditionally produced and used in Sweden... the manufacturing process is a heat treatment process” (European Smokeless Tobacco Council, 2010¹). This definition distinguishes snus from other STP that are marketed as “Swedish-style snus” but have not been used in Scandinavia and may have characteristics that are distinctly different from traditional Swedish snus (Foulds and Furberg 2008).

The term STP includes a broad range of products that vary considerably with regard to usage patterns, chemical composition, and content of potential toxicants (McNeill et al. 2006). There are differences in risk associated with use of different STP, and according to the 2009 WHO Tobacco Product Regulation report it would be “scientifically inappropriate to consider smokeless tobacco as a single product for purposes of estimating risk or setting policies” (WHO 2009). Thus, it is essential to use a consistent terminology and clear definition of STP when addressing patterns of use.

There is growing consensus that use of STP in place of smoking tobacco reduces an individual’s risk from tobacco use-related harm (Klus et al. 2009; Lee and Hamling 2009). There is considerable research documenting the reduction in smoking-related harm to individual tobacco users by switching to other sources of nicotine, such as Swedish snus. Tobacco harm reduction is defined as the goal of reducing adverse health impacts for smokers who will not or cannot abstain from using tobacco. The most challenging aspect of harm reduction concerns the role of STP in global smoking reduction at the population level. Issues of concern include the characteristics of STP introduced and used as harm reduction products, how health effects are communicated and received by the public, how products are marketed, and patterns of use (IOM 2001; WHO 2008).

¹ ESTOC. 2011. <http://www.estoc.org/about-smokeless-tobacco>, accessed November 2010

Individual and population harm reduction is a fundamental element of the 2009 US Family Smoking Prevention and Tobacco Control Act (Tobacco Control Act). Section 911, Modified Risk Tobacco Products, requires the Food and Drug Administration (FDA) to establish a process for determining whether a product will significantly reduce harm and the risk of tobacco-related disease. The FDA released a draft guidance report for a Modified Risk Tobacco Product Application in March 2012 ([FDA 2012](#)). The guidance provides extensive information about the types of scientific studies and analyses FDA recommends that applicants should consider in order to provide sufficient evidence for a modified risk product. More specifically, FDA requires scientific data to support an applicants' position that their product provides significant reduction in harm and in risk of tobacco-related disease to individual tobacco users and the benefit to the population as a whole, taking into account both users of tobacco products and non-tobacco users.

This report presents a comprehensive examination of the current scientific literature on the usage patterns of Swedish snus in Scandinavian countries and of smokeless tobacco generally in the United States. We, further discuss the interconnected issues of harm reduction as it relates to snus/smokeless tobacco use, including gateway to cigarette smoking, smoking cessation and tobacco use initiation.

Swedish and other Scandinavian studies cited in this report are specific to snus to the extent that it is possible to distinguish it in the literature. Studies that refer to moist snuff or STP use in Sweden or Norway are assumed to describe snus as other types of snuff or chewing tobacco are far less common, particularly in the recent past. Chewing tobacco use is very rare (<1% of the population according to most of the studies that were found) but does exist in Sweden ([Andersson et al. 1994](#); [Axell 1976](#); [Axell et al. 1992](#); [Ye et al. 1999](#)). Although the vast majority of the literature on the patterns and determinants of snus use comes from Sweden, Norway² and Finland; there are other traditional Scandinavian STPs, including skrå in Denmark³ and Norway ([Rutqvist and Lewin 2006](#)). More specifically, up until the early 1980s, skrå dominated the Norwegian market ([Rutqvist and Lewin 2006](#)).

There is much research on use of STP in the US, and that research is not specific to Swedish snus. Many US-based research articles use the term STP to refer to both snuff and chewing tobacco compared to the predominance of a single smokeless tobacco product. In this report, when addressing US based studies, the term STP refers to both snuff and chewing tobacco, except where specified, and we retain the authors' terminology. Much of the of US information comes from national surveys, including the National Survey on Drug Use and Health, National Youth Tobacco Survey, National Health and Nutrition Examination Survey, and the National Health Interview Survey.

The following chapter, Chapter 2 contains two subsections. The first subsection discusses the patterns of snus in Sweden and other Scandinavian countries ([Section 2.1](#)) and the following

² The marketing, personal possession and use of snus are legal in Norway, which is not a member of the EU.

³ Some traditional Asian and Africa smokeless tobacco products are used in the EU but the constituents of these products are relatively unknown and the epidemiology is poorly understood so these products are excluded from this review.

section ([Section 2.2](#)) describes the patterns of smokeless tobacco use in the United States. Chapter 2 includes fourteen appendices (A through N) that complement the information presented in the chapter. The appendices consist of tables that provide additional and more detailed information summarized in the chapters.

Chapter 3 presents a summary of the available and more recent research on the relationship between smokeless tobacco (snus in Scandinavia, others forms in the US) and cigarette smoking.

The report does not attempt to assess the application of quantitative harm reduction models. Nor does the report address the marketing or public perceptions of snus or other STP. Further, the report does not compare the chemical composition and components of US STP, but these types of comparisons have been the subject of reviews by Rickert and colleagues (2009) and Stepanov and colleagues (2008). In addition, ENVIRON International Corporation (ENVIRON) previously prepared a report for Swedish Match that summarized the chemical characteristics, toxicological, and epidemiological data on traditional Swedish snus (ENVIRON, March 2010), which has been updated (ENVIRON, 2013).

1.2 Literature search and methods

The literature review conducted for this paper focused on studies that were published from 2007 through December 2012, with relevant publications in 2013. Articles and reports were identified from a Medline search and a search of Swedish and Norwegian government reports. Unless otherwise stated, only documents available in English are referenced. Studies of special populations (e.g., users of traditional non-western and non-indigenous STP products such as Iq' mik or toombak, alcoholics) are excluded. Medical case reports and case series were also excluded, with the exception of the section on exposure estimates.

An initial Medline search was conducted using the keywords below, limited to studies on humans only:

"tobacco, smokeless"[MeSH Terms] OR chew* tobacco* OR oral tobacco* OR snuff OR snus OR plug tobacco* OR (spit* AND tobacco*) OR smokeless tobacco* OR loose leaf tobacco* OR dip tobacco* OR dipping tobacco* OR snus OR cigar OR cigars OR ((smoke* OR tobacco*) AND (pipe OR pipes))"

Approximately 600 publications were identified, and the relevance of each publication was selected based on subject headings, excluding, for example, publications related to human health outcomes, biomarkers, or constituents of snus or smokeless tobacco. In addition to the Medline search, searches were conducted for specific authors (e.g., Digard; Edvardsson, etc), and the references of key publications were searched for additional potentially-relevant publications (including those published prior to 2007). These methods produced additional publications.

All publications were imported into a Reference Manager database and sorted by country/region, i.e. United States or Scandinavia.

Except for temporal trends, all information presented from national surveys conducted serially is for the most recent data available (if multiple years of data are available). In the Appendices, for case-control studies, whenever possible, the tobacco use estimates provided were for non-diseased participants (i.e., controls).

2 Temporal, Geographic and Demographic Patterns of Smokeless Tobacco Use.

2.1 Scandinavia

The use of snus is more common in Sweden than in other western countries, largely due to the cultural acceptance of this form of tobacco. The factors that influence the use of snus and other STPs include gender, age, educational background, and to a lesser extent, social economic status. There is a lengthy history of snus use in Sweden, beginning in the early 19th century when a segment of the population – farmers, artisans, and factory workers— began to favor a new type of oral tobacco product made of ground leaves, water, salt, and potash which was generally referred to as “snus”, the Swedish term for snuff (Lowe et al. 2009). It remained the predominant form of tobacco used in Sweden until the early 1940s, by which time cigarettes replaced snus as the most commonly used tobacco product. Use was widespread in the 19th century and decreased in the first half of the 20th century to a niche market consisting primarily of older men with outdoor occupations in rural areas (Axell 1993; Nordgren and Ramström 1990). Ease of use during manual labor and low cost may have contributed to the early popular appeal of snus. The prevalence of snus use increased in the latter half of the 20th century and moist snuff in pouches was introduced in the late 1970s.

European Union (EU) regulation of STPs, including snus, greatly impacts the geographic variation in use as well as the absence of accurate prevalence of use estimates outside of Sweden and Norway. When Sweden joined the EU in 1995, it was granted an exception to the directive that bans the marketing of tobacco products that are not smoked or chewed (92/41/EEC, 2001/37/EC). The sale of snus was legal in Finland until it entered the EU in 1995. (The legal age to purchase tobacco in Finland was 16 years old from 1977 until 1995, when it was raised to 18 years old). Snus is available for sale on the internet and personal possession and use of snus are legal elsewhere in the EU, as is the sale of nasal snuff, chewing tobacco, and cigarettes.

The following sections provide information on the patterns of snus use by the Swedish population and by other Scandinavian countries.

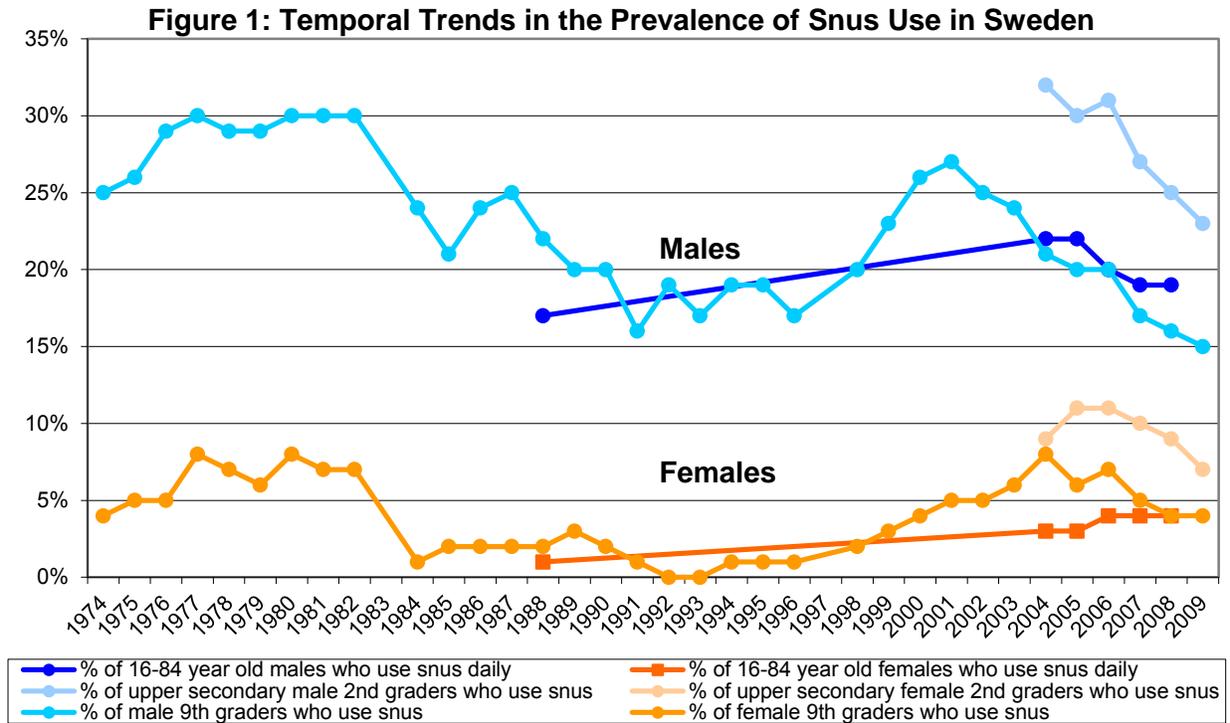
2.1.1 Current and Historical Temporal Trends of Swedish Snus

Currently, the prevalence of daily snus use among 16-84 year-old males and females in Sweden is 19% and 4%, respectively.⁴ Occasional use of snus (less than daily use) is reported by 6% of Swedish males and 4% of Swedish females. There have been contemporary measurable changes in the prevalence of snus use, which are described below, for Sweden and other Scandinavian countries (Appendix A).

According to data from the Swedish Tobacco Company (as reported by Nordgren and Ramström 1990), the prevalence of snuff use among males (15-67 years old) in Sweden increased prior to collection of data by the Swedish government, increasing from 12% in 1969-

⁴ <http://www.fhi.se/en/Highlights/National-Survey-of-Public-Health/Living-habits/Tobacco-habits-/>. Accessed on January 22, 2013.

70 to 17% in 1972-73. The Swedish government has reported per capita snus consumption since 1970 and snus use among adults since 1988, among secondary students (equivalent to US grades 10-12, or upper high school) since 2004 and among 9th graders (roughly equivalent to US 9th grade, or 15-year olds) since 1974 (Hvitfeldt and Gripe 2009). These data indicate a slight decrease in the prevalence of snus use among male youth and a slight increase in snus use among adults (Figure 1).



Source: Drug trends in Sweden, 2009; The survey questions for the 9th graders changed in 1983 and 1997. Note: Adult age group is 18-84 years old in 2004.

The Norwegian government began monitoring snus use in 1985 (Lund and Lindbak 2007). Since then the prevalence of daily snus use has increased (from 3% in 1985 to 17% in 2006 among 16 to 44 year old males). Between 1985 and 2005, the percentage of 8th grade boys who use snus (daily or occasionally) decreased slightly while the prevalence among 9th grade boys was fairly constant and the prevalence among 10th grade boys decreased. In 2011, data from Statistics Norway reported that the prevalence of daily snuff use among adults aged 16 through 74 years was 7%; among males daily snuff use was 13% and 3% among females.⁵ In Finland between 1981 and 2003, the prevalence of daily or occasional snus use stayed constant among 14 year old boys at about 5% and 14 through 18 year old girls at about 1%, while it increased slightly among 16 and 18 year old boys, from about 5% to 10% (Huhtala et al. 2006).

⁵ http://www.ssb.no/royk_en/main.html. Accessed on January 23, 2013.

2.1.2 Geographic variations in snus use

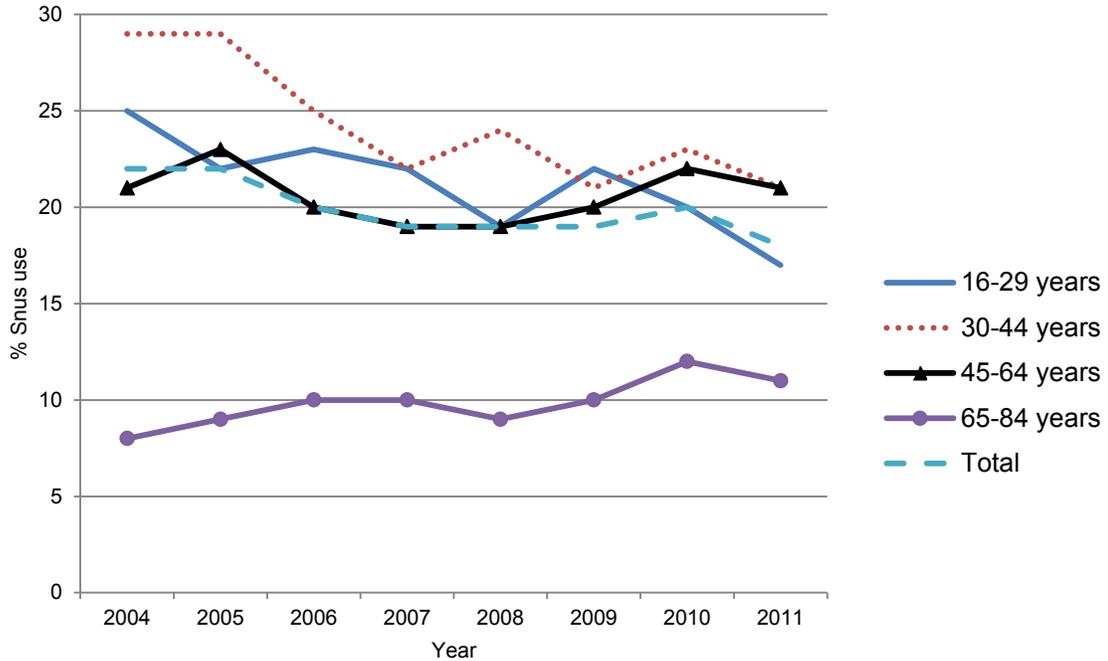
The use of snus is more common in Sweden than in other western countries, largely due to the cultural and legal acceptance of snus in the region. In Europe, the prevalence of snus use has mostly been quantified in Sweden, Norway and Finland; but it is reasonable to assume that snus use elsewhere in the EU is less common due to the EU ban. The prevalence of overall tobacco use in the EU is estimated to be 25 to 30% (Eurostat); and the rate is similar in Sweden (Eurostat). However, unlike the rest of the EU, the predominant form of tobacco use in Sweden is snus not cigarettes. There are dated reports of snus use in Germany and elsewhere in the EU (Hoffmann and Adams 1981) but no quantitative estimates were found. Males are much more likely to use snus than females in all three countries, so whenever possible, sex stratified prevalence estimates are presented.

There are a limited number of reports and studies in the peer-reviewed literature that present geographic differences in snus use within Sweden and Norway (Appendix B). Snus is more commonly used in northern Sweden, with a south to north gradient of decreasing prevalence of smoking and increasing prevalence of snus (Hvitfeldt and Gripe 2009; Norberg et al. 2011). Use of snus has traditionally been most prevalent in the Norwegian county that borders Sweden, Trondelag, though presently, the prevalence of snus in the northernmost counties is just as high in Trondelag. Overall, the prevalence of daily snus in northern Norway is 21% compared to 13 - 15% in the remainder of the country (Hergens et al. 2008b). The most recent tobacco survey conducted by the Swedish National Institute of Public Health (2011) highlighted these geographical differences; regional differences were most apparent among females. Females in northern Sweden were more likely to use snus daily than those residing in the south. Daily snus use was mostly uniform among males from the different regions in Sweden. Similar patterns were observed in Norway, where snus use more prevalent in northern Norway compared to southern Norway and higher in rural areas compared to urban areas (Grotvedt et al. 2008; Lund and Lindbak 2007).

2.1.3 Age and gender

As noted above in Figure 1 for Sweden, males are much more likely to use snus (or smokeless tobacco) than females. This is true not only in Sweden, but also Norway, Finland and the United States (see Section 2.2 below), across all age groups and for both current and lifetime measures of snus use. The prevalence of snus use among females is so low that many studies of the health effects of snus use (e.g., analyses of the Swedish Construction Workers' cohort) only have a sufficient sample size to study male snus users. Figure 2, below, presents the prevalence of snus use among males, by age group, from 2004 to 2011.

Figure 2: Prevalence of Daily Snus Use by Swedish Males



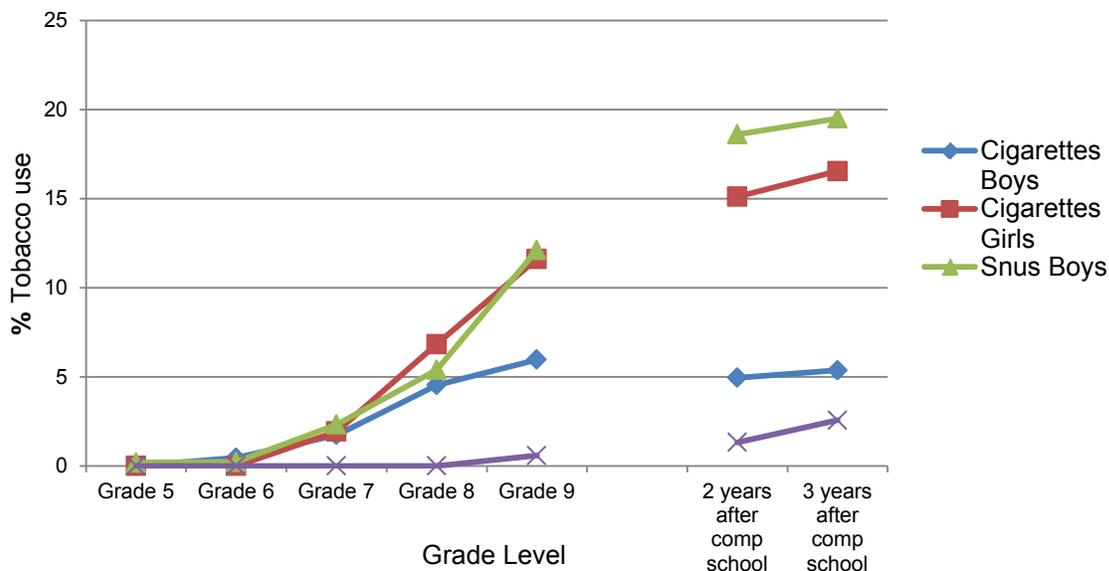
Source: <http://www.fhi.se/en/Highlights/National-Survey-of-Public-Health/Living-habits/Tobacco-habits/>

The proportion of adults over 18 who use snus in both Sweden and Norway vary by age (Appendix C). Those younger than about age 60 years are more likely to use snus than older adults. According to data from the Swedish Council for Information on Alcohol and Other Drugs (CAN) (as reported by Hvitfeldt and Gripe 2009), daily snus use was highest among males aged 16 – 29 years old, followed by 30-44 year olds, 45 -64 year olds and those 65 years or older, 22%, 21%, 19% and 9% respectively. This pattern was observed in other national surveys in both Sweden and Norway (Lund and Lindbak 2007; Statistics Sweden 2007).

Among adolescents, daily snus use was higher among those in higher grades compared to the lower grades (Lund and Lindbak 2007). This was specifically examined in the BROMS cohort, which followed students from fifth grade (approximately age 11 years old) to three years after compulsory school (approximately age 19 years old) (Galanti et al. 2001a; Galanti et al. 2008; Lager et al. 2012). Figure 3, below, presents the prevalence of use at the different follow-up periods for cigarette smoking and snus use among adolescent boys and girls in this cohort. Among girls, daily snus use was low in compulsory school (1-2%) and it was still low two to three years after compulsory school (2-3%). Cigarette use among school-age girls increased from 7th through 9th grade from approximately 3% to 12%; the increasing trend was observed two to three years following completion of compulsory school, 15% to 17%. Among school-aged boys, daily snus use increased from 7th to 9th from about 3% to 13%. Two to three years after compulsory school, daily snus use had increased, and was reported by 18 to 20% of these boys. Cigarette use among boys, typically followed a similar trend, increase from 2% to 6%, from 7th through 9th grade. Two to three years post compulsory school cigarette use remained

steady, at approximately 5-6%. In summary, tobacco use continued to increase in girls after compulsory school, mainly in the form of cigarettes. Among boys, no increase in cigarette use was observed after compulsory school, whereas an increase in the proportion of snus use was observed.

Figure 3: Prospective Follow-Up of Tobacco Use Among Adolescents



Source: Lager et al. 2012

2.1.4 Socioeconomic and occupational variations in snus

The available literature that describes information describing snus use patterns by occupational and employment groups in Scandinavia are presented in [Appendix D](#). Some of these differences can be partially explained by temporal trends and by differences in the ages of participants. Snus use prior to the later third of the twentieth century was largely limited to manual workers in outdoor occupations (e.g. loggers) and blue-collar workers, but the socioeconomic differences in snus use have become less apparent since 1980, especially among youth. This was observed among male participants in two studies that examined tobacco use prior to 1997 ([Haglund et al. 2007](#); [Janzon and Hedblad 2009](#)) but the difference by occupational category was not as apparent among females⁶ ([Janzon and Hedblad 2009](#)). Since then, snus use among men has increased among all professional groups ([Statistics Sweden 2007](#)) though the overall prevalence of use by working professionals is still below that of working groups.

Additionally, snus use is more common among the less educated than among the highly educated ([Engstrom et al. 2010](#); [Statistics Sweden 2007](#)), which is more apparent in males

⁶ <http://www.fhi.se/en/Highlights/National-Survey-of-Public-Health/Living-habits/Tobacco-habits/>. Accessed on January 22, 2013.

compared to females.⁶ [Norberg et al. \(2011\)](#) reported tobacco use trends among adults in Northern Sweden (VIP cohort) in several education categories: basic, mid-level and high educational groups from 1990 to 2007. Snus use increased proportionally in all educational groups; the authors noted that the participants with lower educational level had a greater overall prevalence of snus use compared to other educational groups (a change from 1990-1996 to 2002-2007 from approximately 15 percent to 24 percent, compared to the higher education group which had a snus use prevalence of approximately 10 percent in the earlier time period to 19 percent in the later timer period).

There have also been studies investigating snus use among athletes (e.g., [Rolandsson et al. 2005](#)). Most recently, [Martinsen and Sundgot-Borgen \(2014\)](#) reported that in a sample of Norwegian high school students, those that participated in team sports were more likely to use snus, most notably among handball and soccer players. They suggested that high school sport subcultures may play a role in initiating and sustaining snus use.

Three studies found a higher prevalence of snus among military personnel in Scandinavia than among the general population ([Bergstrom et al. 2006](#); [Jungell and Malmstrom 1985](#); [Mattila et al. 2008](#)). For example, [Bergstrom et al. \(2006\)](#) reported that 35% of the younger service men in the Swedish Armed Forces who were study participants reported current snus use.

2.1.5 Other individual level characteristics related to snus

Other individual level characteristics associated (or hypothesized to be associated) with snus use have been studied ([Appendix E](#)). In Scandinavia, these characteristics include exercise/physical activity, alcohol and illicit drug use and parental behaviors. With the exception of physical activity, several studies have suggested that those who engage in other risky behaviors (e.g., heavy consumption of alcohol or illicit drug use) are more likely to use snus ([Aro et al. 2010](#); [Eliasson et al. 1991](#); [Engstrom et al. 2010](#); [Galanti et al. 2001a](#); [Wickholm et al. 2003](#)). The presence of these associations does not infer causality or even temporal sequence (as will be discussed in the section about the relationship between STP use and smoking, see Chapter 3). In addition, adolescents whose parents use snus or smoke are more likely to use snus ([Hedman et al. 2007](#); [Rosendahl et al. 2003](#)).

2.1.6 Exposure estimates: frequency, amount and duration of snus

Understanding the frequency, amount, and duration of snus use and the degree of variability among individual and trends over time is an important part of examining STP use and the potential health effects of snus. For example, there are inconsistencies in how information is collected, the units of time, and the frequency of use. Surveys of snus use have measured lifetime snus use (ever versus never) or current snus use (compared to former users and never users). People who use snus daily may be compared to occasional users and never users, and units for individuals may be reported as daily or weekly, or as grams, cans, or tins of snus (or other smokeless tobacco product).

The most common method of snus use is to deposit one to two grams of loose product or a pouch of pre-portioned packaged snus in the vestibular area inside the upper lip ([Andersson 1991](#)); [Digard and colleagues](#) reported that 96% of pouched users and 99% of loose snus users

placed the snus at that site, though approximately one-third of pouched users and one-fifth of loose snus users move the portion around the mouth during use.

Additional exposure estimates that may include the number of pouches, packages or grams used per day or week, the amount of time that snus is left in the mouth, as well the number of years of snus use are described below, in Table 1, and in [Appendices F](#). For ease in comparison, note that one can of loose snus in Sweden is often assumed to contain 50 grams ([Eliasson et al. 1995](#); [Lewin et al. 1998](#); [Schildt et al. 1998](#)).

The most recent and comprehensive assessment of Swedish snus exposure patterns was reported by Digard and colleagues (2009). The authors conducted a telephone survey of daily snus users to quantify tobacco consumption among 2,914 snus users between the ages of 18 and 72 years (Table 1). They reported that female snus users (n=359) were more likely to use pouched snus (92.8%) than loose snus (6.4%) and 0.8% used both. Snus use among males (n=2,555) was more evenly distributed; 54% reported pouched snus use, 42.1% used loose snus and a minority reported use of both. The prevalence of the use of packaged snus in this more recent study by Digard and colleagues was an increase compared to a 1992 report (date of data collection unknown) that indicated that 73% of snus users consume only loose snus, 13% only snus pouches and 14% use both (Svenska Tobaks AB, Basdata om tobakskonsumtion 1992, TEMO AB, reported by [Andersson et al. 1994](#)). These differences reflect an increase in pouched snus use since its introduction in the late 1970s.

Pouched Snus	Male	Female
Packages per day	0.54	0.49
Portions per day	12.0	10.4
Consumption per day (g) from packages	12.4	9.3
Consumption per day (g) from portions	11.8	8.5
Time per day (hrs.)	13	7.7
Length of time in mouth (min)	69.7	47.3
Loose Snus		
Packages per day	0.59	0.58
Portions per day	12.3	13.5
Consumption per day (g) from packages	29.3	29.0
Consumption per day (g) from portions	32.1	33.8
Time per day (hrs.)	12.7	14.6
Length of time in mouth (min)	69.6	56.1

The Norwegian Tobacco statistics reported average values among adult Norwegian snus users; average consumption was 9.5 pinches of snus per day for daily snus users, and 3.6 pinches per week for occasional users ([Lund and Lindbak 2007](#)). A pinch is typically considered 2.5 grams; using this conversion, the average consumption for Norwegian snus users was 23.75 g/day. The authors noted that it was extremely difficult to measure self-reported consumption of snus, both because it can be difficult to remember and because the size of a pinch may vary. The authors reported that as of 2003, the loose form of snus was used by 63% of the Norwegian male snus users, and the remainder used portioned snus. By 2006, the type of snus used was

more evenly divided between loose snus and portioned snus; however, those who used snus daily were typically loose snus users (70%).

Additional studies that provide some information about the frequency, intensity and/or duration of snus use in Scandinavia are summarized in [Appendix F](#). Many of these studies were conducted prior to the consumption study conducted by Digard and colleagues, have smaller sample sizes, and some were conducted specifically among heavy users (e.g., [Wedenberg et al. 1996](#); [Rosenquist et al. 2005](#)). The amount of snus reported in these studies is highly variable, though the results are mostly consistent with that observed more recently by [Digard et al \(2009\)](#). For example, on average, snus users in these studies consumed less than 50 grams of snus per day and less than four cans per week. There was variability in the number of hours that snus users reported using between studies ranging from 11 to 13 hours, but again, this was similar to the findings by [Digard and colleagues \(2009\)](#).

2.2 United States

There is also a long history of use of STP in the United States, but unlike in Sweden, snus is the not the dominant form of tobacco. Traditionally there have been two main types of STP in the US, snuff and chewing tobacco. Snuff may be dry or moist, loose or packaged in sachets while chewing tobacco comes in the form of loose leaf, plug or twist tobacco ([CDC 2009](#)). Moist snuff remains the most common type of smokeless tobacco in the US market compared to dry snuff or chewing tobacco. The moist snuff, however, is produced differently from Swedish snus, is not heat treated, and is not chemically equivalent. The term “moist snuff” used in the remainder of this report refers to US moist snuff; the term snus refers to Swedish snus, as described above, in the [Section 2.1](#).

The use of STP in the US was widespread until the end of the 1800s. Its use declined rapidly from 1900 to the 1970s when smoked tobacco became the predominant form of tobacco used ([Psoter and Morse 2001](#); [USDHHS 1986](#)). However, between approximately 1970 and 1987, there was a marked increase in the use of smokeless tobacco in the US, with white males aged 18 to 34 years accounting for the largest proportion of this increase ([CDC 1994](#)). More recently sales of moist snuff products have increased, especially the pouched and flavored forms of moist snuff ([Delnevo et al. 2014](#)). However, there has been no corresponding increase in STP use. Smokeless tobacco use has remained relatively stable throughout the 1990s and into the 2000s, its use fluctuating between about 3% and 3.5% of the US adult population who are considered current users ([SAMHSA 2012](#)).

Much of the information on STP use patterns originates from the US national surveys. Most peer reviewed studies focused on STP use among males because smokeless tobacco use among females is much less common (as will be described later). [Appendix G](#) summarizes the available US national surveys that collect data on tobacco use, including STPs. Information on STPs is less commonly reported and less detailed compared to data on cigarette smoking; however, these surveys collectively provide substantial information on the demographics and patterns of STP use nationally. An important difference between the data collected in Sweden and Scandinavia is that the majority of US national surveys define current use as use of the product on one or more days in the last 30 days. This combines daily and occasional users,

and may not necessarily represent daily use. One of the surveys conducted among youth (the MTF survey) did collect information on daily use separately from occasional use.

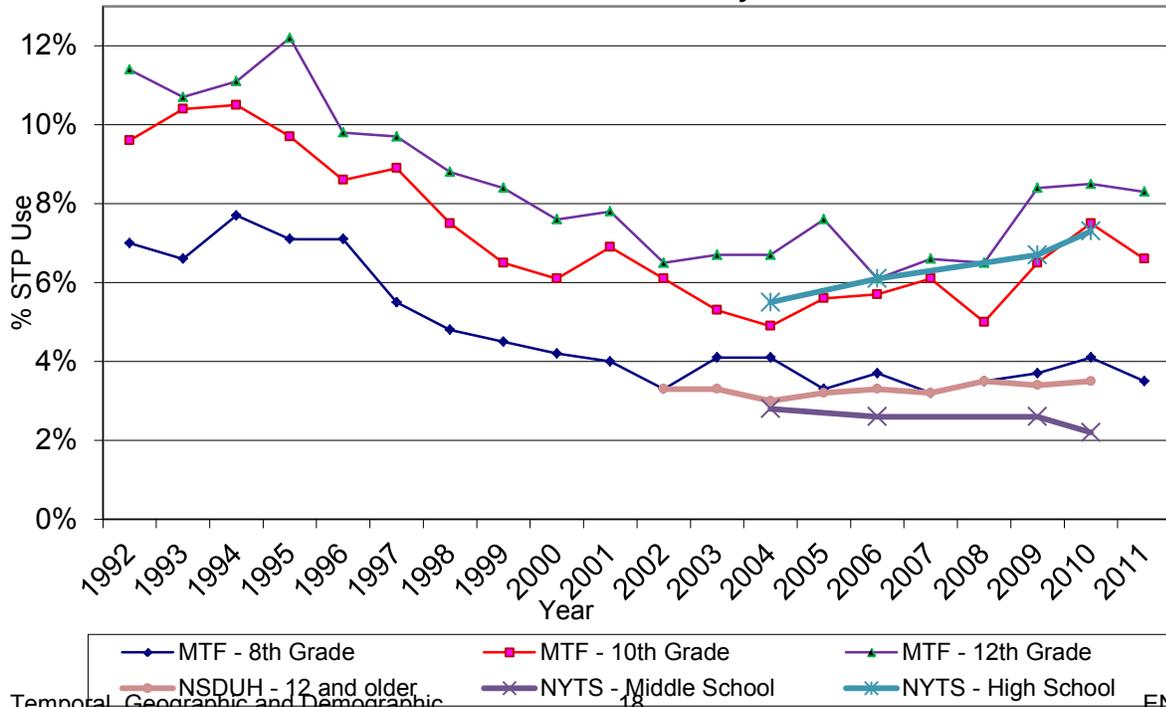
2.2.1 Temporal trends

The most recent estimates of trends in STP use in the US are from several national surveys that cover different age segments of the population. The 2010 National Survey of Drug Use & Health (NSDUH) is a random sample of households, and collects information on residents ages 12 and older. The 2011 Monitoring the Future (MTF) survey collects information on students in grades 8, 10, and 12 (middle school and high school). A third survey, the National Youth Tobacco Survey (NYTS), also collects information on middle and high school students, and provides data for a shorter period (2004-2010). Note that the majority of these surveys ask about current use (usually defined as at least one day in the last 30 days), but are not necessarily reporting on daily use; in fact, no surveys that include adult participants were identified in which information on daily use of smokeless tobacco products was collected.

Data from the NSDUH indicated that 3.5% of the U.S population aged 12 or older were current smokeless tobacco users. As shown in the Figure 4, below, the prevalence of STP use has not changed substantially since the early 2000s; rates of past-month use of STP have remained relatively similar from 2002 through 2011 (SAMHSA 2012). Using data from the MTF surveys, Johnston et al. (2010) noted that STP use among secondary school students was on a decline in the 1990's but has leveled off in recent years, and showed a significant increase in 2009.

Rodu and Cole (2009) reported that current STP use among adult male NHIS respondents was 4.4% in 2000 compared to 4.3% in 2005, also indicative of a plateau in the prevalence of STP use over recent years. The results of the surveys depicted in Figure 4 show varying temporal trends which highlight the different patterns of STP use across the different age groups.

Figure 4: Temporal Trends in the Prevalence of STP Use (30-day) from US National Surveys



Overall, among adolescents STP use declined in the 1990's but the decline has not continued; increases in STP use in the US have been more recent and less substantial.

2.2.2 Geographic variations in smokeless tobacco use

The prevalence of STP use in the US is highly variable by geographic region. For example, the reported prevalence of STP use in the southern states was often greater than in other parts of the country, as well as in the mid-west, followed by the west and lastly the northeast region. Several national surveys that provide information on the population variability in smokeless tobacco use across the US; Table 2 presents the most recent population data on the current use of STP from all the surveys (outlined in [Appendix G](#)) ([SAMHSA 2012](#)).

Northeast	2.1%
Midwest	3.9%
South	4.3%
West	3.0%
Overall	3.5%
Source: (SAMHSA 2012).	

[Rodu and Cole \(2009\)](#) analyzed data from the 2000 and 2005 adult NHIS survey on STP use among males. Among this population, the distribution of current STP use was highest in the south (with 45% of STP users), and the mid-west (35%), followed by 12% in the west and 8% in the northeast region.

Generally, regional STP use patterns among adolescents and young adults ([Figure 5](#)) mirrored the national adult population data with STP, use highest in the mid-western and southern states such as West Virginia (14.4%) and Oklahoma (13.1%); followed by western states (Montana (13.5%) and Wyoming (15.1%) and lastly the northeastern states New York (7.3%), and Maine (7.7%) ([Eaton et al. 2012](#)). Among high school students, the prevalence of current STP use was highest in Kentucky (15.8%) and lowest in Maryland (4.2%).

Other region-specific differences in STP use were highlighted in the studies by [Bell et al. \(2009\)](#) and [Proescholdbell et al \(2009\)](#); they conducted studies among residents of North Carolina and reported higher rates of smokeless tobacco use that exceed the US regional prevalence estimates presented above in Table 2. As mentioned earlier, STP use is higher in the south compared to other parts of the United States, partially explaining the higher prevalence of STP use reported in these studies (Bell et al. 2009; Proescholdbell et al. 2009).

In the US, the prevalence of STP use is higher in rural areas compared to places with higher population densities. Smokeless tobacco users are more likely to live in non-metropolitan areas and/or small metropolitan areas compared to large metropolitan areas (SAMHSA 2012). Among persons aged 12 and older, the prevalence of current STP use was lowest in large metropolitan areas (2.3%); followed by 4.0% in small metropolitan areas and 6.5% in nonmetropolitan areas (SAMHSA 2012). An analysis of the YRBSS data (1997 – 2003) by Lutfiyya et al. (2008) found that high school students who lived in rural areas were significantly more likely to try and report daily use of STPs than those living in metropolitan and suburban areas.

There is a strong geographic element to smokeless tobacco use in the US; products are most commonly used by those living in the southern and north central states. In the figure, the gaps represent states for which no information was available. Population density is an indicator of STP use in the US; use is typically higher among those living in rural, less densely populated areas.

2.2.3 Age and gender

There are several national surveys in the US that monitor demographic variations among smokeless tobacco users. These data, and data from other institutions and groups, show that STP use varies by age, race/ethnicity and especially gender.

Figure 5: Current (30-day) Use of STP Among Youths by US States

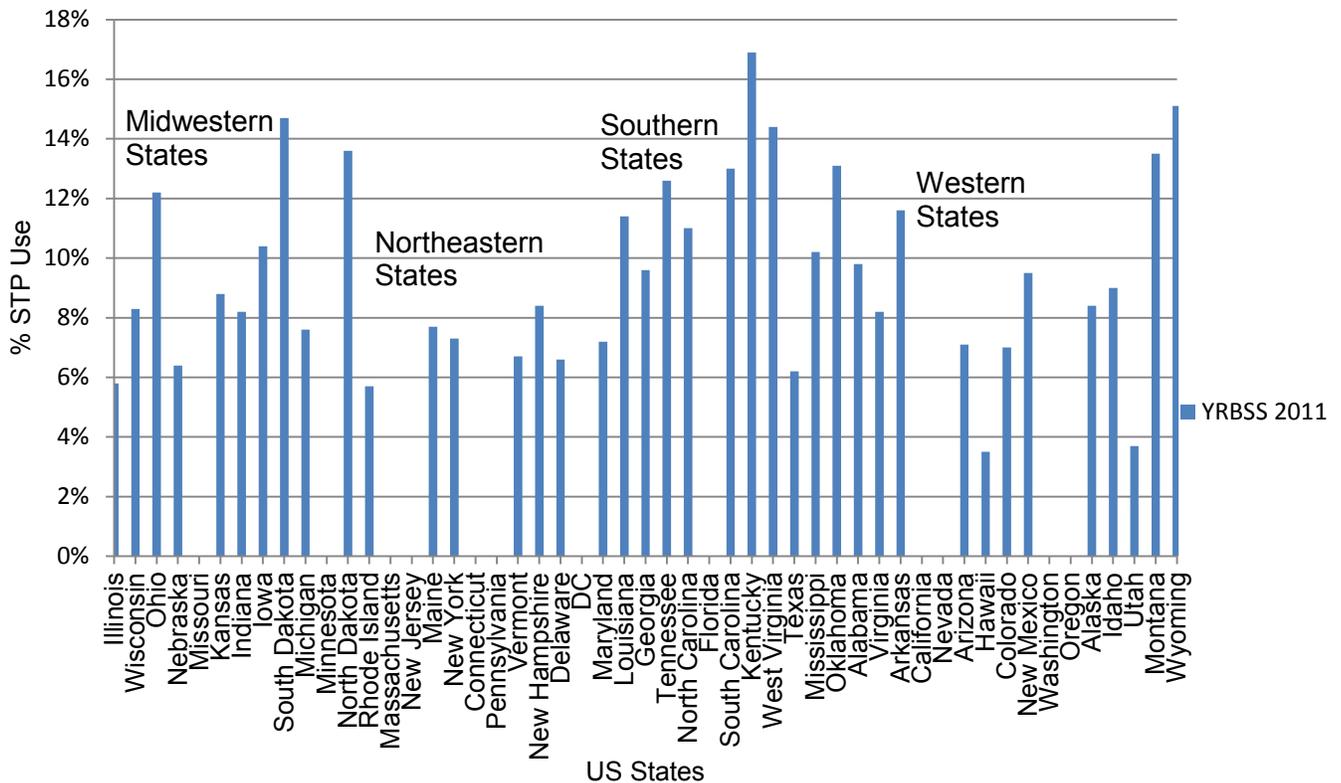
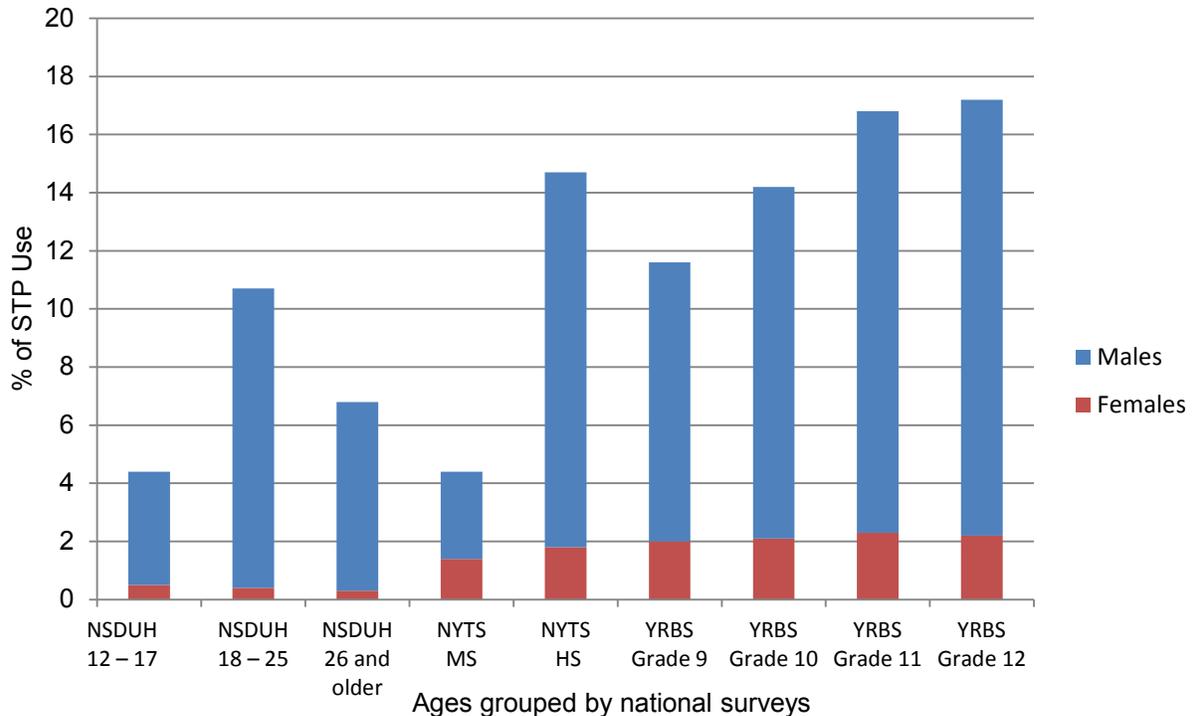


Figure 6 below represents the prevalence of current STP use by age and gender from the most recent data available in the national surveys conducted in the US. In two surveys ([Centers for Disease Control and Prevention \(CDC\) 2012](#); [Eaton et al. 2012](#)), STP use among younger students was lower than use among high school students and/or older students. Though these data are cross-sectional (that is, there was no individual follow-up through high school), the prevalence of STP use was consistently higher in the older grades compared to younger grades in both the three surveys presented in Figure 6.

Figure 6: Current (30-day) Use of STP by Gender and Age



Source: NSDUH 2008, NYTS 2012, YRBS 2012

In the US, among persons age 12 or older, males had higher rates of current STP use compared to females (6.8% versus 0.4%) ([SAMHSA 2012](#)). This trend can be observed across all population groups (see [Appendix H](#)) and for all measures of STP use. Overall, males in all age groups, regions and time frames studied were more likely to use STP than females. The one exception is a study in North Carolina in which older females had a higher prevalence of use ([Bell et al. 2009](#)) though smokeless tobacco use among young females in North Carolina was not higher than male students ([Proescholdbell et al. 2009](#)).

2.2.4 Race/ethnicity

In the United States, the prevalence of STP use varies substantially across racial/ethnic subpopulations ([LSRO 2008](#)). National estimates showed that smokeless tobacco use is higher among white Americans and American Indians compared to African American, Asians and other ethnic groups in the United States ([SAMHSA 2012](#)). According to the NHIS survey, among all STP users, the majority were white American males ([Rodu and Cole 2009](#)); in the NSDUH data,

the prevalence of STP use among African Americans was reported as 0.7% in 2007 to 1.4% in 2008 (data not shown in table) (SAMHSA 2012). Carroll et al. (2011) examined tobacco use among young African American males residing in five counties in Alabama; the prevalence of smokeless tobacco was equally low, 2.8%. An exception to this pattern was again observed in North Carolina, where African Americans and Native Americans had higher prevalence of smokeless tobacco use (Bell et al. 2009; Appendix I).

2.2.5 Socioeconomic and occupational variations in smokeless tobacco use

Similar to Sweden, the use of STP in the US differs by socioeconomic status, as measured mainly by employment, income and educational background (Appendix J). These studies provided no consistent pattern for the relationship between STP use and socioeconomic differences. According to the NSDUH survey, similar rates of current STP use were observed among adults (18 years or older) who were employed full-time (4.3%) and those unemployed (3.5%) compared to those employed part-time (2.5%) or not in the labor force (2.1%) (SAMHSA 2012).

Using the income/poverty ratio for participants in the NHIS survey, Rodu and Cole (2009) found that smokeless tobacco users were more likely to have lower income than never users, and also reported that smokeless tobacco use is common among persons with lower educational background. In the NSDUH survey, the prevalence of current STP use was lower among college graduates and persons who had “some college” attendance compared to persons with no more than a high school degree (SAMHSA 2012).

Sanem et al. (2009) compared STP use among two and four year college students; students were more likely to report current use if they attended a two year college compared to four year college/university students. The authors concluded that this pattern was attributable to the differences in demographics and the socioeconomic differences in students that attend two and four year colleges/universities. Generally, students who attend two year colleges are typically older, from lower income families, working full-time and attending school part-time (Horn and Nevill 2006 as cited in Sanem et al. 2009). In this study, students were more likely to work 40 or more hours if they were enrolled in a two year college compared to those enrolled in a four year university, 19.7% vs. 6.7% (Sanem et al. 2009).

Another subpopulation with higher smokeless tobacco use is persons in the military (Appendix K and L). STP use among military personnel has been studied in the United States, and found to be higher among persons in the US military compared to the general population (Appendix L). The prevalence of past-month STP use among civilian men aged 18 to 25 years was 9.5% compared to 17.1% among military personnel (NSDUH 2004 as cited by Peterson et al. 2007). Another study reported the prevalence of STP use among military recruits according to a Department of Defense survey and the Naval Health Research Center, as 25.4% and 22.7%, respectively, compared to STP use among civilians (10.7%) (Trent et al. 2007). Among active duty soldiers assigned to Fort Riley, Kansas, prevalence of smokeless tobacco use was reported to be over 19% (Ornelas et al. 2012). In addition, more males than females used tobacco products before and after deployment, with female tobacco use higher during deployment (DiNicola and Seltzer 2010). Hermes et al (2012) reported a higher prevalence of STP and initiation of smokeless tobacco among deployed military personnel's compared to non-

deployed members. Other subgroups such as career and volunteer firefighters were reported to have a high prevalence of smokeless tobacco use ([Haddock et al. 2011](#)).

2.2.6 Other individual level characteristics related to smokeless tobacco use

In the US, among males from 41 high schools in rural California, prevalence of STP use was higher among students who participated in any kind of sports (17.7%) compared to students who did not participate in sports (5.9%) ([Gansky et al. 2009](#)). Furthermore, several studies analyzed individual characteristics, such as sexual orientation, alcohol and illicit drug use, religion and relationship status, in relation to STP use ([Appendix M](#)). Smokeless tobacco use was more prevalent among heavy drinkers (11.7%) than among non-binge drinkers (1.9%) and nondrinkers (1.9%) ([SAMHSA 2012](#)). [Gillum et al. \(2009\)](#) assessed the relationship between attending religious services and STP use. Using information from the NHANES III study (1988 – 1994), the authors found that infrequent attendees were twice as likely to be STP users compared to never attendees among male participants between the ages of 17 and 29, after controlling for age, ethnicity, region, education, and health status (not included in [Appendix M](#)). As mentioned earlier, the presence of these associations does not infer causality. In the US people who engage in other risky behaviors (e.g., heavy consumption of alcohol or illicit drug use) are more likely to use snus.

2.2.7 Exposure estimates: frequency, amount and duration of smokeless tobacco use

There were no reports from US national survey data that presented information on the frequency, amount and/or duration of STP use. However several studies provided data on individual level patterns of STP use among various cohorts, including military personnel ([Appendix N](#)). These studies indicate that, on average, adult male consumers use STP between 5 and 8 times per day for a total of 4 to 7 hours ([Hatsukami et al. 1988](#); [Lemmonds et al. 2005](#)).

2.3 Summary and Conclusions

The term, smokeless tobacco products (STP), includes a broad range of products that vary considerably with regard to usage patterns, chemical composition, and content of potential toxicants. There are differences in potential risk associated with use of different STP, and it is essential to use a consistent terminology and clear definition of STP when addressing patterns of use. Traditional Swedish snus is the form of smokeless tobacco used in Sweden and other Scandinavian countries. It is an oral moist snuff product that is air cured, finely ground and heat treated. It is widely used in Scandinavian countries, particularly in Sweden where for several generations it has been an entrenched part of the culture. Snus is not used widely by tobacco users in the United States, who use a variety of other STP, including dry snuff and chewing tobacco.

In 2011, daily snus use was reported by 19% of adult males and 4% of adult females in Sweden. Occasional use was reported by an additional 6% of males and 4% of females. Snus use is also common in Norway (use by 15 to 20% of adult males), and to a lesser extent in Finland. Snus use among adolescent males and females has been shown to increase through compulsory school and eventually level off in the 2 – 3 years post-school age. The prevalence of snus use at that time remains higher among males compared to females, 20% vs. 3%.

Swedish snus use is most common in northern Sweden and Norway but is used throughout both countries and in both urban and rural areas. There were substantial increases in snus use in Sweden and Norway since the 1960s, but use rates have remained relatively stable since about year 2000.

In the US, combining data for all forms of STP, current use (daily and occasional) is reported by approximately 7% of males and less than 1% of females. Similar to the trend in Sweden, the prevalence of use of smokeless tobacco has remained stable since year 2000. The prevalence of STP use among adolescents reported in three surveys found an increase in STP use by increasing grade level among school-age adolescents.

There is a geographic element to STP use in the US; smokeless tobacco products are more commonly used by those living in the southern and mid-western states. Use is also typically higher among those living in rural, less densely populated areas, and STP use is most common among white Americans and American Indians compared to other racial/ethnic groups. US military personnel represent a subpopulation with higher STP use than the general population.

3 Relationship of Smokeless Tobacco to Smoking

The relationship between snus and other STP use and smoking is complex and understanding it requires investigating patterns of dual tobacco product use, the temporal order of initiation or transition between types of tobacco products, use of STP for smoking cessation and the gateway (harm escalation) hypothesis. Understanding the temporality of the relationship between tobacco product types is critical to understanding the initiation, gateway, smoking reduction, and cessation components of the relationship.

This section addresses gateway to smoking, smoking cessation as related to snus or smokeless tobacco use studied in Sweden and other Scandinavian countries that use snus, and other STPs in the US, and dual use of tobacco products. Studies of the relationship between snus/STPs, and other forms of tobacco, especially smoking, help answer questions about which tobacco product types are used first (that is, to initiate use of tobacco), the frequency and risk factors for switching to more harmful products (gateway), whether and with what frequency STPs are used as a gateway out of use of more harmful tobacco products (that is, smoking cessation and whether it leads to tobacco cessation altogether).

Many studies are available from Scandinavia and the US that have assessed use of both smoked and non-smoked tobacco products. Study designs include intervention studies (clinical trials of smoking cessation), and observational epidemiology studies (longitudinal and cross-sectional). The longitudinal studies that examine tobacco use behaviors in individuals prospectively provide stronger evidence in understanding the patterns of initiation and transitioning between tobacco types. Cross-sectional studies provide supportive evidence but casual inferences are not possible from cross-sectional studies; the temporality of exposure and outcome is unknown.

Some authors have offered several reasons for the patterns of snus use in Sweden; most of which centers around the cultural acceptance of snus in the Scandinavian region, the cost difference between snus and cigarette, which is greater in Sweden compared to costs in the US, and unrestricted sale of snus in Sweden unlike the rest of the EU ([Colilla 2010](#); [Rodu et al. 2003](#); [Zhu et al. 2009](#)).

To supplement the collection of data on tobacco use in the US, the National Institute of Health has partnered with the FDA's Center for Tobacco Product on a large-scale collaboration, the "Population Assessment of Tobacco and Health (PATH study)." This nationally representative study of tobacco use and health in the US population is specifically aimed at identifying trends, monitoring changes in risk perceptions, attitudes, tobacco uptake/initiation, quitting and potential relapse patterns, biomarkers and associated health outcomes, including focusing on important subgroups. The first data from this study may be available as early as 2014, with successive waves of data collection planned through 2016.

This section like the rest of the report is organized by topic area and further demarcated by Scandinavian and US sections. Within each section, the introduction presents definitions of terms, concepts, and key issues, followed by a summary of the adult-related research studies, then the studies in adolescents and young adults, "youth". General definitions of these age groups are adolescents fall between the ages of 11 and 17 years, and young adults are typically

between 18 to 25 years of age, though, developmentally, the period between 18–20 years of age is often labeled late adolescence, and those 26 years of age or older are considered adults (USDHHS 2012). Adolescents and young adults were discussed separately based on the unique behavior pattern among this subgroup, and the fact that nearly all tobacco use begins in childhood and adolescence (USDHHS 2012). Typically, 88% of daily adult smokers reported that they started smoking by the age of 18 years. Several authors have suggested that trying and experimenting prior to teenage years is a weak predictor of later smoking (Galanti et al. 2001a).

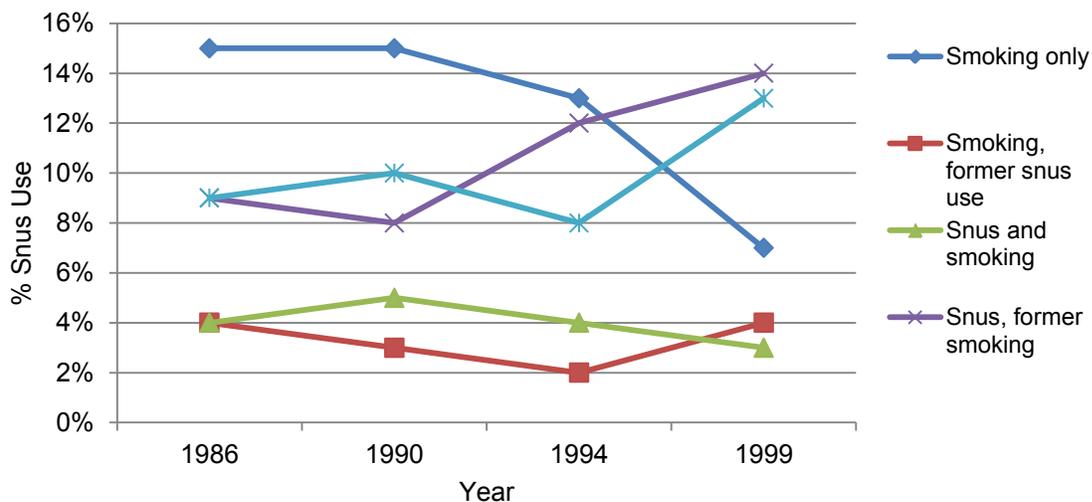
The following section examines transitioning at either the population or individual level; that is, looking at trends, patterns, determinants, and dynamics of tobacco use in a population (or a subset of the population) as an entirety, compared to what individuals are doing or experiencing, and determinants of those behaviors or outcomes, within that population.

3.1 Population-level transitioning between tobacco products

3.1.1 Scandinavia

As discussed previously in Section 2.1, and as shown in Figure 7, below, between the mid-1980s and 1999, there was a population level shift from smoking to snus use in Northern Sweden (Figure 7, Rodu et al. 2002) that stabilized after 2000. The population shift was far more pronounced in men, with a 56% increase in the proportion of those who smoked transitioning to snus use, but there is evidence that some women also transitioned from cigarettes to snus.

Figure 7: Tobacco Use Trends Among Males in Sweden



Source: Data from MONICA study (Rodu et al. 2002)

Additional analysis of data from the WHO Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases (MONICA) project in northern Sweden (an area with a high prevalence of snus use) and the Vasterbotten Intervention Programme (VIP) provide evidence for this population-level transitioning (Lindahl et al. 2003; Rodu et al. 2002; Rodu et al. 2003; Stegmayr et al. 2005). From approximately the mid-1980s to 2007, these studies monitored

trends in cigarette smoking and snus use and found a decreasing trend of daily smokers with a corresponding increase in snus users.

3.1.2 United States

In contrast to the data from Sweden, to date, in the US there is little indication of a population-level transitioning from cigarette smoking to STP use. As mentioned in the [Section 2.2](#), in the US, smokeless tobacco use has remained relatively stable throughout the 1990s and into the 2000s, its use fluctuating between about 3% and 3.5% of the US adult population (SAMHSA 2012). Cigarette smoking has gradually declined in the US from 2002 to 2010 and has remained relatively stable since then at about 23% ([SAMHSA 2012](#)).

3.2 Individual-level transitioning between tobacco products: Gateway and transitioning from smokeless tobacco to cigarettes

Gateway theories have been proposed in various areas of substance use for many years. These theories argue that use of one substance makes it more likely to use other (generally "harder" or more dangerous) substances. Contemporary policy on smokeless tobacco in the US and Europe is influenced by concern that smokeless tobacco may act as a causal gateway to an unhealthier, combusted, tobacco products. The gateway theory as it is applied in tobacco use suggests that using snus or other STPs increases the likelihood that an individual will progress to cigarette smoking.

Gateway studies seek to establish a causal link between snus use and smoking by examining over time the order in which snus and cigarettes are used by the individual and other factors that contribute to tobacco use in general. The term "gateway" is not merely a shorthand for the transition from STP use to smoking (which occurs in both the US and Sweden). Gateway theory is more complex than demonstrating a correlation between use of STP and cigarettes and a temporal sequence (i.e., use of STP precedes smoking). STP use is only a gateway to cigarette smoking if the temporal sequence is established and the relationship is causal. According to several authors, this is true only if someone who would have not started smoking if they did not have the option of using STP begins to use STP and later initiates smoking ([Gartner and Hall 2009](#); [Golub and Johnson 2002](#); [Kozłowski et al. 2003](#); [Nissen et al. 2010](#)).

Many studies conducted in Scandinavia and in the US have assessed the prevalence of use of both smoked and non-smoked tobacco products. Several points about this relationship are noteworthy; for example, there are many smokeless tobacco users in both Sweden and the US who have smoked at some point in their lifetime, so a high degree of correlation between the two is expected. When temporality is considered, however, there is conclusive evidence of switching from smoking to snus use at both the population level in Sweden, as discussed in [Section 3.1](#), and at the individual level, to be discussed in the following sections. Therefore, the ideal evidence to examine potential gateway issues are studies in which temporality is considered, as in prospective studies in which individuals are followed over time, and in which co-factors for tobacco use are also considered.

An adequate model has not been established to accurately depict the gateway hypothesis. Some of the issues result from identifying psychosocial and behavioral factors that interplay in an individuals' decision to initiate smoking ([Colilla et al. 2010](#)). Some of these factors include

access to tobacco, family smoking habits, cultural bans on smoking, alcohol use, socioeconomic status, susceptibility to tobacco use (Colilla et al. 2010; Grotvedt et al. 2012; Galanti et al. 2008).

3.2.1 Scandinavia

Numerous studies have examined the relationship between snus and cigarette smoking (Furberg et al. 2005; Furberg et al. 2006; Galanti et al. 2001a; Galanti et al. 2008; Grotvedt et al. 2013; Haukkala et al. 2006; Lindstrom and Isacson 2002b; Lundqvist et al. 2009; Ramström and Foulds 2006; Rodu et al. 2003; Stenbeck et al. 2009). These studies evaluated the potential transitioning or switching from snus to cigarette smoking in Sweden and Norway either at a time point (cross-sectional) or by following a cohort over time (longitudinal).

Longitudinal assessment of various Scandinavian cohorts to understand the impact of snus use on subsequent smoking is described in four longitudinal studies on transitioning from snus use to cigarette smoking in Scandinavia among adults (Lundqvist et al. 2009; Norberg et al. 2011; Rodu et al. 2003; Stenbeck et al. 2009) and four studies conducted similar analyses among adolescents and young adults (Galanti et al. 2001a; Galanti et al. 2008; Grotvedt et al. 2013; Haukkala et al. 2006).

Lundqvist et al. (2009) conducted a ten-year assessment of smoking and snus habits among northern Sweden participants from the Vasterbotten Intervention Programme (VIP) study. Study participants included men and women who were 30-years old in 1990, 1991, 1992, 1993 or 1994 and invited for follow-up 10 years later. The authors found that among snus users, only a small proportion transitioned from snus to smoking, specifically, only 1.1% of baseline snus users (n = 1800) became cigarette smokers. Among those who were snus-free at follow-up (n = 356), it was more common to remain nicotine free than to switch to cigarette smoking. For this cohort, sustained snus use over follow-up period was most prevalent for both male and female snus users. A second look at the same longitudinal cohort and additional cross-sectional subjects, Norberg et al. (2011) ultimately reached similar conclusions; it was more common to switch from cigarette to snus than to transition from snus to smoking. Norberg et al (2011) reported that approximately 1.2% participants who used snus at baseline (n = 2587) became smokers while 9.4% of participants who smoked at baseline (n = 5153) became snus users within the ten-year follow-up period. Overall, trends from 1990 -1997 to 2000 – 2007 showed that smoking decreased and the use of snus increased, consistent with population trends observed in Sweden. Gender differences were apparent among this cohort, never-smokers increased among male snus users while female snus users were dominated by former smokers.

The Swedish Level of Living Survey (ULF) is an annual national survey performed by Statistics Sweden which collects information on social and health conditions; part of the survey includes a supplement conducted in 8-year waves. Using the ULF survey from 1988/9 and 1996/7, Stenbeck et al. (2009) examined whether the use of snus in 1988/9 was associated with smoking in 1996/7. Participants were stratified by age, younger (16 – 44 year olds) and an older sub-group (45 – 84 year olds) to account for tobacco habits established at younger ages. Regarding smoking initiation based on prior snus use, Stenbeck et al. (2009) found that compared to non-snus users at baseline, younger participants who were considered “snus beginners’ and those who were consistent snus users were more likely to stop smoking

compared to smoking initiation. Among older participants, compared to non-snus users, those who began snus use in the follow up period had nearly equal odds of either initiating or quitting cigarette smoking (OR 8.2 vs. 6.6). Also, among older participants, consistent snus users were no different from the non-snus users in initiating or quitting cigarette smoking. Nevertheless, among the younger cohorts, those who quit snus use during the follow-up period were more likely to initiate smoking (~6% of the snus users); although, the authors noted that “the overall net effect was small, as this group represented very few people.” In summary, these authors concluded that 1990s snus use was associated with a greater incidence of smoking cessation than smoking initiation. Smokers who started using snus were much more likely than non-snus using smokers to quit smoking.

Another prospective study in northern Sweden was conducted by Rodu and colleagues (2003) among adults, aged 25 – 64 years, enrolled in the MONICA project in 1986, 1990, 1994 with a follow-up in 1999; the follow-up period ranged from 5 -13 years for study participants. Rodu and colleagues reported that snus was the most stable form of tobacco use among men: 75% remained snus users, only 2% of snus users switched to cigarettes, 3% became combined users and 20% of snus users quit tobacco altogether. Smoking among males was less stable: 54% remained smokers, 27% of were tobacco-free, 7% became combined users and 12% used snus at follow-up. As mentioned above, it was more likely to transition from cigarette smoking to snus than vice versa. Similar patterns were observed by Furberg and colleagues (2006), they examined patterns of use among adult males participating in the Swedish Twin Registry over a four-year period ending in December 2002. Among men who began tobacco use with snus (n=1327), 21.9% took up smoking later in life, 67.1% remained snus users while 32.9% of exclusive snus users had quit using snus. On the other hand, among cigarette starters (n=6490), 28.5% transitioned to snus. Most tobacco initiated occurred with cigarette smoking first. However, the authors concluded that once snus use occurred participants typically remained snus users instead of quitting.

Youth Behaviors: A bulk of the transitioning from snus to cigarette literature in Sweden has focused on males and adolescents/young adults as most tobacco habit are formed before age 25 years (Colilla 2010; Stenbeck et al. 2009; USDHHS 2012). Review of the literature among adolescents surveyed as part of several Swedish and Norwegian cohorts found that tobacco initiation with snus or current snus use was not a predictor of future cigarette smoking (Galanti et al. 2001a; Galanti et al. 2008; Grotvedt et al. 2013; Haukkala et al. 2006).

In a study of the BROMS cohort, Galanti and colleagues (2001a; 2008) assessed tobacco initiation among adolescents between the ages of 11 and 18 years in 5th grade through three years post-compulsory school (n = 2,938). At one-year follow-up (6th grade), the authors reported that 36% of baseline snus users (n=52) had also smoked while the others remained snuff-only users; among baseline cigarette smokers (n=419), 18% used snuff at follow-up (Galanti et al. 2001a). In the longer follow-up (3-years post-compulsory school), a more established pattern was observed. The authors found that compared to non-tobacco users, baseline snus users were not more likely to become cigarette smokers at follow-up (OR= 1.95; 95% CI: 0.96 – 3.8); exclusive cigarette users (OR= 2.89; 95% CI: 2.25 – 3.71) and mixed starters (OR= 4.81; 95% CI: 3.09 – 7.5) were more likely to smoke cigarettes at the end of follow-up. Additionally, the odds of being a current smoker at end of follow up was higher, but

not significantly increased, for cigarette starters compared with snus starters (OR=1.42; 95% CI: 0.98 - 2.1); those who were mixed starters (cigarette and snus) were more likely to smoke at follow-up (OR=2.54; 95% CI: 1.68 – 3.91) (Galanti et al. 2008). Due to the low rates of snus initiation and smoking progression among snus starters, the authors concluded that “at most 6% of the final smoking prevalence in this cohort could theoretically be attributable to the gateway effect of snus (Galanti et al. 2008).” Galanti and colleagues (2008) concluded that those who started tobacco using both snus and cigarettes were stronger predictors of being a current smoker by the end of follow up; that is, snus starters had a lower risk of ending up as a current tobacco user when compared to those who had experimented with both products at the earlier time point.

In another prospective study, Grotvedt and colleagues (Grotvedt et al. 2013) assessed smoking initiation among 16-year old Norwegian males (n = 1,440) and followed for three years. The authors reported that baseline snus use was not associated with increased odds of smoking only at follow-up (OR= 0.86; 95% CI: 0.40 - 1.81); after adjusting for “previous smoking” experience. However, baseline snus users were more likely to be dual users, i.e. occasional smoking and daily snus use (OR= 1.88; 95% CI: 1.06 - 3.33). The authors emphasized that there were no trends of switching from use of snus alone to cigarettes alone. Furthermore, baseline smokers were most likely to remain smokers (OR= 13.31; 95% CI: 8.2 - 21.6) or become dual users (OR= 10.74; 95% CI: 6.56 - 17.57). In addition, adolescents using snus only at baseline were more likely to be tobacco free (24%) at follow-up than smokers and dual users (14% and 15%, respectively). The authors concluded that snus use at baseline increased the risk of being a dual tobacco user.

Lastly, Haukkala and colleagues conducted a 3-year longitudinal study among students participating in their schools’ (n = 27) smoking prevention program in Helsinki, Finland (Haukkala et al. 2006). Because the prevalence of oral snuff experimentation was low among girls, the authors only examined the impact of snuff experimentation upon later smoking among boys at three time points, 8th grade, and start and end of 9th grade. In predicting the impact of snuff experimentation on later smoking, they compared those who had at least tried oral snuff to those who had never tried. Those who had tried oral snuff in 7th grade (baseline) had a higher risk for regular smoking in the 8th grade (OR= 6.21; 95% CI: 3.20 – 12.06) among boys who were not regular smokers at baseline. In a similar model, 8th grade snuff experimentation predicted weekly smoking at the start of 9th grade (OR= 4.38; 95% CI: 2.82 – 6.80). Similarly, boys who were regular smokers at baseline had a higher risk of oral snuff use at one year follow-up (OR= 7.26; 95% CI: 7.26 – 14.67). The impact of snuff experimentation upon later smoking experimentation was smaller than vice versa; the authors attributed this to smoking experimentation being more prevalent than snuff experimentation. The authors did not ask about “current snus use” they only asked about “experimentation” with tobacco; response to use of snus may have accurately reflected those who progressed to smoking. Snuff experimenters could have stopped oral snuff use long before study commenced.

In addition to the prospective studies discussed above, several cross-sectional studies on the relationship between snus use and cigarette smoking support some of the findings observed in the longitudinal studies (Furberg et al. 2005; Ramström and Foulds 2006). Furberg et al. (2005) evaluated the association between snus use and subsequent smoking initiation among adult

males as part of the Swedish SALT twins study. Men who had used snus before they started smoking were compared to men who had never used snus in relation to any lifetime smoking while adjusting for age and other variables associated with smoking initiation. Results from this study suggested that “regular” and “now and then” snus use was inversely associated with smoking initiation. [Ramström and Foulds \(2006\)](#) analyzed retrospective data from a cross-sectional survey completed by adult males participating in the Sweden Your Country and Your Life national survey. Among male primary snus users, 20% reported that they started daily smoking; this is compared to non-primary snus users, among whom more than twice as many (47%) reported that they started daily smoking; male primary snus users had decreased odds of initiating smoking compared to non-snus users (OR= 0.28; 95% CI: 0.22 - 0.36). The authors concluded that the odds of initiating daily smoking were significantly lower for those who had started using snus than for those who had not. Even among primary snus users, who started secondary smoking (*potential gateway subjects*), 74% later ceased daily smoking, where 56% returned to exclusive daily snus use and 18% had, by the time of the survey, reported that they quit daily snus use as well and tobacco altogether.

In summary, following a review of longitudinal and cross-sectional studies that examined snus use and the risk of future smoking in several populations in Sweden and other Scandinavian countries, there is little evidence that prior snus use leads to daily cigarette smoking among adults. These studies show that snus use is associated with a reduced risk of becoming or continuing to be a regular cigarette smoker, (compared to those who start using tobacco as smokers or non-tobacco users), that is, there is an inverse association between snus use and cigarette smoking initiation. Longitudinal studies provide evidence of transitioning from cigarettes to snus as compared to switching from snus use to cigarette smoking. A review of studies among adolescents in Sweden, Norway, and Finland showed that baseline snus use was not a precursor to exclusive cigarette smoking; that is, tobacco initiation with snus or current snus use was not a predictor of future cigarette smoking. According to the 2007 SCENIHR report, “the Swedish data, with its prospective and long-term follow-up do not lend much support to the theory that smokeless tobacco (i.e. Swedish snus) is a gateway to future smoking” ([SCENIHR 2007](#)). Four additional studies published since the SCENIHR report have supported this same conclusion ([Grotvedt et al. 2013](#); [Lundqvist et al. 2009](#); [Norberg et al. 2011](#); [Stenbeck et al. 2009](#)).

Some evidence from these studies showed that dual use of both cigarette and snuff may be a stronger predictor of future smoking. Lastly, a majority of the studies focused on tobacco use behaviors among males, due to the low prevalence of snus among females. Some of difficulty with understanding the gateway hypothesis as it relates to cigarette smoking is the variations in study design, population studies, generating estimates of the risk of starting to smoke cigarettes and methods of modeling smoking predictor variables ([Colilla 2010](#)).

3.2.2 United States

Compared to the available studies conducted in Scandinavian, there are fewer large prospective studies that address transitioning from smokeless tobacco to cigarette smoking; much of the US literature is obtained from the cross-sectional, recurring national surveys. There are several smaller longitudinal studies on the potential transitioning from smokeless tobacco to cigarette smoking in the US ([Ary et al. 1987](#); [Ary 1989](#); [Forrester et al. 2007](#); [Kozlowski et al. 2003](#);

O'Connor et al. 2003; Severson et al. 2007; Timberlake et al. 2009; Tomar 2003; Zhu et al. 2009). As with the Scandinavian studies, these are discussed separately for adults and youths, followed by a section that describes the cross-sectional studies of either adults or youth, and studies in the US military.

Adults aged 18 and older were followed as part of the 2002 TUS-CPS with a one-year follow-up in 2003 (Zhu et al. 2009). Participants were stratified by tobacco use: exclusive cigarette or smokeless tobacco users, dual users, and non-tobacco users. At follow-up, among males using only smokeless tobacco (n = 234), 59.4% continued exclusive STP use, 3.9% quit smokeless tobacco and switched to cigarettes and 1.8% became dual users. The remainder of male smokeless tobacco users (35.0%) became non-tobacco users. Among females using only smokeless tobacco (n = 24), 52.7% continued exclusive STP use, 3.2% quit smokeless tobacco and switched to cigarettes. The remainder of female smokeless tobacco users (44%) quit, and became non-tobacco users. Their results suggested that quitting one form of tobacco and switching to another was infrequent. With regards to the gateway hypothesis, it was more frequent to switch from smokeless tobacco to smoking than vice versa (3.9% vs. 0.3%), leading the authors to conclude that their results did not mirror patterns observed in Sweden.

On the other hand, factoring in product order rather than simple correlational analyses, that is, use of STP first, cigarettes first, or STP only, Kozlowski and colleagues (2003) reached different conclusions. The authors examined possible gateway patterns in US males aged 23-34 years old, part of the NHIS 1987 sample. They excluded ages 18-23 years from all but the initial analysis, stating that potential recruitment to smoking continues to occur in that age group. Their results did not indicate that increased use of STP was associated with increased smoking; on the contrary, their analysis showed a negative relationship between STP and cigarette use (Kozlowski et al. 2003). In their initial analysis, they compared Swedish data from 18–34 year-old males from a 1986–87 survey to 18–34- year-old males in the 1987 NHIS sample based on whether cigarettes or snuff was used first. Those who started either cigarette first or snuff only users were categorized as “non-gateway” users and those who started with snuff first were “potential gateway” users. The authors reported that most snuff users in Sweden (83%) and the United States (77%) appear to be “non-gateway users”, in that their snuff use did not precede smoking or their smoking preceded snuff use. The authors reported that 17.5% of Swedish users and 22.9% of US users used STP before smoking and therefore were possibly gateway users, a small difference in percentage points, but statistically significant.

Additionally, the Kozlowski and colleagues (2003) assessed potential differences in age-related patterns of tobacco use among adult males aged 23-34 years (categorized as 23-26, 27-30 and 31-34 years) over four years. They observed age-related differences, that is, ‘cigarettes only’ use was 9.3% lower in the youngest age group than the oldest group; ‘STP only’ use was 5.1% higher in this younger group. STP use before cigarettes was 1.7% higher in the youngest age group than the oldest group; however, cigarettes before STP was 2.4% lower. The authors noted that despite the slightly higher use of SLT in the younger age group, this younger age group was 0.58 times as likely to have ever been a smoker, indicating that increased use of STP is not associated with increased smoking; on the contrary, they noted, it shows a negative relationship between STP and cigarette use.

Youth Behaviors: As mentioned earlier, there are several studies in the US that have focused on tobacco use behaviors has examined patterns among adolescents and young adults (Ary et al. 1987; Ary 1989; Forrester et al. 2007; Severson et al. 2007). Two longitudinal studies conducted in Oregon school districts examined whether smokeless tobacco use was a predictor of future cigarette smoking (Forrester et al. 2007; Severson et al. 2007). Participants completed surveys in grades 7 and 9, and then 2 years later, completed the survey in grades 9 and 11. Results of multivariate modeling showed that monthly STP use was a strong predictor for smoking at 2 years' follow-up for boys (OR= 2.54; 95% CI: 1.43 – 4.5) (Forrester et al. 2007). Using the same cohort, Severson et al. (2007) showed that adolescents who used STP at least monthly at baseline were more likely to become weekly smokers at the end of the two year follow up period (OR= 2.62; 95% CI: 1.31 – 5.22). The authors analyzed 15 possible predictors of the development of susceptibility to smoking initiation at follow-up: though smokeless tobacco use at baseline did not significantly predict susceptibility (OR= 1.6; 95% CI: 0.98 – 3.3), they concluded that smokeless tobacco use was a risk factor for cigarette smoking. Two older studies, also conducted in several Oregon school districts reached similar conclusions (Ary et al. 1987; Ary 1989).

Two analyses were conducted using data from the Teenage Attitudes and Practices I-II Survey. In the first, Tomar (2003) reported that US adolescents, aged 11 to 19 years old, were more likely to switch from STP use to cigarette smoking compared to never users (OR=3.45; 95% CI: 1.84 – 6.47). Tomar (2003) indicated that his analysis was limited to adolescents who had not smoked at baseline but the never-smoker group included people who had experimented with cigarettes. In the second analysis, O'Connor and colleagues (2003) reanalyzed the data presented in Tomar (2003) by including psychosocial factors that may increase the risk of future cigarette smoking such as depressive symptoms, risk-taking behavior, self-image, and other behavioral factors that influence whether or not an individual becomes a future cigarette smoker. They found that smokeless tobacco as a predictor of future smoking diminished through the addition of psychosocial variables in multivariate analysis, and was no longer statistically significant (OR=1.69; 95% CI: 0.83 – 3.41).

Lastly, considering product order and switching between products, Timberlake and colleagues (2009) in their analysis of daily adolescent smokers as part of the California Tobacco Survey employed the use of propensity scores to account for multiple predictors of becoming a daily smoker. After applying predictors of smoking such as demographic, smoking-related exposures and behavioral risk factors, smokeless tobacco use was not associated with the risk of becoming an ever daily smoker.

Several cross-sectional studies addressed the association between smokeless tobacco and cigarette smoking. These studies reported that smokeless tobacco use was associated with future cigarette smoking (Glover et al. 1989; Lutfiyya et al. 2008; Peterson et al. 1989). Using multivariate analyses, Lutfiyya et al. (2008) reported that smokeless tobacco use in the past 12 months was associated with daily smoking among adolescents aged 12 to 18 years as part of Youth Risk Behavior Surveillance System. Glover et al. (1989) assessed switching patterns among college students from eight separate regions in the US; Peterson (1989) conducted a study among 10th grade students in 14 rural and suburban school districts in Washington State. Both studies suggested an association between smokeless tobacco use and cigarette smoking

(Glover et al. 1989; Peterson et al. 1989); these studies are over 20 years old and may not be relevant for understanding the current relationship between contemporary smokeless tobacco products and smoking. On the other hand, Rodu and Cole (2010) concluded in their analysis of young adults ages 16 through 18 participating in the NSDUH survey, reported that STP played no role in smoking initiation among white males. According to the authors, 90% of ever smokers started with cigarettes or were dual initiators; therefore, STP could have been a gateway to at most 10% of ever smokers (if this relationship was causal for all STP users).

The US military personnel account for approximately 1.4 million of the US population, and represent a unique population for understanding tobacco use patterns. Tobacco use is more common in the military generally, and they are more than twice as likely as civilians to use smokeless tobacco (Peterson et al. 2007). According to a Department of Defense (DoD) survey conducted in 2008, the prevalence of smokeless tobacco use among US military personnel ranged from 9% to 19% in the various military branches (IOM 2009). Several prospective studies have been conducted among US military personnel on smokeless tobacco use and subsequent smoking initiation (Cooper et al. 2010; Haddock et al. 2001; Klesges et al. 2010). These studies have ultimately supported the conclusion of an association between smokeless tobacco use and cigarette smoking. In a cohort of US Air Force military recruits, Haddock and colleagues (2001) reported an association between smoking initiation among baseline smokeless tobacco users. Using a regression model while controlling for ethnicity and income, current STP users (OR=2.33; 95% CI: 1.84 - 2.94) and ex-users (OR=2.27; 95% CI: 1.64 - 3.15) were significantly more prone to report smoking at one-year follow-up than never-users. A more recent one-year longitudinal study of military recruits by Klesges and colleagues (2010) investigated the extent to which cigarette smokers switched to smokeless tobacco (harm reduction) and the extent to which smokers increased their potential risk by switching to dual tobacco use (harm escalation). The authors reported that it was more common to demonstrate harm escalation compared to harm reduction (Klesges et al. 2010).

In summary, a review of the US studies suggests mixed findings that prior smokeless tobacco may be associated with, and may lead to, subsequent cigarette smoking among adults. Though a majority of the study authors concluded that there was evidence of gateway, Kozlowski et al. (2003) found non-gateway use more common than gateway use and thus, highlighted the importance of establishing temporality in understanding gateway, noting that correlation only is inadequate. A majority of the studies in adolescent and young adults found an increased risk of cigarette use among those who reported prior STP use. It is important to note that Kozlowski et al (2003), in their analysis, excluded participants ages 18 through 22 years old, stating that tobacco habits are often not set amongst this age group. In addition, several studies highlight the importance of including psychosocial and behavioral variables that may affect smoking initiation. In studies that suggested an association between STP and future cigarette smoking, when factors such as access to tobacco, family smoking habits, cultural bans on smoking, alcohol use were considered, the strength of the association diminished. As mentioned earlier, one of the recurring limitations in evaluating these studies are the various methods in estimating the risk of initiating cigarette smoking, such as study design variations, study population, and methods of predicting smoking variables. For example, in evaluating gateway patterns, a limited number of studies collected information on the age of tobacco initiation, investigated the initial and subsequent weekly use and/or employed the use of national surveys for analysis

(Peterson et al. 1989; Rodu and Cole 2010; Zhu et al. 2009). These variations highlight the importance of clearly defined reference groups across studies (Grotvedt et al. 2013).

3.3 Transitioning from cigarettes to smokeless tobacco and smoking cessation

The vast majority of cigarette smokers want to quit smoking, but of those who try to quit in a given year, only about 5% manage to do so (NIH 2006). Scientific studies have established that support such as counseling and medication (e.g., an alternate form of nicotine) are more effective in producing long-term smoking cessation, and guidelines from the US Public Health Service Guidelines recommend use of smoking cessation medications to reduce the likelihood of relapse (USDHHS 2009).

Traditional smoking cessation methods using nicotine replacement therapy (NRT), such as nicotine patches, gums, nasal sprays, and oral tablets or lozenges, have been tested in numerous clinical trials (Silagy et al. 2004; Stead et al. 2012). In a meta-analysis of 123 clinical trials that measured smoking abstinence for at least 6 months of follow-up, Silagy and colleagues reported an overall odds ratio combining results for any of the nicotine replacement methods of 1.77 (95% CI: 1.66 - 1.88); they did not observe statistically different results for any of the different forms of nicotine replacement, and reported that there was weak evidence that combinations of forms of nicotine replacement therapy are more effective (Silagy et al. 2004). This meta-analysis was updated in 2012 with an additional 27 trials, with similar results (Stead et al. 2012). The pooled risk ratio combining any of the NRT products for cessation was 1.60 (95% CI: 1.53 - 1.68). In the Silagy et al. (2004) analysis, the authors noted that the use of NRT increased the odds of reducing the number of cigarettes smoked to fewer than 50% of baseline, though they noted that it is unknown what reduction in smoking is needed to affect health risks or to ultimately lead to cessation. Stead et al. (2012) specifically examined “brief” pre-cessation use of NRT, and after excluding one trial due to potential confounding, reported that any type of pre-cessation use of NRT to reduce smoking was significantly effective for cessation at 6 months (1.25, 95% CI: 1.03 - 1.50).

Cessation is considered a dynamic process with the goal of long-term abstinence from cigarettes. Cessation is not a single event but usually achieved after multiple attempts. It is influenced by several factors, including social, psychosocial and biological processes (Furberg et al. 2008a; Lindstrom and Isacson 2002b). Differences in smoking behaviors affects the probability of quitting smoking; for example, intermittent smokers were considered more likely than daily smokers to have strong intention to quit smoking and more likely to attempt to quit. Intermittent smoking may be merely a transitory phase of quitting cigarette smoking (Lindstrom and Isacson 2002b).

Population studies on Sweden snus have shown that the prevalence of smoking in men has declined over the last two decades, while the prevalence of snus use has increased (Lindahl et al. 2003; Rodu et al. 2002; Rodu et al. 2003; Stegmayer et al. 2005). Several Swedish studies (Furberg et al. 2005; Furberg et al. 2006; Galanti et al. 2008; Gilljam and Galanti 2003; Lindstrom and Isacson 2002a; Lindstrom and Isacson 2002b; Ramström and Foulds 2006; Rodu et al. 2002; Rodu et al. 2003; Stegmayer et al. 2005), and Norwegian studies (Grotvedt et al. 2013; Lund et al. 2010; Lund et al. 2011; Scheffels et al. 2012) have shown that snus use is associated with higher rates of smoking cessation.

Evidence for switching from cigarette smoking to snus is understood through not only these types of population trends, but also longitudinal studies that follow individuals, and from clinical trials of snus used as an aid to smoking cessation. The following sections describe clinical trials and longitudinal studies that provide evidence regarding the role of snus (Scandinavia) and smokeless tobacco (US) in smoking cessation.

3.3.1 Scandinavia

3.3.1.1 Clinical trials

None of the cessation trials available for the Silagy et al. (2004) or Stead et al. (2012) meta-analyses included use of snus as an aide to smoking cessation or reduction in the number of cigarettes smoked per day. Since then, three clinical trials in which snus was used as a cessation aide to smoking reduction have been published ([Fagerstrom et al. 2012](#); [Joksic et al. 2011](#); [Sharp et al. 2008](#)); as well as a pooled analysis of the two trials combined ([Rutqvist et al. 2013](#), pre-published manuscript provided in 2012).

Use of snus as a smoking reduction and cessation aid was conducted in Serbia from January 2008-March 2010 in a randomized, double-blind, placebo-controlled clinical trial (Joksic et al. 2011). In the 48-week trial, 319 smokers were enrolled, with the aim to reduce smoking by 50% during the first 24 weeks of the trial, and eventually stop smoking (weeks 24-48). Smoking cessation using carbon monoxide (CO) measurements was verified at 12-week intervals. Though the proportion of participants who achieved the $\geq 50\%$ reduction in smoking was equivalent in the two groups, a higher proportion of participants in the snus group achieved extreme reduction ($\geq 75\%$) in smoking after 24 weeks compared to the placebo group (snus group: 15/158, 9.5% vs. 4/161, 2.5%). Smoking cessation using carbon monoxide (CO) measurements was verified at 2-week intervals. The proportion of participants who achieved 24 week cessation by the end of trial was higher in the snus group (5.7%) compared to the placebo group (1.9%), with an odds ratio of 3.3 (95% CI: 0.9 - 12.5, $p=0.08$).

Another double-blind, placebo-controlled trial in which snus was tested for smoking cessation was conducted at five U.S. trial sites from February 2009 to March 2010 (Fagerstrom et al. 2012). Smoking cessation using CO measurements was verified at weeks 6, 10, 16 and 28. The continuous abstinence rate at end of trial (cumulative for weeks 6-28, or 23 weeks total) in the snus and placebo groups, each with 125 participants, were 4.0% and 1.6% respectively; with an odds ratio of 2.5 (95% CI: 0.4 - 27, $p=0.45$), not statistically significant.

The data from these two placebo-controlled clinical trials using snus as a cessation aid were combined into a pooled analysis (Rutqvist et al. 2013). The single estimate of cessation at 23 or 24 weeks (6 months), pooled from the two studies, was 2.83 (95% CI: 1.03 – 7.75, exact $p=0.06$, chi squared $p=0.03$). Though the individual studies did not achieve statistical significance, and the pooled estimate is of borderline significance, the point estimates of the odds of achieving smoking cessation using snus compared to a placebo are consistent with other nicotine replacement modalities, reported by Silagy et al. (2004) and Stead et al. (2012).

Lastly, to avoid the risk of treatment failure and side effects of smoking, 50 head and neck cancer patients undergoing radiation therapy were enrolled in a 1-year smoking cessation program, using alternative nicotine products and with systematic support ([Sharp et al. 2008](#)).

The primary outcome in the study was continuous abstinence during radiation therapy, while the secondary outcome was abstinence after radiation therapy period. Alternative nicotine products included nicotine patches, nicotine chewing gum, nicotine lozenges, and portion Swedish snus, provided for the first 10 weeks, free of cost. At study entry, each patient was given the opportunity to test all the different nicotine products and use products ad libitum. The study showed that most patients used one or more than one alternative nicotine products as an aid for cessation. Nicotine patches (91%) were the most common product used followed by snus use (54%). Although the study was not intended to compare the effectiveness of the individual products used for smoking cessation, the study showed that all but two patients were smoke-free at the 1-year follow up.

3.3.1.2 Longitudinal studies

Several cohort studies have assessed snus use as a smoking cessation aid and observed trends in tobacco use patterns among adults ([Furberg et al. 2008a](#); [Lindstrom and Isacson 2002b](#); [Lundqvist et al. 2009](#)), and two studies among youths ([Galanti et al. 2001a](#); [Grotvedt et al. 2013](#)).

Lindstrom and Isacson (2002b) also discussed the importance of psychosocial contributions to smoking cessation; these authors assessed the proportion of adult daily or intermittent smokers that remained intermittent smokers, or became daily smokers, and those that quit smoking at one-year follow up, including socio-demographic and psychosocial factors that influence tobacco use. The authors regarded intermittent smokers, or occasional smokers, as transitional stages for many smokers; either an uptake phase of smoking or preparation for smoking cessation. Participants in this study were from the Malmö shoulder-neck study, conducted in southern Sweden. Prevalence of daily smoking decreased from 23.8% to 21.7% ($p < 0.001$) at the one-year follow-up, while the prevalence of intermittent smoking increased from 4.8% to 5.4% ($p < 0.001$) and proportion of study participants who had stopped smoking increased from 33.7% to 35.1% ($p < 0.001$). The majority of baseline intermittent smokers (59.9%) remained intermittent smokers, while 15.9% became daily smokers and 19% quit smoking completely. During the follow-up period, snuff use was higher in all intermittent smoking categories, intermittent/daily, intermittent/intermittent, and intermittent/stopped; suggesting an association between intermittent smoking and snuff use. Notably, over 90% of intermittent smokers were not snuff users; therefore, it was unclear if smoking cessation could be attributed to either the snuff use or their intermittent smoking behavior. The authors suggested that several factors may contribute to intermittent use patterns compared to daily cigarette smoking, including other psychosocial characteristics such as socioeconomic position, extent of nicotine addiction, and social participation. According to the authors, intermittent smokers differ from daily smokers; they tend to be younger, more highly educated, have higher socioeconomic status (SES) and are less addicted to nicotine (Lindstrom and Isacson 2002b).

Another prospective study examined patterns of tobacco use among VIP cohort participants, adults aged 30, 40, 50 and 60 years, with a ten-year follow-up (Lundqvist et al. 2009). In this cohort, 34% of men and 20% of women who quit smoking started to use snus; however, a majority of the smokers were able to quit smoking without switching to snus. More specifically, among male smokers ($n = 1,104$), 25.9% quit smoking completely compared to 13.6% who switched to snus; while among female smokers ($n = 1,914$), it was four times more common to

stop smoking without snus than to switch to snus (33% vs. 8.2%). The smoking cessation rate in this cohort was 4% over the 10-year period; the authors noted that this percentage is lower than cessation rates in other studies with shorter follow-up periods. They suggested that the rates might reflect the increasing risk for relapse over time. The authors also noted that sustained snus use over follow-up period was common for both males and females, however, it was more common to remain nicotine free than to switch to cigarette smoking for those who were snus free at follow-up. Lundqvist et al. (2009) suggested that the sustained use of snus over the follow up period suggested a prolonged state of nicotine addiction; Norberg et al. (2011) have also suggested that snus use may prolong nicotine addiction.

[Furberg et al. \(2008a\)](#) assessed the association between smoking cessation in ever regular smokers and their history of snus use using the Swedish twins (SALT) cohort, who were contacted and asked about tobacco habits, including initiation and cessation. The authors used the data to investigate 12 correlates of smoking cessation, including known predictors such as marital status, education, SES and nicotine dependence. In the model, snus use was found to be associated with being a former regular smoker (HR=2.7; 95%CI: 2.3 – 3.2), and the authors reported that snus use was the strongest independent correlate of smoking cessation. One of the limitations of this study was in the study design, authors did not actually measure smoking cessation rates but rather they estimated the probability of having used STP in a lifetime and being a former regular smoker.

Youth Behaviors: The BROMS cohort is one of the larger studies that have collected information on tobacco use behaviors among adolescent in Sweden. Galanti and colleagues (2001a) reported that prevalence of cigarette smoking and snus use increased among students age 11 to 12 years followed from grades 5th to 6th grade by gender. Experimentation with both tobacco products was far more frequent among boys than among girls; cigarette smoking often marked the onset of tobacco use. The authors reported at 1-year follow-up that 4 in 10 boys with initial experience of oral snuff had experimented with cigarette smoking, while only 2 in 10 smokers had experimented with oral snuff. Overall, for both cigarette only users or snus only users at baseline, each were more likely to remain in their baseline category or become a mixed starter (Galanti et al. 2001a). In another study of male youth, discussed previously, Grotvedt et al (Grotvedt et al. 2013) examined patterns of tobacco use among 16-year old Norwegian students (n = 1,440) followed for three years. Baseline smokers were more likely to remain smokers or dual users at follow-up, while the odds for switching from smoking only to snus only were not significant (OR=1.53; 95% CI: 0.71 - 3.31).

The results from cross-sectional analyses support snus use as a smoking cessation tool, especially among adult Swedish men ([Furberg et al. 2005](#); [Furberg et al. 2006](#); [Gilljam and Galanti 2003](#); [Lund et al. 2010](#); [Lund et al. 2011](#); [Ramström and Foulds 2006](#); [Scheffels et al. 2012](#)). The cross-sectional nature of these studies limits the ability to draw conclusions; nevertheless, they provide evidence for snus as a smoking cessation aid.

Among adult males participating in the Swedish SALT survey, discussed previously as a prospective study, men who were regular snus users were three times more likely to be former smokers than current smokers at the cross-sectional analyses ([Furberg et al. 2005](#); [Furberg et al. 2006](#)). In a retrospective study conducted among former and current Swedish adult

smokers, Gilljam and Galanti (2003) found that there was an increased probability of being a former smoker among ever snus user rather than being a current smoker (OR= 1.72; 95% CI: 1.30 – 2.28) or current snus use (OR=1.81; 95% CI: 1.31 – 2.53), conditionally on age, education and use of nicotine replacement therapy. However, Gilljam and Galanti (2003) found mean duration of abstinence was longer among former smokers who were never snus than among those who were ever snus users, implying abstinence may be unrelated to snus use. To this effect, the authors reported that having used snus at the latest quit attempt increased the probability of being abstinent by about 50% (OR= 1.54; 95% CI: 1.09 – 2.20). Their results suggested that Swedish male smokers who used *snus* may increase their overall chances of abstinence but snus may not be a necessary component of smoking cessation at the population level (Gilljam and Galanti 2003).

Two cross-sectional studies published by the Norwegian Institute for Alcohol and Drug Research and UK Centre for Tobacco Control Studies and University of Nottingham surveyed a large sample of Norwegian adults for smoking cessation methods and outcome of last attempt to quit smoking (Lund et al. 2010; Lund et al. 2011). Among former (n = 1,775) and current smokers (n = 1,808), snus use (17%) was reported as the most common method for quitting smoking compared to other medicinal nicotine products, such as nicotine patches (4%), nicotine chewing gum (10%), and Zyban (3%). For all quitting methods surveyed, the proportion of unsuccessful quitters (current smokers) was greater than the proportion of successful quitters (former smokers); however, the ratio of successful to unsuccessful quitters was higher for snus than the other smoking cessation methods (Lund et al. 2010). In addition, total abstinence at time of survey was significantly higher for snus use-only than for any other methods of quitting (OR= 2.66, p<0.001). Among smokers who reported using snus to quit (n = 671), 62.4% reported still using snus at time of survey, while only 9.5% of smokers who had used nicotine chewing gum or patch still used these nicotine replacement products; however, 75% of those who were still using snus reported at least some reduction in the amount smoked.

Similar findings were reported by the same researchers in a meta-analysis of seven cross-sectional studies among Norwegian former/current smokers (Lund et al. 2011). The meta-analysis combined studies that provided usable information for calculating the quit ratio for smoking (number of former daily smokers as a proportion of ever smokers in a population), among Norwegian adults, aged 16- 74 years. Quit ratios for the individual studies varied, ranging from 32.2% in a nationally representative sample, among those aged 16-20 years to 67.4% in a student population in Oslo. In general, the quit ratio for smoking was significantly higher for daily snus users than for never snus users (6 out of 7 studies), though, the quit ratio for smoking among those who used snus occasionally was significantly lower compared to never snus users. Overall, former smokers formed the largest group of snus users (6 out of 7 studies); that is, daily snus use was associated with former smoking. Occasional snus use was less likely to be associated with being a former smoker (Lund et al. 2011). Another pooled analysis by the same researchers, combining studies conducted among Norwegian adults who were surveyed as part of Statistics Norway, reached similar conclusions (Scheffels et al. 2012). The authors compared smoking cessation with snus to other nicotine replacement therapies. The study results showed that snus was the most common method for quitting smoking among male participants, while women were more likely to use nicotine replacement therapies. These

studies showed that snus was the most prevalent method among all categories of smokers and former smokers (Lund et al. 2010; Lund et al. 2011; Lund and Lindbak 2007).

Ramström and Foulds (2006) conducted a retrospective analysis of a cross-sectional survey among adult Swedish smokers, and found that among male primary smokers ($n = 1,226$), approximately one-third started secondary daily snus use. Eighty-eight percent of those secondary snus users had ceased daily smoking completely by the time of the survey as compared with 56 percent of those primary daily smokers who never became daily snus users (OR= 5.7; 95% CI: 4.9 - 8.1). Ramström and Foulds (2006) also reported that snus was the most commonly used cessation aid among men who made attempts to quit smoking. They compared snus to other cessation aids (nicotine chewing gum, spray, tablets, inhaler, and bupropion tablets); snus was the third most common cessation therapy following nicotine chewing gum and the patch. A success rate of 66% was observed among men who had used snus as a single aid compared to a success rate of 47% observed among nicotine gum users and 32% for those using the nicotine patch. Lastly, the odds of remaining a daily smoker at the time of the survey were significantly higher for those without a history of daily snus use as compared to those with a history of daily snus use (OR=4.4; 95% CI: 3.2 to 5.9).

In summary, the clinical trials in which snus use was specifically used for smoking cessation support resulted in a success rate roughly equivalent to other NRTs. The data from Scandinavian cohorts should not be interpreted that use of snus is a necessary or sufficient condition for smoking cessation. However, the available studies indicate that snus use has been used more often than NRTs by Scandinavian males as an aid for smoking cessation, and being a former smoker is common among snus users (Lund et al. 2010; Lund et al. 2011; SCENIHR 2008; Scheffels et al. 2012). These data have consistently shown that male snus users are more likely to quit smoking than smokers who do not use snus. The data also indicate that some smokers initiate use of snus specifically to aid in smoking cessation, and successfully quit smoking. The SCENIHR report concluded that “observational data from Sweden indicate that snus has been used more often than pharmaceutical nicotine products by some men as an aid to stop smoking. The data are consistent in demonstrating these male snus users are more likely to quit smoking than non-users” (SCENIHR 2007). Since then, there have been clinical trials and two meta-analyses in Norway on the use of snus as a smoking cessation tool that support this conclusion (Fagerstrom et al. 2012; Joksic et al. 2011; Lund et al. 2010; Lund et al. 2011; Sharp et al. 2008).

There were no clinical trials conducted among adolescent tobacco users. The gradual transitioning from smoking to snus observed in adults was not as apparent among adolescents. The experimentation with snus and smoking was common through teenage years, without an inclination towards a tobacco type, although boys were more likely to be snus users and girls were more likely to be cigarette smokers as young adults. Casual inferences are not possible from cross-sectional studies; the temporality of exposure and cessation outcome is unknown; in most cases, data on smoking cessation was self-reported and not biologically verified. In addition, the definition of tobacco-use categories varies across studies therefore making it difficult to measure success rates for smoking cessation. Several authors discussed the importance of psychosocial contributions to smoking cessation and how this may impact an individuals' decision to quitting tobacco.

3.3.2 United States

Compared to the available evidence from the Scandinavian countries, there are fewer population studies and large cohorts that examine smoking cessation with the aid of smokeless tobacco in the United States; this is likely related to the overall prevalence of smokeless tobacco use in the US (~3%) being much lower than prevalence rates in Sweden (~23%) ([SAMHSA 2009](#); [Statistics Sweden 2007](#)). Nonetheless, there are several clinical trials in which US smokeless tobacco was examined as a cessation aid, and additional epidemiological evidence from a longitudinal study and several cross-sectional studies discussed in this section.

3.3.2.1 Clinical trials

Four reports of clinical trials that evaluated the use of smokeless tobacco as a cessation aid for cigarette smoking were identified ([Carpenter and Gray 2010](#); [Tilashalski et al. 1998](#); [Tilashalski et al. 2005](#); [Tonnesen et al. 2008](#)). These studies provide the most recent evidence regarding the efficacy of smokeless tobacco products as cigarette smoking cessation aids.

Use of smokeless tobacco as a smoking reduction and cessation aid was conducted in the US as an initial pilot study among 63 inveterate smokers (Tilashalski et al. 1998). The initial pilot study recruited adult smokers, aged 18 and older who were given a 20-minute lecture about the health effects of all forms of tobacco use, including smokeless tobacco (Skoal bandits) as an aid to quit smoking. Smoking cessation was defined as self-reported abstinence for the 4 weeks before contact; partial cessation was defined as a 50% or greater reduction in the number of cigarettes smoked daily compared to baseline. At the 1-year follow-up, abstinence was confirmed by carbon monoxide (CO) measurements. The results showed that 25% of participants achieved complete cessation with STP, followed by those who achieved partial cessation with STP (6.3%) and those who quit without using STP (10%) and those who continued to smoke (59%).

A follow-up assessment was conducted seven years later (Tilashalski et al. 2005). Of the 15 participants who quit smoking with STP (one had died in the interval), 11 (75%) remained smoke-free. In the partial cessation group, 67% remained smoke-free; and lastly, among those who continued to smoke, 29% became smoke-free (3 had used STP to quit). Furthermore, among the group who had quit smoking using STP, 8 were still using STP and 7 were entirely tobacco free. In general, most participants demonstrated a reduction in cigarette smoking or became smoke-free and these changes were still evident at the seven year follow-up (Tilashalski et al. 2005).

A randomized pilot study was initiated among inveterate smokers (n = 21) with a shorter follow-up period of two weeks (Carpenter and Gray 2010). Participants in the treatment group were provided potentially reduced exposure products (PREPs), Ariva/Stonewall (n = 19), and the control group remained with their use of conventional cigarettes (n = 12). Lighter smokers (1 or less pack/day) received Ariva and heavier smokers (more than 1 pack/day) were given Stonewall; both groups were advised to use the products every 2 hours. Within the two-week study period, those using PREPs reported a significant reduction in cigarettes smoked per day, amounting to a 40% reduction (95% CI: 24% – 55%). Although not statistically significant, participants in the control group also reported 11% reduction (95% CI: -6% - 28%). The authors noted that total tobacco (cigarette and PREP use) units per day remained relatively

stable in both groups. Lastly, the PREP participants reported a significantly increased readiness to quit in following months but this was not observed among controls.

Additional information comes from an open, randomized clinical trial for smoking cessation using smokeless tobacco (Oliver twist tobacco pellets) conducted in Denmark (Tonnesen et al. 2008). In the six-month trial, 263 healthy smokers were randomly assigned into either a treatment group or a control group (group therapy only). The treatment group receiving the Oliver twist tobacco pellets was advised to taper STP use by a 12-week time point. At 7 weeks, the quit rates differed significantly between the two groups: STP users had a higher prevalence of smoking cessation compared to controls (36% vs. 21%, $p = 0.001$). This difference in smoking cessation rates between treatment and control groups did not persist at the 6 month follow-up (11.9% vs. 8.3%, NS). Furthermore, smoking reduction rates was less than seven cigarettes per day; there were no significant differences between both groups. The authors concluded that STP use can effectively substitute for smoking cessation in the short-term, but it may not increase smoking cessation in long-term, particularly if STP use is discontinued (Tonnesen et al. 2008)

Despite the apparent limitations of these trials such as limited sample size, short follow-up periods and low participant retention, STPs have shown the potential for long-term smoking cessation.

3.3.2.2 Longitudinal studies

A single US longitudinal study among adults was identified in which the role of STPs in smoking cessation was examined. Zhu and colleagues (2009) (also discussed in the [Section 3.2.2](#)) conducted an analysis that included adults 18 or older surveyed as part of the TUS CPS in 2002, with a follow-up in 2003. The authors reported that quitting from one tobacco product and/or switching to another was infrequent during the 1-year follow-up. Among males ($n = 1,387$), at follow-up, it was more common for STP users to have switched to smoking cigarettes than for smokers to have switched to STP (3.9% vs. 0.3%). Similar patterns were observed among females, except that most females were smokers at baseline than were STP users. Tobacco cessation rates were significantly lower for smokers than for smokeless tobacco users (11.6% vs. 38.8%). The pattern of smoking cessation and STP use observed in this study and among US men differs from behaviors reported in Sweden (Furberg et al. 2006; Rodu et al. 2003). Zhu et al. (2009) attributed their findings to the fact that STP has not been promoted as a safer alternative cigarettes but also acknowledged that snus has also not been widely promoted in Sweden as safer. Colilla (2010) discusses this difference and attributes it to possible product composition differences (as discussed by Foulds et al. 2003), cultural acceptance of STP use, or the cost differential between ST and cigarettes, which is much greater in Sweden (Colilla 2010).

Youth Behaviors: Patterns similar to those observed in the adult study were observed in the studies conducted among adolescents. In 2003, the Roswell Park Cancer Institute initiated a two-year longitudinal National Youth Smoking Cessation Survey (NYSCS) to track history of quitting behavior among smokers ($n = 1,827$), aged 16 to 24 years (Barker et al. 2006). Participants were smokers who had quit smoking or had made several quitting attempts and were questioned about their use of assisted methods (i.e., recommended by Public Health

Service clinical guidelines such as health professional, nicotine gum, patch, inhaler, and lozenge) and unassisted methods (e.g., exercise, stopped buying cigarettes, switch to chewing tobacco, snuff or other tobacco). The results showed that only one of the assisted methods, talking to health professional, was employed by at least 20% of young smokers; while for unassisted strategies, 'decreasing number of cigarettes smoked' (83%) was the most common method, followed by buying less cigarettes (56%), exercise (51%), quit with a friend (47.5%), telling others they quit, and switching to light cigarettes). Switching to chewing tobacco, snuff or other tobacco was used by only 10% of the participants overall, however, male smokers were more likely to switch to chewing tobacco, snuff, or other tobacco products compared to female smokers, 18% vs. 1.6% (Barker et al. 2006).

In another prospective study, Tomar (2003) assessed initiation rates of STP use and cigarette smoking and switching between tobacco products. Analysis was limited to males, aged 11 – 19 years as part of the Teenage Attitudes and Practices I-II Survey. The authors reported that current smokers were not significantly different from never-smokers in rates of initiating STP use (OR= 1.65; 95% CI: 0.32 – 8.52). In this study, sample size was a limiting factor, with 107 current smokers and 13 former smokers; most were never smokers (n = 2,682). Tomar (2003) also reported that four-year prevalence of smoking cessation rates did not differ for current smokers at baseline who were regular STP users compared to those who had never used STP (20.5% vs. 26.3%, NS). As observed by Zhu et al. (2009), it was more common for STP users to switch to smoking cigarettes at follow-up than vice versa (25.5% vs. 0.8%). According to the authors, these patterns suggest that few young male smokers switch completely to smokeless tobacco. They concluded that smokeless tobacco may not be widely used as a method for smoking cessation among young males but perhaps serves as a supplementary source of nicotine dosing for some smokers.

In addition to the clinical trials and prospective studies, several cross-sectional studies were available that addressed the impact of smokeless tobacco use on smoking cessation (Rodu and Phillips 2008; Tomar 2002; Tomar 2010). Using the 1998 NHIS survey, Tomar (2002) evaluated the association between snuff use and smoking among adults males, 18 years or older. He found that ever smokers who were daily snuff users were more likely than those never used snuff to have quit smoking in the past 12 months (OR= 4.23; 95% CI: 2.16 - 8.28). Also, occasional snuff users were more likely than never users to have tried to quit smoking in the past year (OR= 1.68; 95% CI: 1.03 - 2.72). Current smoking was most prevalent among occasional snuff users (38.9%) but was lowest among those who used snuff every day (19.2%) and among those who have never used snuff (25.4%). Men were more likely to be former snuff users who currently smoked (2.5%) than to be former smokers who currently used snuff (1%). Tomar (2002) concluded that snuff may serve as an alternative form of nicotine dosing for inveterate smokers, who will or cannot overcome nicotine dependence.

To contrast trends in tobacco use patterns in the US from those of Sweden, Tomar (2010) compared tobacco rates from the 2000 NHIS survey to rates in 2005. From 2000 to 2005, US smoking rates declined (25.7% to 23.8%), while smokeless tobacco rates for the same time period remained relatively stable, 4.4% to 4.3%. According to Tomar (2010), this trend analysis of tobacco rates reflected that the decline in smoking was unaffected by the stable rates of

smokeless tobacco use, and thus should be attributed to other explanations in the population, and not use of STPs for smoking cessation.

Another analysis of the 2000 NHIS survey was conducted by Rodu and Phillips (2008). They derived estimates for the number of smokers who had tried one of 12 different cessation methods in their last quit attempt. The authors reported that switching to smokeless tobacco compared favorably with other pharmaceutical nicotine replacement therapies. According to study estimates, 359,000 survey participants reported switching to STP (73% of whom were former smokers), 2.9 million used nicotine patch (35% of whom were former smokers), and 1.1 million used bupropion (29% of whom were former smokers). More specifically, among former smokers, exclusive use of a single method was most common among patch users (70%), followed by bupropion (64%), and gum users or switching to STP (55%). In addition, former smokers who switched to STP (21%) reported the highest proportion of individuals in the 20+ years since quitting compared to nicotine patch (1%), nicotine gum (5%) and bupropion (5%) (Rodu and Phillips 2008).

In summary, the US clinical trials provide some evidence that smokeless tobacco can be used for smoking reduction and a cessation aid. There is some evidence from use of NRT products that pre-cessation use increases the likelihood of smoking cessation. The length of the STP trials limits their generalizability; however, one study conducted an assessment seven years later and reached similar conclusions. There is limited evidence from the single cohort study conducted among adults that STP use aids in quitting cigarettes, the cross-sectional studies provide conflicting evidence that smokers who use STP daily are prone to quit smoking (Rodu and Phillips 2008; Tomar 2002). The studies conducted among adolescents and young adults do not provide evidence of STP use as a cessation aid. This may be due in part to the low prevalence of smokeless tobacco use in the US, which is evident in the limited number of studies that address smokeless tobacco use behaviors. Cross-sectional studies provided some evidence that snuffers were more likely to quit smoking compared to never snuffers; however, the surveys provided no evidence of transitioning from snus to smoking. There is a need for more longitudinal studies that adequately address the temporality of smokeless tobacco use in relation to cigarette smoking, as well as co-factors that contribute to this relationship.

Furthermore, the questionnaires that ascertain tobacco use often do not delineate chewing tobacco use and snuff use, especially those used in studies conducted prior to the late 2000s; therefore, it has been difficult to individually analyze initiation rates specific to the various forms of smokeless tobacco. Characterization of tobacco use also varied between studies; for example, Tomar (2003) defined current smokers as smoking at least 100 cigarettes in their lifetime and at least one day in the 30 days preceding the interview, while other national surveys defined current smokers as having smoked on at least one day of the 30 days preceding the interview, without the “100 cigarettes” qualifier (Eaton et al. 2012). Smokers surveyed as part of the NYSC Survey were defined as those who smoked at least 20 cigarettes in their lifetime and who had smoked at least once during the preceding 30 days of the interview (Barker et al. 2006). Inconsistencies such as this often make it difficult to compare across studies. Specifically, among adolescents and young adults, varying definitions may over- or underestimate current smoking in younger groups because adolescents are frequently in the early

stages of tobacco behavior and the more stringent definition may only identify more-established smokers.

3.4 Snus/Smokeless Tobacco Initiation

Snus and other smokeless tobacco initiation among non-tobacco users have been indirectly addressed in cohort studies in both Sweden and the US; most of the research has focused on tobacco use behaviors among those who are already tobacco users. As observed in the majority of the studies, smokeless tobacco use is a predominantly male behavior.

3.4.1 Scandinavia

Several studies have focused on snus uptake, and specifically among adolescents ([Edvardsson et al. 2009](#); [Galanti et al. 2001a](#); [Galanti et al. 2008](#); [Ramström and Foulds 2006](#)). Tobacco uptake is often initiated at an early age, particularly, smoking is initiated between 10 and 13 years of age, with a rapid increase occurring between the ages of 14 through 15 years ([Edvardsson et al. 2009](#); [Furberg et al. 2008b](#); [Galanti et al. 2008](#)). Adolescent males surveyed as part of the BROMS cohort were shown to initiate snus at the median age of 15 years; while females exhibited snus use at a later age, 18 years ([Galanti et al. 2008](#)); overall, snus uptake seems to occur between ages 15 through 18 years ([Furberg et al. 2008b](#); [Post et al. 2010](#); [Wium and Aaro 2011](#)). Among adult Swedes, almost all daily smoking (91%) had been initiated by age 22, while initiation of daily snus use continued throughout all age ranges ([Ramström and Foulds 2006](#)). In addition, less than 10% of Swedish daily male smokers started smoking after age 22, whereas a third of snus users started after age 22 years, regardless of their tobacco use status. Daily snus use was most common among participants aged 25 to 44 years, while daily smoking is most common in ages 45–64 years ([Ramström and Foulds 2006](#)).

Three studies assessed population trends in tobacco use among adults in Sweden and Norway ([Lundqvist et al. 2009](#); [Norberg et al. 2011](#); [Rodu et al. 2003](#)). Lundqvist and colleagues conducted a population trend survey among middle-aged adults in Northern Sweden and found that at follow-up, among tobacco-free participants at baseline, 5% (n=328) of women and 7.8% of (n=368) men initiated tobacco use during the 10-years, but some of them were former tobacco users (ex-smokers) that had relapsed, 2.2% and 3.2% respectively. Overall, males were more likely to initiate snus use compared to females; while females were more likely to initiate cigarette smoking ([Lundqvist et al. 2009](#); [Norberg et al. 2011](#)). Rodu et al. (2003) assessed tobacco patterns among adult men and women in the MONICA project survey. In the follow-up of five to thirteen years, never users of tobacco were the most stable group (98%) compared to tobacco users. Smokeless tobacco or cigarette initiation was more common among those already using tobacco compared to never users or ex-tobacco users ([Rodu et al. 2003](#)).

Galanti and colleagues conducted six follow-up assessments on tobacco use behaviors among adolescents between the ages of 11 and 18 years ([Galanti et al. 2001a](#); [Galanti et al. 2008](#)). One-year follow-up revealed that among male baseline non-tobacco users (n=1,114), 1.7% became oral snuff users, 12.3% became cigarette smokers, and 5.7% became dual users by follow-up in the 6th grade. Among female non-tobacco users (n=1,185) by one-year follow-up, 1% became oral snuff users, 15.5% initiated cigarette smoking and 1.8% became dual tobacco users ([Galanti et al. 2001a](#)). For both male and female non-tobacco users, snus-only initiation

was lower than for smoking. Overall, compared with never users, ever users of tobacco at baseline had a higher risk of continuing to smoke or to be smokeless tobacco users at the end of follow-up.

Furthermore, Galanti and colleagues (2001a) measured susceptibility to tobacco use as a lack of firm intention not to smoke or use oral snuff in the near future among never tobacco users at baseline (i.e., not strongly opposed to starting). Adolescent non-tobacco users classified as “susceptible” to smoking at baseline were more likely to have experimented with smoking a year later, OR= 3.6; 95% CI: 2.7 – 4.8 (Galanti et al. 2001a). Overall, the relative odds of snuff use for susceptible boys were comparable to that of smoking (OR= 6.1 vs. 6.2). Susceptibility to oral snuff was not assessed among female students given their low prevalence of oral snuff (Galanti et al. 2001a). Lastly, the authors reported that tobacco initiation was gender-dependent, a higher proportion of snus starters were boys (15.5%) compared to girls (6.8%). On the other hand, a higher proportion of cigarette starters were girls (82%) compared to boys (57.3%). In the follow-up study, the authors concluded that, “Progression of tobacco use in adolescence is not predicted by onset with snus or cigarettes, but rather by initiation with both tobacco types close in time and/or at young age. The proportion of adolescent smoking prevalence attributable to a potential induction effect of snus is likely small” (Galanti et al. 2008).

In summary, in Sweden and Norway, uptake of snus occurred across all age categories compared to cigarette uptake which appeared to occur more frequently at a younger age. In addition, tobacco initiation was shown to be gender-dependent; males were more likely to initiate snus while females more likely to initiate cigarette smoking. Studies in Sweden and Norway have shown that snus initiation was more prevalent among former cigarette smokers than among non-tobacco users (Furberg et al. 2005; Furberg et al. 2006; Lund et al. 2010; Lund et al. 2011).

3.4.2 United States

A limited number of studies address STP initiation among non-tobacco users due to the overall low prevalence of smokeless tobacco use in the US, approximately 3-4% (NSDUH 2009). The Surgeon General report (USDHHS 2012) presented a review of data from several US national surveys (NYTS, MTF, BRFSS, SAMSHA). It stated that collectively, these surveys showed that majority of smokeless tobacco initiation often occurred in 11th grade, which was notably different from cigarette use, where initiation occurred in earlier grades (USDHHS 2012). Among 12th graders, surveyed as part of the NYTS who had ever used STP, the majority (35.2%) tried it at the age of 15 or 16 years, with the next followed by use at the age of 17 years of older (25.4%).

Using the TAPS I & II survey, Tomar (2003) assessed tobacco initiation among adolescents and young adults, aged 11 through 18 years. At 4-year follow-up, rates of smoking initiation (9%) among baseline non-smokers were higher than rates of smokeless tobacco initiation (1.5%) among baseline non-smokeless tobacco users. Similar findings were reported by Zhu et al. (2009) in their analysis of the TUS-CPS survey. The authors assessed changes in cigarette and smokeless tobacco use among never cigarette smokers. At one-year follow-up, among male never smokers, 2.5% had initiated cigarette smoking, 0.7% had initiated smokeless tobacco use, and 0.1% had initiated use of both cigarette and smokeless tobacco. On the other

hand, among female never smokers, at follow-up, only cigarette initiation (1.7%) was observed and no smokeless tobacco use.

Smokeless tobacco initiation in the US was even lower than rates of snus initiation in Scandinavia. Tobacco users were more likely to initiate with cigarettes, and at a younger age than for STP initiation. Overall rates of STP initiation was lower among non –tobacco users compared to those already using cigarettes.

3.5 Dual Use

Dual tobacco use describes the period of time of concomitant use of cigarettes and smokeless tobacco products. An examination of dual use takes into account the transition period from one predominant type to another or a period where both tobacco products are used interchangeably without trending toward either product (Frost-Pineda et al. 2010). In the clinical trials of smoking cessation using NRT, short-term dual use was labeled as “pre-cessation” use. In observational epidemiology, however, dual tobacco use does not necessitate the simultaneous use of both cigarette and smokeless tobacco. This makes it difficult to understand dual use in a cross-sectional study, as that study design often does not collect or report the data on temporality necessary to understand pattern of dual use in individuals over time.

Much of the debate on dual use of tobacco products stems from the definition and interpretation which often varies from study to study. Studies in this review define dual use as either daily or occasional use of smokeless tobacco and cigarettes, or lifetime/ever use of either product and or use of either product in the preceding month or week. It is important to note that some dual users represent smokers in transition to becoming ex-smokers, so it is important to capture this transition, which is best accomplished using a longitudinal study design. The difficulty in establishing a definition for dual use was also highlighted in a recent review by Frost-Pineda et al. (2010); their review considered dual use to be a period of time when people smoke cigarettes concomitantly with the STP use.

In addition to understanding the patterns of dual tobacco product use, it is also important to attempt to quantify the amount of cigarettes and STP used among dual users. There is evidence that smokers who use snus smoke fewer cigarettes per day or smoke less often in a specified period than smokers who do not use snus. The following sections describes the available literature on the prevalence of dual use in Scandinavia and the US, including transition patterns related to dual tobacco use and tobacco consumption patterns among this subgroup of users.

3.5.1 Scandinavia

Several studies have examined trends in dual use of snus and cigarette in both Sweden and Norway. These studies are made up of large cohorts that provide information on the prevalence of dual tobacco use among populations studied in these countries. We discuss several studies that have assessed prevalence of dual use and the varying definitions applied (Engstrom et al. 2010; Galanti et al. 2008; Grotvedt et al. 2013; Janzon and Hedblad 2009; Lund et al. 2010; Lund and Lindbak 2007; Norberg et al. 2011; Ramström and Foulds 2006; Rodu et al. 2002; Rodu et al. 2003; Statistics Finland 2008; Stegmayr et al. 2005).

According to the 2011 Swedish National Tobacco Survey, the prevalence of daily snus and daily cigarette use was reported to be 2%, and has been stable since 2004.⁷ Cross-sectional studies in Sweden and Norway have reported similar prevalence rate, ranging 2% to approximately 10%. Among adult male participants in the Swedish “Your Country and Your Life” survey, dual use (daily snus, daily cigarette) was low (2%) and none was observed among female tobacco users (Ramström and Foulds 2006). When occasional dual use of combustible tobacco products among snus users was considered, Digard et al. (2009), reported that 12.6% reported dual use of smokeless and any combustible tobacco product; 9.8% of the daily snus users also smoked cigarettes (daily or occasional), among both male and female study participants. Of these dual users of daily snus and occasional or daily use of cigarettes, 53.5% reported that they smoked daily.

In the northern Sweden-based MONICA cohort study, which included 25-64 year-olds, dual use was reported among 2-5% (Rodu et al. 2002; Stegmayr et al. 2005). This prevalence of dual use was stable for the study period, from 1986 to 1999. Dual use was classified as “use” of both products; the authors did not further elaborate on the definition. According to the authors, dual use reflects a temporary transition between cigarette and snus as an unstable and transient period. Rodu et al. (2003) examined the stability of dual users compared to other tobacco use groups, that is, did the participants who were dual users at baseline remain in the dual use category at follow-up. They reported that combined use (smoking and snus) was the least stable category (39%), as 43% switched to snus and 6% switched to cigarettes. Also, former users of both products were much less stable than former users of either cigarettes or snus.

In another cohort study, among participants surveyed as part of the northern Sweden VIP survey, overall smoking prevalence (smoking only plus dual use) decreased by 10 percent points (from 26 to 16%) among men from 1990-1995 to 2002- 2007, and by 9 percent points (from 27 to 18%) among women (Norberg et al. 2011). Dual users in this study were defined as current (use intermittently or daily) smoker and snus user.

In the Malmö study, conducted in southern Sweden, Janzon and Hedblad (2009) reported an overall prevalence of snus use among men of 7% (mean age 59 years) and among women (mean age 57 years), less than 1%. Among the male snus users, 34% were also current smokers, 57% were ex-smokers, and 9% were never smokers.

Among all age groups (16 through 74 years) surveyed as part of the Norway Tobacco Statistics (n=3,145), 7% used both snus and smoke, 27% were exclusive smokers, 8% were exclusive snus users, and 58% were non-tobacco users (Lund and Lindbak 2007; SCENIHR 2010). In this survey, dual use was defined as daily or occasional use of both snus and cigarette. In a meta-analysis by Lund et al. (2011) of seven cross-sectional data sets from Norway, 3.1% to 10.6% of snus users smoked daily, while a higher percent of participants reported that they smoked occasionally (16–35%). Tobacco consumption was not quantified. The authors noted that it is difficult to draw any conclusions about whether this combined use was more or less

⁷ <http://www.fhi.se/en/Highlights/National-Survey-of-Public-Health/Living-habits/Tobacco-habits/>. Accessed on January 22, 2013.

damaging than the amount of smoking that would have taken place without the influence of snus.

Youth Behaviors: In Norway, Grotvedt et al. (Grotvedt et al. 2013) examined patterns of tobacco use among tenth graders living in Oslo County surveyed as part of the Oslo Health study in Norway (n=1395), with a three-year follow-up. Prevalence of dual use was at 10%, 6% were snus users, and 13% smoked. Lastly, Hamari et al. (Hamari et al. 2013) conducted a study among young male military recruits (n = 1174) living in Northern Finland. The prevalence of daily snus use in this study was 15.6% which was higher than the 2.1% rate observed in the general male population (Statistics Finland 2008). The authors found daily use of both snus and cigarettes to be 6.9%. Occasional smokers were twice more likely to be daily snus use than daily smokers, 30.1% vs. 15.1%. The authors concluded that concomitant snus use seemed to increase dependence to cigarettes in dual users, albeit not statistically significant. Also, they suggested that snus did not seem to serve as a substitute for cigarettes in adult daily smokers; instead it served as an additional habit. This study has no information on duration of use and daily tobacco consumption.

Overall, dual use was more common among men in all age groups than women (Norberg et al. 2011; Ramström and Foulds 2006; Rodu et al. 2002; Stegmayr et al. 2005). Norberg and colleagues examined other factors that affected dual tobacco use; being male and those with low education backgrounds seemed to increase the likelihood of being a dual user, observed by Engstrom et al. (2010). Additionally, compared to non-tobacco users, dual users were more likely to be skilled and/or unskilled workers, binge drink, and engage in risky alcohol consumption. There were no significant differences in prevalence of dual use across all age groups (Engstrom et al. 2010; Ramström and Foulds 2006). Digard et al. (2009) reported a slightly higher prevalence of cigarette smoking among pouched snus users (10.5%) in comparison with loose users (8.7%).

3.5.1.1 Transition patterns

Two authors examined transitioning patterns among adult dual users registered in the VIP cohort study (Lundqvist et al. 2009; Norberg et al. 2011). Of the total baseline snus users who transitioned to smoking at the ten-year follow-up (6.1% males, 8.1% females), a majority of them were most likely to be dual users, 5% males and 6.2% females (Norberg et al. 2011). Additionally, among baseline smokers (n=1,104), 7.4% of men and 2.4% of women became dual tobacco users. Baseline smokers were most likely to become snus users or remain smokers; although, the authors reported that for men it was twice as common to stop smoking without becoming snus dependent than to switch to snus (Lundqvist et al. 2009). Furthermore, among dual tobacco users at baseline, a third of the men and a fourth of the women remained dual users at 10 years follow-up; baseline dual users were most likely to transition to snus use at follow-up (Norberg et al. 2011). The authors concluded that the increase in snus use was paralleled by a slight increase in dual use and the smoking prevalence does not seem to be influenced by snus. They concluded that dual use of cigarettes and snus seemed to be more frequent in Sweden with its high prevalence of snus use, and may contribute to continuation of smoking among some smokers.

In another follow-up study, Tillgren et al. (1996) examined the tobacco patterns among participants aged 16-84 years in the Swedish Survey of Daily Living who responded in both 1980/81 and 1988/89. Baseline mixed users (n=120) transitioned mostly to snuff use (31%) or remained mixed users (31%) at follow-up. The remaining 25% became cigarette smokers and 15% became non-tobacco users.

In a cross-sectional analysis, Furberg et al. (2005) assessed lifetime use or ever (daily or occasional) use of either smokeless tobacco and/or cigarettes. The authors found that compared to never snus users, there were reduced odds of being an ever smoker among regular snus users (OR= 0.2; 95% CI: 0.2 – 0.3) and “now and then” snus users (OR= 0.5; 95% CI: 0.3 – 0.7). There are other examples in the literature provided in studies for which the primary purpose was not to describe dual use patterns. For example, in the Hergens et al. (2005) case control study of myocardial infarction, of the 1,810 controls, 33% had never used tobacco, 5.2% were former smokers and current snus users and 3.3% used both forms of tobacco; however, less than 1% were former snus users and current smokers (Hergens et al. 2005).

Youth Behavior. Grotvedt and colleagues (Grotvedt et al. 2013) grouped tobacco users into several sub-groups: both products occasionally, occasional smoke with daily snus use, daily smoke with occasional snus and both products daily. This categorization made it useful to examine patterns of use among dual users. Baseline snus users who were dual users at follow-up seemed to prefer using snus daily and cigarettes occasionally, OR= 7.42; 95% CI: 2.9 - 18.7, rather than daily smoking and occasional snus use (not significant) (Grotvedt et al. 2013). Likewise, baseline smokers only who became dual users at follow-up preferred to smoke daily and use snus occasionally. Overall, results showed that for all tobacco users (daily or occasional users) who became dual users at follow-up, users were more likely to use either one of the products occasionally compared to daily use of both products (Grotvedt et al. 2013). Snus was associated with the increased odds of dual use at follow-up. Relative to no tobacco use, snus use at baseline was associated with increased odds of dual use at follow-up, OR=3.49, 95% CI 1.8 to 6.8). When the outcome was restricted to no smoking only (including snus use), the risk of being a dual user was OR 1.88, 95% CI 1.1 to 3.3). Additionally, baseline dual users had high odds of remaining dual users (OR=9.28; 95% CI: 5.7-15.2) or becoming smokers only (OR=3.29; 95% CI: 1.8-6.0).

Furthermore, Galanti and colleagues assessed development of tobacco use among adolescents and young adults participating in the BROMS cohort survey between the ages of 11 and 18 years (Galanti et al. 2008). Six follow-up assessments were conducted to understand how the initiation of snus, cigarette or both led to the development of a tobacco habit over time. This study was previously discussed in Section 3.4. Assessment to follow-up showed that 69.5% (n=1,582) started by smoking cigarettes, 11.2% (n=256) by using snus, and 19.3% (n=439) started by using snus and cigarettes during the same year. Baseline mixed starters (snus and cigarette users) had a significantly higher risk of being a current smoker at follow-up (OR= 2.54; 95% CI: 1.68 – 3.91). In general, the risk of current smoking or tobacco use was significantly higher for mixed starters compared with snus starters.

3.5.1.2 Amount of cigarettes and STP used

Actual tobacco consumption among dual users is often not reported or quantified. There is evidence that smokers who use snus smoke fewer cigarettes per day or smoke less often in a specified period than smokers who do not use snus.

There is evidence to suggest that tobacco consumption among dual tobacco users and exclusive users may be different from exclusive users of either product with respect to the amount of product used (Galanti et al. 2008; Gilljam and Galanti 2003; Rodu et al. 2002); dual users consumed less tobacco than exclusive snus or cigarette users. In one study (Rodu et al. 2002), exclusive snus users reported average daily consumption of 0.41 packages among ex-smokers and 0.44 packages amongst never smokers. With regard to smoking, ex-snus users' averaged 15.1 cigarettes daily and never users of snus smoked 16.0 cigarettes. In comparison, dual users consumed 0.25 packages of snus daily, about 40% less, and smoked an average of 10.8 cigarettes daily, about 30% fewer (Rodu et al. 2002). Digard et al. (2009) also investigated the frequency of cigarette use among daily snus users; all daily snus users who also smoked reported doing so at least once per week, and 53.5% of them did so daily. In the Malmö study, Janzon and Hedblad (2009) reported that the male dual users smoked significantly less cigarettes per day (12.3) than exclusive smokers (16.1 cigarettes per day). This was also observed among female dual users, who smoked on average 7.8 cigarettes per day compared to 12.9 cigarettes per day among exclusive smokers. Likewise, Gilljam and Galanti (Gilljam and Galanti 2003) reported that the proportion of current smokers smoking less than 10 cigarettes/day was nearly twice as high among users of snus than among non-users (44% versus 24%, respectively) (Gilljam and Galanti 2003).

On the other hand, when tobacco consumption was considered among adolescents in the BROMS cohort, tobacco consumption was not significantly different among snus, cigarette, and mixed starters (Galanti et al. 2008); similar results were also observed in the Finnish study of male military recruits (Hamari et al. 2013). Additionally, mixed starters were over-represented in the 85 or more cigarettes and/or snus portions per week (highest category of tobacco consumption).

In summary, the frequency of daily dual use has been reported in several studies, and is approximately 2% in men and less than 1% in women, but appears to vary slightly depending on whether the criteria are daily dual use, or occasional use of one of the tobacco types. Other studies have reported a slightly higher prevalence of dual use in Sweden, for example, 3.2% of male and 4.4% of female snus users in northern Sweden were found to smoke regularly in the VIP cohort (2009), and Digard et al. (2009) reported a prevalence of about 9.8% (daily and/or occasional). Taken together, among adults and adolescents, the range of dual use appears to be less than 10% in the Swedish population of snus users. Dual use appears to mark a transient period in tobacco use. Among adult tobacco users, baseline dual users were most likely to transition to snus use or remain dual users, whereas among adolescents, some dual users did transition to smoking. Some evidence suggests slightly lower overall tobacco use among the dual tobacco users.

3.5.2 United States

There are a several studies on dual use of STP and cigarettes in the US. The estimates of the proportion of STP users who also smoke varied depending on the population surveyed, the type of STPs, and the US region where data are collected. There is a high degree of variability in the definition of dual tobacco use across the studies reviewed in this section.

In the US, there are numerous surveys that capture trends of tobacco use, including dual use of smokeless tobacco and cigarette smoking, such as the Current Population Survey, NHIS, NHANES, NYTS; analysis of these surveys have been published, including other peer reviewed cohort studies that have examined dual use trends ([Backinger et al. 2008](#); [Bombard et al. 2008](#); [Boyle et al. 2012](#); [Klesges et al. 2010](#); [McClave-Regan and Berkowitz 2011](#); [Mushtaq et al. 2012](#); [Rath et al. 2012](#); [Rodu and Cole 2009](#); [Tomar 2002](#); [Tomar et al. 2010](#); [Zhu et al. 2009](#)). The following section presents data from some of the more contemporary US surveys and from selected segments of the population, such as the military.

Population data from the 2005 NHIS survey reflect a low prevalence of dual tobacco use, approximately 1.4% of the male population were dual tobacco users (Rodu and Cole 2009). In this survey, dual use was defined as subjects who had used either chewing tobacco or snuff 20 times in their life and who used either tobacco product every day or some days were classified as current STP users. An older 1998 NHIS survey was analyzed by Tomar (2002); dual tobacco use during this survey period was 1.1%.

Tomar et al. (2010) analyzed results from the 2006 to 2007 CPS-TUS survey. The prevalence of dual tobacco (daily use of STP and cigarettes) among adults 25 years or older was 0.6%. Men who used snuff on a daily basis had the lowest prevalence of daily smoking (7.3%), compared to prevalence of smoking among men who had never used snuff (14.9%). Similar results were obtained from the 2002 to 2003 CPS-TUS survey analysis by Zhu et al. (2009). Prevalence rates of dual tobacco use in this study ranged from 0.3 to 2.9% (having smoked at least 100 cigarettes, smoking cigarettes every day or some days, and using chewing tobacco or snuff every day or some days). Additionally, Backinger and colleagues (2008) examined trends and patterns of tobacco use among adults 18 years or older, using the 1995 to 2002 CPS survey, prevalence of snuff use among cigarette smokers was 0.97%.

Using the 2010 BRFSS survey, Mushtaq and colleagues (2012) reported that the prevalence of dual use among adults 18 years or older overall was 1.6% among males and 0.3% among females. Dual use was categorized as use of both STP and cigarettes irrespective of the frequency of use. Dual use was reported by 8.5% of male smokers and 2.3% of female smokers, compared to 28% of male STP users and 42.4% of female STP users who reported cigarette smoking.

Rath et al. (2012) assessed the prevalence of tobacco use in a longitudinal sample of young adults, ages 18 through 34 years, (n = 4,201). The study collected use information on dip, snuff and snus in addition to other tobacco types such as little cigars, cigarillos, bidis and hookah. The prevalence of ever use and current use of electronic cigarettes, chewing tobacco, pipes, dip/snuff (Skoal or Copenhagen), snus (Camel snus), dissolvable products, and nicotine products were all at 10% or less; specifically, prevalence of past 30-day snus use in this group

was 7%. Twenty-three percent reported current use of any tobacco products, while 7% reported dual tobacco use (the authors did not estimate dual tobacco use specific to STPs).

There have been several reports among US military personnel (Cooper et al. 2010; Grier et al. 2010; Klesges et al. 2010). Among men in the Air Force exposed to a 6-week period of enforced tobacco abstinence, the prevalence of baseline dual use (defined as daily or nondaily users of both cigarettes and STP) was low, 0.5% (Klesges et al. 2010). In another analysis (same cohort as Klesges et al. 2010) and among intermittent non-daily and light daily smokers (<10 cigarettes per day), Cooper et al (2010) examined baseline predictors associated with tobacco use. Smokeless tobacco use was associated with intermittent smoking and not daily smoking. Relative to never use, the use of smokeless tobacco products either intermittently (OR= 1.98, $p < .001$), or daily (OR= 5.39, $p < .001$) increased the odds of being an intermittent smoker versus being a daily smoker. The authors concluded that more smokeless tobacco use was associated with less smoking. In a separate study, among new US Army personnel, the odds of cigarette use was higher among occasional (OR=4.03; 95% CI 3.57–4.54) and frequent (OR=2.90; 95% CI 2.67–3.14) smokeless tobacco users compared to non-users in the same category (Grier et al. 2010).

Youth Behaviors: Using data from the 2002 to 2004 NYTS survey, Bombard et al. (2008) showed that among students (grades 6 through 12) who were current smokers, 26.4% (estimated 1.9 million youth) used one tobacco product⁸ in combination with cigarettes and 19.7% (estimated 1.4 million youth) used more than one. Of the students who used cigarettes and one other tobacco product, 17.7% concurrently used STP and cigarettes. Concurrent use of smokeless tobacco and cigarette was defined as use of either form of tobacco in the preceding 30 days.

There are apparent differences in the use of smokeless tobacco by US region as mentioned in Sections 2.1 and 2.2. These differences are also reflected in the combined use of both STPs and cigarettes. Polytobacco use (including dual use) was more common in those participants residing in the Midwest, South or West (Bombard et al. 2008; McClave-Regan and Berkowitz 2011). For example, Boyle et al (2012) examined trends in dual tobacco use among tobacco users participating in the Minnesota Adult Tobacco Survey, 1999 - 2010. Their results showed that prevalence of dual tobacco was essentially unchanged through 2007, but increased significantly between 2007 and 2010 (4.4% to 9.6%). Dual use was mostly observed among males (Rath et al. 2012; Tomar et al. 2010), and young adults aged 25–34 years were significantly more likely to use cigarettes only or cigarettes and other tobacco products compared to those aged 18–24 years (RR = 1.48; CI: 1.07–2.06 and RR =1.60, CI: 1.03–2.49, respectively) (Rath et al. 2012). Other authors have also reported that rates of dual use increased as age decreased (McClave-Regan and Berkowitz 2011; Mushtaq et al. 2012; Rodu and Cole 2009). Heavy alcohol consumption was associated with increased odds of being a dual user (Klesges et al. 2010; Mushtaq et al. 2012). Higher rates of dual use among military personnel have also been reported, recalling also that the overall prevalence of tobacco use

⁸ Other tobacco products including cigars, pipes, bidis and/or kreteks, and smokeless tobacco

among this subpopulation is higher than use among civilian populations and includes youth (Peterson et al. 2007; Trent et al. 2007).

3.5.2.1 Transition patterns among dual tobacco users

Data from the 2002-2003 CPS survey analyzed by Zhu and colleagues (2009) reported even lower prevalence rates of dual tobacco use, 0.3 – 2.9% (having smoked at least 100 cigarettes, smoking cigarettes every day or some days, and using chewing tobacco or snuff every day or some days). Among males who exclusively smoked cigarettes in 2002, 86.2% still exclusively smoked cigarettes in 2003, 2.2% became dual users, 0.3% had quit smoking and switched to smokeless tobacco. Of the remainder of the population of smokers, 11.3% quit cigarettes and did not use smokeless tobacco. Among males using only smokeless tobacco in 2002, 1.8% became dual users, 59.4% continued exclusive use in 2003, and 3.9% quit smokeless tobacco and switched to cigarettes. The remainder (35.0%) quit smokeless tobacco and did not use cigarettes. If only quitting smokeless tobacco was considered, then 38.8% had quit (Zhu et al. 2009). And lastly, among males using both cigarettes and smokeless tobacco in 2002, 45% continued to use both. Of the remainder, 37.0% continued smoking but quit smokeless tobacco, 4.9% continued using smokeless tobacco but quit smoking, and 13.1% quit both smoking and smokeless tobacco. The authors concluded that their results suggested that quitting one form of tobacco and switching to another was infrequent.

The progression of tobacco use was examined among employed adult males (n=4886) residing in the southeastern US participating in the Working Well cancer prevention trial, designed to test effectiveness of worksite health promotion interventions in reducing cancer risk behaviors (Wetter et al. 2002). A follow-up was conducted among baseline male STP users (n=859), smokers (n=936), and concomitant users (n=220), four years later. The prevalence of dual tobacco use among this cohort was 4.5%. Dual users were the least stable tobacco use group: 44.4% remained in their use category, compared to 77% who remained stable among STP users and 80% remained stable among cigarette smokers. With regards to tobacco progression, dual users were most likely to transition to cigarette smoking (27%), followed by STP use (17.4), and lastly, 11.3% quit tobacco use (Wetter et al. 2002).

In a cross-sectional analysis of the 2006 NYTS survey conducted by Tomar and colleagues (2010), patterns among middle and high school students showed that dual tobacco use behaviors was mostly occasional STP user with either daily (20%) or occasional (15.7%) cigarette smoking. Similar results were reported by Boyle and colleagues (2012), in which some-day smokers were significantly more likely to report use of STP compared to daily smokers, 17.3% compared to 7.3%. In the sample of adults participating in 1998 NHIS survey, Tomar (2002) reported that the prevalence of current smoking was 38.9% among males who used snuff on some days, 19.2% among those who used snuff every day, and 25.4% among never snuff users. Tomar (2002) also found that ever smokers who used snuff every day were more likely than those who never used snuff to have quit smoking (OR=3.22; 95% CI: 1.98–5.21) or to have quit within the past year (OR=4.07; 95% CI: 2.07–8.00).

In a study of the US Air Force population, Klesges and colleagues (2010) investigated the extent to which cigarette smokers switched to smokeless tobacco and the extent to which smokers became dual tobacco users at the 12-month follow-up. Harm reduction was defined as

cigarette smoking or dual use at baseline but no cigarette use in the past 7 days at follow-up. Harm escalation was defined as smoking at baseline and both cigarette and smokeless tobacco use within the past 7 days at follow-up, or smokeless tobacco use at baseline and smoking within the past 7 days at follow-up. Harm elimination was defined as use of cigarettes, smokeless tobacco, or both at baseline and no cigarette or smokeless tobacco use in the past 7 days at follow-up. The authors reported that harm reduction was observed less frequently, that is, 0.9% of baseline smokers (n=1,751) quit cigarettes and switched to smokeless tobacco use. In comparison, 5.6% of baseline smokers demonstrated harm escalation by initiating smokeless tobacco use in addition to cigarette smoking. Among baseline smokeless tobacco users (n=193), 14.0% switched to cigarettes and an additional 14.5% became dual users. Overall, baseline smokers who initiated STP were 5.4 times more likely to demonstrate harm escalation than harm reduction. The authors noted that restrictions placed on smoking might be responsible for dual use in the military. Furthermore, they found that Airmen who anticipated a moderate to large reduction in health risk by switching from cigarettes to smokeless tobacco were more than 3 times as likely to demonstrate harm reduction (OR=3.47; 95% CI=1.45-8.31). A differing opinion was observed by McClave and Bekowitz (2011) among adults 18 years or older surveyed as part of the 2008 ConsumerStyles survey. They reported that those who believed STP was as harmful (63.6%) as cigarettes were more likely to be dual users than those who believed STP was less harmful (7.5%).

3.5.2.2 Amount of cigarettes and STP used

A limited number of studies were identified in which the quantity of cigarettes smoked by dual tobacco users was compared to exclusive smokers. Some studies showed that on average the number of cigarettes consumed by dual users was lower than the number of cigarettes consumed by exclusive smokers (Rodu and Cole 2009; Tomar 2002; Wetter et al. 2002).

Rodu and Cole (2009) compared the number of cigarettes consumed daily by dual users with the quantity consumed by exclusive smokers reported in the 2000 and 2005 NHIS surveys. Everyday smokers who also used STP every day consumed significantly fewer cigarettes on average than exclusive smokers (13 vs. approximately 20 cigarettes/day). However, the authors observed no significant difference in cigarette consumption between every-day smokers who used STP on some days and exclusive smokers. In comparison, cigarette consumption among some-day smokers was very low in both survey years, and no differences were observed between some-day smokers who used STP and exclusive some-day smokers. Among adults 18 or older (1998 NHIS survey), Tomar (2002) reported that smokers who used snuff tended to smoke fewer cigarettes per day, on average, than those who never used snuff. Similar to Rodu and Cole (2009), Tomar (2002) found cigarette consumption among smokers who used snuff only on some days did not differ from never snuff users (19.3 vs. 18.4; p=0.42), while those who used snuff everyday smoked, on average, significantly fewer cigarettes per day (11.4; p=0.0001). Additionally, among adult males participating in the Working Well cancer prevention trial in southeastern United States, the number of cigarettes per day was higher among exclusive smokers compared to concomitant users, 24.6 vs. 19.5 cigarettes/day (Wetter et al. 2002).

Furthermore, in a cohort of adult concurrent tobacco users in Minnesota, light smokers (1-9 cigarettes/day) were significantly more likely to report use of STP than smokers using half a

pack or more (10-19 cigarettes/day), 13.7% vs. 5.5%. However, smokers using a pack or more per day reported similar STP use as light smokers, 11.1% vs. 13.7% (Boyle et al. 2012).

In two other analyses, Tomar and colleagues (Tomar et al. 2010) reported that among adults surveyed as part of the 2006 – 2007 CPS survey, there were no statistically significant differences in the quantity of cigarette smoked among exclusive cigarette smokers or STP users compared to dual users. Daily smokers who also used STP every day smoked about the same mean number of cigarettes per day as did daily smokers who used STP on some days or had never used STP. Similarly, Rath and colleagues (2012) reported that participants who reported using cigarettes only had a mean daily use of 9.20 cigarettes per day (95% CI: 8.18–10.23) and those who reported using cigarettes and other tobacco products reported 8.73 cigarettes per day (95% CI: 6.66–10.80), not statistically different. The authors concluded that the use of other tobacco products does not replace cigarette smoking or decrease the mean number of cigarettes smoked daily among young adults.

Among adolescents, Tomar et al. (2010) reported that 8th grade students surveyed in the 2005-2006 MTF survey who used STP daily had a much higher prevalence of smoking one-half pack of cigarettes or more per day (10.8%) than did those who did not use STP at all (1.3%). This suggests that cigarette consumption was higher among STP users; however, these students were surveyed at age 13 or 14 years old, which represents a period of experimental tobacco use.

In summary, the rates of dual tobacco use in the US appear to be low, in the range of <1 to 3%, but may be higher among those in the military, in certain US regions, among males, and by age (adolescents and young adults appear to have higher rates of dual use). Overall, studies reported low rates of switching between tobacco products. Among adults, dual users were most likely to transition to cigarette smoking than smokeless tobacco use. Prospective studies on dual use patterns among adolescents are limited. Cross-sectional studies among adolescents showed that dual users were inclined to use smokeless tobacco or smoke cigarette either daily or occasionally. The evidence suggests that in the US, daily dual users consume less cigarettes than exclusive smokers, but due to some mixed results, some uncertainty exists as to whether dual users have overall lower rates of tobacco consumption.

4 Summary and Conclusions

The term smokeless tobacco products (STP) includes Swedish snus, a single smokeless tobacco product used in Sweden and nearby Scandinavian countries, and a suite of products in the US, including moist and dry snuff and chewing tobacco. In Sweden, daily snus use is reported by 19% of adult males and 4% of adult females. Occasional use is reported by an additional 6% of males and 4% of females. Snus use is also common in Norway (use by 15 to 20% of adult males), and to a lesser extent in Finland. There were substantial increases in snus use in Sweden and Norway since the 1960s, but use rates have remained relatively stable since about year 2000.

In the US, combining data for all forms of STP, current use (daily and occasional) is reported by approximately 7% of males and less than 1% of females. Similar to the trend in Sweden, the prevalence of use of smokeless tobacco has remained stable since year 2000, as have the rates of smoking. There is a geographic element to STP use in the US; smokeless tobacco products are more commonly used by those living in the southern and mid-western states. Use is also typically higher among those living in rural, less densely populated areas, and STP use is most common among white Americans and American Indians compared to other racial/ethnic groups. US military personnel represent a subpopulation with higher STP use than the general population.

Gateway: Following a review of longitudinal and cross-sectional studies conducted on snus use in Sweden and other Scandinavian countries, there is little evidence that prior snus use leads to daily cigarette smoking among adults. These studies show that snus use is associated with a reduced risk of becoming or continuing to be a regular cigarette smoker, (compared to those who start using tobacco as smokers or non-tobacco users), that is, there is an inverse association between snus use and cigarette smoking initiation. Longitudinal studies provide evidence of transitioning from cigarettes to snus as compared to switching from snus use to cigarette smoking. Review of studies among adolescents in Sweden, Norway and Finland showed that baseline snus use was not a precursor to exclusive cigarette smoking; that is, tobacco initiation with snus or current snus use was not a predictor of future cigarette smoking. According to the 2007 SCENIHR report, “the Swedish data, with its prospective and long-term follow-up do not lend much support to the theory that smokeless tobacco (i.e. Swedish snus) is a gateway to future smoking.” Several additional studies published since the SCENIHR report have supported this same conclusion

A review of the US studies suggests mixed findings that prior smokeless tobacco may be associated with, and may lead to, subsequent cigarette smoking among adults. Though a majority of the study authors concluded that there was evidence of gateway, one well-conducted study in which non-gateway use was found to be more common than gateway use highlighted the importance of determining temporality in studies of tobacco gateway, noting that correlation only is inadequate. A majority of the studies in adolescent and young adults found an increased risk of cigarette use among those who reported prior STP use; however, it is important to note that tobacco habits are often not set amongst adolescents. In addition, several studies highlight the importance of including psychosocial and behavioral variables that may affect smoking initiation. In studies that suggested an association between STP and future cigarette smoking,

when factors such as access to tobacco, family smoking habits, cultural bans on smoking, and alcohol use were considered, the strength of the association diminished. As mentioned earlier, one of the recurring limitations in evaluating these studies are the various methods in estimating the risk of initiating cigarette smoking, such as study design variations, study population, and methods of predicting smoking variables. For example, in evaluating gateway patterns, a few studies collected information on the age of tobacco initiation, investigated the initial and subsequent weekly use and/or employed the use of national surveys for analysis. Recurring limitations in the US studies are study design variations and small and non-representative study populations, especially in youth studies.

Transitioning and Cessation: The clinical trials in which snus use was specifically used for smoking cessation support resulted in a success rate roughly equivalent to other NRTs. The data from Scandinavian cohorts should not be interpreted that use of snus is a necessary or sufficient condition for smoking cessation. However, the available studies indicate that snus has been used more often than NRTs by Scandinavian males as an aid for smoking cessation, and being a former smoker is common among snus users. These data have consistently shown that male snus users are more likely to quit smoking than smokers who do not use snus. The data also indicate that some smokers initiate use of snus specifically to aid in smoking cessation, and successfully quit smoking. The 2007 SCENIHR report concluded that “observational data from Sweden indicate that snus has been used more often than pharmaceutical nicotine products by some men as an aid to stop smoking. The data are consistent in demonstrating these male snus users are more likely to quit smoking than non-users.” Since then, there have been clinical trials and two meta-analyses in Norway on the use of snus as a smoking cessation tool that support this conclusion.

There were no clinical trials conducted among adolescent tobacco users. The gradual transitioning from smoking to snus observed in adults was not as apparent among adolescents. The experimentation with snus and smoking was common through teenage years, without an inclination towards a tobacco type, although boys were more likely to be snus users and girls were more likely to be cigarette smokers as young adults. Several authors discussed the importance of psychosocial contributions to smoking cessation and how this may impact an individuals’ decision to quitting tobacco.

There are fewer available studies in the US. While some of the clinical trials and observational studies provide evidence that smokers who use STP daily are prone to quit smoking, other evidence show that tobacco users were more likely to transition from STP to cigarette smoking than vice versa, and smokers who used STPs were not more likely to quit smoking. The studies conducted among adolescents and young adults do not provide evidence of STP use as a cessation aid. This may be due in part to the low prevalence of smokeless tobacco use in the US, which is evident in the limited number of studies that address smokeless tobacco use behaviors. There is a need for more longitudinal studies that adequately address the temporality of smokeless tobacco use in relation to cigarette smoking, as well as co-factors that contribute to this relationship.

Initiation: In Sweden and Norway, uptake of snus occurred across all age categories compared to cigarette uptake which appeared to occur more frequently at a younger age. In addition,

tobacco initiation was shown to be gender-dependent; males were more likely to initiate snus while females more likely to initiate cigarette smoking. Studies in Sweden and Norway have shown that snus initiation was more prevalent among former cigarette smokers than among non-tobacco users.

Smokeless tobacco initiation in the US was even lower than rates of snus initiation in Scandinavia. Tobacco users in the US were more likely to initiate with cigarettes, and at a younger age than for STP initiation.

Dual Use: Recent cross-sectional studies in Sweden and Norway have reported the prevalence of dual use from 2% to approximately 10%, depending on whether the criteria are daily dual use, or occasional use of one of the tobacco types. Factors associated with dual tobacco use included being male and those with low education. Some evidence suggests slightly lower overall tobacco use among the dual users. One study reported that pouched snus users had a slightly higher prevalence of cigarette smoking compared to users of loose snus. Taken together, among adults and adolescents, the range of dual use appears to be less than 10% in the Swedish population of snus users. Dual use appears to mark a transient period in tobacco use. Among adult tobacco users, baseline dual users were most likely to transition to snus use or remain dual users; whereas among adolescents, some dual users did transition to smoking.

In the US, the rates of dual tobacco use appear to be in the range of <1 to 3%, but may be higher among those in the military, in certain US regions, among males, and by age (adolescents and young adults appear to have higher rates of dual use). Overall, studies reported low rates of switching between tobacco products. Among adults, dual users were most likely to transition to cigarette smoking than smokeless tobacco use. Prospective studies on dual use patterns among adolescents are limited. Cross-sectional studies among adolescents showed that dual users were inclined to use smokeless tobacco or smoke cigarette either daily or occasionally. The evidence suggests that in the US, daily dual users consume less cigarettes than exclusive smokers, but some uncertainty exists as to whether dual users have lower rates of tobacco consumption.

In summary, there is conclusive evidence of switching from smoking to snus use at both the population and individual levels in Sweden. Switching from cigarettes to snus is more common than switching from snus to cigarettes in Sweden. Also, STPs have been used as a smoking reduction and cessation aid by individuals in Sweden; the data are less clear in the US.

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Appendix A

Appendix A: The Prevalence of Snus Use in Scandinavia				
Country (Year)	Frequency of Use	Male	Female	Data source (reference)
Sweden (2011)	Daily Occasionally	19% 6%	4% 4%	16-84 year olds. Swedish National Institute of Public Health (http://www.fhi.se/en/Highlights/National-Survey-of-Public-Health/Living-habits/Tobacco-habits-/)
Norway (2010)	Daily	7%		16 -74 year olds. Norway Tobacco Statistics. (http://www.ssb.no/royk_en/main.html)
Sweden (2004 – 2005)	Daily	23.1%	2.8%	16-84 year olds (Statistics Sweden 2007)
Norway (2006)	Daily Occasionally	9% 7%	0.4% 1%	16-74 year olds, Norwegian Tobacco Statistics 1973-2006 (Lund and Lindbak 2007)
Finland (2005)	Daily Occasionally	2% 2%	0% 0%	15-64 year olds (Statistics Finland 2008).
Studies in the peer reviewed literature		Male	Female	Sample (Reference)
Daily snus user		(n=3,107) 9.2%	(n=3,155) 0.4%	Pooled data of 16 – 74 year old Norwegian men. (Scheffels et al. 2012)
Occasional snus user		6.4%	1.5%	
Former snus user		8.9%	2.2%	
Never snus user		75.5%	95.9%	
Currently use snus		(n=737) 7.0%	(n=75) 0.4%	Sweden Malmo Diet and Cancer Cohort (1991-1996) (Janzon and Hedblad 2009)
Currently use snus regularly (regardless of smoking status)		(n=7,686) 24.6%	(n=8,880) 3.1%	Baseline (1990-1994) data from the Sweden Vasterbotten Intervention Programme (Lundqvist et al. 2009)
Baseline				
Ten-year follow up		(n = 7,687) 26.3%	(n = 8,800) 6%	
Lifetime (regardless of smoking status)		(n=8,553)	(n=10,520)	Swedish Twin Registry (Study of Twin Adults: Genes and Environment - STAGE ~2005) (Furberg et al. 2008b)
Ever used snus				
Yes		59.9%	25.4%	
Ever used snus daily		31.1%	4.8%	
Ever used snus occasionally		28.8%	20.6%	
No		40.1%	74.6%	
At interview				
Current daily use of snus		25.7%	3.7%	
Former daily use of snus		5.4%	1.1%	

Appendix A: The Prevalence of Snus Use in Scandinavia				
Country (Year)	Frequency of Use	Male	Female	Data source (reference)
Use of moist snuff		(n=139)	(n=245)	Cross sectional study of people reporting chronic pain in southern Sweden 2005 (Jakobsson 2008)
Daily		17.4%	1.2%	
Occasionally		2.3%	1.2%	
Former		11.6%	0%	
Never		68.6%	97.5%	

Appendix B

Appendix B: Regional variation in Snus use within Sweden and Norway					
	Snus Use			Population (Reference)	
National Statistics					
Region 2008-2011	Women		Men		16-84 year olds. Swedish National Institute of Public Health 2011
Sverige <i>Sweden</i>	4%		19%		
Stockholm	4%		16%		
Uppsala	3%		18%		
Södermanland	2%		19%		
<i>Southeast</i>					
Östergötland	3%		18%		
<i>South</i>					
Jönköping	3%		22%		
<i>South</i>					
Kronoberg	4%		19%		
<i>South</i>					
Kalmar	4%		22%		
Gotland	6%		21%		
Blekinge	1%		21%		
Skåne	3%		16%		
<i>South</i>					
Halland	4%		22%		
<i>West</i>					
Västra Götaland	3%		18%		
<i>West</i>					
Värmland	5%		24%		
<i>Central</i>					
Örebro	3%		18%		
Västmanland	4%		24%		
<i>North</i>					
Dalarna	4%		22%		
<i>Central</i>					
Gävleborg	4%		21%		
Västernorrland	8%		22%		
<i>North</i>					
Jämtland	8%		25%		
<i>Central</i>					
Västerbotten	12%		24%		
<i>North</i>					
Norrbottn	8%		25%		
<i>North</i>					
Region 2007-2009	Grade 9		High school grade 2		Students in Sweden (Hvitfeldt and Gripe 2009)
	Boys	Girls	Boys	Girls	
Stockholms län	14%	4%	25%	6%	
Vastra Gotaland	14%	4%	22%	10%	
Skane län	16%	2%	23%	3%	
Sodra Sverige (South Sweden)	18%	2%	25%	7%	
Mellersta Sverige (Central Sweden)	17%	5%	24%	9%	
Norra Sverige (North Sweden)	18%	10%	27%	20%	

Appendix B: Regional variation in Snus use within Sweden and Norway				
	Snus Use			Population (Reference)
2004-2006	Daily snus use	Occasional snus use		16 to 64 year olds, Norwegian Tobacco Statistics, 1973 - 2006 (Lund and Lindbak 2007)
Oslo/Akershus	13%	9%		
Rest of Osttlandet	15%	8%		
Agder/Rogaland	7%	9%		
Vestlandet	9%	8%		
Trondelag	21%	11%		
Nord-Norge	21%	13%		
Scandinavian studies in the peer reviewed literature				
	Snus Use			Sample (Reference)
Region	Never	Former	Current	Sweden Construction workers' cohort 1978-1993 (Hergens et al. 2008a)
North (n=32,815)	68%	2%	29%	
Middle (n=61,682)	71%	2%	27%	
South (n=23,968)	74%	2%	25%	
Gender and Urbanicity	Daily	Occasional	None	10th graders in 6 counties in Norway 2000-2004 (Grotvedt et al. 2008)
Male				
Urban areas (n=4,870)	4.9%	14.5%	80.6%	
Rural areas (n=2,892)	7.2%	17.5%	75.3%	
Female				
Urban areas (n=4,911)	0.1%	2.4%	97.5%	
Rural areas (n=2,857)	0.1%	5.1%	94.8%	
Residential area	Use snus daily			16 to 74 year old males in the Swedish Survey of Living Conditions (ULF) from 1988-89 (Haglund et al. 2007)
Metropolitan areas (n=1,556)	13.6%			
Cities (n=2,759)	18.6%			
Rural areas(n=687)	23.3%			
City (n=2,989)	Use snus			14-15 year olds. Northern Sweden 2003 (Hedman et al. 2007)
Lulea	7.2%			
Kiruna	9.8%			
Pitea	17.5%			

Appendix C

Appendix C : Age of Snus Users in Scandinavia							
	Males			Females			Data source (reference)
Scandinavian National Surveys							
Ages (years)	Daily		Occasionally	Daily		Occasionally	Swedish National Institute of Public Health 2011
16-29	17%		10%	5%		9%	
30-44	21%		9%	4%		4%	
45-64	21%		4%	3%		2%	
65-84	11%		2%	2%		0%	
Column percents	Daily	Weekly	Occasionally	Daily	Weekly	Occasionally	Snus using 16- to 20-year-olds living in Norway 2007 (Wium and Aaro 2011)
Age began using snus (years)							
9-11	2.3%	0%	2.1%	1.7%	3.4%	0	
12-14	28.5%	35.0%	17.0%	13.6%	3.4%	11.2%	
15-17	62.7%	50.0%	66.0%	72.9%	75.9%	66.4%	
18-20	6.5%	15.0%	14.9%	11.9%	17.2%	22.4%	
Age began using snus regularly (years)							
9-11	0.8%	0%	3.2%	-	-	-	
12-14	11.9%	15.0%	10.6%	5.1%	0%	7.5%	
15-17	67.7%	57.5%	64.9%	66.1%	58.6%	57.9%	
18-20	19.6%	27.5%	21.3%	28.8%	41.4%	34.6%	
2007		Daily		Daily			Sweden (Hvitfeldt and Gripe 2009)
16-29		22%		5%			
30-44		21%		4%			
45-64		19%		4%			
65-84		9%		1%			

Appendix C : Age of Snus Users in Scandinavia				
	Males		Females	Data source (reference)
2005	Daily or Occasional Snus Use			Population data, Norway. (Lund and Lindbak 2007)
Grade 8	5%			
Grade 9	15%			
Grade 10	29%			
2004-2006	Daily	Occasional		
16-24	17%	17%		
25-34	19%	9%		
35-44	11%	4%		
45-54	6%	5%		
55-64	2%	4%		
65-74	1%	--		
Studies in the peer-reviewed literature				
40 year olds (n=12,341)	28.1%		11.8%	Data from the Sweden Vasterbotten Intervention Programme, 2002 - 2007 (Norberg et al. 2011)
50 year olds (n=13,046)	23.8%		6.2%	
60 year olds (n=13,023)	17.5%		2.5%	
Age (years)	OR (95% CI) for current daily snus use versus non-use, adjusted for age, occupational class, disposable income and education		OR (95% CI) for current daily snus use versus non-use, adjusted for age, occupational class, disposable income and education	Stockholm Public Health Survey, 18-84 year olds in Stockholm County (2006) (Engstrom et al. 2010)
18-24	1.00		1.00	
25-34	0.92 (0.74, 1.14)		0.63 (0.43, 0.92)	
35-44	0.85 (0.69, 1.06)		0.72 (0.50, 1.04)	
45-54	0.58 (0.46, 0.72)		0.59 (0.40, 0.86)	
55-64	0.31 (0.25, 0.39)		0.22 (0.15, 0.35)	
65-74	0.18 (0.14, 0.24)		0.14 (0.08, 0.25)	
75+	0.07 (0.05, 0.11)		0.02 (0.00, 0.12)	

Appendix C : Age of Snus Users in Scandinavia						
	Males			Females		Data source (reference)
Age (years)	Snus use (results not stratified by gender)					18-80 year olds in Northern Sweden, 1998 (Aro et al. 2010)
	Current	Former		Never		
20-34 (n=94)	25%	7%		68%		
35-49 (n=266)	12%	7%		81%		
50-64 (n=375)	14%	6%		80%		
>=65 (n=254)	5%	7%		89%		
Maternal age (years)				% used snus during pregnancy		Women born in Sweden, Norway, Denmark, Finland, Iceland, had singleton infant in Sweden at >=28 weeks gestation during 1999-2006, (Wikstrom et al. 2010)
<=19 (n=8,982)				1.8%		
20-24 (n=66,367)				1.7%		
25-29 (n=184,163)				1.3%		
30-34 (n=205,933)				1.0%		
>=35 (n=104,927)				1.7%		
Age (years)	Ever Tried	Currently Use	Ever Tried	Currently Use	Swedish 13, 15 and 17 year olds, 2003 (Nilsson et al. 2009)	
13	18%	2%	8%	0%		
15	41%	10%	20%	0%		
17	52%	19%	40%	4%		
Mean age (years)	Current (n=2,661)	Former (n=1,456)	Never (n=12,525)			Twin registry (Hansson et al. 2009)
	52.5	53.5	56.9			
Mean age (years)	Current Snus Use (n=10,473)		Current Snus Use (n=16,754)		Malmo Diet and Cancer Cohort, 1991-1996 (Janzon and Hedblad 2009)	
	Yes	No	Yes	No		
	56.8	59.2	54.6	57.4		
Age group (years)	Snus User (did not smoke and used snus >= once/week)					Males in a small municipality in a rural area in southwest Sweden, 2001-2003 (excluded current dual users) (Sundbeck et al. 2009)
	Yes	No				
30-49	28%	72%				
50-76	10%	90%				

Appendix C : Age of Snus Users in Scandinavia											
	Males					Females					Data source (reference)
Age group (years)	Used Snus Daily					Used Snus Daily					Jonkoping (Sweden) 15-70 years old 2003 – latest year available (Hellqvist et al. 2009)
15	7%					0%					
20	26%					0%					
30	29%					0%					
40	23%					6%					
50	22%					2%					
60	16%					0%					
70	5%					0%					
Age (years)	n	None	Occasional	Every Week	Every day	n	None	Occasional	Every Week	Every day	16-20 year olds randomly sampled from the Norwegian Population Registry, 2004 (Wium et al. 2009)
16	253	80.2%	7.9%	5.5%	6.3%	243	94.2%	4.9%	0.4%	0.4%	
17	251	67.7%	13.5%	5.2%	13.5%	235	90.6%	6.4%	1.7%	1.3%	
18	245	69.0%	11.4%	4.9%	14.7%	231	90.5%	6.1%	1.3%	2.2%	
19	240	66.3%	11.3%	5.0%	17.5%	232	91.4%	6.9%	1.7%	0.0%	
20	240	60.4%	19.6%	4.2%	15.8%	229	92.6%	4.4	1.3	1.7	
Age at cohort entry (years)	Ever used snus (regardless of smoking)										Males, Construction Industry's Organization for Working Environment Safety and Health, "Bygghälsan" (1978- 1993) (Carlens et al. 2010)
< 24 (n=78,377)	38%										
25-34 (n=72,289)	33%										
35-44 (n=59,025)	25%										
45-54 (n=37,404)	18%										
>=55 (n=30,684)	18%										
Age (years)	Daily										10th graders in Oslo county participating in Health Study 2000 – 2001 (Grotvedt et al. 2013)
16 year old	7%										
Age (years)	n	Daily	Occas- ional	None	n	Daily	Occas- ional	None	10th graders in 6 counties in Norway, 2000-2004 (Grotvedt et al. 2008)		
14.5-15.6	1,888	5.6%	15.5%	78.9%	1,991	0.3%	3.3%	96.4%			
15.6-15.9	1,901	6.4%	15.3%	78.3%	1,974	0.1%	3.5%	96.4%			
15.9-16.1	1,956	5.3%	15.8%	79.0%	1,915	0.0%	3.6%	96.4%			
16.1-18.4	1,988	5.6%	15.9%	78.5%	1,872	0.0%	3.2%	96.9%			

Appendix C : Age of Snus Users in Scandinavia					
	Males		Females		Data source (reference)
Grade	(n=1,494)		(n=1,444)		BROMS cohort (baseline in 1998) (Galanti et al. 2008)
	Ever used snus	Currently use snus	Ever used snus	Currently use snus	
	5	0.2%	3.2%	0.0%	
	9	18.2%	32.3%	1.9%	
3 rd year post-compulsory (18 years old)	71.5%	25.0%	55.9%	5.6%	
Grade (n=4,098)	Tried snus	Currently use snus	Tried snus	Currently use snus	Survey of Norwegian lower secondary students, 13-15 year olds, 1995 (Braverman et al. 2001)
9th grade	40.1%	19.7%	15.5%	4.2%	
8th grade	26.0%	11.5%	8.3%	2.0%	
7th grade	15.8%	4.5%	4.0%	1.3%	
Age (years)	Use Snus Daily				Swedish Survey of Living Conditions (ULF, 1988–89), 16 to 74 year old males (Haglund et al. 2007)
16-24 (n=1,000)	23.2%				
25-44 (n=2,113)	22.1%				
45-64 (n=1,392)	10.1%				
65-74 (n=497)	9.5%				
Age (years)	% Use Snus (male and female combined)				Cohort in Northern Sweden (baseline: 1996) (Hedman et al. 2007)
12-13	3.2%				
14-15	9.9%				
Age (years)	Daily snus user				Born in 1942 or 1952, Orebro and Ostergotland, Sweden 2002 (Halling et al. 2007)
50 (n=2,606)	20%				
60 (n=2,755)	12%				
Age (years)	Use Snus Daily		Use Snus Daily		Your Country and Your Life (Sweden, 2001-2002) (Ramström and Foulds 2006)
16-24	24%		2%		
25-44	31%		4%		
45-64	19%		2%		
65-79	8%		0%		

Appendix C : Age of Snus Users in Scandinavia					
	Males		Females		Data source (reference)
Age (years)	Occasional or Daily Use	Experimented	Occasional or Daily Use	Experimented	Finnish Adolescent Health and Lifestyle Survey, 2003 (Huhtala et al. 2006)
12 (n=758)	0.3%	0.8%	0%	0%	
14 (n=2,337)	1.3%	8.7%	0.5%	3.5%	
16 (n=2,299)	7.1%	30.4%	0.6%	12.0%	
18 (n=1,367)	8.5%	44.0%	0.9%	17.6%	
Age (years)	Snuff Use				14 to 19 year olds in public dental clinics in Göteborg, 1986 (Hirsch et al. 1991)
14 (n=137)	4%				
15 (n=394)	6%				
16 (n=385)	7%				
17 (n=393)	8%				
18 (n=520)	14%				
19 (n=316)	11%				
Portion snus (n=23)	Mean (std) age (years)	Age range (years)			Healthy men who used snus but not other tobacco for >= 3 months, subset of sample used by (Andersson 1991), chewing tobacco users were a subset from (Andersson et al. 1994)
Loose moist snus (n=22)	40.8 (8.7)	21-57			
Chewing tobacco (n=9)	38.8 (13.8)	22-75			
	50.4 (9.6)	38-68			
191 current users	Age started using snus				Case-control study, 40-79 year olds, born in Sweden, living in 1 of 5 counties in northern or central Sweden (1989-1995), controls selected from population registers (Ye et al. 1999)
	16-20 (n=77)		>=21 (n=114)		
	40%		60%		

Appendix D

Appendix D: Socioeconomic Status (as measured by employment, occupation, education or income) and Snus Use in Scandinavia					
Socioeconomic status	Snus Use			Data source (reference)	
Manual worker	Males		Females	16-84 year olds. Swedish National Institute of Public Health 2011	
	23%		4%		
	Assistant non-manual employees	22%			3%
	Intermediate and higher non-manual	13%			3%
Other	20%		2%		
Employment					
Employed	22%		5%		
Unemployed	17%		3%		
Sick leave	18%		1%		
Studying or training	18%		2%		
Education					
Upper secondary less than 3 years	23%		3%		
Post-secondary less than 3 years	20%		4%		
Post-secondary 3 years or more	11%		3%		
<hr/>					
Education	Current	Former	Never	18-80 year olds in Northern Sweden (1998) (Aro et al. 2010)	
Low education (elementary, comprehensive or secondary school) (n=579)	11%	7%	82%		
High education (upper secondary school or university) (n=410)	13%	7%	81%		
<hr/>					
			OR (95% CI) for current daily snus use versus non-use, adjusted for age, occupational class, disposable income and education	Stockholm Public Health Survey, 18-84 year olds in Stockholm County (2006) (Engstrom et al. 2010)	
			Males		Females
Education					
Low	1.49 (1.26, 1.77)		1.07 (0.73, 1.55)		
Intermediate	1.60 (1.41, 1.81)		1.49 (1.17, 1.89)		
High	1.00		1.00		
Disposable income					
Very low	0.98 (0.82, 1.16)		1.16 (0.82, 1.64)		
Low	1.25 (1.06, 1.47)		1.28 (0.92, 1.78)		
Intermediate	1.25 (1.07, 1.46)		1.29 (0.94, 1.78)		
High	1.24 (1.06, 1.43)		1.17 (0.84, 1.62)		
Very high	1.00		1.00		
Occupational Class					
Unskilled worker	1.02 (0.85, 1.23)		1.35 (0.92, 1.96)		
Skilled worker	1.40 (1.17, 1.68)		1.30 (0.87, 1.94)		
Low-level clerk	1.14 (0.94, 1.40)		1.00 (0.70, 1.43)		
Middle level clerk	1.06 (0.91, 1.24)		1.27 (0.94, 1.73)		
Self-employed	1.09 (0.90, 1.31)		1.02 (0.63, 1.63)		
High level clerk	1.00		1.00		

Appendix D: Socioeconomic Status (as measured by employment, occupation, education or income) and Snus Use in Scandinavia						
Socioeconomic status		Snus Use			Data source (reference)	
Year and socio-educational status		% use snus (regardless of smoking status)			2 studies of 16-20 year old Norwegians (2004, 2007) (Overland et al. 2010)	
2004 (n=2,400)		10.6%				
Academic (n=1,225)		9.2%				
Vocational (n=834)		11.2%				
Other (n=224)		15.7%				
2007 (n=2,415)		16.1%				
Academic (n=986)		13.2%				
Vocational (n=1,029)		18.4%				
Other (n=182)		21.4%				
Education		% used snus during pregnancy			Women born in Sweden, Norway, Denmark, Finland, Iceland, had singleton infant in Sweden at >=28 weeks gestation during 1999-2006 (Wikstrom et al. 2010)	
<=9 (n=42,322)		2.1%				
10-12 (n=267,136)		1.7%				
13-14 (n=86,061)		1.2%				
>=15 (n=174,251)		0.9%				
		Snus User (did not smoke and used snus >= once/week)			Males in a small municipality in a rural area in southwest Sweden (2001-2003) (excluded current dual users) (Sundbeck et al. 2009)	
Employment		Yes	No (includes smokers)			
Housework		19%	81%			
Employed		23%	77%			
Retired		12%	88%			
Student		33%	67%			
Unemployed		33%	67%			
Gender and educational plans		n	Daily	Occasional	None	10th graders in 6 counties in Norway, 2000-2004 (Grotvedt et al. 2008)
Male						
Academic studies		3,320	4.2%	12.5%	83.3%	
Upper secondary school, general studies		436	5.7%	14.2%	80.1%	
Upper secondary school, vocational studies		2,420	7.9%	19.6%	72.6%	
One year of upper secondary school/other plans		408	7.8%	20.3%	71.8%	
Undecided		1,053	4.2%	15.3%	80.5%	
Female						
Academic studies		3,942	0.1%	2.6%	97.3%	
Upper secondary school, general studies		390	0.0%	3.9%	96.2%	
Upper secondary school, vocational studies		1,700	0.2%	5.1%	94.7%	
One year of upper secondary school/other plans		303	0.3%	4.0%	95.7%	
Undecided		1,355	0.0%	3.5%	96.5%	

Appendix D: Socioeconomic Status (as measured by employment, occupation, education or income) and Snus Use in Scandinavia					
Socioeconomic status	Snus Use				Data source (reference)
Gender and family economy	n	Daily	Occasional	None	
Male					
Very well off	879	7.4%	15.5%	77.1%	
Well off	4,186	5.7%	15.6%	78.7%	
In between	2,347	5.3%	15.7%	79.0%	
Short of money	232	3.0%	18.1%	78.9%	
Female					
Very well off	603	0.2%	3.5%	96.4%	
Well off	4,042	0.1%	3.2%	96.7%	
In between	2,736	0.1%	3.6%	96.4%	
Short of money	281	0.0%	6.1%	94.0%	
	Snus Use (regardless of smoking)				60+ year old men in Stockholm, 1997-1999 (Wandell et al. 2008)
Employed	Current	Former	Never		
Yes (n=1,338)	8%	1%	91%		
No (n=517)	9%	1%	90%		
Weekly spending money and gender	Use of smokeless tobacco				14 and 16 year olds in Finland (Adolescent Health and Lifestyle Survey, 2001 (Leena et al. 2005)
	n	Never	Used once	Used > once	
Males					
Lowest quartile	639	82%	10%	8%	
Two middlemost quartiles	881	70%	12%	18%	
Highest quartile	433	67%	10%	23%	
Females					
Lowest quartile	913	93%	5%	2%	
Two middlemost quartiles	1,051	90%	7%	3%	
Highest quartile	466	85%	9%	6%	
Occupation	Daily Snus Use				Swedish Survey of Living Conditions (ULF) from 1988–89, 16 to 74 year old males (Haglund et al. 2007)
Unskilled manual (n=945)	22.2%				
Skilled manual (n=990)	25.4%				
Non-manual, low (n=580)	16.7%				
Non-manual, intermediate (n=944)	13.7%				
Non-manual, high (n=782)	10.1%				
Self-employed, including farmers (n=638)	16.0%				
Missing information (n=123)	13.8%				
Students	Use Snus			Ostergötland in 1999 (Vaez et al. 2006)	
	Yes	No			
First year university students (n=2,147)	9%	91%			
20 to 35 year olds with paid employment (n=668)	25%	75%			

Appendix D: Socioeconomic Status (as measured by employment, occupation, education or income) and Snus Use in Scandinavia				
Socioeconomic status	Snus Use		Data source (reference)	
Occupational level based on Swedish socioeconomic index	Current Snus Use		Malmö Diet and Cancer Cohort (1991-1996) (Janzon and Hedblad 2009)	
	Yes	No		
Males (n=10,473)				
Low level	57.0%	45.4%		
Medium level	13.8%	18.0%		
High level	11.3%	14.5%		
Others	17.9%	22.2%		
Females (n=16,754)				
Low level	25.2%	44.3%		
Medium level	23.9%	20.0%		
High level	22.5%	14.2%		
Others	18.3%	21.4%		

Appendix E

Appendix E: Other Individual Level Characteristics Related to Snus Use					
Characteristic	Snus Use			Data source (reference)	
Exercise, physical activity and sports participation					
Physical activity, days/week <2 2-4 5+	OR (95% CI) for current daily snus use versus non-use, adjusted for age, occupational class, disposable income, education, and BMI			Stockholm Public Health Survey, 18-84 year olds in Stockholm County (2006) (Engstrom et al. 2010)	
	Males		Females		
	1.09 (0.97, 1.22)		0.90 (0.71, 1.14)		
	0.95 (0.83, 1.07)		1.11 (0.88, 1.40)		
Physical exercise No (n=603) Light (n=3,493) Energetically (n=906)	Use snus daily			Swedish Survey of Living Conditions (ULF) from 1988–1989, 16 to 74 year old males (Haglund et al. 2007)	
	18.7%				
	16.7%				
	20.6%				
Exercise None Occasionally >= once/week	Non-smoking daily snuff users (n=107)		Non-smokers (n=1036)	Swedish Annual Level-of-Living Survey, males 30-74 years old, 1988-1989 (Johansson et al. 2005)	
	13.1%		9.9%		
	33.1%		30.9%		
	53.8%		59.2%		
Type athletic event All athletes (n=446) Speed and power events (e.g., track and field) (n=113) Endurance events (e.g., cross-country skiing) (n=108) Motor skill demanding events (e.g., shooting) (n=73) Team sport events (e.g., ice hockey) (n=152) Controls (n=1,504)	Current snuff use				Athletes eligible for financial support from the National Olympic Committee in Finland (2002) and controls from the Finnish National Health Survey (18-29 years old) (2000) - adjusted for age, sex and education (Alaranta et al. 2006)
	Daily	Occasional	Not at all	OR (95% CI)	
	9.6%	15.0%	75.3%	9.13 (5.51, 15.1)	
	9.7%	21.2%	69.0%	4.94 (2.70, 9.06)	
	7.4%	9.3%	83.3%	3.33 (1.54, 7.21)	
	2.7%	9.6%	87.7%	15.63 (9.55, 25.6)	
	14.5%	17.1%	68.4%	1.0	
Participation in sports Yes No	Snus use			2,989 14 - 15 year olds (males & females) in Northern Sweden, 2003 (Hedman et al. 2007)	
	15.5%				
	7.4%				

Appendix E: Other Individual Level Characteristics Related to Snus Use						
Characteristic	Snus Use				Data source (reference)	
Tobacco use	Mean (std dev) Physical Activity (times/week)				Males (Eliasson et al. 1991)	
Used >=1 can (50 g) snuff per week for 2 years (n=21)	1.3 (1.6)					
No tobacco use (n=18)	2.3 (1.6)					
Other Substance Use						
	Current Tobacco Use				1998 survey of 9th grade boys in Stockholm county (Galanti et al. 2001b)	
	None	Smoking only	Snuff only	Cigarettes and snuff		
Ever been drunk						
Yes (n=3,626)	47.3%	21.2%	8.9%	22.6%		
No (n=2,569)	93.4%	4.4%	1.2%	1.0%		
Tried illicit drugs						
Yes (n=777)	20.5%	30.4%	8.1%	41.1%		
No (n=5,418)	73.1%	11.8%	5.3%	9.8%		
Parental Characteristics						
Parent's marital status and gender	Snuff use			10th graders in 6 counties in Norway, 2000-2004 (Grotvedt et al. 2008)		
	Daily	Occasional	None			
Males						
Married, cohabitating (n=5,135)	5.0%	14.2%	80.8%			
Divorced, separated, etc. (n=2,555)	6.9%	18.4%	74.7%			
Females						
Married, cohabitating (n=5,152)	0.1%	2.9%	97.0%			
Divorced, separated, etc. (n=2,587)	0.1%	4.3%	95.6%			
Snus Use						
Mother currently smokes	Snus Use				2,989 14 to 15 year olds (males & females) in Northern Sweden (2003) (Hedman et al. 2007)	
Yes	17.4%					
No	6.4%					
Father currently smokes						
Yes	13.7%					
No	7.4%					
Other family member currently smokes						
Yes	17.2%					
No	7.1%					

Appendix E: Other Individual Level Characteristics Related to Snus Use					
Characteristic	Snus Use				Data source (reference)
	Snus Use in the 8th grade (limited to boys, adjusted for other parent's tobacco use (any vs. none)) OR (95% CI)				Completed baseline (1998) and 2001 assessments, had not tried tobacco at baseline, lived with >= 1 parent (n = 2232) (Rosendahl et al. 2003)
Mother's tobacco use	Any current snus use		Current snus use only		
Snus and cigarettes	2.4 (0.3, 22.5)		4.5 (0.5, 43.7)		
Cigarettes only	1.7 (0.9, 2.9)		1.8 (0.8, 4.0)		
Snus only	2.2 (0.5, 10.9)		4.2 (0.8, 21.4)		
None	1.0		1.0		
Father's tobacco use					
Snus and cigarettes	2.3 (0.9, 5.5)		1.9 (0.5, 6.9)		
Cigarettes only	1.6 (0.8, 3.1)		1.2 (0.4, 3.6)		
Snus only	2.4 (1.3, 4.4)		3.0 (1.4, 6.4)		
None	1.0		1.0		
	Current Tobacco Use				1998 survey of 9th grade boys in Stockholm county (Galanti et al. 2001b)
	None	Smoking only	Snuff only	Smoking and snuff	
Live with both parents					
Yes (n=4,279)	68.3%	13.4%	5.5%	12.7%	
No (n=1,955)	61.9%	16.0%	6.0%	16.1%	
Both parent born in Sweden					
Yes (n=4,262)	63.8%	14.0%	6.7%	15.5%	
No (n=2,025)	71.3%	14.8%	3.6%	10.3%	
Mother's education (years)					
<=9 (n=680)	66.8%	11.9%	6.0%	15.3%	
10-12 (n=1,601)	66.4%	13.2%	7.1%	13.2%	
>12 (n=2,153)	65.9%	16.2%	4.5%	13.4%	
Other (n=313)	70.0%	12.5%	5.1%	12.5%	
Father's education (years)					
<=9 (n=712)	62.9%	12.9%	7.7%	16.4%	
10-12 (n=1,401)	65.9%	12.9%	6.6%	14.6%	
>12 (n=2,344)	67.3%	16.0%	4.5%	12.2%	
Other (n=301)	71.1%	12.3%	6.3%	10.3%	

Appendix E: Other Individual Level Characteristics Related to Snus Use					
Characteristic	Snus Use				Data source (reference)
	Current Tobacco Use				
	None	Smoking only	Snuff only	Smoking and snuff	
					1998 survey of 9th grade boys in Stockholm county (Galanti et al. 2001b)
Fight after drinking					
Yes (n=1,083)	29.7%	23.6%	9.7%	36.9%	
No (n=4,516)	73.4%	13.0%	4.7%	9.0%	
Drinking and driving					
Yes (n=775)	27.0%	21.8%	10.7%	40.5%	
No (n=4,801)	70.9%	13.9%	5.0%	10.2%	
Unsafe sex after drinking					
Yes (n=583)	24.7%	25.6%	10.5%	39.3%	
No (n=4,984)	69.5%	13.8%	5.2%	11.5%	
School truancy					
Never (n=2,664)	82.2%	7.9%	4.0%	5.9%	
<= once/month (n=2,613)	61.0%	16.9%	6.5%	15.5%	
> once/month (n=976)	36.5%	24.6%	8.1%	30.8%	
Hit/injured someone during current school year					
Yes (n=621)	36.1%	21.7%	8.7%	33.5%	
No (n=5,484)	70.3%	13.1%	5.3%	11.3%	
Coffee intake					
	High Coffee Intake				35-60 year old firefighters in Stockholm, 1993 (Bolinder 1997; Bolinder and de Faire 1998)
Snus use (among non-smokers)					
Yes (n=47)	21%				
No (n=59)	19%				
	Mean (std dev) Coffee Intake (cups/day)				Males (Eliasson et al. 1991)
Used >=1 can (50 g) snuff per week for 2 years (n=21)	3.0 (1.7)				
No tobacco use (n=18)	1.3 (1.3)				
Alcohol consumption					
High alcohol consumption ([100 g/week)	Current	Former	Never		18-80 year olds in Northern Sweden (1998) (Aro et al. 2010)
Yes (n=125)	24%	9%	67%		
No (n=864)	10%	6%	84%		

Appendix E: Other Individual Level Characteristics Related to Snus Use					
Characteristic	Snus Use				Data source (reference)
	OR (95% CI) for current daily snus use versus non-use, adjusted for age, occupational class, disposable income and education				Stockholm Public Health Survey, 18-84 year olds in Stockholm County (2006) (Engstrom et al. 2010)
	Males	Females			
Risky alcohol consumption					
No	1.00	1.00			
Yes	1.81 (1.63, 2.02)	1.79 (1.45, 2.20)			
Binge drinking					
Never/seldom	1.00	1.00			
Monthly	2.34 (2.08, 2.63)	1.53 (1.12, 2.11)			
Weekly	3.01 (2.55, 3.56)	3.16 (2.08, 4.81)			
	Tobacco Use				
Any consumption of alcoholic beverages in the past 7 days	None	Cigarette smoking only	Snus only	Both	9th grade boys in Stockholm, 1998 (Wickholm et al. 2003)
Yes (n=2391)	24.4%	57.2%	64.4%	72.5%	
	Medium/high Alcohol Intake				
Snus use (among non-smokers)					35-60 year old firefighters in Stockholm (1993) (Bolinder 1997; Bolinder and de Faire 1998)
Yes (n=47)	34%				
No (n=59)	45%				
	Mean (std dev) Alcohol Consumption (g/month)				
Tobacco use					Males (Eliasson et al. 1991)
Used >=1 can (50 g) snuff per week for 2 years (n=21)	284 (200)				
No tobacco use (n=18)	147 (182)				

Appendix E: Other Individual Level Characteristics Related to Snus Use				
Characteristic	Snus Use		Data source (reference)	
Other characteristics				
	OR (95% CI) for current daily snus use versus non-use, adjusted for age, occupational class, disposable income and education		Stockholm Public Health Survey, 18-84 year olds in Stockholm County (2006) (Engstrom et al. 2010)	
	Males	Females		
Fruit consumption				
Once a week or less	2.53 (2.10, 3.03)	1.80 (1.23, 2.64)		
Several times a week/daily	1.63 (1.39, 1.90)	1.47 (1.19, 1.81)		
Several times a day	1.00	1.00		
Vegetable consumption				
Once a week or less	1.71 (1.41, 2.07)	1.36 (0.86, 2.15)		
Several times a week/daily	1.23 (1.05, 1.44)	1.31 (1.06, 1.62)		
Several times a day	1.00	1.00		
	OR (95% CI) for regular versus no snus use		16-20 year olds randomly sampled from the Norwegian Population Registry, 2004 (Wiium et al. 2009)	
Higher subjective attractiveness of snus	3.26 (2.64, 4.03)			
Higher perceived trendiness of snus	1.28 (1.11, 1.49)			
	Smokeless tobacco use		9th grade students (15-16 year olds) in Umeå and Stockholm (Sweden) and Bergen (Norway) (1996) (Low-meat consumers - seldom or never ate pork, poultry or other animal products in the past 12 months) (Larsson et al. 2002)	
Diet and gender	Daily	Sometimes		Never
Male				
Low-meat consumers (n=41)	12%	17%		71%
Omnivores (n=976)	5%	14%		81%
Female				
Low-meat consumers (n=108)	0%	10%	90%	
Omnivores (n=880)	0%	2%	98%	
	OR (95% CI) for 1 category increase in the intensity of mobile phone use (not at all, occasionally, daily <1 hour, daily 1-3 hours, daily 4+ hours) (from cumulative logistic regression)		14 and 16 year olds in Finland (Adolescent Health and Lifestyle Survey, 2001 (Leena et al. 2005))	
Smokeless tobacco use and gender	Unadjusted	Adjusted for smoking status, alcohol consumption and weekly spending money		
Males				
Never tried	1.0	1.0		
Used once	1.9 (1.5, 2.5)	1.2 (0.9, 1.6)		
Used > once	2.9 (2.3, 3.7)	1.4 (1.0, 1.9)		
Females				
Never tried	1.0	1.0		
Used once	2.3 (1.7, 3.1)	1.2 (0.9, 1.7)		
Used > once	3.6 (2.4, 5.3)	1.6 (1.0, 2.4)		

Appendix F

Appendix F: Patterns of Snus Use in Scandinavia				
Intensity of Use			Data source (Reference)	
Grams per day/week				
27 (35-60 year old) firefighters in Stockholm	Grams of smokeless tobacco per day Mean (std dev): 27 (15) Median (25 th , 75 th percentile): 21 (14, 36)		(1993) (Bolinder 1997; Bolinder and de Faire 1998)	
15 male patients in Göteborg, Sweden who were suspected to have snuff-induced oral lesions	Mean (std) grams per day 36.1 (17.6)		(1992-1993) (Ibrahim et al. 1996)	
Current users (n=31)	Consumption (g/day) 1-14 >14 68% 32%		People in the southern healthcare region of Sweden with no previous cancer diagnosis (controls only), 2000-2004 (Rosenquist et al. 2005)	
Portion snus (n=23) Loose moist snus (n=22) Chewing tobacco (n=9)	Mean (std) g/day 14.4 (7.1) 20.8 (15.5) 7.2 (4.0)	g/day range 5.8-32.8 6.7-82.4 1.9-12.7	Healthy men who used snus but not other tobacco for >= 3 months, subset of sample used by (Andersson 1991), chewing tobacco users were a subset from (Andersson et al. 1994)	
Current users (n=32,973)	Grams per day (mean=22.5 g day) <12.5 12.5-24.9 25.0-50 >50 21.8% 45.0% 22.8% 10.4%			Swedish construction workers' cohort males, 1978-1993 (Hergens et al. 2008b; Hergens et al. 2008a)
	Grams per day <50 50 >50 78% 18% 5%			Ice-hockey players and students in Värmland (Rolandsson et al. 2005)
Snuff users (n=92)	Mean (95% CI) g snuff use/day 22.9 (20.7, 25.0)		Males in Northern Swedish MONICA sample (1990) (Eliasson et al. 1995)	

Appendix F: Patterns of Snus Use in Scandinavia		
	Intensity of Use	Data source (Reference)
20 habitual non-smoking users of loose snus	Mean (std) g per day 36 (17) g/day	(subsample of Axel 1976 sample) with degree 3 or 4 lesions (Andersson and Warfvinge 2003)
15 regular snuff users who did not smoke and had snuff induced lesions	Mean (std) g per day 36.1 (17.6)	(Wedenberg et al. 1996)
114 male snuff dippers who underwent biopsy	Mean (range) grams per day 13.8 (4 - 50)	(Axell et al. 1976)
Loose snus: Portion snus:	Average consumption of snus per day 15.7 g/day 9.3 g/day	(Svenska Tobaks AB, Basdata om tobakskonsumtion 1992, TEMO AB, reported by Andersson et al. 1994)
Controls selected from the National Population Registry and National Registry for Causes of Death	Median daily consumption 2 packages (100 grams)	Controls in a case-control study (Schildt et al. 1998)
Grams per week		
Daily snuff users in southern Sweden (9 nonsmokers, 1 smoked on weekends) (n=10)	Average weekly snuff consumption (g) 160	(Holm et al. 1992)
Regular snuff users, not current smokers, hospital workers (n=27)	152	
Current users (n=48)	Median grams per week (range) 88 (12 to 525)	18-75 year olds in Göteborg (Gyllen et al. 2004)

Appendix F: Patterns of Snus Use in Scandinavia			
Intensity of Use			Data source (Reference)
	Grams per week		Controls: 40-79 year olds in Stockholm and southern Sweden (1988-1991) (Lewin et al. 1998)
n=91	<=50 g/week 63%	>50 g/week 37%	
	Mean (std dev) current consumption (g/week)		Male who did not use tobacco, used >=1 can (50 g) snuff per week for 2 years or smoked >= 10 cigarettes per day for 2 years (Eliasson et al. 1991; Eliasson et al. 1993)(Ellingsen et al. 2009)(Ellingsen et al. 2009)
n=21	146 (60)		
	Grams of snuff used per week		Blue-collar workers in southern Norway (Ellingsen et al. 2009)
	Mean	Range	
Snuff only users (n=11) Smokers who use snuff (n=2)	75 2.6	2-200 0-50	
Pinches/quids per day/week			
	Mean consumption (pinches per day)		Schoolchildren in Huddinge (outskirts of Stockholm) (Modeer et al. 1980)
13 boys who regularly used snuff	5		
	Quids per week in past 2 years		Controls (<80 year olds, 1995-1997) who used >= 1 quid per week for >= 6 months (Lagergren et al. 2000)
Snus users	1-14	15-35 >35	
n=124	36%	27% 36%	
	Mean pinches per week		Subsample of the BROMS cohort (Post et al. 2005)
Regular users (n=28)	31		
Cans/boxes per day/week			
Tobacco use	Average cans/week (1 can = 24–50 g)		18-80 year olds in Northern Sweden (1998) (Aro et al. 2010)
Snus only	3.2		
Snus and cigarettes	2.2		
Snus use	≤ 4 cans/week	> 4 cans/week	Males in Twin registry

Appendix F: Patterns of Snus Use in Scandinavia							
	Intensity of Use		Data source (Reference)				
Former (1,456)	81.7%	18.3%	(Hansson et al. 2009)				
Current (2,661)	77.0%	23.0%					
Gender	≤ 4 cans/week	> 4/cans per week	Vasterbotten Intervention Programme 30-50 year old current snus users (1990-1994 - baseline, 10-year follow-up) (Norberg et al. 2006)				
Males (n=7,692)							
Baseline	77%	23%					
Follow-up	74%	26%					
Females (n=8,880)							
Baseline	88%	12%					
Follow-up	87%	13%					
	Boxes/week		Non-smoking male 19-year-olds living in the community of Goteborg, Sweden (Monten et al. 2006)				
n=33	1	2		3	4	5	>=6
	21%	45%		12%	6%	12%	3%
	Mean boxes per week: 2.6 (std dev = 1.5)						
	Current # of snus boxes per week		(Persson et al. 2000)				
2,599 males born between 1938-1957, living in Stockholm, oversampled men with a strong family history of diabetes	<2	>=3					
	48%	52%					
	Mean (95% CI) cans of snuff/week		Males in Northern Swedish MONICA sample (1990) (Eliasson et al. 1995)				
Snuff users (n=92)	3.2 (2.9, 3.5)						
Snuff users who smoke (n=38)	2.5 (2.2, 2.9)						
	Mean: 3.5 cans per week		Males in a small municipality in rural southwest Sweden, 2001-2003. (Sundbeck et al. 2009)				
Snus user (did not smoke, used snus >= once/week)							
	Packages (1 package = 14 g) of chewing tobacco used per day		(Axell et al. 1992)				
	Mean # days per package	Range of packages per day					

Appendix F: Patterns of Snus Use in Scandinavia		
	Intensity of Use	Data source (Reference)
20 users of a non-fermented Swedish brand of chewing tobacco	4.2 1.5-10	
Hours/Times per day		
50 non-smoking daily snus users who use > 2 cans/week (>100 g snus) for ≥10 years	Hours per day using snus Mean (std dev) Range 15.2 ± 2.1 7 to 22	(Sweden) (Wallstrom et al. 2010)
15 regular snuff users who did not smoke and had snuff induced lesions	Mean (std) # hours per day with snuff in mouth 13.1 (3.8)	(Wedenberg et al. 1996)
15 male patients in Göteborg, Sweden who were suspected to have snuff-induced oral lesions	mean (std) hours per day of snuff use 13.1 (3.8)	(1992-1993) (Ibrahim et al. 1996)
114 male snuff dippers who underwent biopsy	Mean (range) hours per day 6.8 (1 - 24)	(Axell et al. 1976)
Portion snus (n=23) Loose moist snus (n=22) Chewing tobacco (n=9)	Mean (std) hours/day hours/day range 13.1 (3.1) 8.0-20.0 12.3 (3.6) 6.0-16.0 13.0 (4.0) 7.5-17.0	Healthy men who used snus but not other tobacco for ≥ 3 months, subset of sample used by (Andersson 1991) chewing tobacco users were a subset from (Andersson et al. 1994)
	Hours per day using chewing tobacco	(Axell et al. 1992)
	Mean Range	

Appendix F: Patterns of Snus Use in Scandinavia		
	Intensity of Use	Data source (Reference)
20 users of a non-fermented Swedish brand of chewing tobacco	10.7 3.5-22	
11 moist snuff users in Finland	Times per day Range 4-10 Mean 8	(Luomanen et al. 1997)
Current users (n=191)	Times per day <=5 59% >5 41%	Case-control study, 40-79 year olds, born in Sweden, living in 1 of 5 counties in northern or central Sweden (1989-1995), controls selected from population registers (Ye et al. 1999)
Total consumption		
n=91	Total consumption (kg) <125 69% ≥125 31%	Controls: 40-79 year olds in Stockholm and southern Sweden (1988-1991) (Lewin et al. 1998)
21 males who used ≥1 can (50 g) snuff per week for 2 years or smoked ≥ 10 cigarettes per day for 2 years	Mean (std dev) cumulative tobacco consumption (kg) 52.2 (35.1)	(Eliasson et al. 1991; Eliasson et al. 1993)
Controls from the National Population Registry and National Registry for Causes of Death	Median lifetime consumption among controls 156.0 kg	Controls in a case-control study (Schildt et al. 1998)
Current snuff users (n=122) Former snuff user (n=31)	Used ≥ 5 can-years (average # of cans per week *year used snuff) 78% 60%	31-40 year olds Stockholm residents born in 1945-1954 (Wickholm et al. 2004)

Appendix F: Patterns of Snus Use in Scandinavia						
	Intensity of Use				Data source (Reference)	
Type of snus						
Gender and frequency of snus use	Snus product used often				16- to 20-year-olds living in Norway (Wiiium and Aaro 2011)	
Males	Traditional loose snus	Portion snus	Mini portion snus	Loose and portion		Don't know
Males						
Occasional (n=94)	21.3%	60.6%		16%		2.1%
Weekly (n=40)	27.5%	70.0%		2.5%		0%
Daily (n=260)	44.6%	40.4%		15%		0%
Total (n=394)	37.3%	48.2%		14.0%		0.5%
Females						
Occasional (n=107)	4.7%	59.8%	25.2%	4.7%		5.6%
Weekly (n=29)	0%	65.5%	27.6%	6.9%		0%
Daily (n=59)	5.1%	78.0%	11.9%	5.1%		0%
Total (n=195)	4.1%	66.2%	21.5%	5.1%		3.1%

Appendix G

Appendix G: US National Surveys								
Survey	Description	Years Data Collected	Sampling Methods	Geographic focus	Sample size⁹	Age/Grade	Definition of STP Use	Sponsor
Youth Risk Behavior Surveillance Survey (YRBSS)	School-based survey 39 state surveys, 22 local surveys Monitors priority health-risk behaviors, obesity, and asthma	1991 - 2011 Occurs every 2 years	Random design, self-administered in classroom	National	15,425	Grades 9 - 12	Current use – used on at least 1 day during the 30 days before the survey	CDC's Division of Adolescent & School Health
Monitoring the Future (MTF)	Secondary school students from 48 contiguous states, 420 public and private schools To study changes in the beliefs, attitudes and behavior among young people	1975 - present Annually	Random design, self-administered in classroom	National	46,700	Grades 8, 10 & 12	Current use – 30 day prevalence	University of Michigan
National Youth Tobacco Survey (NYTS)	Mainstream US public and private schools Information on tobacco-related beliefs, attitude, behaviors and exposure to pro-and anti-tobacco influences	1999, 2000, 2002, 2004, 2006, 2012 Occurs every other year	Anonymous and confidential self-administered questionnaire administered in classrooms	National	18,866	Middle & high schools students	Current use – used STP on at least 1 of the 30 preceding days	CDC's Office on Smoking and Health

⁹ Represents most recent year
 RDD - Random-digit-dial
 Bolded years indicate surveys available

Appendix G: US National Surveys								
Survey	Description	Years Data Collected	Sampling Methods	Geographic focus	Sample size⁹	Age/Grade	Definition of STP Use	Sponsor
Teenage Attitudes and Practices Survey (TAPS I & II)	Civilian non-institutionalized persons, residing in the United States Initiated as a follow-up to NHIS Collects specific information on every aspect of tobacco use, including measures of prevalence, knowledge, attitudes, and predictors of taking up smoking	1989 and 1993 only	Primary data collection for TAPSI was by telephone and secondary data collection by a mail questionnaire.	National	7,690	10 – 22 year olds	Current user – based strictly on the self-classification as a regular user (frequency of use in past 30 days)	US Dept. of Health and Human Services & National Center for Health Statistics
National Youth Smoking Cessation Survey (NYSCS)	Adolescents and young adult cigarette smokers Collects information on quitting behavior, intervention preferences and unique dynamics of young smokers.	2003	Telephone survey	National	2,582	16 – 24 year olds	N/A	Robert Wood Johnsons Foundation, CDC & NCI
National Longitudinal Study of Adolescent Health (Add Health)	Collects information examining social contexts (families, friends, peers, schools, neighborhoods, communities) and influence on teens' health and risk behaviors. Also, health changes over the course of early adulthood.	1994-95, 1996, 2001-02, 2008	First phase – in-school survey Second phase: in-home interviews	National	15,701	Grades 7 through 12	Past month use of STP- number of days of use (0 – 30)	National Institute of Health

Appendix G: US National Surveys								
Survey	Description	Years Data Collected	Sampling Methods	Geographic focus	Sample size⁹	Age/Grade	Definition of STP Use	Sponsor
National Health and Nutrition Examination Survey (NHANES)	Civilian non-institutionalized US population and weighted to reflect the US population.	1974, 1989, 1998-continuing	In person interviews – Computer-Assisted Self-Interview (A-CASI) technique	National	10,000 individuals per 2-year study	12 years and older.	Past 5-days use of cigarettes, pipes, cigars and other forms of nicotine. Blood and urine samples evaluated for cotinine and other biomarkers of exposure and effect	CDC's National Center for Health Statistics
National Health Interview Survey (NHIS)	Civilian non-institutionalized population residing in the United States at the time of the interview Collects annual health data to monitor trends on illness and disability	1957 – 2011 Annually STP information Occurs approximately every 5 year	RDD design, personal interviews administered in the home	National	33,014	18 years or older	Current : used snuff or chewing tobacco 20 times every day or some days Former: used at least 20 times but not a current user.	CDC's National Center for Health Statistics
National Survey on Drugs use and Health (NSDUH)	Civilians, non-institutionalized populations Collects information on the patterns, prevalence and consequence of alcohol, tobacco, and illegal drug use.	2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011 Annually	Random sample, household interviews administered in the home	National	70,109	12 years and older	Current use – past-month use Lifetime use – ever STP use Past year STP use	US Substance Abuse and Mental Health Services Administration

Appendix G: US National Surveys								
Survey	Description	Years Data Collected	Sampling Methods	Geographic focus	Sample size⁹	Age/Grade	Definition of STP Use	Sponsor
Tobacco Use Supplement to the Current Population Survey (TUS CPS)	Civilian, non-institutionalized population. Collects information on the labor-force characteristics; including employment status, earnings, and other indicators.	1955, 1966/1967/1968, 1985, 1989, 1992/1993, 1995/1996, 1998/1999, 2000, 2001/2002, 2003, 2006/2007, 2010/2011 (data not available yet) Every 3 years	Random digit dial (RDD) design, household survey with telephone follow-up	National & State	240,000	15 years or older	Current STP use – every day and someday current use of STP	U.S. Census Bureau and National Cancer Institute
Behavioral Risk Factor Surveillance System (BRFSS)*	Adult non-institutionalized population. State-based surveys that collect information on health risk behaviors, preventive health practices, and health care access primarily related to chronic disease and injury	1984 - 2010 Every 2 years	cross-sectional telephone survey	National	432,607	18 years or older	Current use - everyday use or someday use	CDC, Division of Adult and Community Health, National Center for Chronic Disease Prevention and Health Promotion
US Adult Tobacco Survey (ATS)	Adult non-institutionalized population. Collects data on tobacco use, smoking cessation, secondhand smoke exposure, risk perception, social influences, health influences and tobacco-related policy issues	2002, 2003, 2010 Every 2 years	RDD design telephone survey	State	Varies by state	18 years or older	Current use – everyday use or someday use	CDC's Office on Smoking and Health

Source: www.cdc.org; Delnevo and Bauer 2009

* This is the first year a question related to smokeless tobacco was included on the core questionnaire. In previous years, it was offered as an optional module

Appendix H

Appendix H: Gender Differences in STP Use in the United States (Mixed Ages)			
	Prevalence of STP Use		Data source (reference)
	Males	Females	
Current	98.2%	1.8%	Minnesota Adult Tobacco Survey, 1999-2010. (Boyle et al. 2012).
n = 15,056 Current use	2%	0.2%	Tobacco Use Supplement Current Population Survey (TUS – CPS) 2002 – 2003, persons aged 18 or older (Zhu et al. 2009)
Current use	Prevalence of use (95%CI)		NHANES III (1988 – 1994), Population aged 17 and older. (Gillum et al. 2009)
	5.74% (4.7, 7)	0.69% (0.47, 1.02)	
Smokeless tobacco use	Prevalence of use (95% CI)		National Youth Tobacco Survey (NYTS). Students in middle school (grades 6 – 8) and high school (grades 9 – 12) in the US. (Centers for Disease Control and Prevention (CDC) 2010)
2009			
Middle School	3.7% (2.6,4.8)	1.4% (0.9, 1.9)	
High school	11.6% (7.8, 15.4)	1.8% (1.2,2.4)	
2006			
Middle School	4.1% (3.1, 5.1)	1.2% (0.9, 1.5)	
High school	11% (9.1, 12.9)	1.5% (1.1, 1.9)	
2004			
Middle School	3.8% (3.0, 4.6)	1.9% (1.5, 2.3)	
High school	9.9% (8.0, 11.8)	1.2% (0.8, 1.6)	
Snuff use	(n = 291.2*)	(n = 343.8*)	Adults in 2 North Carolina Counties Aged 60 and older. (Bell et al. 2009) * weighted average
Current	3.1%	9.9%	
Former	6.3%	17.4%	
Never	90.6%	72.7%	
Chewing tobacco			
Current	12.4%	11.2%	
Former	16.5%	10.1%	
Never	71.1%	78.7%	
	% (± 95% CI) Smokeless Tobacco Use		North Carolina public and charter school with at least one grade between 6 th and 12 th , from the North Carolina Youth Tobacco Survey, from 1999 to 2007. (Proescholdbell et al. 2009)
2007, (n = 7,431)			
Middle School	3.3% (0.9)	1.3% (0.6)	
High School	14.5% (3.3)	2.4% (0.7)	
2005, (n = 6,405)			
Middle School	4.1% (1.9)	1.3% (0.4)	
High School	15.9% (3.7)	2.3% (1.8)	
2003 (n = 6,334)			
Middle School	7.2% (1.7)	1.5% (0.7)	

Appendix H: Gender Differences in STP Use in the United States (Mixed Ages)			
	Prevalence of STP Use		Data source (reference)
	Males	Females	
High School	17.3% (4.2)	1.8% (0.7)	
2001 (n = 10,950)			
Middle School	5.7% (1.4)	2.3% (0.9)	
High School	15.2% (2.6)	2.5% (0.5)	
1999 (n = 12,575)			
Middle School	6.3% (1.6)	1.4% (0.5)	
High School	14% (2.6)	1.8% (0.5)	
	Odds ratio – adjusted		Students at 14 colleges and universities in Minnesota (Sanem et al. 2009)
Daily STP use	1.00	0.02 (0.01, 0.05)	
Current STP use	1.00	0.09 (0.07, 0.12)	

Appendix I

Appendix I: Race/Ethnicity of STP Users in the United States				
Race/ethnicity	Prevalence of use		Data source (reference)	
White, non-Hispanic	4.1%		18 years or older. BRFSS 2008 Survey (2010).	
Black, non-Hispanic	1.2%			
Hispanic	1.4%			
Other, non-Hispanic	1.9%			
White	5.2%		18 years or older. BRFSS 2010 Survey (Mushtaq et al. 2012)	
African American	1.9%			
American Indian/Alaska Native	6.7%			
Hispanic	1.2%			
Multiracial	5.5%			
Other	1.6%			
Current (Past-month) STP Use				
White	4.1%		Persons 12 or older, 2002 – 2007, (NSDUH 2009)	
Black/African American	1.4%			
American Indian or Alaska Native	7.1%			
Pacific islander	2.9%			
Asian	0.6%			
Latino	0.9%			
Two or more races	2.9%			
Current STP use (%) Never STP Use				
White	94%	81%	NHIS Adult sample and Cancer control cohort (Rodu and Cole 2009)	
Black	4%	13%		
Other	2%	6%		
White (n = 303.8*) African American (n = 135.9*) American Indian (n = 195.3*)	Snuff use			Adults in 2 North Carolina Counties Aged 60 and older. (Bell et al. 2009) * weighted average
	% Current	% Former	% Never	
	3.7%	6.1%	90.2%	
	6.7%	16.7%	76.7%	
11.7%	19%	69.4%		
Chewing Tobacco				
% Current	% Former	% Never		
4.9%	10.5%	84.6%		
11.6%	9.1%	79.3%		
22.5%	19.8%	57.7%		
Bivariate Association Between Ever Snuff Use and Ethnicity				
Ethnicity	Odds ratio (95%CI)			
African American	2.8 (1.62 – 4.86)			
American Indian	4.07 (2.51 – 2.62)			
White	Referent group			
Middle School			Middle and High school students. NYTS survey 2011. (CDC 2012)	
White, non-Hispanic	2.3%			
Black, non-Hispanic	1%			
Hispanic	2.9%			
Asian, non-Hispanic	1.3%			
High School				

Appendix I: Race/Ethnicity of STP Users in the United States							
Race/ethnicity	Prevalence of use					Data source (reference)	
White, non-Hispanic	9.2%						
Black, non-Hispanic	3%						
Hispanic	5.1%						
Asian, non-Hispanic	2.8%						
Percentage of Current STP users (%)							
Middle school students	2007	2005	2003	2001	1999	All North Carolina public and charter school and at least one grade between 6th and 12th, from the North Carolina Youth Tobacco Survey, 1999 - 2007. (Proescholdbell et al. 2009)	
White	2.7%	3.4%	5.9%	4.3%	4%		
African American	1.5%	1.6%	1.7%	3.5%	2.6%		
Latino	1.4%	2.9%	5.7%	3.7%	4.7%		
High school Students							
White	12%	12.1%	13.1%	10.7%	9.7%		
African American	3.3%	3.4%	3.0%	3%	2.6%		
Latino	3.1%	8.5%	3.9%	11.5%	8.7%		
Odds ratio – adjusted							
	Current STP use (95%CI)		Daily STP use (95%CI)		Students at 14 Minnesota colleges and universities (Sanem et al. 2009) Referent group are students who did not select the indicated ethnicity		
African American/black	0.75 (0.27, 2.10)		2.20 (0.22, 22.42)				
American Indian/Alaska	0.79 (0.34, 1.83)		0.75 (0.10, 5.60)				
Asian/Pacific	0.67 (0.30, 1.50)		1.09 (0.12, 10.12)				
Latino/Hispanic	1.84 (0.87, 3.92)		1.18 (0.15, 9.05)				
Middle eastern	1.20 (0.27, 5.30)		--				
Caucasian	2.14 (1.08, 4.24)		17.61 (1.49, 208.49)				
Other	0.93 (0.31, 2.73)		--				

Appendix J

Appendix J: Socioeconomic Differences in STP use in the United States			
Socioeconomic/Education level/	STP use		Data source (reference)
	Past 30-day		
Less HS	13.9%		Minnesota Adult Tobacco Survey, 1999-2010. (Boyle et al. 2012).
HS graduate	20.1%		
Some college	35.9%		
College +	30%		
Less than high school	3.8%		18 years or older. BRFSS 2008 Survey (McClave et al. 2010).
High school/GED	4.2%		
Some college or more	2.6%		
Annual income <15,000	3.2%		
15,000-24,999	3%		
25,000-34,999	3.5%		
35,000-49,999	3.2%		
50,000-74,999	3.5%		
≥75,000	3.8%		
	Past-month STP Use		
Less than high school	4.3%		Persons 18 or older (SAMHSA 2009)
HS Graduate	4.6%		
Some College	3.2%		
College graduate	2.5%		
	Distribution by Education Level		NHIS Adults sample, all Male participants, aged 18 and older (Rodu and Cole 2009)
	Current STP Use	Never STP Use	
At least High school	56%	38%	
College to BS/BA	41%	48%	
Grad/professional	3%	13%	
Education – Odds ratio	Snuff Use (95%CI)	Chewing Tobacco (95%CI)	Adults in 2 North Carolina counties, 60 and older (Bell et al. 2009)
Less than 6 th grade	10.99 (4.13, 29.26)	3.28 (1.68, 6.41)	
7 th and 8 th grade	10.17 (3.78, 27.33)	5.32 (2.74, 10.33)	
Some high school	6.77 (2.55, 17.96)	2.31 (1.20, 4.44)	
High school degree	3.57 (1.31, 9.78)	1.67 (0.86, 3.26)	
More than high school	Referent group	Referent group	
Poverty status			
Yes	0.28 (0.19, 0.43)	-	
No	Referent group	-	

Appendix J: Socioeconomic Differences in STP use in the United States			
Socioeconomic/Education level/	STP use		Data source (reference)
Odds ratio - adjusted	Current STP use (95%CI)	Daily STP use (95%CI)	Students at 14 Minnesota colleges and universities (Sanem et al. 2009)
2 year college students	1.65 (1.32 – 2.06)	1.64 (1.06 – 2.53)	
4 year college students	1.00	1.00	
Hours worked per week by all students (hours)			
0	Referent group	Referent group	
1 – 19	0.97 (0.77, 1.22)	0.72 (0.44, 1.19)	
20 – 39	0.81 (0.61, 1.08)	0.88 (0.50, 1.55)	
40 or more hours	1.07 (0.71, 1.60)	1.29 (0.64, 2.59)	

Appendix K

Appendix K: Snus Use among the Military in Scandinavia				
Characteristic	STP use			Data source (reference)
Age	Current	Former	Never	84 males in the submarine service of the Swedish Armed Forces (2002- 2003) (Bergstrom et al. 2006)
Mean age	38.4	42.8	39.7	
26-36 (n=26)	35%	15%	50%	
37-42 (n=30)	40%	20%	40%	
43-54 (n=28)	14%	39%	46%	
Current or former users	Mean boxes/week (95% CI)			
Current users	3.2 (2.6 - 3.8)			
Former users	3.1 (2.0 - 4.1)			
	% use smokeless tobacco			Finnish Conscript Health Survey (2000, 2003, 2005, 2006) (Mattila et al. 2008)
Male conscripts during their first days of military service (n=6,471)	14%			
	Daily	Occasional	Never	Male military recruits in Finland (Hamari et al. 2013)
18-20 years (n=1144)	15.6%	44%	40.4%	
Education				
Primary school (n=110)	19.1%	60%	20.9%	
Vocational school (n=577)	17.2%	48.9%	34%	
High school or academic degree (n=457)	12.9%	33.9%	53.2%	
n=48 (11%) of 441 participants used snuff	Snus exposure			17-29 year old military recruits in Finland who use snuff (n=48) (Jungell and Malmstrom 1985)
	Mean	Range		
Mean exposure time per day (minutes)	45	1 to 20		
Number of times per day		1 to 20		
Initiation age (year)	14.4	8 to 20		

Appendix L

Appendix L: STP Use among Military Personnel in the US				
Recruits	STP Use			Data source (reference)
Military recruits, n = 31107	Prevalence of STP Use % (99%CI)	Odds Ratio (99%CI)		
Overall	6.7%			Baseline data on young military recruits (Vander Weg et al. 2008)
Gender				
Male	8.8% (8.3, 9.2)	20.67 (12.94, 33.02)		
Female	0.4% (0.2, 0.6)	Ref group		
Race/ethnicity				
African American.	0.5% (0.3, 0.8)	0.06 (0.04, 0.10)		
Asian/Pacific Islander	1.7% (0.7, 2.6)	Ref group		
Caucasian	9.7% (9.2, 10.2)			
Hispanic	1.9% (1.2, 2.5)	0.19 (0.13, 0.27)		
Native American	8.1% (3.5, 12.8)	-		
Other	3.0% (1.5, 4.4)	0.32 (0.19 - .53)		
Age				
< 20 yr. old	6.3% (5.9, 6.8)	Ref group		
> 20 yr. old	7.2% (6.6, 7.9)	1.21 (1.05, 1.39)		
Education				
High school or GED	6.9 (6.4, 7.3)	Ref group		
Post high school	6.0 (5.2, 6.7)	0.87 (0.74, 1.03)		
Income				
≤ \$25 000	5.4 (4.7, 6.0)	Ref group		
\$25,001 to \$45 000	6 (5.3, 6.7)	-		
\$45 001 to \$70 000	6.9 (6.2, 7.6)	-		
≥ \$70 000	8.6 (7.8, 9.5)	1.21 (1.01, 1.44)		
All STP Users (n = 784)	Distribution among STP Users (%)			20 military installations as recruitment sites; 28 military dental clinics (Peterson et al. 2007)
Gender				
Male	99%			
Race/ethnicity				
Caucasian (n = 699)	89%			
African American (n = 15)	1.9%			
American Indian (n = 12)	1.5%			
Asian (n = 9)	1.1%			
Hispanic	4%			
Military rank				
Enlisted (n = 681)	86.8%			
Officer (n = 104)	13.2%			
n = 543	Current users	Former users	Never users	Two naval aviation training wings in West Florida in 2006. (McClellan et al. 2010)
Mean age (years)	28.6	30.2	28.9	
US military personnel	13%	31%	56%	
	Frequent user	Occasional users		Service members attending Advance Individual Training at US Army Ordnance Center and School, 2000 – 2006. Mean age: 20 years (Grier et al. 2010)
Smokers	35%	8%		
STP users	10%	5%		

Appendix L: STP Use among Military Personnel in the US				
Recruits	STP Use			Data source (reference)
Male Marine recruits (n = 15,689)	Proportion of Current STP Use (%)			Pre-military, US Marine Corps (USMC) recruit depot, San Diego, California (Trent et al. 2007)
Used STP ≥20 times in lifetime (n = 4,067)	26.1%			
Used 20+ STP only (no cigarettes) (n = 1,191)	7.6%			
Comparisons of Tobacco Use among Young Males in 3 Study Cohorts				
Past-month STP use	Age group	Population	% (n)	
NHRC, 2002 - 2003	18 - 24	USMC recruits	22.7% (3365)	
DoD survey, 2002	18 - 24	USMC	25.4% (-)	
NSDUH, 2002	18 - 25	Civilians	10.7% (891)	

Appendix M

Appendix M: Individual-level Characteristics Associated with STP use			
Alcohol use	Prevalence of Current STP use (%)		Data source (reference)
Heavy drinkers	11.7%		Adults 18 or older, (SAMHSA 2012)
Non-binge drinkers	1.9%		
Nondrinkers	1.9%		
n = 1950			
Female	Ever STP Use (%)	Current STP Use (%)	California Tobacco Survey, 2003 – 2004 (Gruskin et al. 2007) *Statistically significant when testing for independent proportions between LGB males and general California population
Lesbians (n = 329)	1.6%	0%	
Bisexuals (n = 290)	0%	0.1%	
Heterosexuals who have sex with women (n = 383)	0%	0%	
California population (n = 11,037)	1.5%	0.1%	
Males			
Gay (n = 548)	0.6%*	0.3%*	
Bisexual (n = 85)	10.6%	3.2%	
Heterosexuals who have sex with men (n = 83)	5.8%*	0%	
California population (n = 9,488)	16.5%	1.8%	
Relationship status – Odds ratio adjusted			
	Current STP use (95% CI)	Daily STP use (95% CI)	Students at 14 Minnesota colleges and universities (Sanem et al. 2009)
Single	Referent group		
Married/domestic partner	0.73 (0.49, 1.09)	0.94 (0.48, 1.83)	
Separated	1.36 (0.31, 6.03)	0.0	
Widowed	0.0	0.0	
Divorced	1.28 (0.42, 3.88)	1.39 (0.28, 7)	
Engaged or committed dating relationship	0.86 (0.69, 1.07)	0.83 (0.52, 1.33)	

Appendix N

Appendix N: Patterns of STP Use in the United States		
Use parameters	STP Use	Data source (Reference)
Daily users, n= 56	Mean (\pm SD)	Males, Mean age: 20.7 years, (Hatsukami et al. 1988)
Number of tins/week	2.8 (1.5)	
Number of dips/day	6.3 (2.2)	
Mean dip interval (min)	102.6 (42.1)	
Mean duration of dips (min)	39.9 (16.5)	
Mean duration/day (min)	254.6 (129.3) = 4.2 hrs.	
Mean grams of tobacco/dip	1.97 (0.96)	
Mean total grams of tobacco used/day	12.0 (6.8)	
Mean duration of STP (years)	5.2 (2.4)	
Mean age of onset of use	16.2 (2.3)	
Daily Users, n = 30	Mean (\pm SD)	Male, Mean age 20 yrs., participants who used at least one tin of Copenhagen per week for 6 months (Hatsukami et al. 1991)
Time of dip onset	11:03 am	
Time of last dip	11:08 pm	
Number of dips/week	50.9 (17.8)	
Number of tins per week	3.4 (1.6)	
Dips per day	7.2 (2.5)	
Dip interval (min)	71.2 (32.2)	
Duration per dip (min)	39.6 (18.3)	
Total dips duration per day	283.5 (149.2) = ~ 4.9 hours	
Duration of STP use (years)	4.9 (2.5)	
Dry weight of tobacco per dip after use (g)	0.75 (0.57)	
Dry weight of tobacco per day after use (g)	4.88 (2.87)	
Daily Users, n = 1498	Mean (\pm SD)	Male students in grades 7 through 10 from nine middle schools and 4 high schools in 4 school districts in Oregon followed 9 months later (Ary et al. 1987)
Duration for a tin/can (days)	5.1 (3.3)	
Number of chews per day (chews)	5.3 (3.2)	
Dip size per day	1.3	
Duration per day	10 to 20 min	
Average age of initiation	14 years	
Daily users, n = 54	Mean (\pm SD)	Male STP users, aged 21 – 65 years, Average age – 32.1 years, using at least 1 tin/week for 1 year. (Lemmonds et al. 2005)
Years of use	12.5 (5.8)	
Dips per day	6.8 (3.0)	
Tins per week	3.4 (2.8)	
Duration of dip in mouth per day (min)	423 (224.4)	
Duration per dip (min)	71.2 (44.3)	
Total daily dipping time (morning till night) (min)	820.6 (120.4)	

Appendix N: Patterns of STP Use in the United States				
Use parameters	STP Use			Data source (Reference)
Daily users, n = 20	Mean (\pm SD)			Female participants between the ages of 19 and 39 years, average age of 22 years. Participants used mainly Kodiak, Copenhagen and others used Skoal and Cooper. (Boyle et al. 1998)
Number of dips per day	3.6 (3.0)			
Number of days per can	2 days to 3 months, median of 6 days			
Dip duration in mouth (min)	22.5 (9.6)			
Dip weight (g)	1.64 (0.2, 4.6)			
STP Use average (month)	18 (16.7)			
2011	Age of Initiation			U.S population aged 12 – 49 years. (SAMHSA 2012)
Males	19.9 yrs.			
Females	20.1 yrs.			
Overall	19.8			
2010				
Overall	19.3 yrs.			
Days of dip or chew per week	Mean or Proportion			20 military installations as recruitment sites and 28 military dental clinics (Peterson et al. 2007)
Days that tin or pouch last	6.21 \pm 1.47			
Years of Use	3.7 \pm 2.16			
Age of Initiation	12.8 \pm 8.39			
Swallows spit	17.7 \pm 5.11			
First use < 30 minutes after waking	49.9%			
Frequent smokers	< 10 cigarettes/day	10 to 20 cigarettes/day	20 cigarettes/day	Service members attending Advance Individual Training at US Army Ordnance Center and School, 2000 – 2006. Mean age: 20 years (Grier et al. 2010)
	31%	45%	24%	
Frequent STP users	< 1 can/pouch/plug/day	1 can/pouch/plug/day	2 or more cans/pouch/plug/day	
	63%	3%	5%	
Mean was reported where appropriate (n = 635)	Snuff Use Pinch/pouch** years (SD)	Chew Tobacco - Chew years*** (SD)	Adults in 2 North Carolina counties, Mean age – 71.5 years (Bell et al. 2009) weighted average	
Male, n = 274 (291.2 *)	70 (15.5)	28.9 (4.3)	**Pinch years – average number of pinches, dips, or rubs used per day X number of years	
Female, n = 361 (343.8*)	95.1 (9.8)	37.7 (6.8)	***Chew years – ounces per day X number of years	
African American n = 212 (135.9)	70.4 (8.8)	31.9 (3.4)		
American Indian, n = 226 (195.3*)	88.5 (8.3)	37.5 (6.5)		
White, n = 197 (303.8*)	119.8 (26.6)	24.8 (6.9)		
Overall average	89.4 (8.4)	33.1 (4.2)		
SD – Standard deviation				

Appendix N: Patterns of STP Use in the United States				
Use parameters	STP Use			Data source (Reference)
Age of initial use (yr.)	Hours of use per day			4 high schools in Richmond, VA, consisting of a diverse group of rural and urban school students, n = 3725 (Riley et al. 1989)
	< 1	1 – 4	5 or more	
10 or younger	50	27.4	22.6	
11 – 12	55.8	40	1.2	
13 – 14	69.7	25.3	4.9	
15 or older	68.3	26.8	4.9	