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# SUPPORTING EARLY ADOLESCENT TOBACCO REFUSAL SELF-EFFICACY: AN INTERVENTION STUDY

Johanna Nyman

TURUN YLIOPISTON JULKAISUJA – ANNALES UNIVERSITATIS TURKUENSIS
SARJA – SER. D OSA – TOM. 1785 | MEDICA – ODONTOLOGICA | TURKU 2024

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*To Matilda and Sofia*

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## ABSTRACT

The decline in adolescent tobacco and nicotine product use has now ceased, therefore more attention is required on prevention, in which supporting tobacco refusal self-efficacy holds great potential. This study aimed to develop an intervention to support early adolescent tobacco refusal self-efficacy and to evaluate the effectiveness of the intervention among early adolescents in comprehensive school grades 4 to 6. The study was conducted in two phases.

The development phase included three sub-studies strengthening the theoretical basis for the intervention and further developing a previously developed digital health game intervention. 1) A qualitative descriptive study described self-efficacy in peer interactions among adolescents (n = 155). 2) A systematic review summarised evidence on digital interventions to support refusal self-efficacy in child and adolescent health promotion. 3) A cross-sectional study explored factors associated with tobacco refusal self-efficacy among early adolescents (n = 295). The evaluation phase consisted of a two-arm cluster randomised controlled trial to examine the effectiveness of the intervention in schools at three measurement points on tobacco refusal self-efficacy among early adolescents (n = 781).

This study found that adolescents' have an active role in the formation of their self-efficacy, and it is also influenced by their social atmosphere. Tobacco refusal self-efficacy in early adolescence is especially influenced by the social atmosphere, namely the smoking behaviour of peers and relatives. The evidence supported the use of digital interventions with a sound theoretical basis to promote refusal self-efficacy. The results demonstrated the effectiveness of the intervention on tobacco refusal self-efficacy among 12-year-olds and early adolescents with a smoking friend or parent, and on the sources of tobacco refusal self-efficacy.

Based on the results, early adolescent tobacco refusal self-efficacy can be strengthened through the intervention. The results support the implementation of the intervention into school contexts. In general, a systematic evaluation of existing digital health interventions is needed to support their implementation.

KEYWORDS: adolescents, digital intervention, health education, intervention study, self-efficacy, tobacco

TURUN YLIOPISTO
Lääketieteellinen tiedekunta
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Hoitotiede
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Hoitotieteen tohtoriohjelma
Maaliskuu 2024

## TIIVISTELMÄ

Nuorten tupakka- ja nikotiinituotteiden käytön väheneminen on pysähtynyt, mikä korostaa tarvetta ennaltaehkäisylle ja kieltäytymiseen liittyvän minäpystyvyyden tukemiselle. Tämän tutkimuksen tavoitteena oli kehittää minäpystyvyyttä tukeva interventio edistämään nuorten tupakoimattomuutta ja arvioida sen vaikuttavuutta varhaisnuorilla peruskoulun 4.–6. luokilla. Tutkimus toteutettiin kahdessa vaiheessa.

Kehittämisvaiheeseen sisältyi kolme osatutkimusta, joissa intervention teoreettista perustaa vahvistettiin ja aiemmin laadittua digitaalista peli-interventiota jatkokehitettiin. 1) Laadullisessa kuvailevassa tutkimuksessa kuvattiin nuorten (n = 155) näkemyksiä minäpystyvyydestään kaverisuhteissa. 2) Järjestelmällisessä kirjallisuuskatsauksessa koottiin näyttöä digitaalisista interventioista kieltäytymiseen liittyvän minäpystyvyyden tukemisessa lasten ja nuorten terveyden edistämisessä. 3) Poikkileikkaustutkimuksessa tarkasteltiin varhaisnuorten (n = 295) tupakasta kieltäytymiseen liittyvään minäpystyvyyteen yhteydessä olevia tekijöitä. Arviointivaiheessa arvioitiin intervention vaikuttavuutta varhaisnuorten (n = 781) kieltäytymiseen liittyvän minäpystyvyyden tukemisessa kouluissa ryvästetyllä satunnaistetulla kontrolloidulla tutkimuksella kolmena mittausajankohtana.

Tuloksissa korostui nuorten oma aktiivinen rooli minäpystyvyytensä muotoutumisessa, ja sosiaalisen ilmapiirin rooli. Varhaisnuorilla tupakasta kieltäytymiseen liittyvän minäpystyvyyden yhteys sosiaaliseen ilmapiiriin tunnistettiin erityisesti kavereiden ja sukulaisten tupakoinnin osalta. Tutkimusnäyttö tuki vankan teoreettisen perustan omaavien digitaalisten interventioiden käyttöä kieltäytymiseen liittyvän minäpystyvyyden edistämisessä. Tulokset osoittivat intervention vaikuttavuuden tupakasta kieltäytymiseen liittyvän minäpystyvyyden tukemisessa 12-vuotiailla ja nuorilla, joilla oli tupakoiva kaveri tai vanhempi, ja tupakasta kieltäytymiseen liittyvän minäpystyvyyden lähteiden tukemissa.

Tulosten perusteella varhaisnuorten tupakasta kieltäytymiseen liittyvää minäpystyvyyttä voidaan tukea kehitetyllä interventiolla. Tulokset tukevat intervention käyttöönottoa kouluissa. Olemassa olevien interventioiden järjestelmällistä arviointia tarvitaan niiden käyttöönoton tukemiseksi.

AVAINSANAT: digitaalinen interventio, interventiotutkimus, minäpystyvyys, nuoret, terveyskasvatus, tupakka

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# Abbreviations

| | |
|---|---|
| α | Cronbach's Alpha |
| ALLEA | All European Academies |
| ASSES | Anti-Smoking Self-Efficacy Scale |
| CFR | Code of Federal Regulations |
| CI | Confidence Interval |
| CONSORT | Consolidated Standards of Reporting Trials |
| COPD | Chronic Obstructive Pulmonary Disease |
| df | Degrees of Freedom |
| e-cigarette | Electronic Cigarette |
| EMCDDA | European Monitoring Centre for Drugs and Drug Addiction |
| ESPAD | European School Survey Project on Alcohol and Other Drugs |
| EU | European Union |
| GRADE | Grading of Recommendations Assessment, Development and Evaluation |
| HRP | Human Reproduction Programme |
| ICC | Intraclass Correlation Coefficient |
| KAVI | National Audiovisual Institute |
| LMM | Linear Mixed Model |
| MRC | Medical Research Council |
| NA | Not Available |
| NIDA | National Institute on Drug Abuse |
| OR | Odds Ratio |
| PEGI | Pan European Game Information |
| PICO | Patient, Intervention, Comparison, Outcome |
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |
| PROSPERO | International Prospective Register of Systematic Reviews |
| REDCap | Research Electronic Data Capture |
| RQ | Research Question |
| SCENIHR | Scientific Committee on Emerging and Newly Identified Health Risks |
| SD | Standard Deviation |
| SOES | Smoking Outcome Expectation Scale |

| | |
|---|---|
| $\tau$ | Kendall's Tau |
| TENK | Finnish Advisory Board on Research Integrity |
| THL | Finnish Institute for Health and Welfare |
| TIDieR | Template for Intervention Description and Replication |
| UN | United Nations |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNFPA | United Nations Population Fund |
| UNICEF | United Nations Children's Fund |
| W | Wilcoxon Rank Sum Test with Continuity Correction |
| WHO | World Health Organization |
| $\chi^2$ | Kruskal-Wallis Chi-Squared |

# List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I Nyman J, Parisod H, Axelin A & Salanterä S. Finnish adolescents' self-efficacy in peer interactions: a critical incident study. *Health Promotion International*, 2019; 34(5): 961–969.

II Nyman J, Tornivuori A, Salanterä S, Barroso T & Parisod H. Systematic review of digital interventions to support refusal self-efficacy in child and adolescent health promotion. *Health Promotion International*, 2022; 37(5): daac085.

III Nyman J, Pinto D, Salanterä S, Barroso T, Pasanen M & Parisod H. Factors associated with smoking refusal self-efficacy among Finnish and Portuguese early adolescents. *Journal of Substance Use*, 2022; 14 Nov.

IV Nyman J, Salanterä S, Pasanen M & Parisod H. Effectiveness of a digital health game intervention on early adolescent smoking refusal self-efficacy. *Health Education & Behavior*, 2024; March 18.

# 1 Introduction

Early adolescence marks the beginning of exploring and initiating new health behaviours, including the use of tobacco and nicotine products (Viner et al., 2012). Tobacco and nicotine product use in adolescence can have detrimental health consequences throughout life, as it is strongly linked to the use of these products later in adulthood (Viner et al., 2017). In addition, tobacco and nicotine product use causes considerable costs to society; nationally this has been estimated to be up to 1.6 billion euros per year (Viljakainen et al., 2022). The aim of the national Tobacco Act (549/2016) is to create a tobacco-free Finland. However, in recent years, worrying observations have been made that the long-term decrease in adolescent tobacco and nicotine product use has ceased and even reversed into an increase (Ollila & Ruokolainen, 2023). Experimentation and use of newer tobacco and nicotine products has increased among adolescents (THL, n.d.) and the long-term health consequences of these still remain unknown (Gordon et al., 2022; Stanfill et al., 2021). Although cigarette smoking rates have decreased nationally and globally over the last decade (Jääskeläinen & Virtanen, 2021; WHO, 2021d), the use of these newer products by adolescents may expose them to the initiation of cigarette smoking later in life (Kinnunen et al., 2019; WHO, 2021d). Thus, there is need for effective means to support refusal skills and the non-use of tobacco and nicotine products among early adolescents.

Policies and health education interventions preventing the use by adolescents of tobacco and nicotine products are well worth their financial costs (Leão et al., 2018) and may offer a healthier future for adolescents. As refusal self-efficacy predicts adolescent tobacco use behaviour (Peters et al., 2009; Wang et al., 2019), health education interventions supporting refusal self-efficacy offer great promise in adolescent tobacco use prevention (Ausems et al., 2009; Wang et al., 2019). There is also evidence supporting their use (Thomas et al., 2013, 2015). However, despite long traditions of research on self-efficacy, there is still some uncertainty regarding the development of self-efficacy from the perspective of adolescents (Usher & Pajares, 2008).

Use of digital technologies in health care is supported nationally (Finnish Government, 2022) and globally (WHO, 2021a). Digital technologies offer new

possibilities for adolescent tobacco use prevention, as they can provide safe and cost-effective (Murray et al., 2016) as well as adolescent-friendly platforms for health education (Duncan et al., 2018b). Despite the potential of these interventions, there is need to systematically evaluate their effectiveness using rigorous methods (Willis et al., 2022).

The aim of this doctoral study was to develop an intervention to support early adolescent tobacco refusal self-efficacy and to evaluate the effectiveness of the intervention among early adolescents in comprehensive school grades 4 to 6. Early adolescents in these grades are usually 10 to 13 years old. The intervention is based on a previously developed and tested digital health game '*Fume*' (Parisod et al., 2018) which was further developed and evaluated for effectiveness. This doctoral dissertation uses the term tobacco refusal self-efficacy to refer to self-efficacy concerning the refusal of tobacco products. However, in some sections, the focus is specifically on refusal self-efficacy related to smoking cigarettes. This is because measuring refusal self-efficacy related to other tobacco and nicotine products was challenging due to the lack of appropriate instruments. This study was conducted in the field of nursing science. Although the theoretical basis related to adolescent health behaviour is borrowed from psychology (Bandura, 1977), health promotion and education, and preventing early adolescent tobacco and nicotine product use is also an integral part of nursing (Malone, 2006), and school health nursing in particular (Hakulinen-Viitanen et al., 2012).

# 2 Review of the Literature

## 2.1 Refusal self-efficacy as a determinant of adolescent risky health behaviour

### 2.1.1 Adolescent development and health behaviour

Adolescence is a sensitive phase of life during which adolescents experience many developmental changes (Sawyer et al., 2012). The World Health Organization (WHO, 2001) has defined an adolescent as a person between 10–19 years of age. Adolescence can be classified into three different phases based on the developmental characteristics of adolescents of different ages: early adolescence, middle adolescence, and late adolescence (Christie & Viner, 2005). Early adolescence has been defined as the period between approximately 10 to 13 years of age (Salmela-Aro, 2011; Sawyer et al., 2012; Smetana et al., 2006). This definition of early adolescents is also used in this study.

The features of adolescent development can be divided into physical, cognitive, as well as social and emotional development. Puberty and its biological aspects are traditionally thought to be the beginning of adolescence (Sawyer et al., 2018; Smetana et al., 2006). This biological maturation begins around the age of 10 with a physical growth spurt and breast development among girls (Rosenfield et al., 2009; Sawyer et al., 2018). During early adolescence, there are also other physical changes, for example, body hair starts to grow, oiliness of hair and skin starts to increase, among girls mensuration starts, and among boys genitals start to grow and the voice becomes lower (Sawyer et al., 2012). The maturation of the adolescent brain already begins in early adolescence and continues until the age of 24 years (Arain et al., 2013). There is also evidence that pubertal hormonal changes are associated with adolescent brain development (Vijayakumar et al., 2018). In early adolescence, cognitive development is manifested, for example, in the development of moral and abstract thinking. However, early adolescents live in the present, and are only a little concerned with the future. In terms of social and emotional development, early adolescents start to explore their identity and are interested in developing their independence. (Sawyer et al., 2012.) They also tend to doubt themselves, be self-critical, have conflicts with parents, seek approval from and be influenced by their

peers, become interested in sex, have mood swings, push boundaries, test rules (Sawyer et al., 2012), and take risks (Arain et al., 2013).

The health choices and health behaviour made during adolescence shape the basis for future health (WHO, 2009). At the same time, adolescent development influences health behaviour. For example, the development of abstract thinking and their increasing need for a unique identity may lead to an exaggerated perception of invulnerability and risk-taking, for example, in terms of experimentation with and use of tobacco and nicotine products (Christie & Viner, 2005). Thus, adolescence provides a unique opportunity to foster healthy behaviour and prevent the development of health issues later in life (McAteer et al., 2018).

### 2.1.2 Role of self-efficacy in adolescent health promotion

Self-efficacy has been defined as a belief in one's own ability to perform or execute behaviours to attain intended outcomes. It encompasses the control of actions, motivation, thought processes, as well as feelings and emotions. (Bandura, 1997.) Thus, self-efficacy influences the behaviour initiated, the extent of effort utilised, as well as the duration of maintaining the behaviour despite challenges and adverse encounters (Bandura, 1977). The perception of self-efficacy already begins to develop in childhood as children grow up and begin to interact with their environment. In childhood, families have an influential role in the development of self-efficacy beliefs but as children expand their social environment, the role of friends, and peers increases. (Bandura 1997.) Their influence on self-efficacy develops as adolescents, lacking familiarity with numerous tasks, rely on the behaviour of their friends and peers for self-assessment (Meece & Schunk, 2006).

Self-efficacy is a key concept in Bandura's (1997) Self-Efficacy Theory. According to the theory, self-efficacy beliefs are developed through reflective thought and cognitive processing of information related to the four principal sources of self-efficacy. These hypothesised sources of self-efficacy are mastery experiences, vicarious experiences, verbal persuasion, and physiological and emotional states.

Mastery experiences indicate personal capability. The most effective way to develop self-efficacy is through these direct personal experiences since they offer the most reliable evidence of one's capabilities. (Bandura, 1997.) Although successful events elevate mastery experiences and recurring failures reduce them, once strong self-efficacy beliefs have been established through repeated success, the negative influence of sporadic failures are prone to diminish (Bandura, 1977). Vicarious experiences refer to the experiences derived from the performances of others (Bandura, 1977, 1997). Modelling the attainments of others and comparing them with one's own capabilities are most influential when the role models are

similar to oneself (for example, peers) (Bandura, 1997; Jerusalem & Klein Hessling, 2009). Verbal persuasion means social persuasion from others suggesting that one has certain capabilities (Bandura, 1997). These are symbolic experiences through feedback from others (Jerusalem & Klein Hessling, 2009). Verbal persuasion might have constraints in generating lasting improvements in self-efficacy, however, it is able to support self-efficacy in a positive way if the positive appraisal is realistic enough (Bandura, 1997). Physiological and emotional states refer to somatic and mood states, such as fatigue, pain, aches, happiness, sadness, and fear (Bandura, 1997). Although physiological and emotional states have been considered the weakest source of self-efficacy (Jerusalem & Klein Hessling, 2009), they are especially relevant in health behaviour, physical activity, and stressful or demanding situations (Bandura, 1997).

Bandura's Self-Efficacy Theory is comprehensive, aiming to explain human behaviour across various age groups, from children to the elderly. Despite previous research findings supporting the theory, there is a level of uncertainty regarding its direct applicability to different contexts and domains. Given the variations in context and domains identified in research, it has been suggested the theory be re-examined, particularly focusing on the sources of self-efficacy, using qualitative methods (Usher & Pajares, 2008). For example, qualitative studies with adolescents in the context of learning and sports have identified self-regulation (Chase et al., 2005; Usher, 2009), interest (Butz & Usher, 2015; Chase, 1998; Klassen & Lynch, 2007), and adult practices (Butz & Usher, 2015; Chase, 1998) as sources of self-efficacy in addition to the four sources of the Self-Efficacy Theory.

Self-efficacy has been identified as a determinant of adolescent health that operates at an individual level. Other individual determinants of health include, for example, age, gender, education, skills, and knowledge. (World Health Organization, 2014.) Self-efficacy has an essential role in initiating, adopting, and sustaining health behaviours (Schwarzer & Luszczynska, 2006). It influences health behaviour both directly and indirectly (Bandura, 2004; Schwarzer & Luszczynska, 2006). Indirectly influencing health behaviour, self-efficacy influences goals, outcome expectations, and perceived facilitators and barriers (Bandura, 2004).

Refusal self-efficacy is rooted in the concept of self-efficacy and signifies belief in one's ability to refuse or resist a certain behaviour, for example, tobacco use (De Vries et al., 1988), drinking alcohol (Oei et al., 1998; Oei & Morawska, 2004), or engaging in unwanted sex (Vanable et al., 2009; Zimmerman et al., 1995). Adolescent tobacco use behaviour (Lotrean & De Vries, 2012; Wang et al., 2019), along with other health behaviours such as substance use, sexual behaviour, and healthy nutrition, are determined by refusal self-efficacy (Peters et al., 2009). There are also some other factors that determine adolescent tobacco use, including peer norms, modelling the tobacco use behaviour of peers and parents (O'Loughlin et al.,

2017; Peters et al., 2009; Scalici & Schulz, 2017), perceived needs or beliefs of physiological and psychological satisfaction (O'Loughlin et al., 2017; Peters et al., 2009), and being offered tobacco (Rachiotis et al., 2020).

In childhood and adolescence, refusal self-efficacy is not only a protective factor against tobacco use and other risky health behaviours (Chang et al., 2006; Wang et al., 2010; Wang et al., 2019) but also moderates the adverse effects of peer influence on such behaviours (Wang et al., 2010). Low levels of adolescent refusal self-efficacy have been associated with initiating (Lotrean & De Vries, 2012) and continuing to use tobacco (Ausems et al., 2009). In particular, adolescent tobacco use initiation is associated with a decrease in refusal self-efficacy (Hiemstra et al., 2011).

Although self-efficacy plays an essential role in determining child and adolescent tobacco-related behaviour, measuring it can be challenging. In previous intervention studies among children and adolescents, the baseline refusal self-efficacy scores have already been high indicating a strong refusal self-efficacy (Isensee et al., 2014; McGee et al., 2016; Parisod et al., 2018; Weser et al., 2021a, 2021b), and thus, making it difficult to detect changes over time and between different study groups. One challenge in measuring tobacco refusal self-efficacy is that as children and adolescents are more reliant on their previous experiences (Bandura, 1997), they might overestimate their self-efficacy if they have not yet encountered situations where they had been offered or where peers use tobacco and nicotine products (Hiemstra et al., 2016). Although many self-efficacy instruments are available for measuring self-efficacy, it has been argued that there is still a need for research that aims to identify the key elements of adolescents' self-efficacy that is amenable to intervention, can be reliably measured, and is suitable for comparative assessments (Tsang et al., 2012).

## 2.2 Tobacco and nicotine product use as a risky health behaviour in adolescence

### 2.2.1 Towards a tobacco-free society

There are national and international initiatives and visions aiming at a tobacco-free society. The goal of the national Tobacco Act (549/2016) is to end the use of tobacco and nicotine products. In addition, for example, the European Commission has outlined the aim for a tobacco-free Europe as a part of Europe's Beating Cancer Plan (2021). According to the national Current Care Guideline on tobacco and nicotine dependence, the prevention of tobacco and nicotine product use is essential especially among 10–16-year-olds before their first tobacco and nicotine product use

experimentations (Tobacco and nicotine dependency, prevention, and treatment: Current Care Guidelines Abstract 2018).

One challenge to achieve a tobacco-free society lies in the tobacco and nicotine product industry and market. As cigarette smoking rates have decreased globally, tobacco companies have taken up the challenge by introducing new tobacco and nicotine products, such as electronic cigarettes (later: e-cigarettes) and nicotine pouches, and constantly improving these products (Lietzmann & Moulac, 2023; O'Connor et al., 2022). At the same time, tobacco companies have tried to change their public image by portraying themselves as allies in tackling the tobacco epidemic, rather than acknowledging their role as contributors (Bialous & Glantz, 2018). Thus, they are now spreading the message of harm reduction and a smoke-free world concerning the new tobacco and nicotine products (Bialous & Glantz, 2018; O'Connor et al., 2022). Tobacco companies have also embraced social media as a channel to publish their key public messages, to promote a more positive public image, and to reach a wider audience of possible consumers (Venrick et al., 2023; Watts et al., 2019). Adolescents and young people are especially at risk of being exposed to this marketing (Gentzke et al., 2022; Venrick et al., 2023) due to the popularity of social media among young people (Vogels et al., 2022). There is also evidence that being exposed to tobacco marketing on digital platforms, such as social media, is linked to tobacco and nicotine product use (Pierce et al., 2018; Soneji et al., 2017; Venrick et al., 2023).

In Finland, the Tobacco Act (549/2016) regulates the ban on tobacco and nicotine products, as well as their sales, supply, import, and marketing. However, there is indirect marketing on social media that is difficult to control, and the social media platforms lack age restrictions on this kind of harmful content related to tobacco and nicotine products (Venrick et al., 2023). For example, in a study in the Nordic countries, the adolescents frequently reported encountering appealing content related to e-cigarettes on social media (Scheffels et al., 2023). In addition, there are still some gaps in current legislation, for example, related to the sale of nicotine pouches. As new tobacco and nicotine products are being rapidly developed and brought on to the market, legislation may lag behind (Lietzmann & Moulac, 2023). There are also black tobacco and nicotine product markets even among adolescents which may be difficult to track (Paraje et al., 2022).

### 2.2.2 Experiences with tobacco and nicotine products in adolescence

The first tobacco and nicotine product experimentations begin in early adolescence. In Finland, 5.5 percent of 4th and 5th graders (approximately 10–11 years old) have tried a tobacco or nicotine product, whereas among 8th and 9th graders

(approximately 14–15 years old) tobacco and nicotine product experimentation was more common with 39.4 percent having tried a tobacco or nicotine product (THL, n.d.). In general, the experimentation and use of tobacco and nicotine products has increased among Finnish adolescents in recent years due to the increased use of newer products, such as e-cigarettes, nicotine pouches, and snus. According to the European School Survey Project on Alcohol and Other Drugs (ESPAD), on average, 23 percent of Finnish boys and 14 percent of girls have tried using tobacco by the age of 13 years or younger (ESPAD Group 2020). Tobacco experimentation, especially at an early age, predisposes to regular use in the future (Dierker et al., 2012; Reidpath et al., 2014; Sargent et al., 2017) due to an increased vulnerability to long-lasting nicotine dependence (Arain et al., 2013). Existing evidence suggests that over two-thirds (68.9 percent) of those who have tried tobacco smoking have started to smoke regularly (Birge et al., 2018).

Although daily smoking among young people has declined over the past decade, the decline in the use of tobacco and nicotine products has stabilised (Kinnunen et al. 2019, THL, n.d.). Currently, 6.3 percent of Finnish 8th and 9th grade boys and 3.8 percent of girls smoke cigarettes daily, and 12.4 percent of boys and 9.0 percent of girls use a tobacco or nicotine product daily. In Finland, snus use is remarkably more common among boys than among girls. Among boys in 8$^{th}$ and 9$^{th}$ grades, snus use in particular is as prevalent as smoking, with 6.4 percent using snus daily, compared to 1.7 percent for girls. The prevalence of e-cigarette use among adolescents has increased rapidly from 2.3 (in 2021) to 6.6 (in 2023) percent users on a daily basis. The use of nicotine pouches is as common with 6.8 percent occasional or daily users. (THL, n.d.) The popularity of newer tobacco and nicotine products has increased during the last decade (Ollila et al. 2017). For example, among young people the acceptance of e-cigarettes is widespread and the most common compared to tobacco smoking and snus use (THL, n.d.). Research among adolescents in Europe suggests that using e-cigarettes appears to be complementary to tobacco smoking, and not a substitute (Kinnunen et al., 2021). This could indicate that e-cigarette experimentation may, in fact, lead to smoking tobacco (Kinnunen et al., 2019, 2021). Moreover, the simultaneous use of different tobacco and nicotine products has been remarkably common among adolescents in the Nordic countries. In Finland, approximately 32 percent of current users, and 49 percent of experimental users use multiple tobacco and nicotine products at the same time. (Raitasalo et al., 2022.) Among adolescents, the most often reported reasons for experimenting with tobacco and nicotine products include curiosity and social pressure or use of tobacco and nicotine products among friends (Gentzke et al., 2022; Kinnunen et al., 2016; Wojtecka et al., 2023; Xu et al., 2016). Thus, the influence, norms, and expectations of the social environment, especially friends, are crucial. However, it has also been argued that part of this social influence may be, in fact,

due to other motives, such as willingness to act cool (Defoe et al., 2022). The reasons for experimenting with tobacco and nicotine products are similar regardless of the product. However, experimentation with snus and e-cigarettes is also linked to, for example, being offered an opportunity to try or easy access (Edvardsson et al., 2012; ESPAD Group, 2020; Kong et al., 2015) and perceptions of them being less unhealthy or less addictive than cigarettes (Havermans et al., 2021). For example, in a study among Finnish adolescents, 22–30 percent perceived that e-cigarettes are not harmful to their health, compared to 2–3 percent for cigarettes (El-Amin et al., 2022). In addition, the reasons for experimenting with e-cigarettes are often related to efforts to quit smoking, and the appeal of different flavors (Havermans et al., 2021; Kinnunen et al., 2016). The availability of sweet and fruity, as well as nicotine-free flavor liquids seems to increase the attractiveness of e-cigarettes among adolescents and give a false impression of it being less harmful (Scheffels et al., 2023).

### 2.2.3 Hazardous consequences of using tobacco and nicotine products

There is a wide variety of tobacco and nicotine products. Tobacco products can be classified into two types: smoking tobacco (that is, combusted tobacco products), and smokeless tobacco (that is, non-combusted tobacco products). Smoking tobacco includes, for example, cigarettes, cigars, cigarillos, pipe tobacco, and waterpipe tobacco. Smokeless tobacco includes, for example, snus, snuff, chewing tobacco, and nasal tobacco. (Tobacco Act 549/2016, NIDA, 2021.) There are also newer tobacco and nicotine products, such as e-cigarettes and nicotine pouches, that are nicotine-based but do not contain tobacco. E-cigarettes resemble traditional cigarettes, and nicotine pouches resemble snus and are used orally in a similar way (Lietzmann & Moulac, 2023). In the following, I describe the most commonly used tobacco and nicotine products in Finland, that is, cigarettes, snus, and electronic cigarettes, and their hazardous health consequences.

#### Cigarettes

Cigarettes are paper rolls with dried tobacco leaves wrapped inside, and are used by smoking (European Union, 2014). Globally cigarettes are the most commonly used tobacco and nicotine products. In 2020, around 70 percent of any use of tobacco products was cigarette smoking. In Europe, around 25 percent of people aged 15 years and older use some tobacco or nicotine product, and 23 percent smoke cigarettes (World Health Organization, 2021.)

Several hazardous health consequences of cigarette smoking have been identified. Although smoking rates have decreased worldwide during the last two

decades (WHO, 2021c), smoking remains the most significant behavioural risk factor for hazardous health consequences and health problems (Dai et al., 2022). Smoking is associated with an increased risk of many diseases and causes of deaths. Evidence suggests that the association is stronger when smoking has been initiated at an early age and among heavy smokers. (Chan et al., 2022.) However, quitting smoking reduces the risks and is beneficial in terms of disease management (Chan et al., 2022; U.S. Department of Health and Human Services, 2014).

Smoking has been associated with several diseases, especially cancers, respiratory diseases, and cardiovascular diseases (Chan et al., 2022; Dai et al., 2022; U.S. Department of Health and Human Services, 2014). There is strong evidence that smoking increases the risk of laryngeal cancer, lung cancer, other pharynx cancer, and pancreatic cancer. There also some evidence that smoking is associated with an increased risk of cancer in the bladder, esophagus, cervix, stomach, lips or oral cavity, nasopharynx, or breasts. (Dai et al., 2022.) The respiratory diseases associated with smoking are especially chronic obstructive pulmonary disease (COPD), and lower respiratory infections (Dai et al., 2022), such as bronchitis and pneumonia (Chan et al., 2022). In addition, smoking increases the risk of tuberculosis (Chan et al., 2022; Dai et al., 2022; U.S. Department of Health and Human Services, 2014), and may increase the risk of other respiratory outcomes, such as, asthma (Chan et al., 2022; U.S. Department of Health and Human Services, 2014), and emphysema (Chan et al., 2022). The cardiovascular diseases and outcomes associated with smoking are especially aortic aneurism and peripheral artery (Dai et al., 2022). Other cardiovascular outcomes associated with smoking are, for example, ischemic heart disease, stroke (Chan et al., 2022; Dai et al., 2022), atrial fibrillation and flutter (Dai et al., 2022), ischemic heart disease, myocardial infarction, and heart failure (Chan et al., 2022).

Other hazardous health consequences of smoking include reproductive implications (U.S. Department of Health and Human Services, 2014), and other outcomes and diseases, such as, rheumatoid arthritis, diabetes, eye diseases (for example, macular degeneration and cataracts) (Chan et al., 2022; Dai et al., 2022; U.S. Department of Health and Human Services, 2014), multiple sclerosis (Dai et al., 2022), peptic ulcer (Chan et al., 2022; Dai et al., 2022), lower back pain, dementia, gallbladder diseases (Dai et al., 2022), outcomes to the immune function, dental diseases (for example, caries) (U.S. Department of Health and Human Services, 2014). In addition, the nicotine in cigarettes can cause nicotine dependence and addiction. Exposure to nicotine in childhood and adolescence can also have adverse effects on the brain development. (U.S. Department of Health and Human Services, 2014.) For example, cigarette smoking modifies child and adolescent brains and this is associated with reducing inhibitory limitations on pursuing rewards and intensifying the pleasurable sensation of smoking (Xiang et al., 2023).

The hazardous health consequences of smoking are not only limited to the smoker themselves, but also the people exposed to secondhand smoke or passive smoking, that is, the tobacco smoke in the environment (Cao et al., 2015; Makadia et al., 2017; Öberg et al., 2011; U.S. Department of Health and Human Services, 2014). The health consequences of secondhand smoking include, for example, respiratory or middle ear infections in childhood, and asthma or other respiratory symptoms, lung cancer (Cao et al., 2015; Öberg et al., 2011; U.S. Department of Health and Human Services, 2014), allergic rhinitis or dermatitis, cervical cancer (Cao et al., 2015), stroke (Cao et al., 2015; U.S. Department of Health and Human Services, 2014), and ischemic heart disease (Öberg et al., 2011; U.S. Department of Health and Human Services, 2014).

## Snus

Snus, also called in Swedish moist snuff, is a moist smokeless tobacco product that is used orally, usually between the gum and the upper lip. It is dispensed in a sachet or in loose form. Snus consists of finely ground tobacco, water, salt, and usually other contents, such as, nicotine. (Clarke et al., 2019; SCENIHR, 2008.)

Research on the health consequences of snus use has resulted in somewhat mixed results (Clarke et al., 2019; Hajat et al., 2021) due to limited research evidence and variations in the contents of snus products (Hajat et al., 2021). For example, chemical analysis has indicated that there can be considerable variation in the chemical characteristics of snus products. The Northern European snus products appear to have higher nicotine levels than those manufactured in the United States. (Lawler et al., 2020.) Additionally, it should be noted that most of the data on the health risks of snus use has been collected from men (Clarke et al., 2019; Vidyasagaran et al., 2016). Some researchers have compared the hazardous health consequences of snus use to those of cigarette smoking. Although, in general, the health consequences associated with cigarette smoking appear to be greater than those associated with snus use (Clarke et al., 2019), there is evidence that snus use increases the risk for hazardous health consequences (Hajat et al., 2021; Tomar et al., 2019).

The hazardous health consequences of snus use include an increased risk for heart failure (Arefalk et al., 2012) and ischemic stroke (Titova et al., 2021), death from cardiovascular diseases (Byhamre et al., 2020; Gupta et al., 2019; Vidyasagaran et al., 2016), as well as increased blood pressure and heart rate (Clarke et al., 2019; Norwegian Institute of Public Health, 2014). In addition, nicotine is rapidly absorbed from snus, thus leading to high nicotine levels in the body and a risk of nicotine dependence (Norwegian Institute of Public Health, 2014). Snus use is associated with increased risk of cancer, especially oesophageal cancer, oral cancer (Hajat et al., 2021), and pancreatic cancer (Norwegian Institute of Public Health, 2014). It

may also increase the risk of other cancers (Norwegian Institute of Public Health, 2014) and increase the risk of death from cancer (Byhamre et al., 2020). There is some evidence that snus use, especially heavy use, may increase the risk of type 2 diabetes (Carlsson et al., 2017; Norwegian Institute of Public Health, 2014), respiratory diseases (such as asthma) and snoring (Gudnadóttir et al., 2017). In addition, snus use causes damages to the oral mucosa, for example lesions (Clarke et al., 2019; Miluna et al., 2022), and receding gums (Norwegian Institute of Public Health, 2014).

### Electronic cigarettes

Electronic cigarettes, also known as e-cigarettes, are products that do not contain tobacco but usually contain nicotine (Breland et al., 2017). They are therefore often considered alongside tobacco products. Here, I classify e-cigarettes as tobacco and nicotine products, although the Finnish legislation defines tobacco products as those that consist at least partly of tobacco (Tobacco Act 549/2016). However, for example, the United States legislation defines tobacco products as all products made or derived from tobacco, including e-cigarettes (21 CFR §1100.3).

E-cigarettes are electronically powered devices which heat and vaporise liquids with a battery or accumulator. The vaporised liquids are then inhaled in the same way as cigarettes. There are various different liquids on the market that usually contain nicotine. However, there are also nicotine-free liquids. Additionally, there are different devices on the market with different design types, methods of use, as well as vapour intensity. (Breland et al., 2017, Aro 2022.)

E-cigarettes can cause numerous hazardous health consequences and adverse effects. However, most of the research has concentrated on examining and assessing the short-term health consequences of e-cigarettes while the long-term consequences remain unknown due to the scarcity of research (Gordon et al., 2022; Helen & Eaton, 2018; Marques et al., 2021; Perikleous et al., 2018; Seiler-Ramadas et al., 2021). Furthermore, the health consequences related to e-cigarettes are partly dependent on, for example, the device itself and the liquids used (Gordon et al., 2022).

The hazardous health consequences of e-cigarettes include consequences on oral health, such as dental caries, periodontitis, and mucosal lesions (Gordon et al., 2022). E-cigarette use increases the susceptibility to cough, respiratory resistance, shortness of breath (Seiler-Ramadas et al., 2021), pulmonary infections, viral or bacterial infections, lung injuries, respiratory diseases (such as asthma and COPD) (Gordon et al., 2022), lung and nasal cancers, and other adverse effects on the respiratory system (Seiler-Ramadas et al., 2021). E-cigarette use has harmful consequences also on the cardiovascular function, such as increased blood pressure and heart rate (Gordon et al., 2022; Seiler-Ramadas et al., 2021), and increased risk of

cardiovascular diseases (Gordon et al., 2022). In addition, other adverse effects are associated with e-cigarette use, such as nausea, vomiting, diarrhea, dependency, anxiety, headache, lack of concentration, sleep problems, skin reactions, and eye irritations (Seiler-Ramadas et al., 2021).

## 2.3 Health education to support adolescent tobacco refusal self-efficacy and non-use of tobacco and nicotine products

### 2.3.1 Health education interventions on preventing tobacco and nicotine product use

Health education has been defined as a multifaceted approach involving diverse learning experiences that aim to empower individuals and communities to enhance their health. This is achieved by boosting knowledge, shaping motivation, and elevating health literacy. (WHO, 2021.) Health education interventions on preventing tobacco and nicotine product use can be provided to children and adolescents at different levels. The interventions can be classified as individual-, family-, school- (Macarthur et al., 2018), and community-level interventions (Carson et al., 2011), as well as interventions combining different levels. The different levels are described in Table 1.

In this section, I focus mainly on school-level health education interventions. Health education interventions on tobacco prevention are most commonly implemented within school settings since schools provide the possibility to reach nearly every child and a natural setting for health education on tobacco along with other school activities (Botvin & Griffin, 2007; Thomas et al., 2015). In addition, the evidence on these school-based interventions is most robust (Macarthur et al., 2018) although different type of interventions may be effective at different developmental states in adolescence (Onrust et al., 2016).

There are three types of approaches to school-based health education interventions: the universal approach addressing the whole population, selective or targeted approach addressing those at higher risk, or indicated approach addressing those who have already experimented with risky health behaviour (Botvin & Griffin, 2007; Macarthur et al., 2018; Onrust et al., 2016). Most of school-based health education interventions on preventing tobacco and nicotine product use have used the universal approach (Macarthur et al., 2018; Onrust et al., 2016) targeting all students within a specific school or classroom before their first experiments with tobacco and nicotine products (Botvin & Griffin, 2007). However, there is some evidence that more targeted approaches may be more effective (Duncan et al., 2018b; Park & Drake, 2015; Sherman & Primack, 2009).

**Table 1.** Description of individual-, family-, school-, and community-level health education interventions to prevent child and adolescents tobacco and nicotine product use.

| Level of health education intervention | Description |
|---|---|
| Individual-level | - Health education offered outside of formal school settings (Duncan et al., 2018b).<br>- Aims to address cognitive behavioural objectives, such as refusal self-efficacy and self-behaviour control (Duncan et al., 2018b).<br>- Uses strategies based on, for example, mentoring and coaching, motivational interviewing, digital health education, developing positive social networks (Macarthur et al., 2018) |
| Family-level | - Health education with children or adolescents and their family members (Thomas et al., 2015).<br>- Aims to enhance family interactions, communication and environment, develop parenting behaviour and practices, foster wellbeing and resilience (Macarthur et al., 2018; Thomas et al., 2015).<br>- Uses strategies based on, for example, behaviour managements, skill enhancement and decision-making practices, goal setting, group sessions, providing support, and addressing shared values (Macarthur et al., 2018). |
| School-level | - Health education offered at schools (Onrust et al., 2016; Thomas et al., 2013).<br>- Aims to address normative beliefs, foster school connections, meet behavioural objectives, encourage commitments to avoid risky health behaviour, and disseminate knowledge (Macarthur et al., 2018).<br>- Uses varied strategies, such as formal classroom curricula, comprehensive school-wide strategies, behaviour management and skill enhancement practices, role-plays, goal setting, and peer-led activities (Macarthur et al., 2018; Thomas et al., 2013).<br>- Can address also individual-level factors, such as self-efficacy (Duncan et al., 2018b). |
| Community-level | - Health education offered widespread in a specific geographical area or region (Carson et al., 2011).<br>- Aims to address social and environmental processes, and thus contribute to wellbeing and health (Carson et al., 2011).<br>- Uses varied strategies, such as, public policy, mass media campaigns, anti-tobacco competitions and clubs, initiatives within school, organisational, healthcare, workplace, and sports settings (Carson et al., 2011), after-school interventions and summer camps (Duncan et al., 2018b).<br>- Influenced by factors specific to the locality (Carson et al., 2011). |

School-based health education interventions on preventing tobacco and nicotine product use can have different theoretical approaches that can be categorised into those providing only information, those supporting social competence, those supporting resistance to social influence, those supporting both social competence and to resistance to social influence, and wider multimodal interventions (Thomas et al., 2013). In the past, tobacco prevention interventions within schools have primarily concentrated on providing information about the risks of tobacco use. However, educating students about the risks is inadequate for behaviour change. (Botvin & Griffin, 2007.) Instead, it has been suggested that effective interventions to prevent adolescent tobacco and nicotine product use might require a combination of conventional methods and individual-level approaches, teaching adolescents to regulate their behaviour related to tobacco use (Duncan et al., 2018b). For example, according to a Cochrane review, interventions combining supporting social competence with resistance to social influences have shown positive results in preventing adolescents from using tobacco and nicotine products. In the longer term, the results have also been positive for interventions based on supporting social competence which aims to enhance adolescents' ability to refuse tobacco. (Thomas et al., 2013.) This approach includes, for example, teaching problem solving skills and self-control (Thomas et al., 2013) that have been beneficial in universal school-based tobacco prevention interventions for most adolescents (Onrust et al., 2016).

Research indicates that school-based health education interventions on preventing tobacco and nicotine product use are more effective when delivered by adults (Thomas et al., 2013), for example, trained or professional health educators (Duncan et al., 2018b; Sherman & Primack, 2009). Research also supports using technology to deliver these interventions (Duncan et al., 2018b). These interventions are called digital health interventions. The World Health Organization (WHO) has defined digital health as the utilisation of digital, mobile, and wireless technologies to promote health-related goals (WHO, 2016). Digital health interventions hold significant promise for enhancing health by offering effective, safe, accessible, and cost-effective solutions (Murray et al., 2016). Digital technologies provide platforms for health education that adolescents often interact with and feel connected to (Duncan et al., 2018b). For example, interventions with multimedia, interactive elements, and personalised feedback have shown promising results (Park & Drake, 2015). One type of digital health intervention are digital health games. Health games are interventions aimed at promoting health and well-being (Baranowski et al., 2016). These interventions use game features to engage, and thus, to support achieving health-related learning outcomes (Garris et al., 2002). Digital health games also enable addressing individual-level factors, such as self-efficacy (Lee, 2015; Peng, 2008).

### 2.3.2 Health education interventions to support adolescent tobacco refusal self-efficacy

I conducted a systematic literature search to identify existing health education interventions to support adolescent tobacco refusal self-efficacy and the evidence on these interventions. The aim of this review was two-fold: to complement the background and to support the discussion of this dissertation. I performed the search in August 2023 in three electronic databases: PubMed/Medline, CINAHL, and PsycINFO. The PICO framework was used to identify the search terms (Miller & Forrest, 2001). The search strings included free-text terms as well as database specific subject headings and are described in Appendix 1 (Table 1). Database search was complemented with manual search via citation searching by browsing reference lists. Eligibility criteria for the literature were: a) the publication is based on an empirical study, b) the publication focuses on children and adolescents, c) the publication presents the results of an intervention to support tobacco refusal self-efficacy, d) the publication language is Finnish or English. The PRISMA flow diagram in Appendix 2 (Figure 1) visually outlines the systematic literature search and selection process. In total, 47 publications met the eligibility criteria and were included in this review. Appendix 4 (Table 3) describes the studies presented in the publications.

#### Description of the health education interventions

Altogether 34 different interventions were described and evaluated in the selected publications. Appendix 3 (Table 2) describes the interventions in more detail. The sample sizes varied from over 20 000 to 25 participants. The largest number of participants were in a study that examined the outcomes of a wide school-based smoking prevention intervention in six European countries (De Vries et al., 2003, 2006), whereas a study examining the preliminary efficacy of a digital videogame intervention with a one-group study design had the smallest sample size (Duncan et al., 2018a). Most of the interventions were school-based (n = 29) out of which ten were delivered in schools but included elements of another level of health education, namely community-level (n = 3), individual-level (n = 2), family-level (n = 2), and both family- and community-levels (n = 3). Four interventions were provided to children and adolescents at an individual level. However, although delivered at an individual level, one of these interventions included elements of community-level health education. One intervention was family-based and offered both to children and to their mothers.

The interventions were aimed at 7–18-year-old children and adolescents. Most of the interventions addressed only cigarette smoking prevention (n = 17), but there were two interventions that addressed both smoking prevention and cessation, two

that addressed tobacco and nicotine products in a wider perspective, and two that addressed only e-cigarettes. In addition, there were two interventions addressing both cigarette and marijuana smoking prevention, and five interventions addressing substance use prevention, which most often meant cigarette smoking and alcohol use prevention. Various theoretical frameworks guided the interventions, most often Social influences model or approach, Social cognitive theory or Self-efficacy theory, Theory of reasoned action, Theory of planned behavior, or Social inoculation theory. The duration of the interventions varied from a 5-year school curriculum with regular activities (Nagler & Lobo, 2019) to shorter sessions of only 20 minutes (Brown, 2016; Parisod et al., 2018; Shegog et al., 2005). Most often the interventions with a shorter duration were digital interventions.

The majority of the interventions (n = 19) were mainly in-school classroom-based interventions. Many of these interventions included lessons or lectures, group discussions, group activities or workshops, and role-plays to discuss and address tobacco-related issues. Some of the interventions also used peer leaders to lead and facilitate activities, and other intervention elements, such as: home assignments, videos, posters or booklets, competitions, anti-tobacco contracts, games or tests, workbooks or learning sheets, other activities or training, questions and answers sessions, feedback on the activities, and support or counselling for a tobacco-free life. Other more rarely used elements were discussion forums, websites supporting the classroom-based activities, giving incentives, and other school-level arrangements, such as, coordinating committees, school regulations and school assemblies. One intervention was school-based but implemented sports activities to prevent smoking. These activities included sports training and coaching sessions. (McGee et al., 2016.)

Some of the in-school classroom-based interventions had also out-of-school elements (Cuijpers et al., 2002; De Vries et al., 2003, 2006; Ellickson et al., 2003; Flay et al., 1988, 1995; Kovach Clark et al., 2010; Meshack et al., 2004; Nagler & Lobo, 2019; Orlando et al., 2005; Perry et al., 2009; Stigler et al., 2011; Turhan et al., 2017). These elements included material for parents, discussion with parents, involving parents in tobacco use prevention for example with conferences or having parents' representatives in intervention coordinating committees, media publications, community actions, marketing events, and sports, art and journalism academies.

In total, ten interventions were digital interventions delivered using digital platforms, such as, computers (Cremers et al., 2015; Kiewik et al., 2016; Prokhorov et al., 2008; Shegog et al., 2005), mobile phones or tablet computers (Duncan et al., 2018a; Parisod et al., 2018), virtual reality headsets (Weser et al., 2021a, 2021b), or online without a specifically defined platform (Brown, 2016; Merrill & Hanson, 2022; Palacheewa et al., 2014). Most of these interventions were delivered in school,

and only two (Brown, 2016; Duncan et al., 2018a) were delivered in home settings. In addition, two interventions (Merrill & Hanson, 2022; Parisod et al., 2018) were delivered mainly in school but also had some activities in the home setting. The interventions included textual information or tips, quizzes, questions or tests, videos or animations, feedback or support, games, activities, and other material, such as risk assessment, links to webpages, and certificates.

Two interventions used mass media to deliver the intervention. However, in both cases, the interventions were delivered to the children and adolescents in controlled settings, that is, in laboratory and school settings. Both interventions used televised public service announcement messages to address tobacco-related issues for smoking prevention. (Helme et al., 2007; Shadel et al., 2009; Tharp-Taylor et al., 2012.) One intervention was home-based and offered to the children and adolescents in a home setting. This intervention used similar intervention elements to the classroom interventions, such as assignments, games, role-plays, contests, discussions, and communication sheets, but the elements were aimed at both the children and their mothers. (Hiemstra et al., 2013, 2016.) There was also one out-of-school intervention that was delivered in a home setting. The main intervention element was a letter to the children and adolescents that consisted of puzzles, cartoons, competitions, and exercises. (Ausems et al., 2002.)

### Evidence on the health education interventions

The intervention effects on child and adolescent tobacco refusal self-efficacy were measured with different instruments, either validated or made by the researchers. Only three interventions with an experimental or quasi-experimental study design and at least two study groups had favourable intervention effects on tobacco refusal self-efficacy at the group level (Gharlipour et al., 2015; Langlois et al., 1999; Zollinger et al., 2003). In addition, there were seven interventions for which there were both statistically significant favourable results as well as statistically non-significant results. The studies describing these interventions had evaluated the intervention effects either in different countries (De Vries et al., 1994, 2003, 2006; Dijkstra et al., 1999; Lotrean et al., 2010; Mohammed et al., 2016), conducted additional analysis (Côté et al., 2006; De Vries et al., 1994; Debenham et al., 2021; Kupersmidt et al., 2010; McGee et al., 2016), or analysed different versions of the intervention (Bell et al., 1993). All interventions with favourable intervention effects on tobacco-refusal self-efficacy were in-school classroom-based interventions. In addition, there were positive results with interventions that used peer leaders, especially to lead and facilitate discussions instead of having only teachers, school personnel or researchers to deliver the intervention (Bell et al., 1993; Langlois et al., 1999; Lotrean et al., 2010; Mohammed et al., 2016). In the additional analysis, the

interventions were efficacious especially among girls (McGee et al., 2016; Zollinger et al., 2003) and those who had previous experiences with smoking (De Vries et al., 1994; Kupersmidt et al., 2010), lower baseline refusal self-efficacy (Côté et al., 2006) or internalising personality traits (negative thinking and anxiety sensitivity) (Debenham et al., 2021).

Seven studies describing six interventions had a study design with only one group. Four of these examined the effects of a digital intervention (Duncan et al., 2018a; Merrill & Hanson, 2022; Palacheewa et al., 2014; Shegog et al., 2005) and three of a mass media intervention (Helme et al., 2007; Shadel et al., 2009; Tharp-Taylor et al., 2012). Most of these studies (n = 6) showed favourable intervention effects on refusal self-efficacy.

There were also six studies that showed negative intervention effects on refusal self-efficacy. The majority had negative intervention effects among some subgroup, either related to location or a slightly different type of intervention delivery (De Vries et al., 2003, 2006; Flay et al., 1995) or being in the highest risk group (Bell et al., 1993). In one study, there were decreases in refusal self-efficacy in both study groups (Guo et al., 2022), and in another study the intervention group showed decreases in refusal self-efficacy compared to the control group (Hiemstra et al., 2013).

Two studies describing the results of three interventions presented only baseline results on refusal self-efficacy (Ausems et al., 2002; Cremers et al., 2015). In addition, one study presented the results in a descriptive style, and thus, it was unclear whether there were any statistically significant intervention effects on refusal self-efficacy (Nagler & Lobo, 2019).

## 2.4 Gaps in current research

Current research supports the use of Self-Efficacy Theory as the theoretical basis for child and adolescent health promotion. However, there is still some uncertainty in its direct applicability to different contexts suggesting that more research is needed especially on the development and formation of self-efficacy in specific contexts of interest. One domain of self-efficacy is refusal self-efficacy that has an essential role in determining adolescent behaviour related to tobacco and nicotine product use. However, based on the existing literature, there is still a need to find ways of measuring refusal self-efficacy with tools that can better differentiate children and adolescents with high- and low-risk. One possibility could be measuring refusal self-efficacy through the sources of self-efficacy.

In general, based on the existing literature, the evidence from health education interventions on supporting adolescent tobacco refusal self-efficacy is rather weak. Thus, research with rigorous study designs on the effectiveness of these interventions is needed. In addition, as some interventions have had positive results only among

girls or adolescents at a high risk of using tobacco and nicotine products, there is still a need to find ways to support tobacco refusal self-efficacy and non-use of tobacco and nicotine products among adolescents with different genders and levels of vulnerability. Most interventions also focus on supporting only non-smoking among adolescents. As the tobacco and nicotine product use is diversifying, there is a need to also address newer tobacco and nicotine products in these interventions. Digital health interventions offer potential, multidimensional, safe, and accessible tools for supporting adolescent non-use of tobacco and nicotine products. Based on existing literature, digital interventions on supporting tobacco refusal self-efficacy used only digital elements. Since the evidence on these digital interventions is limited and supports using school-based interventions, it could be beneficial to complement the interventions with non-digital elements, such as group discussion or group tasks often used in school-based interventions.

# 3 Aims and Research Questions

The overall aim of this study was to develop an intervention to support early adolescent tobacco refusal self-efficacy and to evaluate the effectiveness of the intervention among in comprehensive school grades 4 to 6. The intervention is based on a previously developed and pilot tested mobile health game '*Fume*' (Parisod, et al., 2017) that was further developed in this study. The study design is presented in Figure 1. Based on the Medical Research Council's (MRC) framework for developing and evaluating complex interventions (Craig, et al., 2013; Skivington et al., 2021), the study was carried out in two phases: I) the development phase, and II) the evaluation phase. The sub-aims and research questions (RQ) of this study were:

**Development phase (I):** The aim was to further develop the *Fume* health game intervention to support early adolescent tobacco refusal self-efficacy by identifying existing evidence and strengthening the theoretical framework for the intervention.

**RQ1:** How do adolescents (13–17 years old) perceive their self-efficacy in peer interactions and which factors influence their self-efficacy? (Sub-study I)

**RQ2:** How is refusal self-efficacy manifested in digital interventions to support refusal self-efficacy in the context of the health promotion of children and adolescents, and what is the evidence from digital interventions? (Sub-study II)

**RQ3:** Which factors are associated with tobacco refusal self-efficacy among early adolescents (10–13 years old) in Finland and Portugal? (Sub-study III)

**Evaluation phase (II):** The aim was to evaluate the effectiveness of the further developed *Fume* health game intervention on tobacco refusal self-efficacy among early adolescents in 4$^{th}$, 5$^{th,}$ and 6$^{th}$ grades (who are typically 10–13 years old).

**RQ4:** How effective is the *Fume* health game intervention in supporting early adolescent tobacco refusal self-efficacy, sources of tobacco refusal self-efficacy and motivation to decline tobacco use? (Sub-study IV)

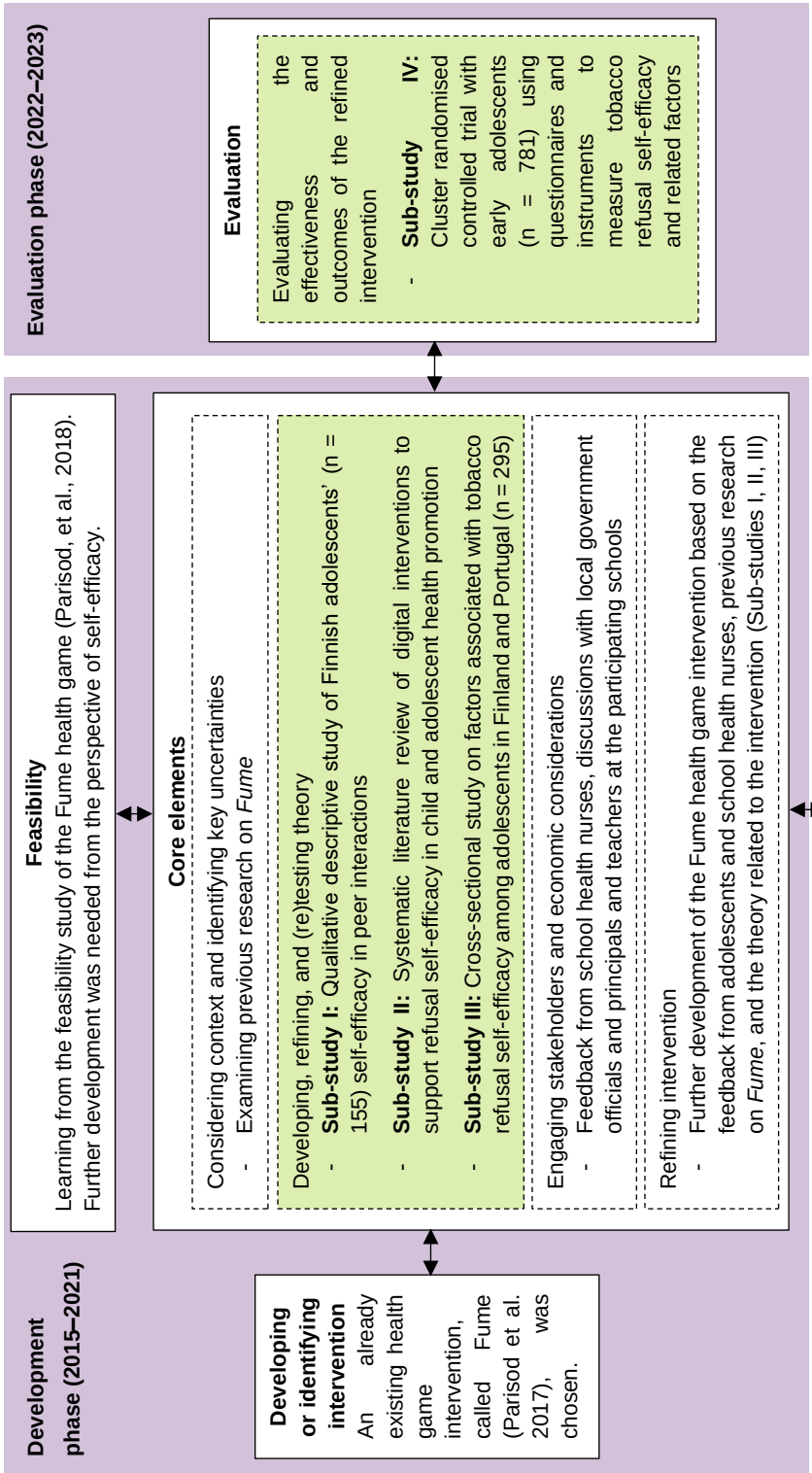



**Figure 1.** The overall study design modified from the MRC's framework (Skivington et al. 2021).

# 4 Materials and Methods

## 4.1 Methodological framework

The Medical Research Council's framework for developing and evaluating complex interventions (Craig et al., 2013; Skivington et al., 2021) was used as the overall methodological framework for this study. According to this framework, various materials and methods were used in the study and its sub-studies.

The Medical Research Council's framework consists of four different phases: development, feasibility and piloting, evaluation, and implementation (see Figure 1). Although these phases can be presented in a linear order, the process of developing and evaluating a complex intervention may not follow a linear sequence. Instead, there might be a need to begin research on complex interventions at any phase of the framework. This study began with the development phase and then moved on to the evaluation phase; this was because there were some uncertainties about the content of the intervention, but not about the feasibility. The intervention was based on an existing intervention, the '*Fume*' health game, a mobile game aimed at supporting early adolescent non-smoking and tobacco-related health literacy (Parisod et al., 2017). As the feasibility of the original intervention had been tested, and an understanding of the intervention context (procedures, recruitment and retention, sample size, acceptability, and delivery) had been attained, another feasibility study was not considered relevant (Craig et al., 2013; Skivington et al., 2021). According to the feasibility study, the *Fume* health game aroused more interest among early adolescents than a website with a similar content ($p < 0.001$). *Fume* raised discussion about the thoughts related to the game and the game experiences. Thus, providing a forum to maintain these discussions was considered relevant for the further development of the intervention. (Parisod et al., 2018.) In this study, the Fume health game was complemented with a debriefing session and additional dimensions from the perspective of tobacco refusal self-efficacy were added to the game.

During this study, in 2021, the MRC's framework was updated, consequently the previous version of the framework (Craig et al., 2013) as well as the revised version of the framework (Skivington et al., 2021) were used concurrently. The revised framework highlights the non-linear or non-sequential nature of the process, and presents six core elements (context, programme theory, stakeholders, key

uncertainties, intervention refinement, and economic considerations) that need to be taken into consideration at every phase (Skivington et al., 2021). These core elements were taken into consideration during the study, for example, by examining previous research on *Fume*, receiving feedback from stakeholders, as well as by refining the theory related to the intervention with Sub-studies I, II, and III (see Figure 1).

This study included four sub-studies. The development phase includes Sub-studies I–III. It consisted of three steps during which the intervention theory was strengthened, refined, and tested. The evaluation phase includes Sub-study IV and consisted of assessing the effectiveness of the intervention. (Craig et al., 2013; Skivington et al., 2021.) Table 2 summarises the materials and methods used in the sub-studies. The next step in the intervention will be implementing it into a school context and focusing on the relevance of the intervention to schools and to society (Craig et al., 2013; Skivington et al., 2021).

**Table 2.** Summary of materials and methods.

| PHASE | SUB-STUDY | STUDY DESIGN | SETTING | PARTICIPANTS | DATA COLLECTION | DATA ANALYSIS |
|---|---|---|---|---|---|---|
| **DEVELOPMENT PHASE (2015–2021)** | I | Qualitative descriptive study | Comprehensive schools (n = 3) within two Finnish cities | Adolescents aged 13–17 years (n = 155) | Open-ended questionnaire with critical incident technique on self-efficacy in peer interactions | Inductive thematic analysis |
| | II | Systematic literature review | Electronic databases (n = 5) and manual literature search | Studies meeting the eligibility criteria (n = 23) | Systematic literature search on digital interventions to support refusal self-efficacy in child and adolescent health promotion | Narrative synthesis, deductive content analysis, quality of evidence (GRADE) analysis |
| | III | Cross-sectional study | Comprehensive schools (n = 8) within three Finnish municipalities, and comprehensive schools (n = 2) within one Portuguese municipality | Early adolescents aged 10–13 years (n = 295) | Questionnaires and instruments measuring background characteristics, tobacco refusal self-efficacy and related factors | Statistical analysis: logistic regression, Kendall's Ƭ coefficient, Mann Whitney U-test and Kruskall-Wallis test |
| **EVALUATION PHASE (2022–2023)** | IV | Cluster randomised controlled trial | Comprehensive schools (n =15) within nine Finnish municipalities | Early adolescents in 4th, 5th, and 6th grades [A] in the intervention group (n = 387) and in the control group (n = 394) | Questionnaires and instruments measuring background characteristics, tobacco refusal self-efficacy and related factors at baseline, 2 weeks, and 3 months | Statistical analysis: linear mixed model, Wilcoxon rank-based test for clustered data |

[A] Including early adolescents aged 9–14 years

## 4.2 Materials and methods in the development phase

### 4.2.1 Study designs, settings, participants, data collection, and data analysis

#### A qualitative descriptive study of Finnish adolescents' self-efficacy in peer interactions (Sub-study I)

A qualitative descriptive study design with the critical incident technique was used to identify and strengthen the theory related to adolescent self-efficacy. This study design was used to obtain a comprehensive description of the phenomena of adolescent self-efficacy within the context of peer interactions (Sandelowski, 2000). The critical incident technique was used to obtain a record of these specific self-efficacy related behaviours (Flanagan, 1954) and to emphasise the adolescents' own perspective. The technique provided a relatively rapid means of obtaining rich information (Schluter et al., 2008) with little effort from the participants (Kemppainen, 2000).

The data were collected from 155 adolescents (13–17 years old) in three Finnish comprehensive schools. The schools were selected using purposive sampling with maximum variation in order to obtain perspectives on self-efficacy from adolescents with diverse backgrounds. All the adolescents who fulfilled the following criteria were invited to participate in the study: 1) gave their consent, 2) were in the $7^{th}$, $8^{th}$, or $9^{th}$ grade, and 3) were able to understand Finnish. In total, 188 adolescents from ten school classes were invited to participate in the study, and of these 33 adolescents refused. Of the participating adolescents, 47 percent were girls and 53 percent were boys. The mean age was 14.37 years.

The data were collected during the spring of 2015 with an open-ended questionnaire that was created for this study. In the questionnaire, the adolescents were asked to describe two situations in which they had been in the company of a peer. The adolescents were asked to describe one situation in which they had been able to act according to their own choice and another situation when they had not. Based on a pilot test with the questionnaire, three sub-questions were added for each situation to ensure that accurate reports were obtained (Flanagan, 1954). The data were collected in the participating schools during ordinary lessons. The data collection events took about 30 minutes each.

The data were analysed using inductive thematic analysis to identify and describe patterns within the data in detail and driven by the data itself (Braun & Clarke, 2006). The data included altogether 270 critical incidents. First, the written data were transcribed into an electronic form and examined in detail. Second, initial codes (n = 76) and sub-themes were generated. I generated the codes and sub-themes for the whole data, and another researcher verified my analysis by independently reviewing and coding ten percent of the data. After comparing the codes and sub-themes, a consensus was achieved, and no new further sub-themes were identified. Third, the codes and sub-themes were sorted into overarching themes. Fourth, the identified themes were reviewed and refined. Finally, after having developed a thematic map of the data, the themes were defined and names for each theme were generated. It was concluded that saturation had been reached with the data, since new sub-themes could not be identified after the ninth participating school class. The study procedures as well as materials and methods used in this sub-study have been described in more detail in Paper I.

### A systematic literature review of digital interventions to support refusal self-efficacy in child and adolescent health promotion (Sub-study II)

A systematic literature review was made to identify and summarise the evidence related to digital interventions to support refusal self-efficacy in the health promotion of children and adolescents. This approach enabled us to compile, examine, and summarise the existing evidence systematically using rigorous methods (Cumpston et al., 2023). During the review process, the Cochrane Collaboration guidelines for systematic reviews of interventions (Higgins & Green, 2011) were followed. Of the 1700 publications retrieved from the five databases, 23 publications were included in the systematic literature review.

A systematic literature search was made in PubMed/Medline, CINAHL, Cochrane Library, PsycINFO and Embase electronic databases in March 2019, and updated in April 2020. The search was limited to publications that were published between 2009 and 2020 in order to reach the most up-to-date digital interventions as well as acknowledging the constantly developing and evolving technology (Michie et al., 2017). The literature search was complemented with a manual search by examining the reference lists of the retrieved publications. The eligibility criteria were decided based on the PICO framework (P: population, I: intervention, C: comparison, O: outcome) (Miller & Forrest, 2001). Studies were included in the review if 1) most of the participants (≥50 percent) were children or adolescents up to the age of 18 (P), 2) the intervention was digital (I), 3) there were intervention and control conditions (C), 4) refusal self-efficacy was measured both before and after

the intervention (O), 5) and the design was an experimental or quasi-experimental (study design).

After removing duplicates, one reviewer initially screened the titles and abstracts of all records based on the eligibility criteria. Full-texts of the potentially relevant publications, and the risk of bias of the publications included in the review were reviewed by two independent reviewers. Altogether 23 studies were included in the review. These studies examined 18 interventions. The Cochrane Collaboration's checklist of items to consider in data collection (Higgins & Green, 2011) and the template for intervention description and replication (TIDieR) checklist (Hoffmann et al., 2014) to formulate a data extraction plan were used. Based on this plan, all relevant data were extracted concerning the study, intervention, and how refusal self-efficacy is addressed in the intervention.

The data were analysed using narrative synthesis to summarise the results narratively (Popay et al., 2006) and deductive content analysis to analyse and test how the interventions addressed refusal self-efficacy based on Bandura's (1997) Self-Efficacy Theory (Elo & Kyngäs, 2008). These analysis methods were chosen since statistical methods, for example meta-analysis, were not considered feasible due to the heterogeneity of the interventions and the refusal self-efficacy instruments. However, it was possible to summarise the intervention effects in a table, and to compare the p-values on refusal self-efficacy among the reviewed studies. In addition, the evidence quality was evaluated with the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) approach. The study procedures as well as materials and methods used in this sub-study have been described in more detail in Paper II.

### A cross-sectional study on factors associated with tobacco refusal self-efficacy among adolescents in Finland and Portugal (Sub-study III)

A cross-sectional study was made to strengthen the theoretical basis of adolescent tobacco refusal self-efficacy. This study design was chosen because it enabled information to be obtained about potential associations with tobacco refusal self-efficacy to inform the intervention development (Wang & Cheng, 2020). For example, according to De Vries et al. (1988) the development of interventions to support tobacco refusal self-efficacy need to consider the target group and its characteristics.

The data were collected from 295 early adolescents (10–13 years old): 151 in Finland and 144 in Portugal. These two countries, one from Northern Europe and the other from Southern Europe, were chosen because early adolescent smoking rates were similar in both countries (ESPAD Group 2020). This selection was made to not only reflect the similarity in smoking patterns but also to bring an international

perspective into the development of the intervention. The study was a secondary analysis of data collected for two feasibility and pilot studies conducted in schools. These studies have been described in more detail in Parisod et al. (2018) and in Pinto et al. (2022). Cluster sampling was used to select participants from eight schools in Finland. The two Portuguese schools were selected purposively based on previous contacts with the schools. The early adolescents in the participating schools were eligible to participate in the study if they 1) were from 10 to 13 years old, 2) were able to understand and communicate in Finnish, Swedish, English, or Portuguese, and 3) had access to a smartphone or tablet computer during the data collection. All 10–13-year-old early adolescents in the participating schools met the eligibility criteria, with the total number of early adolescents in each class remaining unknown. Thus, it was not possible to calculate the response rate.

The data were collected during the spring of 2016 (Finnish data) and the spring of 2019 (Portuguese data) from 10–13-year-old early adolescents with questionnaires and validated or pilot tested instruments. Questionnaires were used to measure the participants' background information and other factors that might be associated with tobacco refusal self-efficacy, and instruments to measure tobacco refusal self-efficacy and related variables, such as smoking outcome expectations. The instruments included: The Anti-Smoking Self-Efficacy Scale (ASSES), the Smoking Outcome Expectation Scale (SOES) (Chen et al., 2015), and three short scales on tobacco-related attitudes, motives for smoking tobacco, and motivation to refrain from smoking tobacco in the future (Parisod et al., 2018). ASSES and SOES were translated, and pilot tested with early adolescents before data collection. The three short scales were developed for the feasibility and pilot studies, and pilot tested with early adolescents before data collection.

Statistical analysis was used to analyse the data as a whole and the Finnish and the Portuguese samples separately. Similar statistical analyses were used for all samples. The background characteristics were analysed with descriptive analysis (for example, mean and percentage). The association between tobacco refusal self-efficacy and background factors and the studied variables was examined with Kendall's Τ coefficient (continuous variables) as well as with the Mann Whitney U-test and the Kruskall-Wallis test (categorical variables). In addition, logistic regression was used to examine the predictors of tobacco refusal self-efficacy. The study procedures as well as materials and methods used in this sub-study have been described in more detail in Paper III.

## 4.3 Development of the intervention

The aim of the intervention was to support early adolescent tobacco refusal self-efficacy and non-use of tobacco and nicotine products. The intervention was based on a previously developed and tested mobile health game '*Fume*' that was designed to support early adolescents' (10–13 years old) non-smoking and tobacco-related health literacy (Parisod et al., 2017). During the development phase, the intervention was developed based on the theoretical basis of adolescent self-efficacy (specifically refusal self-efficacy), the results from the feasibility study of *Fume* and the outcomes on the preliminary effectiveness, as well as on the feedback from the early adolescents and school health nurses. The development of the intervention was two-fold consisting of further developing the *Fume* game and designing and developing a debriefing session.

Based on previous literature and the results from the feasibility study, early adolescents value good health but have only a little and partly inaccurate information on the consequences of using snus. Thus, there was a need to add snus-related content into the *Fume* game. The feasibility study indicated a need to further develop the game content from the perspective of self-efficacy. The theoretical basis of adolescent self-efficacy and refusal self-efficacy revealed a need to strengthen the perspective of social and peer pressure on the *Fume* game, for example by providing a possibility to test out different means to refuse smoking or using snus. The feasibility study also indicated a need to add a debriefing session after playing the game because the early adolescents discussed the game events with their peers. In addition, the early adolescents asked for the game to be more attractive, for example via graphics, a global high score list, and more minigames. The school health nurses asked for a more comprehensive game speed and tempo because the speed was too fast for students with special educational needs.

### 4.3.1 Further development of the *Fume health* game

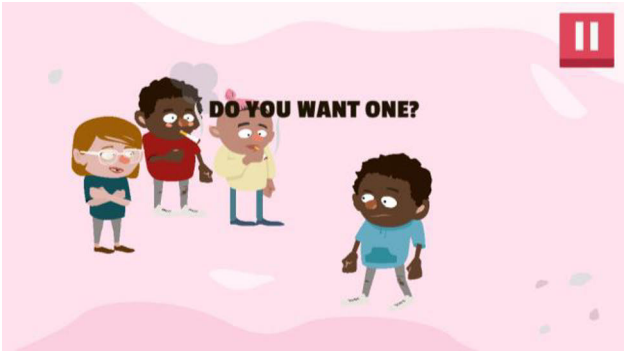
Further development of the *Fume* health game was done together with the game development company, *Hehto*. The content of the game was designed by us whereas *Hehto* took care of the technical design and development. According to the pilot test of *Fume*, more research was needed from the point of view of tobacco-related self-efficacy, and how it can be strengthened in *Fume* (Parisod, et al., 2018).

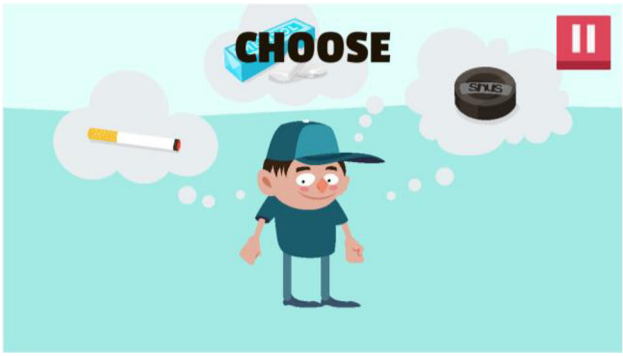
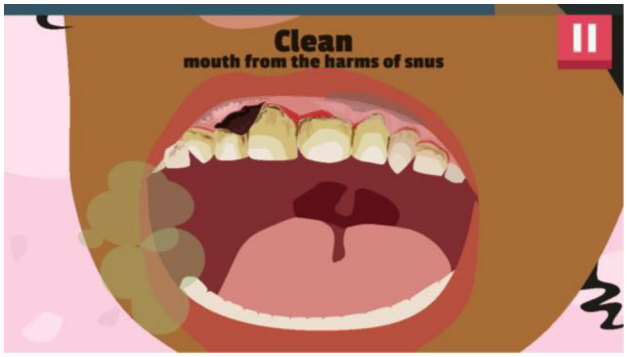
The *Fume* health game approaches health education related to non-use of tobacco and nicotine products in a fun way. The original game consists of fact sheets and five minigames in which the players can familiarise themselves with the various consequences of smoking tobacco and using snus from the perspectives of health and physical health, environment, and social environment, as well as personal finances.

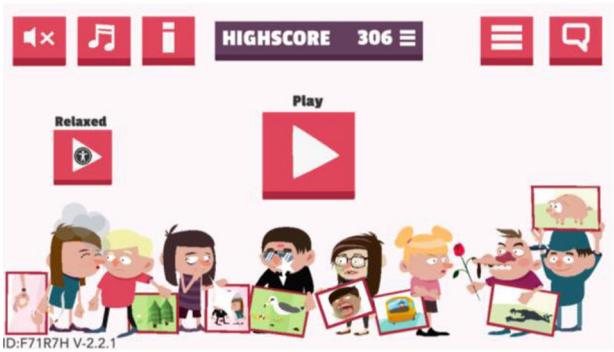
It is free to use and can be played via mobile phones, tablet computers, or computers. (Parisod, et al., 2017.) The *Fume* health game is owned by the University of Turku.

The following changes were made to the *Fume* health game. Two minigames were added that highlighted the health consequences of smoking tobacco and using snus specifically on oral health and from the perspective of addiction. Changes were made to two existing minigames to strengthen the perspective of social pressure and to learn different means to refuse smoking or using snus, and to make the content of the minigames clearer. A relaxed game mode was added that offers a slower game speed. The game graphics were updated and improved by adding game characters with different backgrounds. The further developed *Fume* health game is presented in more detail in Table 3.

**Table 3.** Description of the new game elements in the further developed *Fume* health game.

| Game element | Description of the game element and the rationale |
|---|---|
| Information box on the consequences of tobacco smoking and snus use to oral health<br>  | An information box was added to give information on the consequences of tobacco smoking and snus use to oral health. Another information box was needed since a game on the consequences of snus to oral health was added. |
| Game on refusing tobacco and snus<br>  | The game was further developed to highlight the perspective of social pressure and to give examples on how to refuse tobacco and snus. |

| | |
|---|---|
| Game on the consequences of tobacco smoking and snus use on physical health<br>  | The game was further developed to let the player choose the action (smoking tobacco, using snus, or healthier choice, such as, chewing gum) instead of choosing a game character. Also, the loss event was modified to make the message of the game clearer. |
| Game on the addiction caused by tobacco and snus<br>  | A game was added to illustrate the addition caused by tobacco and snus since it was lacking from the original game. According to previous literature, adolescents' knowledge of the health consequences of smoking and snus use in particular are limited. |
| Game on the consequences of snus use to oral health<br>  | A game was added to illustrate the consequences of snus use to oral health since, based on previous literature, there was a need to highlight the health consequences of snus use. Also, the perspective of oral health was lacking in the original game. |

| | |
|---|---|
| Relaxed game mode<br>  | Based on the feedback from school health nurses, a relaxed game mode was added to the game to improve the accessibility of the game for players with different needs. |
| New and varying game characters<br>  | New and randomly varying game characters were added to improve the accessibility of the game for players with different backgrounds. |

### 4.3.2 Design and development of the debriefing session

Based on the theoretical basis and the feasibility study of the *Fume* health game (Parisod et al., 2018), the development of the intervention started by designing a debriefing session to complement the game play and to provide a forum for maintaining discussion on game experiences and tobacco-related content. Two comprehensive school teachers were consulted and asked to comment on the ideas and give feedback. Debriefing was used because it is an appropriate method to use with school classes in which the children know each other and form a natural group together (Pfefferbaum et al., 2015). The early adolescents were offered a debriefing session after playing the game to link the game experience and events more closely with their learning and learning objectives (Garris et al., 2002). The method is a good means to support the early adolescents' learning because it offers a suitable space for the early adolescents to examine and analyse the game events, and thus helps

them to connect and apply their learning in the game to real-life events (Garris et al., 2002; Hromek & Roffey, 2009; Nieh & Wu, 2018). One strength of the method is that is provides the participants with feedback on their behaviour and prepares them to face similar situations in real-life (Sugai & Colvin, 1997). During debriefing, the participants discuss and reflect on their experiences (Lederman, 1992). Thus, it is important that the group leader understands the participants, their developmental stage, and their abilities to reflect and discuss (Hromek & Roffey, 2009).

The debriefing was organised in groups, separately for each school class. The design of the debriefing session was as follows: 1) breaking the ice with easy questions related to the early adolescents' feelings and thoughts on the *Fume* health game (Adler et al., 2019), 2) describing the schedule and tasks with a power point presentation, 3) diving the class into small groups of 2-4 early adolescents, 4) small group discussions on two questions during 10–15 minutes, 5) sharing and summarising the discussions with the whole class, and 6) ending the debriefing session.

Small group discussions were used to complement whole class discussions and to promote interaction between the early adolescents (Galton et al., 2009). Furthermore, supplementary questions were used to promote the discussions, to ask the early adolescents to share more about their thoughts, to ask for and to suggest alternative perspectives and thoughts, as well as to ask them to explain and give reasons for their perspectives and thoughts (Adler et al., 2019; Gillies, 2011). During the small group discussions, the early adolescents were asked to write down their thoughts on the *Flinga* platform which is a cloud computing platform for co-creation and sharing thoughts (Nordtouch, n.d.). *Flinga* was used because it is easy to use via web browsers (either with a smartphone, tablet computer, or computer) and did not require registration from the participants.

## 4.4 Materials and methods in the evaluation phase

### 4.4.1 Study design

A single-blind two-arm cluster randomised controlled trial study design was used to evaluate the effectiveness of the developed intervention on early adolescent tobacco refusal self-efficacy (Sub-study IV). Tobacco refusal self-efficacy was regarded as the primary outcome. Sources of self-efficacy related to smoking and snus refusal, and motivation to decline smoking and snus use in the future were considered as secondary outcomes. The outcomes were derived from our previous studies at the development phase concerning identifying and developing the theory (Sub-studies I and III, Paper I, Paper III) and modelling process and outcomes (Sub-study II, Paper

II). Figure 2 presents the study design. The study procedures as well as materials and methods used in this sub-study have been described in more detail in Paper IV.

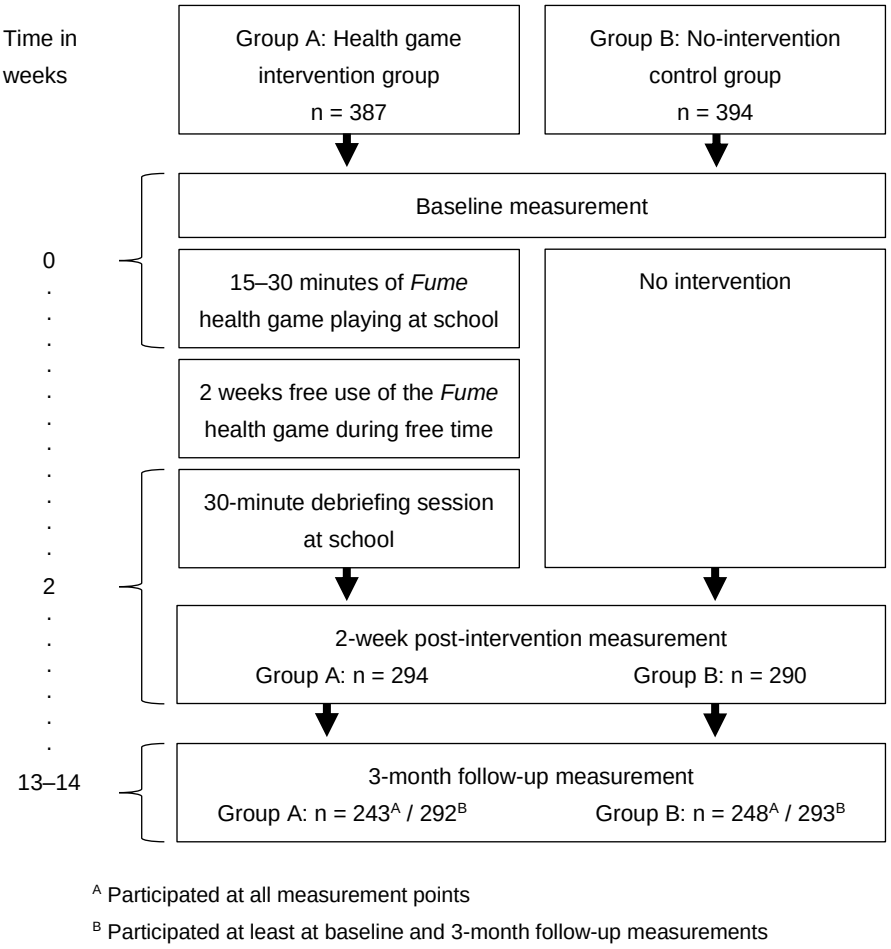



**Figure 2.** Study design and participant flow in Sub-study IV.

### 4.4.2 Participants and settings

In Sub-study IV, the participating early adolescents were recruited from nine Finnish municipalities that represented areas with the highest rates of tobacco and nicotine product experimentation among early adolescents in 2021 according to the Finnish School Health Promotion study (THL n.d.). All schools in these municipalities were invited to participate in the study if they had 1) a 4th, 5th, or 6th grade, 2) Finnish as the official language, and 3) tablet computers for the students for educational use.

Altogether fifteen schools participated in the study. The participating schools were randomly allocated to the two arms: intervention (8 schools) and control (7 schools). All students in the participating schools were invited to participate in the study that met the eligibility criteria: 1) they were at the 4th, 5th, or 6th grade, 2) they could speak and understand Finnish, Swedish, or English, 3) they were willing to participate, and 4) their parent or guardian did not refuse their participation.

The data were collected from altogether 781 early adolescents at the baseline. The aim was to collect data from 10–13-year-old early adolescents from 4th, 5th, and 6th grades. However, in our total data there were a few individual participants who were 9 years old or who had already turned 14. In order not to exclude individual students, participants aged 9–14 years were included in the study.

A power analysis was used to estimate the sample size needed for the study. Since tobacco refusal self-efficacy was our primary outcome, the power calculation was made based on the results on tobacco refusal self-efficacy in the feasibility and pilot study of the *Fume* health game (Parisod et al., 2018). The effect size of 0.30, significance level of 0.05, and power level of 0.80 were used. Based on this calculation, the required sample size was 290 participants in total. The analysis was complemented with the clustering effect of 1.49 (ICC: 0.01, cluster size: 50) since it has been estimated that cluster randomised trials require 50–100 percent more participants than trials with individual randomisation to attain the needed statistical power (Puffer, et al., 2005). With the clustering effect and an estimated loss of 20 percent, at least 542 participants were needed in total (271 participants in each arm).

Of the 781 early adolescents participating at the baseline, 561 participated at the 2-week post-intervention, and 585 at the 3-month follow-up (out of which 491 took part in all measurement points). There was a twenty-five percent loss at the 2-week post-intervention, and a thirteen percent loss at the 3-month follow-up. At both measurement points, the main reasons for the loss were absences from school, and problems with e-mail.

### 4.4.3 Data collection and instruments

In Sub-study IV, the data were collected during the spring of 2022. The REDCap application was used with online questionnaires for measuring the outcomes of the intervention at baseline, 2-week post-intervention, and 3-month follow-up. The participants were the same at each measurement point.

Questionnaires were used to measure the early adolescents' background characteristics and factors associated with adolescent tobacco refusal self-efficacy based on our cross-sectional study (Sub-study III). The questionnaire included the following items of the early adolescents: age, gender, mother language, parents' mother language, values, experiences of being offered tobacco and snus, tobacco

smoking and snus use experimentations, tobacco smoking and snus use behaviour of other people, experiences of seeing other people smoke tobacco and use snus, and experiences of being offered health education on smoking tobacco and snus use.

Two previously developed instruments were used: one measuring smoking refusal self-efficacy (Lazuras et al., 2009), and another measuring motivation to decline smoking tobacco and snus use in the future (Parisod et al., 2018). In addition, a structured questionnaire was developed to measure the sources of refusal self-efficacy related to smoking tobacco and snus refusal. All instruments and questionnaires measuring outcomes were pilot tested with 10–13-year-old early adolescents (n = 5) before data collection.

### Instrument measuring tobacco refusal self-efficacy

The smoking refusal self-efficacy instrument developed by Lazuras et al. (2009) was used to measure tobacco refusal self-efficacy. The instrument consists of six items on a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree). The items measure the adolescents' self-efficacy to refuse smoking tobacco in different situations, for example, if a friend wants them to smoke or if they believe most people around them are smokers. The total score ranges from 6 to 24 with higher scores indicating stronger smoking refusal self-efficacy. The instrument was originally developed for and tested with 12–15-year-old Greek adolescents. The internal consistency was good (Cronbach's alpha 0.95), and the mean score was 3.22. (Lazuras et al., 2009.)

### Instrument measuring sources of tobacco refusal self-efficacy

A structured questionnaire was developed to measure the sources of tobacco refusal self-efficacy. The questionnaire consists of two sub-scales: one related to smoking tobacco and another related to the use of snus. The questionnaire is based on previous literature on self-efficacy and refusal self-efficacy, as well as on adolescents' perspectives on smoking tobacco and using snus. Each sub-scale consists of seven items on a 4-point Likert scale (1 = bad, 4 = good; 1 = easy, 4 = difficult; 1 = disagree, 4 = agree). The items measure the sources of self-efficacy according to Bandura's Self-Efficacy Theory (Bandura, 1997): mastery experiences (1 item), vicarious experiences (4 items), social persuasion (1 item), and physiological and emotional states (1 items). The total score of each sub-scale ranges from 7 to 28 (two items reverse-coded) with higher scores indicating stronger sources of refusal self-efficacy related to tobacco refusal.

### Instrument measuring motivation to decline tobacco use in the future

The questionnaire developed by Parisod et al. (2018) was used to measure the early adolescents' motivation to decline tobacco use in the future. The questionnaire consists of two sub-scales: one measuring the motivation to decline smoking tobacco, and the other to using snus. Each questionnaire consists of one item on a 4-point Likert scale (1 = definitely could not, 4 = definitely could). The total score of each sub-scale ranges from 1 to 4 with lower scores indicating stronger motivation to decline tobacco use in the future. (Parisod et al., 2018.)

## 4.4.4 Implementation of the intervention

### Health game intervention group

The early adolescents in the health game intervention group received the health game intervention including the *Fume* health game and the debriefing session. First, the participating schools were approached, and given instructions on how to download and use the game. According to the initial plan, the game was supposed to be played with the schools' tablet computers. There were difficulties with publishing the game at the application store of iOS operating system (App Store). Thus, the schools were offered a possibility to play the game via the web browsers of their computers. However, the game was the same in each platform. The early adolescents played *Fume* at school for 15–30 minutes either individually or in small groups of two or three early adolescents. Afterwards, they could play *Fume* during their free time based on their own interest.

Two weeks after the game playing session at school, the early adolescents received a 30-minute debriefing session led by a researcher (the author) using a remote connection. The class teacher facilitated the debriefing session, and the date and time were agreed with the teacher. A remote connection via Zoom, Teams, or Google Meet platform was used due to the Covid-19 pandemic, and the schools' recommendations to avoid receiving external visitors. The debriefing session included small group discussions about the themes in the *Fume* health game. During the small group discussions, the early adolescents wrote their thoughts on the *Flinga* platform. Finally, the small group discussions were summarised with the whole group (school class).

### No-intervention control group

The early adolescents in the no-intervention control group received no intervention. However, they participated in the baseline, 2-week post-intervention, and 3-month follow-up measurements.

### 4.4.5 Data analysis

The data were analysed with statistical analysis in Sub-study IV. The analysis included descriptive statistics with the background variables and a linear mixed model (LMM) to examine the effectiveness of the intervention on the outcome variables. The linear mixed model was used because it has been considered a robust approach to missing data and data in which participants are organised in clusters which are common in cluster randomised trials (Hilbert et al., 2019; Hossain et al., 2017). Moreover, a sub-group analysis was conducted based on gender, age, parental smoking, friends' smoking, smoking experimentation, as well as lowers scores on outcome variables. The changes in individual items at different time points were examined with the Wilcoxon rank-based test for clustered data. The Fisher's Exact test and Mann Whitney U-test were used to examine the possible differences between the intervention group and the control group at baseline and between those continuing study participation and those dropping out of the study before the post-intervention.

## 4.5 Ethical considerations

The guidelines for responsible conduct of research and research integrity were followed during the whole study and its sub-studies. Research integrity was ensured by designing, conducting, analysing, and reporting the study with accuracy, honesty, accountability, meticulousness, and respect, especially for all participants and participating organisations. Ethically sustainable research methods were used, and it was ensured that the samples and research methods corresponded to the research questions, aims and objectives of the sub-studies. (ALLEA, 2023; TENK, 2023.) Ethical pre-approval was applied for Sub-studies I, III and IV. Ethical pre-approval was received for Sub-study I from the Ethics Committee of the University of Turku (reference number 12/2015), for Sub-study III from the Ethics Committee of the University of Turku (reference number 11/2016) and from the Ethics Committee of the Health Sciences Research unit in Nursing at the Nursing School of Coimbra (reference number P521-09/2018), and for Sub-study IV from the Ethics Committee of the University of Turku (reference numbers 27/2021 and 2/2022). Research permission was applied and received from the participating municipalities according

to their own practices. The schools and the principals of the schools were approached and asked for permission to conduct the study. In addition, in Sub-study IV, the permission to translate and use the smoking refusal self-efficacy scale by Lazuras et al. (2009) was asked for and received via e-mail on July 2, 2021. Furthermore, regarding Sub-study III, the permission to translate and utilise the ASSES and SOES instruments by Chen et al. (2015) was obtained before the original feasibility studies.

This study was conducted following the ethical guidelines and principles related to conducting research with children and adolescents. It was considered important to hear the adolescents' own perspectives and views. Thus, adolescents were invited to participate in the development and effectiveness evaluation of the health game intervention. The aims of the sub-studies could not have been achieved if the research data had not been collected directly from the adolescents themselves. For example, the Constitution of Finland (6 §, 731/1999) and the United Nations (UN) Convention on the Rights of the Child (Article 12, 1989) support hearing the perspectives and views of children and adolescents in accordance with their age and developmental stage. The Finnish Advisory Board on Research Integrity (TENK) has outlined that minors must be given the opportunity to influence their own affairs in accordance with their maturity (TENK, 2019). Therefore, the research methods of the sub-studies were selected in accordance with the maturity of early adolescents and adolescents. Moreover, the sample sizes were meticulously considered in order to meet the aims of the sub-studies. Discussions were held with the teachers before data collection. Thus, it was ensured that the participating adolescents could understand the topic of the study and what participation in the study meant.

The Finnish Act on Child Custody and Right of Access (4 §, 361/1983) determines that the legal guardians have the right to decide on the affairs of their child. In addition, according to the Finnish Advisory Board on Research Integrity, the legal guardian primarily decides on the participation of a child under 15 years of age in a study. However, for surveys that aim for large numbers of respondents, it is sufficient to inform the guardians about the study and give the possibility to prohibit the participation of their child. (TENK, 2019.) Participation in the sub-studies included completing questionnaires (Sub-studies I, III, and IV) and participation in the health game intervention (Sub-studies III and IV) in which the content was similar to the general health education related to non-use and refusing tobacco and nicotine products. Thus, the studies did not interfere with the physical integrity of the adolescents, and participation did not cause them any risk or harm (TENK, 2019).

Before the onset of Sub-studies I, III and IV, the study participants and their parents (or guardians) were informed in writing. The information letters with contact details were given to the participating schools, and it was ensured that they distributed the letters to the adolescents and their parents before data collection. In these letters the purpose of the study, the study participation, and the autonomy and

confidentiality procedures were described. Separate letters were prepared for the adolescents and their parents to ensure that they understood the language. In Sub-study IV, the information letter was pilot tested with early adolescents to ensure comprehensibility.

Sub-studies I, III, and IV included a request for the adolescents' consent to participate in the study. In addition to which their parents were given the possibility to prohibit their child's participation, since the participants were mainly children under the age of 15 (TENK, 2019). In Sub-study I, the participating adolescents gave their written consent during a school class session, and the parents could decline their child's participation by informing the class teacher. In Sub-study III, both the early adolescents and their parents were asked for written consent before data collection. The early adolescents could participate in the study if they themselves and at least one of their parents gave consent. Sub-study IV was comparable to a large survey (TENK, 2019), consequently, the early adolescents gave their consent to participate in the study by filling in the questionnaires. Their parents could prohibit their participation by informing the class teacher. Although the data in Sub-studies I, III, and IV were collected in schools, participation or non-participation in the study did not affect the learning, care or grades that adolescents received at school.

Current data protection regulations were followed in each sub-study. Participation in the sub-studies was voluntary, and the adolescents were able to terminate participation until the data had been collected. Afterwards, terminating participation was not possible since the data were de-identified before data analysis to ensure protecting the privacy of the participating adolescents. In the sub-studies, the adolescents' personal data (Sub-studies I and III: name, Sub-study IV: e-mail address) was kept separate from the research data and was destroyed when it was no longer needed. The adolescents' personal data were kept confidential, and individuals outside the research group had no access to the data. All written research data and material was kept locked up in filing cabinets (in Sub-studies I and III), and all electronic research data and material was stored on a computer behind a confidential password (in Sub-studies I, III, and IV). In Sub-study IV, the e-mail address was considered the personal identifier based on which it was possible to connect the baseline, post, and follow-up measurements of each participating early adolescent. This enabled evaluating the effectiveness of the health game intervention. However, after data collection, each early adolescent was given a research number from which they were no longer identifiable. In addition, the participating adolescents remained anonymous in all publications and reports of the sub-studies. According to the General Data Protection Regulation (Articles 13 and 14, Regulation (EU) 2016/679) of the European Union, the early adolescents were provided with a data protection statement for scientific research prior to responding to the questionnaire.

In this study, a digital health game intervention was used to support early adolescent tobacco refusal self-efficacy and non-smoking. Digital interventions and games are providing new means to promote child and adolescent health by facilitating learning and the acquisition of skills, and have many benefits, mainly in terms of attractiveness and enjoyment (Baranowski et al., 2016). Indeed, it has been identified, that people play games because they enjoy playing them and perceive them as useful (Hamari & Keronen, 2017). One significant benefit of digital health games is that they can increase engagement and the use of the intervention (Sardi et al., 2017). For example, in the feasibility study of the *Fume* health game, the early adolescents found the game more attractive and used it more often compared to its non-gamified counterpart (Parisod et al., 2018). The attractiveness of the digital intervention or health game can increase interaction with the health content, and thus, promote health. However, the interventions need to be fun and enjoyable to be effective (Baranowski et al., 2016). For example, in the study of Khalil et al. (2017), the more the adolescents perceived the digital intervention as fun and interactive, the more likely their intention to smoke decreased.

In addition to its benefits and aims to promote health, digital health games can cause some unintentional negative consequences, and thus, raise some ethical concerns. This is especially important with children and adolescents since they are particularly vulnerable due to their limited rational capacities and abilities to avoid being harmed (Giesinger, 2019). Globally, different age rating systems are used to ensure that the digital games are appropriate for children. In Finland, the Pan European Game Information (PEGI) age rating is the most used (KAVI, n.d.). However, the rating systems do not consider all ethical aspects of digital games. For example, the PEGI rating considers only the harmfulness of the content but does not address the suitability of the game or the level of difficulty for a particular age (KAVI, n.d.). Thus, digital intervention and game designers and developers, as well as other stakeholders involved in the process, need to assure that all ethical issues have been considered and addressed (Arora & Razavian, 2021; Brall et al., 2019). Although research on health games started to increase in the 2010s (Sardi et al., 2017), evidence on the ethical issues of health games is very limited (Arora & Razavian, 2021; Hyrynsalmi et al., 2017).

The negative consequences of health games can be categorised into the limitations and the harmful consequences of games. The limitations are mostly related to the failed implementation of the game that limits its full potential. (Hyrynsalmi et al., 2017.) For example, if the game does not achieve its goals due to issues with the content (Arora & Razavian, 2021; Hyrynsalmi et al., 2017), if there are information security weaknesses (Arora & Razavian, 2021; Brall et al., 2019), or if the game is not accessible for all the intended audience (Brall et al., 2019). Although the content of the *Fume* health game included information that was

approached in a youth-centered manner, it was developed carefully as well as based on factual information and a sound theoretical background. The implementation of *Fume* into the school context was also previously tested in the feasibility and pilot study (Parisod et al., 2018), and thus, an understanding of the consequences of the game and its content was achieved. The accessibility of the *Fume* health game was addressed by having it freely available in application stores, and also accessible via web browsers. The accessibility of *Fume* to players was further improved with different backgrounds and needs by adding varying game characters and a relaxed game mode. A thorough consideration was given to information security and privacy issues. The players are informed about the privacy policy, and the game does not collect any personal information. It can also be played without registration via a web browser.

The unintended harmful consequences of health games include, for example, harm to physical health (Huard Pelletier et al., 2020), negative social outcomes, and psychological harm (Arora & Razavian, 2021). Many of these unintended harmful consequences are related to screen time and the sedentary nature of games and digital media which can reduce physical activity, interfere with sleep, and have negative consequences on health, for example, by increasing the risk of obesity and depression, as well as by disturbing cognitive development (Canadian Paediatric Society, 2019). Thus, the unintended harmful consequences of games need to be taken into careful consideration when designing and developing games, although the aim of the game would be to promote health or educate. For example, although *Fume* is a sedentary game, it can be played through in 5 minutes, and familiarising oneself with the content does not require long periods of gameplay. In addition, the position statement of the Canadian Paediatric Society (2019) recommends considering the type of digital media and encouraging the meaningful use of digital media (with educational or active activities) for school-aged children.

One serious harmful consequence related to games is excessive or problematic gaming that can lead to game dependence or addiction (Arora & Razavian, 2021; Canadian Paediatric Society, 2019). Excessive gaming, in turn, is associated with various harmful outcomes on health and well-being, such as, depression, obsessive–compulsive disorder, anxiety, and somatisation (Männikkö et al., 2020). There is evidence that excessive gaming is especially related to specific game genres (such as, action, role-playing, strategy or shooting games) that represent games developed for entertainment (Männikkö et al., 2018). However, enjoyment and fun cannot be ignored with health games either (Baranowski et al., 2016). Thus, excessive gaming needs to be taken into consideration, for example, from the perspective of how the motivation of the player is being supported and what are the incentives and rewards (Arora & Razavian, 2021).

# 5 Results

## 5.1 Results of the development phase

### 5.1.1 Adolescent self-efficacy is influenced by the surrounding social atmosphere

Based on the open-ended questionnaires, the adolescents described their self-efficacy in peer interactions as an ongoing and dynamic process (RQ 1, Sub-study I). During this process the adolescents engage in self-reflection around the following themes: surrounding social atmosphere, self-identity, evaluating the consequences of the planned action, cognitive aspect, and emotional aspect. These themes illustrate factors that influence adolescents' self-efficacy in peer interactions. Depending on how the adolescents reflect on these themes, they can either strengthen or weaken self-efficacy. The identified themes and sub-themes are presented in Table 4.

**Table 4.** Factors influencing adolescent self-efficacy in peer interactions.

| THEME | SUB-THEME |
|---|---|
| **SURROUNDING SOCIAL ATMOSPHERE** | Social pressure<br>Closeness in peer relationships |
| **SELF-IDENTITY** | Self-confidence<br>Morals |
| **EVALUATING THE CONSEQUENCES** | Understanding the consequences<br>Own vs. someone else's needs |
| **COGNITIVE ASPECT** | Rationality |
| **EMOTIONAL ASPECT** | Emotions and feelings |

The surrounding social atmosphere was the most unstable theme, and often weakened the adolescents' self-efficacy. The adolescents' contemplations on the social atmosphere varied depending on the circumstances. Social atmosphere appeared in the descriptions of the adolescents as social pressure that was present in different situations and a perceived closeness in peer relationships. Social pressure was experienced by

the adolescents as either direct (for example, when their peer persuaded or provoked them) or indirect (for example, when they were left alone with their opinions). The adolescents described closeness in peer relationships as trust in the peer that they would not make the adolescent do anything unwillingly and the depth of the peer relationship. The adolescents contemplated the depth of the peer relationship, for example, when they perceived that the friendship was close, and the friend was important to them.

Based on the adolescents' descriptions, self-identity was the most solid theme. It is characterised by self-confidence and morals. Self-confidence appeared in the adolescents' descriptions as the determination to act according to one's own choice, self-knowledge, and belief in oneself. Morals appeared as the adolescent's conception of what is right and wrong and what is fair. For example, they wanted both to be treated fairly and to treat their peers fairly.

The adolescents evaluated the consequences of intended actions by understanding the consequences and comparing the needs of oneself with the needs of others. Understanding the consequences meant, for example, that the adolescents wanted to stay out of trouble and avoid conflicts. Comparing the needs of oneself with the needs of others meant that the adolescents either put their own needs or other people's needs first, and this influenced how the adolescents perceived the consequences of their action.

Based on the adolescents' descriptions, cognitive aspects appeared as a rationality of their own or their peers' opinions and thoughts. Rationality also meant that the adolescents reasoned how to act and prioritised what was most important for them. Emotional aspects included emotions and feelings (for example, fear or fatigue) which influenced the adolescents' self-efficacy. The results are described in more detail in Paper I.

### 5.1.2 Digital interventions offer possibilities to support refusal self-efficacy

Previous literature and evidence collected in Sub-study II (RQ 2) suggest that digital interventions offer several possibilities to successfully support child and adolescent refusal self-efficacy. The interventions consisted of different digital elements that addressed refusal self-efficacy from the perspective of the four hypothetised sources of self-efficacy: mastery experiences, vicarious experiences, social persusion, and emotions and physiological states. The digital elements are presented in Table 5.

**Table 5.** Digital elements supporting refusal self-efficacy.

| SOURCE OF SELF-EFFICACY | DIGITAL ELEMENT | RATIONALE |
|---|---|---|
| **MASTERY EXPERIENCES** | Games<br>Role-plays<br>Skill-based exercises<br>Goal and limit setting exercises<br>Quizzes | To practice skills<br>To obtain experiences of challenging situations<br>To reinforce learning of skills and knowledge |
| **VICARIOUS EXPERIENCES** | Videos, stories, and voice messages from peers<br>Animated scenes presenting consequences<br>Role models presenting activities<br>Chat forums | To learn from peers about their experiences and skills<br>To witness peers' experiences and skills<br>To share thoughts with peers and vice-versa |
| **SOCIAL PERSUASION** | Automated feedback<br>Scores, prizes, incentives<br>Choice-based advancement<br>Online support and counselling | To receive encouraging feedback on tasks and exercises<br>To receive supportive interaction |
| **EMOTIONS AND PHYSIOLOGICAL STATES** | Support for positive feelings and communication<br>Platform for reflection and personalisation<br>Feel-good material<br>Exercises to regulate and cope with feelings | To be in an environment that fosters positive feelings for healthy behaviours<br>To learn how to cope with different feelings |

The evidence collected showed somewhat varying results on the effectiveness of the digital interventions on child and adolescent refusal self-efficacy. There were studies which resulted in only statistically significant favourable outcomes (n = 6), in only statistically nonsignificant outcomes (n = 6), and both statistically significant and nonsignificant outcomes (n = 9). There were also studies (n = 2) which reported that refusal self-efficacy had been measured, but no outcomes were available. Two studies resulting in only statistically significant favourable outcomes used the same data.

Among the interventions that resulted in only statistically significant favourable outcomes, most were delivered in home setting (n = 4), addressed only girls' refusal self-efficacy (n = 4), and addressed refusal self-efficacy with various digital elements from the perspective of almost all four sources of self-efficacy. The results on the evidence quality assessment with the GRADE approach are presented in Table 6 for each subtype of refusal self-efficacy outcomes measured in the studies: substance use refusal self-efficacy, sex refusal self-efficacy, and peer resistance self-efficacy. In addition, a subgroup analysis was made by assessing the evidence quality of digital interventions to support substance use refusal self-efficacy among girls. The results are described in more detail in Paper II.

**Table 6.** Evidence quality of digital interventions to support child and adolescent refusal self-efficacy assessed by GRADE.

| SUBTYPE OF REFUSAL SELF-EFFICACY (NUMBER OF STUDIES) | EVIDENCE QUALITY[A] | SUBGROUP ANALYSIS (NUMBER OF STUDIES)[A] |
|---|---|---|
| **SUBSTANCE USE REFUSAL SELF-EFFICACY (10[B])** | Low quality  | Among girls (4[C]): Moderate quality  |
| **SEX REFUSAL SELF-EFFICACY (8[D])** | Low quality  | |
| **PEER RESISTANCE SELF-EFFICACY (2[E])** | Very low quality  | |

[A] The number of plus signs inside the four circles demonstrates the level of evidence quality based on four categories: high, moderate, low, very low (Balshem et al., 2011). A higher number of plus signs indicates a higher evidence quality.

[B] Schinke et al., 2009; Fang and Schinke, 2013, 2014; Fang et al., 2010; Chang et al., 2018; Parisod et al., 2018; Dietrich et al., 2015; Ismayilova and Terlikbayeva, 2018; Lotrean et al., 2010; Schwinn et al., 2010; Cunningham et al., 2009

[C] Schinke et al., 2009; Fang and Schinke, 2013, 2014; Fang et al., 2010; Schwinn et al., 2010

[D] Peskin et al., 2015, 2019; Potter et al., 2016; Tortolero et al., 2010; Sznitman et al., 2011; Kaufman et al., 2018; Markham et al., 2012; Winskell et al., 2018; Musiimenta, 2012

[E] Norris et al., 2013; Kaufman et al., 2018

### 5.1.3 Smoking of friends and relatives is associated with tobacco refusal self-efficacy

In the cross-sectional study with early adolescent (RQ 3, Sub-study III), the participants were 10–13 years old (mean age 11.39). Based on the total sample, being offered tobacco (W = 2284.5), having tried tobacco smoking (W = 405), positive ($\tau$ = -0.169) and negative ($\tau$ = 0.216) smoking outcome expectations, smoking-related motives ($\tau$ = -0.217) and attitudes ($\chi^2$ = 13.594, df = 2), as well as motivation to refrain from smoking ($\chi^2$ = 15.433, df = 2) were all associated with early adolescent tobacco refusal self-efficacy. The results on the statistically significant (p-value) associations between tobacco refusal self-efficacy and the background factors examined are presented in Table 7.

**Table 7.** P-values on the association between early adolescent tobacco refusal self-efficacy and the examined background factors in the total sample and both sub-samples.

| | ALL N = 295 | FINLAND N = 151 | PORTUGAL N = 144 |
|---|---|---|---|
| | p-value | p-value | p-value |
| **AGE** | 0.206 | 0.094 | 0.951 |
| **GENDER** | 0.329 | 0.312 | 0.708 |
| **POCKET MONEY PER WEEK** | 0.750 | 0.884 | 0.635 |
| **FREQUENTLY SEES PEOPLE SMOKE TOBACCO** | 0.478 | 0.447 | 0.979 |
| **FREQUENTLY SEES TOBACCO WASTE** | 0.714 | 0.456 | 0.890 |
| **HAS RECEIVED HEALTH EDUCATION ABOUT TOBACCO AT SCHOOL** | 0.709 | 0.645 | 0.232 |
| **HAS BEEN OFFERED TOBACCO** | **0.022** | 0.382 | **0.006** |
| **HAS TRIED TOBACCO SMOKING** | **0.002** | **0.024** | - |
| **SMOKES TOBACCO** | **-** | **-** | - |
| **POSITIVE SMOKING OUTCOME EXPECTATIONS** | **< 0.001** | **0.018** | **0.001** |
| **NEGATIVE SMOKING OUTCOME EXPECTATIONS** | **< 0.001** | **< 0.001** | **0.014** |
| **SMOKING-RELATED MOTIVES** | **< 0.001** | **0.007** | **< 0.001** |
| **SMOKING-RELATED ATTITUDES** | **0.001** | - | - |
| **MOTIVATION TO REFRAIN FROM SMOKING** | **< 0.001** | - | - |

Based on the logistic regression conducted with the total sample (Nagelkerke pseudo-$R^2$ = 0.130, $p < 0.001$), gender (OR = 2.06, 95 % CI: 1.12, 3.86), as well as tobacco smoking by friends (OR = 2.36, 95 % CI: 1.12, 4.88) and relatives (OR = 2.01, 95 % CI: 1.11, 3.66) predicted early adolescent tobacco refusal self-efficacy. Logistic regression with the Finnish sub-sample (Nagelkerke pseudo-$R^2$ = 0.236, $p < 0.001$) revealed that gender (OR = 4.36, 95 % CI: 1.71, 12.03), smoking by friends (OR = 3.23, 95 % CI: 1.13, 9.29), as well as valuing health (OR = 5.38, 95 % CI: 1.27, 27.02) and money (OR = 3.91, 95 % CI: 1.22, 15.78) were independent predictors of tobacco refusal self-efficacy. Based on the logistic regression with the Portuguese sub-sample (Nagelkerke pseudo-$R^2$ = 0.147, $p = 0.003$), only valuing money (OR = 0.23, 95 % CI: 0.07, 0.72) predicted tobacco refusal self-efficacy. The results are presented in Table 8 and described in more detail in Paper III.

**Table 8.** P-values on independent predictors of early adolescent tobacco refusal self-efficacy based on logistic regression analyses with the total sample and both sub-samples.

| | ALL N = 295 | FINLAND N = 151 | PORTUGAL N = 144 |
|---|---|---|---|
| | p-value | p-value | p-value |
| **GENDER: FEMALE** | **0.022** | **0.003** | - |
| **FREQUENTLY SEES PEOPLE SMOKE TOBACCO** | 0.190 | - | - |
| **HAS BEEN OFFERED TOBACCO** | - | - | 0.158 |
| **NON-SMOKING OF OTHERS** | | | |
| **FRIENDS** | **0.021** | **0.027** | - |
| **RELATIVES** | **0.022** | - | - |
| **AUTHORITIES** | 0.251 | 0.287 | - |
| **OTHERS** | - | - | - |
| **VALUES** | | | |
| **HEALTH** | 0.110 | **0.027** | - |
| **NATURE CONSERVATION** | 0.120 | - | - |
| **MONEY** | - | **0.033** | **0.012** |
| **GIVING GOOD IMPRESSION** | - | 0.110 | 0.069 |

### 5.1.4 Summary of the main results

The main results of the development phase of this study are summarised in Figure 3. The results supported the use of digital interventions to promote early adolescent refusal self-efficacy. These results also indicated how the *Fume* health game intervention could be further developed and that it was beneficial to evaluate the effectiveness of the refined intervention.

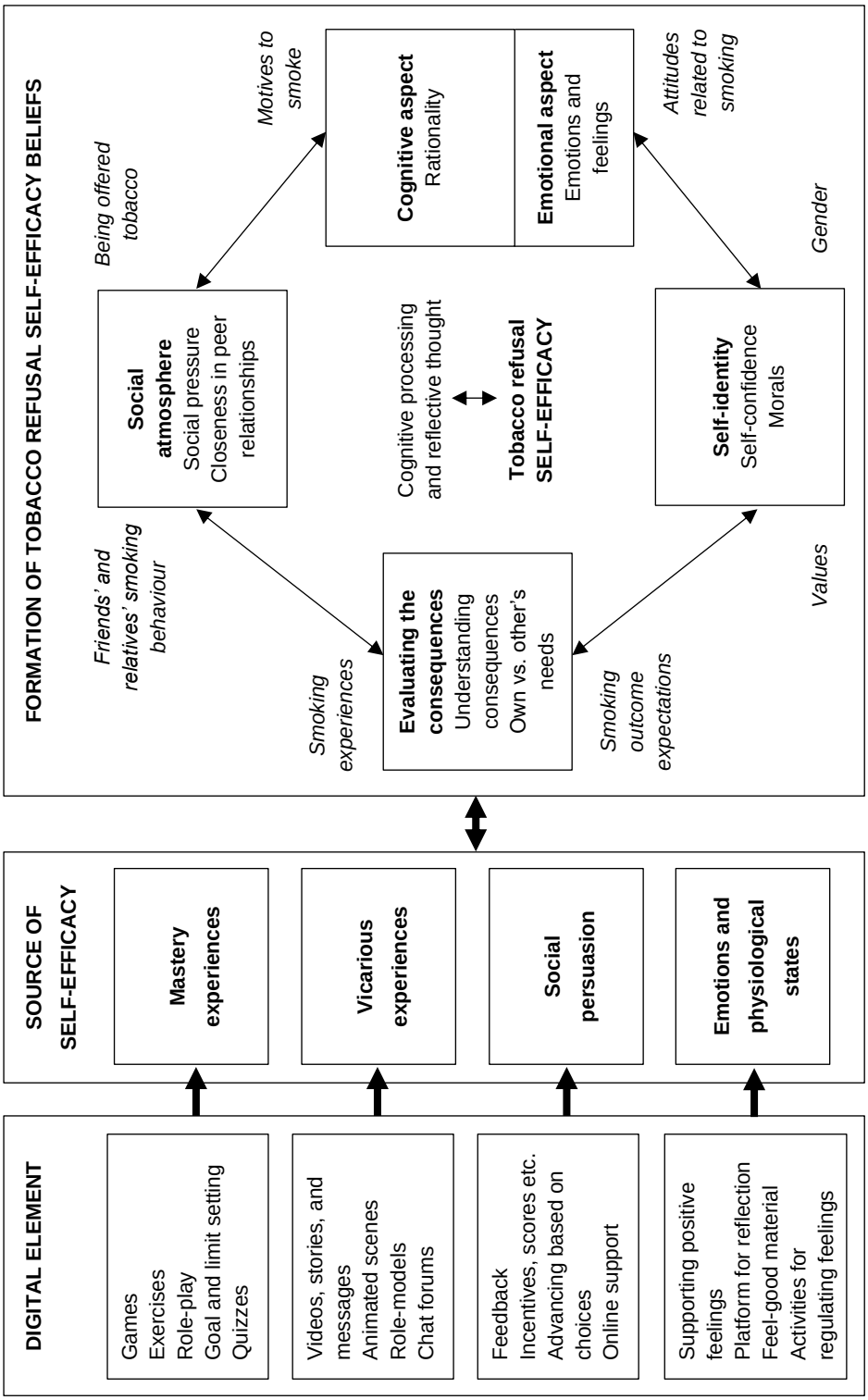



**Figure 3.** Summary of the results on Sub-studies I-III modified from Nyman et al. (2022): refined theoretical basis for the further development of the intervention.

## 5.2 Results of the evaluation phase

### 5.2.1 *Fume* health game intervention supports tobacco refusal self-efficacy among 12-year-olds and early adolescents with a smoking friend or parent

There were 781 early adolescents in the 4th, 5th, and 6th grades (including adolecents aged 9–14 years, mean age 11.25) participating in the cluster randomised controlled trial to evalute the effectiveness of the *Fume* health game intervention (RQ 4, Sub-study IV). Altogether 584 early adolescents completed the post-measurement at two weeks post-baseline, and 491 the follow-up at three months. There were no significant differences between the health game intervention group and the no-intervention control group at baseline. The only statistically significant difference between the two groups was in their grandparents' smoking behaviour.

Based on the linear mixed model, the differences in the outcome variables within the intervention and control groups and between the two groups are presented in Table 9. The intervention group demonstrated statistically significant improvements in the sources of self-efficacy related to smoking and snus refusal. Within the intervention group, sources of self-efficacy related to smoking refusal improved at post-intervention ($p < 0.05$) and sources of self-efficacy related to snus refusal improved both at post-intervention ($p < 0.05$) and at 3-month follow-up ($p < 0.05$), when compared to the control group. In addition, there were statistically significant within-group changes. Among the early adolescents in the intervention group, all the self-efficacy variables remained stable throughout the study period with sources of self-efficacy related to snus refusal strengthening immediately after the intervention at post-intervention ($p < 0.05$). In contrast, among the early adolescents in the control group, tobacco refusal self-efficacy ($p < 0.01$) and sources of self-efficacy related to both smoking and snus refusal dimished at the 3-month follow-up (smoking refusal: $p < 0.01$, snus refusal: $p < 0.01$).

According to the sub-group analysis, the intervention group demonstrated improvements in tobacco refusal self-efficacy compared to the control group. These improvements were observed among 12-year-old early adolescents at the 3-month follow-up ($p > 0.05$) and among early adolescents with a smoking friend or parent between the post-intervention and 3-month follow-up (friend smoking: $p < 0.05$; parental smoking: $p < 0.05$) relative to the control group. The intervention group also demonstrated significant improvements in sources of self-efficacy related to smoking refusal. In comparison to the control group, the sources of self-efficacy related to smoking refusal strengthened in the intervention group for the following: the 9-10-year-olds at post-intervention ($p < 0.05$), the girls at post-intervention ($p < 0.01$), the early adolescents with non-smoking parents ($p < 0.01$) and friends ($p < 0.05$), as well

as the early adolescents with no smoking experimentations at post-intervention ($p < 0.05$). The intervention group demonstrated similiar improvements in sources of self-efficacy related to snus refusal compared to the control group. These improvements were observed among 12-year-olds at follow-up ($p < 0.01$), girls at post-intervention ($p < 0.01$), early adolescents with non-smoking parents ($p < 0.001$) and friends ($p < 0.05$), early adolescents with no smoking experimentations ($p < 0.05$), and those with lower scores on sources of self-efficacy related to snus refusal at both post-intervention and follow-up ($p < 0.05$).

In terms of motivation to decline smoking in the future and motivation to decline snus use in the future, no statistically significant differences were found between the intervention group and the control group at the post-intervention or follow-up.

**Table 9.** Mean values of tobacco refusal self-efficacy as well as sources of self-efficacy related to smoking and snus refusal among the control and intervention groups, and between-group p-values.

| | CONTROL GROUP | INTERVENTION GROUP | BETWEEN GROUP[A] |
|---|---|---|---|
| | Mean (SD) | Mean (SD) | p-value |
| **TOBACCO REFUSAL SELF-EFFICACY** | | | |
| **BASELINE** | 23.05 (2.13) | 22.87 (3.01) | |
| **2-WEEK POST-INTERVENTION** | 22.90 (2.50) | 22.58 (3.39) | 0.851 |
| **3-MONTH FOLLOW-UP** | 22.57** (3.46) | 22.78 (2.66) | 0.402 |
| **SOURCES OF SELF-EFFICACY RELATED TO SMOKING REFUSAL** | | | |
| **BASELINE** | 23.02 (3.15) | 23.15 (3.06) | |
| **2-WEEK POST-INTERVENTION** | 22.73 (3.26) | 23.37 (3.24) | **0.0499** |
| **3-MONTH FOLLOW-UP** | 22.57** (3.49) | 23.05 (3.47) | 0.259 |
| **SOURCES OFSELF-EFFICACY RELATED TO SNUS REFUSAL** | | | |
| **BASELINE** | 23.01 (3.39) | 23.02 (3.19) | |
| **2-WEEK POST-INTERVENTION** | 22.80 (3.28) | 23.42* (3.32) | **0.010** |
| **3-MONTH FOLLOW-UP** | 22.70** (3.46) | 23.18 (3.67) | **0.030** |

* p-value <0.05, ** p-value <0.01 indicating statistically significant changes within the group

[A] Indicating a statistically significant difference in the within-group changes of tobacco refusal self-efficacy and sources of self-efficacy related to smoking and snus refusal between the intervention group and the control group

### 5.2.2 Summary of the main results

Based on the findings in the evaluation phase, the *Fume* health game intervention was effective in supporting early adolescent tobacco refusal self-efficacy among 12-year-olds, and those who had smokers in their close social circle. The intervention also supported early adolescents' sources of smoking and snus refusal self-efficacy especially among girls, as well as early adolescents with smokers in their close social circle and with no previous smoking experimentations. These findings indicate that the *Fume* health game intervention can be implemented in a school context with good results.

# 6 Discussion

## 6.1 Discussion of the results

The aim of this study was to develop an intervention to support early adolescent tobacco refusal self-efficacy and to evaluate the effectiveness of the intervention among early adolescents in comprehensive school grades 4 to 6. This study found that the adolescents' themselves have an active role in the formation of their self-efficacy in peer interactions and this role is influenced by their social atmosphere (Sub-study I, Paper I). Tobacco refusal self-efficacy in early adolescence is especially influenced by the social atmosphere, namely the smoking behaviour of peers and relatives (Sub-study III, Paper III). Previous evidence supports the use of digital interventions with sound theoretical basis to promote child and adolescent refusal self-efficacy (Sub-study II, Paper II). The digital *Fume* health game intervention developed in this study demonstrated its effectiveness in supporting early adolescent tobacco refusal self-efficacy and its sources (Sub-study IV, Paper IV).

### Dynamic process of adolescent self-efficacy formation in peer interactions

The formation of self-efficacy in peer interactions was described by the adolescents as a dynamic process in which adolescents engage in self-reflection. The varied social atmosphere surrounding adolescents sets the stage for their self-reflection. Although previous literature has focused mainly on how to develop and support self-efficacy through modelling and social persuasion (for example, Bandura, 1977; Butz & Usher, 2015), in our study the adolescents reported social atmosphere as direct and indirect peer pressure, and closeness with peers. Both frequently leading to a decrease in the adolescents' self-efficacy in peer interactions. It is worth noting that our study focused on self-efficacy in the context of peer interactions, which may have reinforced the importance of the social atmosphere in our results. However, peer interactions have a significant role in adolescent development (Orben et al., 2020) and the importance of social atmosphere is highlighted as adolescents spend a considerable amount of time with their peers (Lam et al., 2014). Thus, when

examining adolescent self-efficacy, age, context, and task sensitivity need to be considered (Usher & Pajares, 2008).

The results revealed that self-identity originating from the adolescents themselves appeared to be another important and one of the most solid themes of adolescent self-efficacy formation in peer interactions. This theme differs somewhat from the mastery experiences, the most influential source of self-efficacy according to the Self-Efficacy Theory (Bandura, 1997). This study suggests a broader perspective that focuses on one's self-identity, encompassing not only the self-belief derived from past experiences but also self-awareness, determination to act in a certain way, and understanding of right and wrong. Although self-efficacy has often been seen as a predictor of this kind of self-identity and self-regulation (Zou et al., 2023), qualitative studies with adolescents have suggested that self-regulation (Usher, 2009) and own choice may also influence the formation of self-efficacy (Butz & Usher, 2015).

According to our results, the other themes were those evaluating the consequences and cognitive and emotional aspects. Although the emotional aspects identified in this study, that is, encompassing both physical and emotional feelings, were rather similar to the source of self-efficacy related to physiological and emotional states (Bandura, 1997), adolescents' cognitive aspects and evaluating the consequences have not been regarded as sources of self-efficacy. However, when interpreting our results, it needs to be considered that this study examined adolescent self-efficacy in a specific context or domain, that is, in peer interactions. For example, Usher and Pajares (2008) have proposed that sources beyond the initial four hypothesised may also contribute to domain-specific self-efficacy.

In summary, the results of this study demonstrated adolescent self-efficacy in peer interactions as a dynamic process of self-reflection. Thereby emphasising that adolescents themselves play an active role in shaping their self-efficacy in the existing social atmosphere. During adolescence, striving for increased independence and a stronger sense of their own identity is another aspect of taking a more active role in their psychosocial development (Sawyer et al., 2012). Based on the authentic descriptions of their self-efficacy given by adolescents in the specific context of peer interactions, there is a need to examine the formation of self-efficacy from the perspective of adolescents themselves, more broadly and sensitive to context, age, domain, and task. For example, although a meta-analysis in the academic domain supported the hypothesised sources of self-efficacy, the influence of vicarious experiences (modelling and observational learning) to self-efficacy was either small or negative (Sheu et al., 2018).

## Previous evidence on digital interventions to support refusal self-efficacy in child and adolescent health promotion

Despite somewhat varying results, previous evidence on digital interventions to support refusal self-efficacy endorses their application in child and adolescent health promotion. The quality of the evidence regarding digital interventions supporting child and adolescent refusal self-efficacy was most robust among girls in terms of substance use refusal self-efficacy. While the evidence was more encouraging among girls, as indicated by research showing their favourable views toward school-based smoking prevention (Lund et al., 2021), it does not imply that digital interventions are ineffective among boys or gender minority children and adolescents. Instead, it underscores the importance of tailoring interventions to appeal to all genders. Many interventions that yielded favourable results for girls were primarily designed for and tested among girls. Subsequently, there is need for content that appeals especially to boys and gender minority children and adolescents since they seem to be more susceptible to substance use (Katz-Wise et al., 2021; Khlat et al., 2020).

The evidence on the digital interventions was most encouraging with interventions administered at home. Although there is evidence supporting the use of school-based social competence interventions on child and adolescent smoking prevention (Thomas et al., 2013), a meta-analysis on school-based resilience interventions on substance use indicated the need for alternative approaches (Hodder et al., 2017). In our study on adolescent self-efficacy in peer interactions (Paper I), it was found that the social atmosphere, particularly among peers, more frequently resulted in a decrease in self-efficacy. Therefore, children and adolescent may need to develop their refusal self-efficacy beyond the school environment, where social pressure may be more pronounced. In addition, it's worth noting that the age of the participants in the reviewed studies ranged from 10 to 18. It is possible, and even likely, that children and adolescents of different ages have varying needs for the development of their refusal self-efficacy. For example, according to the Self-Efficacy Theory, families have an influential role in the development of self-efficacy experiences in childhood but as children expand their social environment, the role of peers in influencing self-efficacy increases (Bandura, 1997).

While the quality of evidence remained low in general, it does not suggest that digital interventions are ineffective in reinforcing refusal self-efficacy among children and adolescent. Rather, it brings into focus the inadequacy of research data to provide more robust appraisal of their effectiveness (Schünemann et al., 2013). For example, in our assessment, small sample sizes as well as differences in populations, interventions and outcomes weakened the evidence quality. Some of the studies were pilot or feasibility studies, typically undertaken on a more limited scale (In, 2017). There remains a strong need to systematically evaluate digital

interventions with rigorous methods and on larger scale to ensure their effectiveness (Willis et al., 2022), even though digital interventions for health promotion have been developed for over a decade. Despite their potential in health promotion (Murray et al., 2016) one challenge with digital interventions is the rapid technological development combined with the slow processes of intervention development and evaluation (Duffy et al., 2022; Michie et al., 2017). For example, although there are limitations to evaluating digital interventions with a randomised controlled trial design, particularly regarding the time-consuming trial process (Duffy et al., 2022; Mohr et al., 2015), it remains unclear which alternative study designs could attain a comparable level of result robustness in the intervention evaluation (Hrynyschyn et al., 2022).

### Factors associated with early adolescent tobacco refusal self-efficacy highlighting social influences

Factors associated with tobacco refusal self-efficacy among early adolescents in Finland and Portugal were examined. The results revealed that gender and tobacco smoking by friends and relatives predicted early adolescent tobacco refusal self-efficacy. In terms of gender, girls exhibited higher levels of tobacco refusal self-efficacy compared to boys. This is an interesting result as previous research indicates that in fact, on the contrary, girls exhibit lower levels of tobacco refusal self-efficacy when they have friends who smoke (Lotrean & De Vries, 2012; McGee et al., 2015). The differences may be attributed to how refusal self-efficacy has been measured. For example, in a study by Gázquez Linares et al. (2023) boys exhibited higher levels of social pressure refusal self-efficacy related to alcohol use in comparison to girls. However, girls displayed higher opportunistic refusal self-efficacy and emotional relief self-efficacy. Considering that in our review the evidence on the digital interventions was also most encouraging among girls (Paper II), our results suggest that there is a need to support tobacco refusal self-efficacy particularly among boys.

According to our results, tobacco smoking by friends and relatives, but not by parents, predicted early adolescent tobacco refusal self-efficacy. Our result on the role of friends is in line with previous research on friend and peer influence on tobacco refusal self-efficacy (Hiemstra et al., 2011; McGee et al., 2015) as well as to tobacco use (Jacobs et al., 2016; McMillan et al., 2018). Research on the role of parents is inconsistent. While parents and siblings play an influential role in the development of self-efficacy and behaviour during childhood (Bandura, 1997), our results suggest that the social world of children becomes significantly more expansive in early adolescence, leading to a heightened influence by peers. In addition, adolescence is a transitional stage towards exhibiting some degree of autonomy (Sawyer et al., 2012; Viner et al., 2012). Instead of serving as role models

for tobacco use, adolescent may consider smoking parents as being unfair and unjust for exposing them to smoking in their close social environment (Woodgate & Kreklewetz, 2012). Thus, parental support and control for preventing the use of tobacco and nicotine products may actually be more associated with adolescent smoking (Zaborskis et al., 2021) and tobacco refusal self-efficacy (Wang et al., 2019) than parental smoking.

The finding on the association between smoking by relatives and tobacco refusal self-efficacy is interesting since research on the role of relatives, other than family members, to adolescent tobacco refusal self-efficacy is lacking. In our study, the relatives identified as smokers by the early adolescents might include cousins whom they consider as friends or other relatives they admire. Nevertheless, the results highlight the importance of social influence on early adolescent tobacco refusal self-efficacy. This finding is also supported by our study regarding the role of social atmosphere in adolescent self-efficacy in peer interactions (Paper I). Accordingly, supporting early adolescents' tobacco refusal self-efficacy requires enhancing their skills to resist social influence from the expanded social environment, especially from peers (Veselska et al., 2011).

In addition to the aforementioned independent predictors, factors associated with tobacco refusal self-efficacy in early adolescence were identified. These factors — previous experiences with tobacco, attitudes, motives, motivation to refrain, and outcome expectations related to tobacco — were mainly in line with previous literature (for example, Ford et al., 2013; Sheeran et al., 2016) and the Self-Efficacy Theory (Bandura, 1997). Overall, the results emphasise the importance of supporting tobacco refusal self-efficacy already in early adolescence as the attitudes, motives, and intentions related to tobacco and nicotine products start to take shape, and before the first experiences these products begin to take place. The importance of this period has also been indicated in the national Current Care Guidelines (Tobacco and nicotine dependency, prevention and treatment: Current Care Guidelines Abstract 2018).

### Demonstrated effectiveness of the *Fume* health game intervention in early adolescent tobacco refusal self-efficacy

According to our results, the further developed *Fume* health game intervention was effective in supporting tobacco refusal self-efficacy and related sources among early adolescents. Although the results on tobacco refusal self-efficacy were not statistically significant at the group level, the results among the 12-year-olds and early adolescents with a smoking friend or parent, can be considered clinically significant since the baseline tobacco refusal self-efficacy levels were high. A longitudinal study has found that smoking initiation in adolescence is particularly

linked to declining refusal self-efficacy over time (Hiemstra et al., 2011). Thus, it may be sufficient to support the already high levels of refusal self-efficacy and prevent them from decreasing. Comparing the changes in mean values between the two study groups indicated that the *Fume* health game intervention achieved this during the three month follow-up. In addition, the feasibility study of the *Fume* health game supported its use since it was found to generate more interest among early adolescents compared to other types of health education (Parisod et al., 2018).

High levels of tobacco refusal self-efficacy were anticipated before the data collection, because high baseline levels have been identified in previous studies, including our study as regards factors associated with early adolescent tobacco refusal self-efficacy (Paper III). For this reason and to balance the possible ceiling effects, the sources of tobacco refusal self-efficacy were also measured. In terms of theses sources, the effectiveness of the intervention at the group level could be demonstrated. The outcomes were not maintained in the follow-up indicating that a more recurrent implementation of the intervention may be needed to support early adolescent refusal self-efficacy in the long term, that is, throughout adolescence (Hiemstra et al., 2011). It should be also noted that the follow-up period of three months can be considered rather short, and a follow-up of longer than a year may be necessary to confirm the sustainability of the results.

The study yielded the most positive results when considering the sources of snus refusal self-efficacy suggesting that the *Fume* health game intervention may be more effective in supporting refusal self-efficacy in relation to snus. Although adolescents are familiar with the health consequences of cigarettes, their understanding on the health consequences of snus and newer tobacco and nicotine products is limited (El-Amin et al., 2022). The effetiveness of the intervention on newer tobacco and nicotine products was not measured. The results suggest that the intervention holds great potential for enhancing health education regarding newer tobacco and nicotine products.

The *Fume* health game intervention includes some content on e-cigarettes, but focuses mainly on the prevention of cigarettes and snus, the two most often used tobacco and nicotine products among adolescents in 2021 (THL, n.d.), during the period when the intervention was further developed. Currently, the experimentation and use of newer tobacco and nicotine products, mainly e-cigarettes and nicotine pouches, has surpassed the use of cigarettes and snus (THL, n.d.). The rapid evolution of tobacco and nicotine product development (Lietzmann & Moulac, 2023; O'Connor et al., 2022), along with the resulting shifts in adolescents' tobacco and nicotine product use, has posed challenges for keeping pace with intervention development. As the intervention aims to support refusal self-efficacy and health literacy related to tobacco, the skills learned with the intervention may support refusing all kinds of tobacco and nicotine products. In addition, there is evidence

suggesting that the use of newer tobacco and nicotine products in adolescence serves as a gateway to the initiation of cigarette smoking (Kinnunen et al., 2019, 2021). Thus, there is still a need to support skills to refuse and prevent cigarette smoking and snus use. The results of this study support the use of the *Fume* health game intervention to boost early adolescent skills to refuse tobacco and nicotine products. In the future, the intervention could be complemented with targeted content on newer tobacco and nicotine products, for example, by adding more variation in the tobacco and nicotine products in the game and ny also adding some textual information.

As the feasibility and effectiveness of the *Fume* health game intervention have been demonstrated, the next step is the implementation of the intervention (Skivington et al., 2021; WHO et al., 2020). Implementing digital health interventions is complex and challenging (Duffy et al., 2022; Ross et al., 2016). Additionally, in this study, challenges were revealed that can be encountered in the implementation and evaluation of effectiveness of interventions; these need to be considered in a large-scale implementation. There is already some legislative support for implementing the *Fume* health game since it is included in the HealthVillage, an online service developed in partnership with Finnish university hospitals, to support non-tobacco use among adolescents with chronic diseases (HealthVillage, 2022). The *Fume* health game intervention is primarily intended for use in schools as part of school healthcare or the school curriculum. Receiving organisational support from the schools and tailoring the intervention to the everyday workflow in schools will be one of the key factors to ensure effective implementation (Ross et al., 2016). It takes rather minimal effort from the schools to implement the intervention since the *Fume* health game can be easily used by early adolescents in their free time and at home. It is important to consider a shift from a collaborative approach involving a researcher and a teacher delivering the intervention to a school-based delivery model. Training and education for school personnel and school health nurses may be necessary to facilitate the implementation of the intervention (Ross et al., 2018).

## 6.2 Validity and reliability of the study

### 6.2.1 Validity and reliability of the development phase

In Sub-study I, the qualitative descriptive study design was chosen to be able to provide a comprehensive overview of adolescents' self-efficacy in peer interactions described both in their own language and from their own perspectives (Sandelowski, 2000). The critical incident technique (Flanagan, 1954) with open-ended questionnaires was used to collect data. The aim was to ensure credibility and authenticity by collecting data from the authentic narratives of adolescents, pilot testing the open-ended questionnaire, writing field notes, using peer review in the

data analysis, as well as using quotations from the adolescents' narratives to complement the results. The questionnaire was pilot tested with adolescents (n = 6) before the data collection to ensure the understandability of the questionnaire among adolescents, and its applicability to provide authentic and rich description of the self-efficacy of adolescents in peer interactions. Based on the pilot test, three sub-questions were added to ensure accurate reports were obtained (Flanagan, 1954). However, there were some limitations on the data collection. Since it was decided to collect the data anonymously, member checking was not possible to ensure that the data corresponds to the reality of the participants (Holloway & Galvin, 2017). Moreover, the adolescents' narratives on the open-ended questionnaire varied since for some adolescents it took more words and for others less words to present their narratives. To balance these limitations and further ensure the credibility of the results, the peer review was used in the data analysis (Holloway & Galvin, 2017). In addition to critically discussing and reflecting on the data and the results among the research team, another member of our research team analysed ten percent of the whole data. Furthermore, to cover possible limitations in the length of the narratives, a large sample was collected of adolescents' authentic narratives. The large sample and the data collection from two cities using maximum variation sampling also supported the transferability of the results as there were participants from school areas with slightly different socio-economic backgrounds.

A systematic literature review design was used in Sub-study II. The Cochrane Collaboration guidelines for systematic reviews of interventions were consulted in order to provide rigorous guidance on the process and the methods (Higgins & Green, 2011). To further ensure the reliability of the study, the review protocol was registered with the PROSPERO database. In addition, the rigorous guidance on reporting reviews provided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) standards for reporting systematic reviews were followed (Moher et al., 2009). To collect the data, a systematic literature search was made on five databases using pre-selected eligibility criteria. There is a risk of a selection bias due to only one researcher performing the title and abstract screening. However, the author and another researcher in our team reviewed each publication selected for the full-text screening. Despite a careful and systematic search of the literature, some relevant publications may not have been identified for the review. A pre-determined data extraction plan was used to extract all relevant data from the publications. To support the reliability of the results, the risk of bias of each selected publication was evaluated following the Cochrane Collaboration's tool for assessing the risk of bias. Although no publication was excluded based on the risk of bias assessment, it supported the reliability of the results by indicating the extent to which the methodological quality, and thus also the results, of the studies presented in the publications could be relied on. In addition, the evidence quality of

the results was evaluated using a rigorous GRADE approach. One limitation of this study was that the risk of bias of the studies remained unclear and the evidence quality ranged from low to very low. However, the review included an appropriate number of studies (n = 23), and the results of our risk of bias and evidence quality assessments were reported in Paper II.

In Sub-study III, a cross-sectional design was used based on a secondary analysis of previously collected data on the *Fume* health game in Finland and Portugal using rigorous methods (Parisod et al., 2018; Pinto et al., 2022). The data were collected with questionnaires developed for the studies and other previously developed instruments. The questionnaires developed for the studies on the original *Fume* health game were pilot tested and included questionnaires on smoking-related attitudes, motives for smoking tobacco, and motivation to refrain from smoking tobacco in the future. The reliability of the questionnaire on tobacco use motives was good in terms of internal consistency ($\alpha = 0.85$) (Parisod et al., 2018). The Cronbach's alphas for the smoking motives and motivation to refrain from smoking could not be calculated because both questionnaires included only one item. The ASSES and SOES instruments have been previously tested with good results on validity and reliability (Chen et al., 2015). The permission to use and the translation of these instruments into Finnish has been described elsewhere (Parisod, 2018). Similarly, the reliability of the ASSES instrument was also evaluated in our analysis with good results on internal consistency ($\alpha = 0.87$) and inter-item correlations (mean 0.314). A statistician analysed the data using rigorous methods: logistic regression and appropriate statistical tests for analysing correlation. One limitation of this study is the rather small sample size in both countries (n = 151 in Finland, and n = 144 in Portugal). This may have weakened the reliability of the results due to wide confidence intervals in some statistical analyses. However, the total sample size was sufficient for a statistical analysis and the results on the total sample can be considered reliable. In addition, the data collected from two countries and the representativeness of the samples in the light of national statistics support the generalisability of the results.

### 6.2.2 Validity and reliability of the evaluation phase

A cluster randomised controlled trial design was used in the evaluation phase in Sub-study IV. Although the literature identified difficulties when conducting studies with this design, it was chosen over an individual allocation design, because only a cluster trial design was feasible when the intervention was delivered and evaluations were made within schools and classrooms that naturally form clusters (Puffer et al., 2005). In addition, efforts were made to avoid contamination between study groups and to encompass whole schools, including their students (Brown et al., 2015). In this study,

the participating schools were recruited from nine Finnish municipalities. Schools served as clusters and computer-assisted randomisation was made at the school level, not at the municipality level. Thus, in each of the municipalities depending on their size and number of participating schools, there could be schools that received either the intervention or control condition.

The sample size was determined based on a power analysis that considered the clustering effect. The power analysis was conducted based on effect size indicating the magnitude of the effect, alpha indicating the significance level and power indicating the probability to identify an effect (Bland, 2000). Since more participants are needed in cluster trials to achieve the required statistical power (Puffer et al., 2005), the power analysis was complemented with the clustering effect of 1.49. To determine the clustering effect, the cluster size was evaluated based on the participating schools and calculated using the ICC value based on the feasibility study on the original *Fume* health game in Finland. Although the ICC value of 0.008 indicated small variation between the clusters, the value of 0.01 was used for the power analysis to slightly increase the clustering effect (Bland, 2000). Furthermore, the estimated loss was added to the power analysis. Based on our power analysis, 271 participants were needed in each of the two study groups. The required sample size was well attained.

The following instruments were used in Sub-study IV: the smoking refusal self-efficacy instrument (Lazuras et al., 2009), the sources of tobacco refusal self-efficacy instrument developed for this study, and the instrument on motivation to decline tobacco use in the future (Parisod et al., 2018). The instruments and their reliability in terms of internal consistency are described in Table 10.

**Table 10.** Instruments used in Sub-study IV and their internal consistency.

| INSTRUMENT | | CRONBACH'S ALPHA | | |
|---|---|---|---|---|
| Instrument | Sub-scales | Baseline | 2 weeks | 3 months |
| **FINNISH VERSION OF THE SMOKING REFUSAL SELF-EFFICACY INSTRUMENT** | | 0.89 | 0.92 | 0.91 |
| **SOURCES OF TOBACCO REFUSAL SELF-EFFICACY** | Sources of smoking refusal self-efficacy | 0.61 | 0.66 | 0.71 |
| | Sources of snus refusal self-efficacy | 0.65 | 0.67 | 0.71 |
| **MOTIVATION TO DECLINE TOBACCO USE IN THE FUTURE** | Motivation to decline smoking in the future | NA | NA | NA |
| | Motivation to decline snus use in the future | NA | NA | NA |

NA = not available, Cronbach's alpha is not applicable with instruments consisting of one item

The permission to use and translate the smoking refusal self-efficacy instrument was obtained from the authors (Lazuras et al., 2009). Since the instrument was available in English, it was translated into Finnish using the back-translation method (Cha et al., 2007). 1) The English version of the instrument was translated into Finnish by two translators independently. 2) A professional translator translated the Finnish translation back into English. 3) The translation was validated by a native English-speaking researcher who compared the original and back-translated English versions of the instrument. There were some small differences, but no errors were found. I consulted the English-speaking researcher and the differences between the two versions were discussed. 4) An expert group discussed the findings concerning the validation and the Finnish translated version, and some minor revisions were made to rephrase the response options. Since the target group for the original instrument were slightly older (from 12 to 15 years old) than for the translated instrument (from 10 to 13 years old), the response options were simplified from "strongly disagree, disagree, agree, strongly agree" to "disagree, somewhat disagree, somewhat agree, agree". 5) The revised version of the Finnish scale was pilot tested with Finnish early adolescents (n = 5). Minor revisions were made based on the pilot test to clarify wording, instructions, and the structure of the response options.

Previously developed instruments used to assess tobacco refusal self-efficacy have reported rather high scores which may indicate a risk of a ceiling effect (Kimberlin & Winterstein, 2008) and not having the required sensitivity to make discriminations (Jacobson, 1997). To complement the instrument measuring smoking refusal self-efficacy and to be able to address these risks, an instrument designed to measure the sources of tobacco refusal self-efficacy was used. Since no previous instruments were found to measure the sources, an instrument was developed for this study. The instrument consists of two sub-scales: seven items related to smoking and seven items related to the use of snus. A group of researchers with expertise in the topic assessed the face validity of the developed instrument. In addition, the instrument was pilot tested with early adolescents (n = 5). Minor revisions were made to clarify the structure of the response options. This instrument appeared to be suitable for measuring the sources of tobacco refusal self-efficacy and there was more variation in scores than with the smoking refusal self-efficacy instrument. The instrument measuring the sources of tobacco refusal self-efficacy has limitations related to the reliability due to somewhat weak values on internal consistency. Although the Cronbach's alpha suggested that further development was warranted, the value was sufficient for group-based comparisons at the 3-month follow-up (Bland & Altman, 1997). In addition, the instrument measuring the primary outcome, that is, the instrument measuring smoking refusal self-efficacy, demonstrated good internal consistency.

The one-item instrument measuring the motivation to decline tobacco use in the future was previously developed and tested with the original *Fume* health game (Parisod et al., 2018). The permission to use the instrument was obtained from the authors who were in our research team. Although the internal consistency of the instrument could not be calculated, it demonstrated its suitability in measuring the outcomes of the original *Fume* health game.

The aim of Sub-study IV was to evaluate the effectiveness of the health game intervention on early adolescent tobacco refusal self-efficacy. The study was conducted following the framework for developing and evaluating complex interventions (Craig et al., 2013; Skivington et al., 2021). There is already some research on this topic both in Finland and in Portugal. For example, the results of the feasibility and pilot study of the *Fume* health game were statistically significant in terms of smoking-related attitudes and outcome expectations (Parisod et al., 2018). Thus, it was realistic to hypothesise that information on the effectiveness and benefits of the health game intervention could be obtained during the three-month follow-up of this study. This is also supported by previous research on digital interventions to support child and adolescent refusal self-efficacy.

There were some limitations in this sub-study that may weaken the reliability of the results. Since Sub-study IV was conducted in a school environment, all confounding factors, for example, any health education received outside the school, could not be controlled. Thus, there is a risk that the difference between the intervention group and the control group is not solely caused by the health game intervention. However, based on our previous studies on the *Fume* health game (for example, Parisod et al., 2018), the aim was to control the identified confounding factors as far as possible. This was done for example, by recruiting public Finnish primary schools which in general are rather similar. The risk of health education being offered outside the schools was similar in both arms of the study.

The *Fume* health game was freely available and also free of charge. Thus, there was a small risk of skewed results, if the early adolescents in the control group downloaded *Fume* during the study. To detect and mitigate this risk, the early adolescents were asked in the 3-month follow-up questionnaire whether they had played the *Fume* health game before. Only 1.1 percent of early adolescents in the control group reported that they had played *Fume* before. In the intervention group, 24.7 percent of early adolescents reported having played *Fume* before the onset of the study. However, when asked at the 3-month follow-up they might have confused it with having played the game during the study. In addition, the usage and upload rates of the *Fume* health game were followed before and during the study. According to the analytics, the usage of the *Fume* game application had been steadily infrequent, and the usage rates did not increase significantly during the study period. This is in line with the implementation of the intervention. In almost all the schools in the

intervention arm, the early adolescents played the *Fume* health game via web browsers on computers.

Although 15 schools participated in the study, there were five schools that declined to participate. In addition, there was a 37 percent loss from baseline to the 3-month follow-up. This was larger than estimated. However, the baseline sample size was large enough (n = 781) to cover this loss in order to obtain sufficient statistical power. The reasons for dropping out were mainly school absenteeism and challenges with e-mail. Despite the rather large number of early adolescents dropping out of the study, there was only one statistically significant difference in terms of gender between those missing from the post-intervention and those that continued to participate. Although the results suggested that girls were most unlikely to drop out of the study ($p = 0.014$), no statistically significant differences were found in pairwise comparisons between the genders.

One limitation of this study is the lack of double-blinding. The participants were blinded to the study design and condition, but because of practical considerations those recruiting the schools or assessing outcomes could not be blinded.

To strengthen the reliability of the study and the results, the study protocol was registered with the ClinicalTrials.gov database. In addition, a statistician analysed the data with rigorous methods on intervention effects that considered the cluster effect (Brown et al., 2015): linear mixed model with schools as random effects and Wilcoxon rank test for clustered data. In addition, the background characteristics of the participating early adolescents were collected at baseline and tested to ascertain whether there were any differences between the intervention group and the control group. The background characteristics of the two groups exhibited considerable similarities, other than in relation to cigarette use of grandparents. In addition, the sample size was rather large (n = 781), and the sample included early adolescents from nine Finnish municipalities and 15 different schools which supports the generalisability of the results. Furthermore, based on the background characteristics, experimenting with tobacco and nicotine products (cigarettes: 5.9 %, snus: 3.6 %) was rather rare which is in line with the national School Health Promotion Study (cigarettes: 2.4 %, snus: 1.7 % in 2023). However, the rates were a little higher in this study which is consistent with recruiting early adolescents from municipalities with higher rates of experimentation in the use of tobacco and nicotine products by early adolescents. To improve the reporting of the study, the CONSORT extension for cluster trials, a rigorous reporting guideline for reporting cluster randomised controlled trials, was followed (Campbell et al., 2012).

Artificial intelligence has been used for language proofreading of this doctoral dissertation.

## 6.3 Suggestions for future research

Based on the studies conducted, the following suggestions are proposed for future research:

- Adolescents have an active role in the formation of their self-efficacy. Research on the development of self-efficacy in adolescence needs to include the perspectives of the adolescents themselves, both as regards the domain of self-efficacy as well as task-related and contextual factors.
- The evidence quality is low for digital interventions supporting child and adolescent refusal self-efficacy. Similar studies with rigorous study designs evaluating the effectiveness of the existing digital health interventions are needed to improve the evidence quality. Such research would support further intervention development and the implementation of digital health interventions.
- The *Fume* health game intervention appeared to be most effective in terms of the sources of snus refusal self-efficacy, and thus, may be most effective for snus and newer tobacco and nicotine products. As the experimentation and use of these products is expanding, research is recommended to examine the perspectives of early adolescents and their knowledge about these products in order to inform health education practices and health policy.
- The results support the use of the *Fume* health game intervention to promote early adolescent tobacco refusal self-efficacy. Research examining the implementation process and related barriers and facilitators together with the long-term health outcomes of a more recurrent delivery of the intervention is recommended.

## 6.4 Practical implications

Based on the results of the study, the following practical implications for clinical practice and health policy can be presented:

Implications for clinical practice:

- The role of social atmosphere and social pressure, especially from peers and friends, need to be more comprehensively addressed in early adolescent health education on tobacco and nicotine products. Adolescents could benefit from the provision of safe environments to equip them to face challenging situations in their social environment.

- In early adolescent health education on tobacco and nicotine products, attention needs to be paid to supporting refusal self-efficacy and social competence. This approach which supports more transferable skills may also have benefits for other health behaviours.
- Early adolescent health education on tobacco and nicotine products should give consideration to the educations' suitability and appeal to all genders.
- The *Fume* health game intervention could be readily incorporated into health education in schools to address early adolescent health education on tobacco and nicotine products. The intervention combines school level and individual level health education. Thus, the *Fume* health game could be used by the early adolescents at home followed by a debriefing group discussion on a school class with the school health nurse.

Implications for health policy and guidelines:

- Adolescents' own active role and perspectives regarding their self-efficacy and health education on tobacco and nicotine products should be considered in the guidelines for school health care and clinical nursing practice.
- Focus should be directed towards feasible and effective evidence-based health education in school health care guidelines on the prevention of tobacco and nicotine products.
- There is currently some support for digital health initiatives and the need for digital health care services has been acknowledged (Vehko, 2022). The emphasis has been on larger digital information systems. However, health policy support for research-based digital health innovations could be more extensive, for example in the form of guidelines and education for clinical nursing practice.

# 7 Conclusions

The results of this study add to the existing theoretical understanding of self-efficacy related to both tobacco refusal by adolescents and the context of peer interactions. The results emphasised the active role of adolescents themselves in shaping their self-efficacy within peer interactions. These interactions are influenced by the adolescents' social atmosphere among other factors. Social atmosphere influences tobacco refusal self-efficacy in particular as it is associated with the smoking behaviour of peers and relatives as well as gender. The development of self-efficacy in adolescence needs more consideration from adolescents' perspectives and further research is warranted.

The summarised evidence on digital interventions to promote child and adolescent refusal self-efficacy supports the use of interventions with sound theoretical basis, but the evidence quality was rather low. Further research with rigorous study designs is needed to examine the effectiveness of existing digital health interventions.

The results indicate that the *Fume* health game intervention can be implemented into a school context with good results on early adolescent tobacco refusal self-efficacy. The effectiveness of the intervention was demonstrated in the results on the sources of tobacco refusal self-efficacy, and tobacco refusal self-efficacy among 12-year-olds and early adolescents with smoking in their close social circle. Although it was found effective, the *Fume* health game intervention could be further refined. Additional attention is needed on a more recurrent delivery mode and more targeted content on newer tobacco and nicotine products. Based on the results of the effectiveness of the *Fume* health game, it is recommended that the intervention be implemented and used in early adolescent health education on tobacco and nicotine products, and also to examine the long-term health outcomes.

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# Appendicies

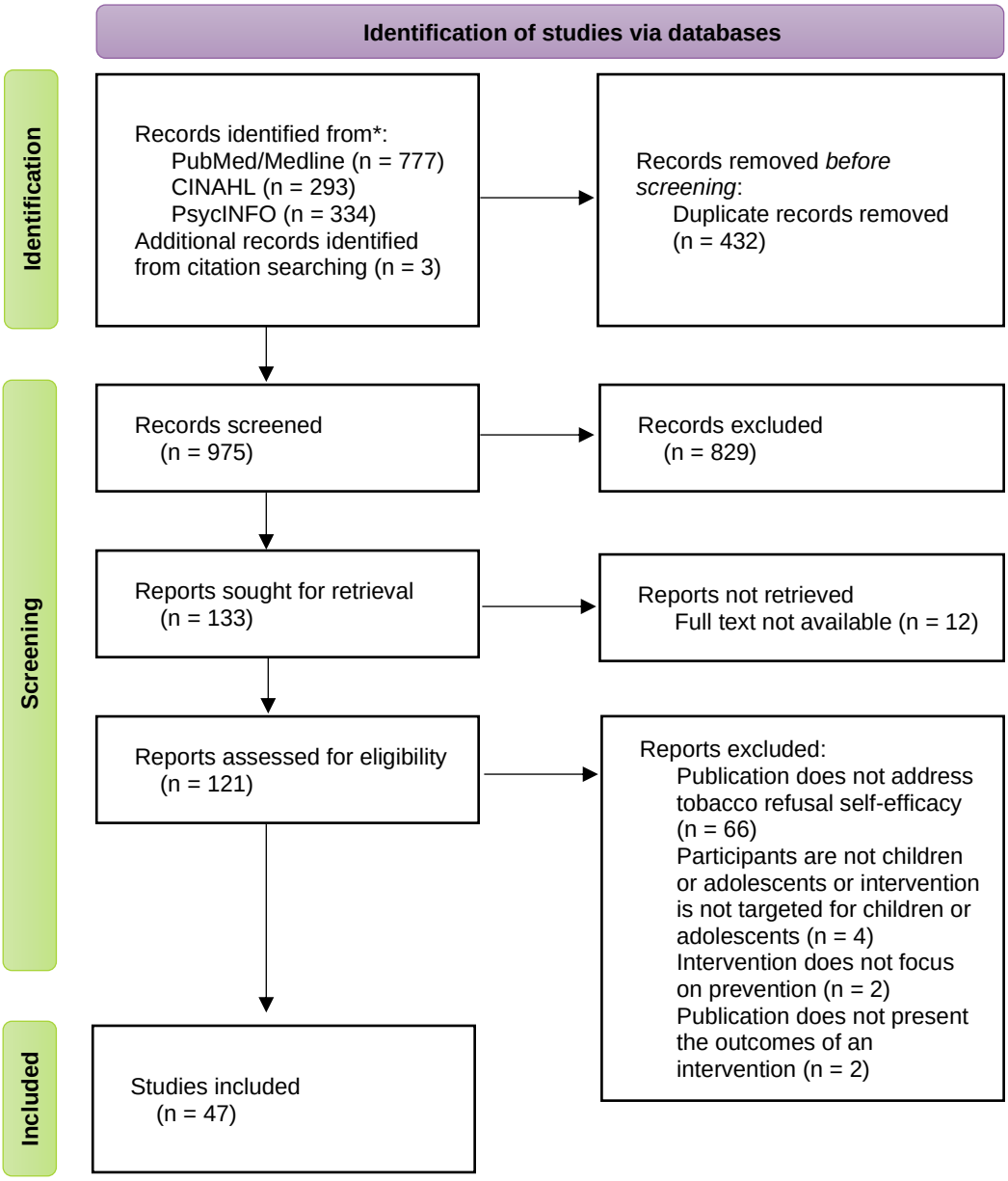
## APPENDIX 1

**Appendix Table 1.** Search strings used in databases for the systematic literature search.

| DATE OF SEARCH | DATABASE | SEARCH STRING | SEARCH RESULTS |
|---|---|---|---|
| 31.8.2023 | PUBMED / MEDLINE | (intervention OR program* OR "Health Promotion"[Mesh] OR “Health Education”[Mesh] OR “Program Development”[Mesh] OR "Program Evaluation"[Mesh] OR “Psychosocial Intervention”[Mesh] OR “Early Medical Intervention”[Mesh]) AND (adolescen* OR teen* OR preadolescen* OR preteen* OR mid-adolescen* OR mid-teen* OR child* OR youth* OR youngster* OR young people* OR young person* OR "Adolescent"[Mesh] OR "Child"[Mesh] OR "Minors"[Mesh]) AND (anti OR refus* OR resist* OR non OR prevent* OR avoid* OR declin*) AND (self-efficacy OR efficacy expectation* OR "Self Efficacy"[Mesh]) AND (smoke* OR smoking* OR “Smoking”[Mesh] OR “Smoking Prevention”[Mesh] OR tobacco* OR “Tobacco Products”[Mesh] OR “Tobacco”[Mesh] OR “Tobacco Use”[Mesh] OR “Tobacco Smoking”[Mesh] OR cigar* OR “Cigarette Smoking”[Mesh] OR “Cigar Smoking”[Mesh] OR snus* OR snuff* OR smokeless* OR “Tobacco, Smokeless”[Mesh] OR e-cigarette* OR vaping* OR vape* OR “Vaping”[Mesh] OR “Smoking, Non-Tobacco Products”[Mesh] OR waterpipe* OR “Tobacco, Waterpipe”[Mesh] OR “Smoking Water Pipes”[Mesh]) | 777 |
| 31.8.2023 | CINAHL | (intervention OR program* OR MH "Nursing Interventions" OR MH "Psychosocial Intervention" OR MH "Intervention Trials" OR MH “Program Planning” OR MH "Program Development" OR MH "Program Evaluation" OR MH "Program Implementation" OR MH “Health Promotion” OR MH “Health Education” OR MH “School Health Education”) AND (adolescen* OR teen* OR preadolescen* OR preteen* OR mid-adolescen* OR mid-teen* OR child* OR youth* OR youngster* OR young people* OR young person* OR MH "Adolescent Health" OR MH "Adolescence+" OR MH "Child+" OR MH "Minors (Legal)") AND (anti* OR refus* OR resist* OR non* OR prevent* OR avoid* OR | 293 |

| | | | |
|---|---|---|---|
| | | declin*) AND (“self-efficacy” OR “self-efficacy” OR “efficacy expectation*” OR MH "Self-Efficacy") AND (smoke* OR smoking* OR MH “Smoking” OR tobacco* OR MH "Tobacco Products” OR MH "Tobacco” OR cigar* OR snus* OR snuff* OR smokeless* OR MH "Tobacco, Smokeless” OR e-cigarette* OR vaping* OR vape* OR MH “Vaping” OR MH “Electronic Cigarettes” OR waterpipe*) | |
| 31.8.2023 | PSYCINFO | (intervention OR program* OR DE “Intervention” OR DE “School Based Intervention” OR DE “Family Intervention” OR DE “Psychosocial Interventions” OR DE “Digital Interventions” OR DE “Health Promotion” OR DE “Health Education” OR DE “Program Development” OR DE “Program Evaluation” OR DE “Educational Programs” OR DE “After School Programs”) AND (adolescen* OR teen* OR preadolescen* OR preteen* OR “mid-adolescen*” OR “mid-teen*” OR child* OR youth* OR youngster* OR “young people*” OR “young person*” OR DE "Adolescent Health" OR DE “Early Adolescence” OR DE “Late Adolescence” OR DE “Adolescent Behavior” OR DE “Child Health” OR DE “Child Behavior”) AND (anti* OR refus* OR resist* OR non* OR prevent* OR avoid* OR declin*) AND (“self-efficacy” OR “self-efficacy” OR “efficacy expectation*” OR DE “Self-Efficacy”) AND (smoke* OR smoking* OR DE “Smoking Prevention” OR DE “Tobacco Smoking” OR tobacco* OR cigar* OR snus* OR snuff* OR smokeless* OR DE "Smokeless Tobacco” OR e-cigarette* OR vaping* OR vape* OR DE “Vaping” OR DE “Electronic Cigarettes” OR waterpipe*) | 334 |

APPENDIX 2




**Appendix Figure 2.** Flow diagram of the systematic literature search and selection process modified from Page et al. (2021).

APPENDIX 3

**Appendix Table 2.** Details of the health education interventions to support adolescent tobacco refusal self-efficacy.

| INTERVENTION | PUBLICATION | SETTING AND LEVEL | AIM | TARGET GROUP | GUIDING THEORY | MECHANISMS GROUNDED IN THEORY | ELEMENTS | DURATION | EFFECTS + / 0 |
|---|---|---|---|---|---|---|---|---|---|
| **Adolescent Smoking Prevention Program (ASPP)** | W. N. Brown, 2016 | Home: Individual-level | Smoking prevention | Female students in grade 10 | Sensitization-homeostasis theory of addiction | Increasing knowledge and awareness | Webpage: pictures, textual information, links on other webpages, questions | 20–40 minutes | 0 |
| **ASPIRE** | Prokhorov et al., 2008 | School: School-level | Smoking prevention and cessation | Culturally diverse high school students | Social cognitive theory, Transtheoretical model of change | Increasing knowledge and awareness, skills development | CD-ROM: animations, videos, tailored interactive activities, quizzes | 5 weekly sessions in one semester and 2 booster sessions in the following semester, 30 minutes per session | 0 |
| **Clearing the Vapor (CTV)** | Merrill & Hanson, 2022 | School: School-level, individual-level | E-cigarette use prevention | 10–18-year-old adolescents | Theory of change | Attitude change, increasing knowledge and awareness, self-efficacy building | Online programme: videos, textual readings, quizzes, reflection activities, certificate | 5 modules | One group: + |
| **Don't play with Fire** | Ausems et al., 2002 | School: School-level | Smoking prevention | Elementary school children (11–12 years old) | Social influence approach | Increasing knowledge and awareness, skills development, social influence | Group discussions, workbook tasks, | 7 lessons, 45–60 minutes each | NA[A] |

| INTERVENTION | PUBLICATION | SETTING AND LEVEL | AIM | TARGET GROUP | GUIDING THEORY | MECHANISMS GROUNDED IN THEORY | ELEMENTS | DURATION | EFFECTS + / 0 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | creative activities, preparation parts | | |
| **Educational program** | Gharlipour et al., 2015 | School: School-level | Smoking prevention | Middle school male students | Extended parallel process model (EPPM) | Increasing knowledge and awareness, skills development, social influence | Posters, lectures, discussion sessions, video clips, home assignments | 5 lectures and discussion sessions, 40 minutes each | + |
| **Eigenständig werden 5+6" (Becoming independent 5+6)** | Isensee et al., 2014; Maruska et al., 2016 | School: School-level | Substance use prevention (tobacco and alcohol) | Students in grades 5 and 6 | Life skills approach; Social influence model | Skills development, social nfluence, critical thinking, decision-making, self-awareness, problem-solving, group work skills, empathy, coping with emotions, increasing knowledge and awareness, social norms, self-efficacy building | Lessons, workshops, group work | 14 units and 2 workshops (4–6 class-hours) over 2 years, 90 minutes per unit | 0 |
| **European Smoking Prevention Framework Approach (ESFA) intervention** | De Vries et al., 2003, 2006 | School: School-level, family-level, community-level | Smoking prevention | School students (12–17 years old) | Social influence approach | Skills development, social influence, increasing knowledge and awareness, decision-making | Lessons, training activities, posters, competitions, brochures for parents, community actions, media publications | 5–6 lessons during first year, 2–7 lessons during second year, 1–5 lessons during third year | + / 0 |
| **Fume** | Parisod et al., 2018 | School: School-level, individual-level | Tobacco use prevention | 10–13-year-old early adolescents | Health literacy model | Increasing knowledge and awareness, skills development, social influence, attitude change, self-efficacy | Mobile game: minigames, quiz, story, textual information, scores | 1 session of 20 minutes, and 2 weeks of free usage | 0 |

| INTERVENTION | PUBLICATION | SETTING AND LEVEL | AIM | TARGET GROUP | GUIDING THEORY | MECHANISMS GROUNDED IN THEORY | ELEMENTS | DURATION | EFFECTS + / 0 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | building, motivation enhancement, personal beliefs | | | |
| **Fun without Smokes** | Cremers et al., 2015 | School: School-level | Smoking prevention | 10–12-year-old primary school children | Social inoculation theory, Theory of reasoned action, Social cognitive theory | Increasing knowledge and awareness, attitude change, social influence, self-efficacy building | Tailored feedback messages, prompt messages, website with textual information, videos, and games | 3 feedback messages, and 6 prompt messages | NA[A] |
| **Headbutt** | Shegog et al., 2005 | School: School-level | Smoking prevention | Middle school children (10–12 years old) | Cognitive social influences theory | Attitude change, self-efficacy building, increasing knowledge and awareness | Web-based intervention: risk assessment, video models, feedback | 20–50 minutes | One group: + |
| **Healthy School and Drugs** | Cuijpers et al., 2002; Turhan et al., 2017 | School: School-level, family-level | Drug use prevention (tobacco, alcohol, marijuana, extasy, and gambling) | High school students (12–18 years old) | Theory of planned behavior; Social cognitive theory; Model of behavioural change; Attitude, social influence, self-efficacy (ASE) model | Increasing knowledge and awareness, attitude change, skills development, self-efficacy building, decision-making, social influence | Coordinating committee, lessons, school regulations, early detection system, support and counselling, manual and brochures for parents, conference for parents | 9 lessons over 3 years: 3 about tobacco during 1st year, 3 about alcohol during 2nd year, 3 about marijuana, extasy and gambling during 2nd or 3rd year<br>In special education schools: 2 booklets (1 on alcohol and 1 on tobacco) | 0 |

| INTERVENTION | PUBLICATION | SETTING AND LEVEL | AIM | TARGET GROUP | GUIDING THEORY | MECHANISMS GROUNDED IN THEORY | ELEMENTS | DURATION | EFFECTS + / 0 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | each containing 4 chapters, each covered in a 50-minute lesson | |
| **Internet-based Tobacco Smoking Prevention Program (ITTSPP)** | Palacheewa et al., 2014 | School: School-level | Smoking prevention | Male adolescents in grade 7 | Health belief model, Theory of reasoned action, Social cognitive theory, Information processing model | Decision-making, self-efficacy building, increasing knowledge and awareness | Internet-based: text information, video clips, a website with graphic screen designs | 4 modules | One group: + |
| **Intervention to Promote and Reinforce Tobacco Abstinence Among Elementary Schoolchildren in A School Transition Period** | Côté et al., 2006 | School: School-level | Smoking prevention | Elementary school children in grade 5 (10–12 years old) | Theory of planned behavior, Theory of interpersonal behavior, Social inoculation theory, Social cognitive theory | Self-efficacy building, personal beliefs, social norms | Workshops, activities | 11 workshops in 3 series of encounters, 50 minutes per week | + / 0 |
| **Invite Only VR** | Weser, Duncan, Pendergrass, et al., 2021; Weser, Duncan, | School: School-level | E-cigarette use prevention | 13–16-year-old adolescents | Theory of planned behavior, Social cognitive theory | Increasing knowledge and awareness, skills development, attitude change, self-efficacy building, social influence, personal beliefs | Virtual reality videogame: scenarios, voice recognition, conversations, interacting with game objects, | 2–4 sessions of 40–60 minutes each with breaks after 20–30 minutes of gameplay | 0 |

| INTERVENTION | PUBLICATION | SETTING AND LEVEL | AIM | TARGET GROUP | GUIDING THEORY | MECHANISMS GROUNDED IN THEORY | ELEMENTS | DURATION | EFFECTS + / 0 |
|---|---|---|---|---|---|---|---|---|---|
| | Sands, et al., 2021 | | | | | | dialogue choices, time rewind, inner voice | | |
| **Life Skills Training curriculum** | Zollinger et al., 2003 | School: School-level | Smoking prevention | Middle school students in grades 6, 7 and 8 | Life skills approach | Decision-making, stress management, communication, skills development, social influence, self-awareness, media awareness | NA | 2 years | + |
| **Media Detective (MD)** | Kupersmidt et al., 2010 | School: School-level | Substance use prevention (tobacco and alcohol) | 7–13-year-old elementary school students | Social cognitive theory, Dual-process theories of attitude change, Theory of reasoned action | Skills development, knowledge and awareness, media awareness | Lessons, activities | 10-day programme including 10 lessons, 45 minutes each | + / 0 |
| **Minnesota Smoking Prevention Program** | Langlois et al., 1999 | School: School-level | Smoking prevention | Students in grade 6 | Social influence model | Increasing knowledge and awareness, social norms, skill development, self-awareness, social influences | Peer-leaders, small group discussions, small group activities | 6 lessons twice a week for 3 weeks and a 30-minute work session, 45 minutes per lesson | + |
| **Mission TNT.06** | Kairouz et al., 2009 | School: School-level | Smoking prevention | Junior high and high school students | NA | Increasing knowledge and awareness, self-efficacy building, skills development | Competition, contract, missions with specific roles, booklets, | 6-month programme | 0 |

| INTERVENTION | PUBLICATION | SETTING AND LEVEL | AIM | TARGET GROUP | GUIDING THEORY | MECHANISMS GROUNDED IN THEORY | ELEMENTS | DURATION | EFFECTS + / 0 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | (12–15 years old) | | | discussion forum, website | | |
| **Out-of-school smoking prevention intervention** | Ausems et al., 2002 | Home: Individual-level | Smoking prevention | Elementary school children (11–12 years old) | Social inoculation theory, Theory of reasoned action, Social cognitive theory | Increasing knowledge and awareness, skills development, social influence, social norms, self-efficacy building | Letters: picture puzzle, cartoons, competition, exercises | 3 letters at 3-week intervals | NA[A] |
| **Peer-led smoking prevention programme** | De Vries et al., 1994; Dijkstra et al., 1999; Lotrean et al., 2010; Mohammed et al., 2016 | School: School-level | Smoking prevention | Vocational and high school students (13–15 years old) | Social influence approach | Increasing knowledge and awareness, skills development, attitude change, self-efficacy building, social influence, personal beliefs, teamwork | Videos including cartoons and recording scenes, small group discussions, role-plays, peer leaders, home activities, making contract, feedback | 5 lessons in 5 weeks, 45 minutes per lesson | + / 0 |
| **PREPARED ON TIME (Op tijd Voorbereid)** | Kiewik et al., 2016 | School: School-level | Substance use prevention (tobacco and alcohol) | 12–15-year-old students | Attitude, social influence, self-efficacy (ASE) model | Increasing knowledge and awareness, skills development, attitude change, social influence, self-efficacy building | E-learning programme: games, videos, quizzes, tests, avatar, tips, feedback, support | 3 weeks period of working with the programme | 0 |
| **Preventure** | Debenham et al., 2021 | School: School-level | Smoking prevention | Adolescents most at risk of substance use (13–14 years old) | Personality-target approach | Skill development, self-awareness, behaviour change | Workbook activities, discussions | 3 years | + / 0 |
| **Project ALERT** | Bell et al., 1993; Ellickson et al., 2003; | School: School-level, family-level | Substance use prevention | Students in grades 6, 7 and 8 | Health belief model, Self-efficacy theory | Social influence, motivation enhancement, | Group discussions, small-group activities, | 8–11 lessons at 6$^{th}$ or 7$^{th}$ grade, 3 | + / 0 |

| INTERVENTION | PUBLICATION | SETTING AND LEVEL | AIM | TARGET GROUP | GUIDING THEORY | MECHANISMS GROUNDED IN THEORY | ELEMENTS | DURATION | EFFECTS + / 0 |
|---|---|---|---|---|---|---|---|---|---|
| | Kovach Clark et al., 2010; Orlando et al., 2005 | | and cessation (alcohol, tobacco, marijuana) | | of behavior change, Social influence model of prevention, Social learning model | increasing knowledge and awareness, personal beliefs, social norms, self-efficacy building | role-plays, videos, questions and answers, games, interviews with parents, tests, oral reports | booster lessons at 7th or 8th grade, and booster lessons at 9th and 10th grades | |
| **Project MYTRI (Mobilizing Youth for Tobacco Related Initiatives in India)** | Perry et al., 2009; Stigler et al., 2011 | School: School-level, family-level, community-level | Tobacco use prevention | Students in grades 6, 7, 8, and 9 | Social influences model, Social cognitive theory | Increasing knowledge and awareness, personal beliefs, skills development, social norms, social influence, attitude change | Classroom activities, posters, parent postcards, peer-led health activism | 2-years | 0 |
| **Project Towards No Tobacco Use (TNT) with media campaigns** | Meshack et al., 2004 | School: School-level, community-level | Smoking prevention | Middle school students in grade 6 (11–12 years old) | Social influences theory | Increasing knowledge and awareness, skill development, social influence, self-efficacy building | Media messages, role-play, activities, marketing events, | 10 sessions | 0 |
| **Public service announcements (PSAS)** | Shadel et al., 2009; Tharp-Taylor et al., 2012 | Laboratory: Individual-level, community-level | Smoking prevention | Adolescents (11–17 years old) | NA | Increasing knowledge and awareness, self-efficacy building | Televised messages | 21–28 public service announcements, 30–31 seconds each | One group: + / 0 |
| **Public service announcements of high sensation value (HSV-PSAS)** | Helme et al., 2007 | School: School-level, community-level | Cigarette and marijuana use prevention | 12–14-year-old middle school students | Activation model of information exposure, Sensation-seeking | Increasing knowledge and awareness, attitude change | Televised messages | 18 public service announcements in 3 intervention sessions (2 weeks | One group: + |

| INTERVENTION | PUBLICATION | SETTING AND LEVEL | AIM | TARGET GROUP | GUIDING THEORY | MECHANISMS GROUNDED IN THEORY | ELEMENTS | DURATION | EFFECTS + / 0 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | targeting approach | | | between sessions) | |
| **Salaam Bombay Foundation (SBF) life skills programme** | Nagler & Lobo, 2019 | School: School-level, community-level | Smoking prevention | Students in grades 8 and 9 (13–15 years old) | Life skills approach | Increasing knowledge and awareness, skills development, self-awareness, decision-making, self-efficacy building, skills development, teamwork, communication | In-school Super Army programme with training, activities, festivals, questions and answers, support, and after-school sports, art, and journalism academies | 5-year curriculum: in-school activities 1–2 times monthly, after-school activities 2–3 times weekly | NA[B] |
| **Smoke-free Kids** | Hiemstra et al., 2013, 2016 | Home: Family-level | Smoking prevention | 9–11-year-old children | Anti-smoking socialization approach | Parental skill development, parental communication, increasing knowledge and awareness, social influence | Assignments, games, role-plays, contests, interviews, communication sheet | 5 activity modules at 4-week intervals and a booster module 12 months later, 1 hour per activity module | 0 |
| **SmokeFree Sports** | McGee et al., 2016 | School: School-level | Smoking prevention | 9–10-year-old primary school children | Socioecological model, Health belief model, Theory of planned behavior, Social cognitive/learning theory | Behaviour change, social influence, increasing knowledge and awareness, self-awareness, social norms, promotion of physical activity | Training, coaching sessions, school assembly with a local sports star, incentives, contracts | 5 coaching sessions | + / 0 |
| **smokeSCREEN** | Duncan, Hieftje, et al., 2018 | Home: Individual-level | Cigarette and marijuana | 11–14-year-old adolescents | NA | Decision-making, social influence, skill development | Videogame: avatars, game activities | 1 hour twice per week for 2 | One group: 0 |

| INTERVENTION | PUBLICATION | SETTING AND LEVEL | AIM | TARGET GROUP | GUIDING THEORY | MECHANISMS GROUNDED IN THEORY | ELEMENTS | DURATION | EFFECTS + / 0 |
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| | | | use prevention | who had never tried cigarettes or marijuana | | | | weeks (4 hours in total) | |
| **Smoking prevention program** | Rafiee et al., 2018 | School: School-level | Smoking prevention | Adolescent females in grade 10 (16 years old) | Self-efficacy theory | Increasing knowledge and awareness, skills development, decision-making, social influence, communication, stress management | Lectures, group discussions, video clips, questions and answers, role-plays, practices in classroom, brainstorming | 1 session a week for 5 weeks, 90 minutes per session | 0 |
| **Smoking prevention program** | Guo et al., 2022 | School: School-level | Smoking prevention | Students in grade 7 | NA | Increasing knowledge and awareness, stress management, skills development, decision-making, social influence, attitude change | PowerPoint lessons, videos, group discussions, feedback, learning sheets | 4 classes within 3 months, 50 min per class | 0 |
| **Social Resistance Classroom curriculum** | Flay et al., 1988, 1995 | School: School-level, family-level, community-level | Smoking prevention and cessation | Students in grade 7 | Social influence approach | Skill development, social influence, increasing knowledge and awareness, social norms, family involvement, social norms, decision-making | Group discussions, role-play, homework assignments, discussions with parents, print material to parents, television segments | 10 sessions in 2 weeks | 0 |

+ = statistically significant favourable results on tobacco refusal self-efficacy, 0 = statistically non-significant or negative results on tobacco refusal self-efficacy
NA = Not available
[A] Only baseline results on refusal self-efficacy available
[B] Results available only in descriptive style, it is unclear whether there were any statistically significant intervention effects on refusal self-efficacy

APPENDIX 4

**Appendix Table 3.** Details of previous studies on health education interventions to support adolescent tobacco refusal self-efficacy.

| AUTHORS, PUBLICATION YEAR, COUNTRY | AIM | DESIGN AND MEASUREMENT POINTS | SETTING | SAMPLE | INTERVENTION | CONTROL | REFUSAL SELF-EFFICACY RESULTS |
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| **BROWN WN 2016 UNITES STATES OF AMERICA** | To "test the effectiveness of a web-based adolescent smoking prevention program". | Pre-post repeated measures<br><br>Baseline and 2-week posttest | Home | n = 54 adolescents, 12–15 years old, mean age 12.9 years | the Adolescent Smoking Prevention Program (ASPP): Web-based online intervention | No intervention | A significant difference was observed between the two groups in terms of resistance self-efficacy, as the complete study group exhibited notably higher resistance self-efficacy compared to the group of participants who dropped out of the study ($p < .001$). The analysis did not reveal any significant impact of the group ($p > 0.30$), time ($p > 0.20$), or the interaction between time and group ($p > 0.70$) on participants' resistance self-efficacy levels. Resistance self-efficacy emerged as a significant individual predictor for participants' willingness to decline an offer of a cigarette and willingness to try a cigarette if offered. |
| **PROKHOROV AV, KELDER SH, SHEGOG R, MURRAY N, PETERS R JR., AGURCIA-PARKER C, CINCIRIPINI PM, DE** | To analyse "the long-term impact of A Smoking Prevention Interactive Experience (ASPIRE), a theoretically sound computer-based | Nested-cohort, group-randomised, controlled trial<br><br>Baseline and 18-month follow-up | School: 16 high schools | n = 1608 culturally diverse high school students in 10th grade | ASPIRE: An interactive multimedia smoking prevention and cessation curriculum | Standard-care | After 18 months, the comparison group and the intervention group had similar levels of self-efficacy (estimated means: 50.4 for comparison, and 49.5 for intervention group). |

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| **MOOR C, CONROY JL, SUCHANEK HUDMON K, FORD KH, MARANI S 2008 UNITES STATES OF AMERICA** | smoking prevention and cessation curriculum for high school students". | | | | | | |
| **MERRILL RM, HANSON CL 2022 UNITES STATES OF AMERICA** | To conduct "a formative evaluation of an online e-cigarette prevention program". | Within-group design<br><br>Pre- and post-test | School: school boards in a five-county area | n = 10758 students, 10–18 years old | Clearing the Vapor (CTV): Online e-cigarette prevention programme | None | The CTV programme seems to be successfully attaining its predetermined short-term results. These immediate results of the intervention include an increase in self-efficacy related to resisting e-cigarette use and communicating the harm associated with them. |
| **AUSEMS M, MESTERS I, VAN BREUKELEN G, DE VRIES H 2002 NETHERLANDS** | To examine "the effects of in-school and out-of-school smoking prevention". | Cluster randomised controlled trial<br><br>Pretest and 6-month follow-up | School: 143 schools | n = 7468 students, 11–12 years old, mean age 11.6–11.7 | Don't play with Fire: School-based social influence programme<br><br>Out-of-school intervention: Out-of-school smoking prevention | Control group | Pretest self-efficacy scores ranged from 8.8 to 9.6. Posttest results on self-efficacy were not available. |
| **GHARLIPOUR Z, HAZAVEHEI SMM, MOEINI B, NAZARI M, BEIGI AM, TAVASSOLI E, HEYDARABADI AB, REISI M, BARKATI H 2015 IRAN** | To "determine the effect of educational programs based on parallel process model for prevention of cigarette smoking among middle school students in Shiraz city". | Quasi-experimental study<br><br>Pretest and posttest 2 months after the intervention | School: 2 middle schools | n = 240 male students | An educational program: Preventive educational programme in cigarette smoking | Control group | There was a significant difference in self-efficacy ($p = 0.048$) between the intervention and control groups at pretest. The intervention group showed significant change in the mean scores of self-efficacy before and after the intervention ($p < 0.001$). In contrast, there were no significant changes before and after |

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| | | | | | | | the educational intervention within the control group (p = 0.197). |
| **ISENSEE B, HANSEN J, MARUSKA K, HANEWINKEL R 2014 GERMANY** | "To test the effects of a school-based prevention programme on students' smoking-related behaviour, attitudes and knowledge." | Cluster randomised controlled trial<br><br>Baseline, posttest 6 months after completing the intervention | School: 45 public secondary schools | n = 3444 students, mean age 10.37 years | Eigenständig werden 5+6 (Becoming independent 5+6): A school-based prevention programme on smoking in early adolescence | Education as usual | At baseline, students in both groups believed they were able to resist cigarette offers. Over the course of the observation period, their self-efficacy continued to increase, with a slightly greater, though statistically insignificant (p = 0.140), rise among students in the intervention group compared to those in the control group. |
| **MARUSKA K, HANSEN J, HANEWINKEL R, ISENSEE B 2016 GERMANY** | "To investigate the mediating mechanisms, that is, the mediators, through which Eigenständig werden 5+6 exerts its effect on smoking onset, which was reported in the previous study." | Cluster randomised-controlled<br><br>Baseline, 8-month posttest, 20-month posttest, 26-month follow-up, and 35-month follow-up | School: 45 schools | n = 2321 students in 5th and 6th grades, 9–12 years old, mean age 10.3 years | Eigenständig werden 5+6'' (Becoming independent 5+6): School-based smoking prevention programme | Education as usual | There was no significant association between the prevention programme and refusal self-efficacy (p = 0.859). |
| **DE VRIES H, MUDDE A, KREMERS S, WETZELS J, UITERS E, ARIZA C, DUARTE VITÓRIA P, FIELDER A, HOLM K, JANSSEN K, LEHTOVUORI R, CANDEL M 2003 SIX EUROPEAN COUNTRIES: FINLAND,** | To examine "the results of the ESFA project 12 months after the first pre-test". | Community Intervention Trial (CIT)<br><br>Pretest and 12-month posttest | School: Finland: 27 schools Denmark: 60 schools Netherlands: 33 schools United Kingdom: 43 schools Portugal: 25 schools | n = 20166 students, 12–17 years old, mean age 13.27–13.29 | The European Smoking Prevention Framework Approach (ESFA) intervention: School-based smoking prevention programme | Usual care | In Spain, students who were part of the intervention group demonstrated notably elevated levels of social (p < 0.01) and stress self-efficacy (p < 0.05) compared to their peers in the control group. Meanwhile, in Portugal, adolescents in the intervention group likewise indicated significantly enhanced social self-efficacy scores (p < 0.05) compared to their counterparts in the control group. In the United Kingdom, a contrasting outcome emerged as |

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| **DENMARK, NETHERLANDS, UNITED KINGDOM, PORTUGAL, SPAIN** | | | Spain: 47 schools | | | | adolescents within the intervention group exhibited significantly reduced self-efficacy scores (stress self-efficacy: $p < 0.01$, situational self-efficacy: $p < 0.05$). |
| **DE VRIES H, DIJK F, WETZELS J, MUDDE A, KREMERS S, ARIZA C, DUARTE VITÓRIA P, FIELDER A, HOLM K, JANSSEN K, LEHTOVUORI R, CANDEL M 2006 SIX EUROPEAN COUNTRIES: FINLAND, DENMARK, NETHERLANDS, UNITED KINGDOM, PORTUGAL, SPAIN** | To examine "the results of ESFA at 24 and 30 months after the pre-test". | Community intervention trial<br><br>Pretest, 24-month posttest, and 30-month posttest | School: Finland: 27 schools Denmark: 60 schools Netherlands: 33 schools United Kingdom: 43 schools Portugal: 25 schools Spain: 47 schools | n = 10751 adolescents | The European Smoking Prevention Framework Approach (ESFA) intervention: School-based smoking prevention programme | Usual care | Schools and national organisations perceived activities aimed at teaching refusal skills as excessively time-consuming. After 24 months, the Portuguese adolescents in the intervention group showed significant improvements in self-efficacy effects. They reported improved social ($p < 0.001$), stress ($p < 0.01$) and situational self-efficacy ($p < 0.05$). The Dutch adolescents in the intervention group, however, showed lower situational self-efficacy ($p < 0.05$). After 30 months, a significant change in social self-efficacy emerged ($p < 0.01$), wherein the intervention group exhibited greater situational self-efficacy compared to the control group. The emergence of this effect can be attributed to significant effects seen in Denmark ($p < 0.05$), Portugal ($p < 0.01$), Spain ($p < 0.10$), and the UK ($p < 0.05$). |
| **PARISOD H, PAKARINEN A, AXELIN A, LÖYTTYNIEMI E, SMED J, SALANTERÄ S** | 1) To "determine the short-term effectiveness of the tobacco-related mobile health game Fume | Cluster randomised controlled trial | School: 8 schools | n = 151 early adolescents, 10–13 years old, median age 11 years | Fume -health game intervention: Tobacco-related mobile health game | Non-gamified website<br><br>No intervention | Statistical analysis revealed that there were no significant differences in the changes pertaining to anti-smoking self-efficacy among the groups ($p = 0.46$). |

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| **2018<br>FINLAND** | and that of a non-gamified website".<br>2) To "compare the demand for and acceptability of Fume to that of the website". | Baseline and 2-week post-intervention | | | | | |
| **CREMERS H-P, MERCKEN L, CANDEL M, DE VRIES H, OENEMA A<br>2015<br>NETHERLANDS** | To "evaluate whether computer-tailored feedback messages, with and without prompt messages, are effective in decreasing children's smoking intentions and smoking behavior after 12 and 25 months of follow-up". | Cluster randomised controlled trial<br><br>Baseline, 12-month follow-up, and 25-month follow-up | Schools:<br>162 schools | 3213 children, 10–12 years old | Fun without Smokes: Web-based, computer-tailored smoking prevention programme | No intervention | There were no notable differences between the study groups in terms of smoking-related factors (such as, attitude, social influence, and self-efficacy expectations) at the baseline. Only baseline results on self-efficacy available. |
| **SHEGOG R, MCALISTER AL, HU S, FORD KC, MESHACK AF, PETERS RJ<br>2005<br>UNITES STATES OF AMERICA** | To present "efficacy findings from the pilot evaluation of one tobacco prevention program, Headbutt, a Web-based component of the Texas Tobacco Prevention Initiative". | One-group pretest-posttest design<br><br>Pretest and posttest | School:<br>9 middle schools | n = 2227 students in 6th grade, 58 % were 12-year-olds | Headbutt: web-based tobacco prevention programme | None | There was a significant improvement in attitude scores related to self-efficacy to refuse cigarettes observed during the programme's implementation ($p < .001$). |
| **CUIJPERS P, JONKERS R, DE WEERDT I, DE JONG A<br>2002<br>NETHERLANDS** | "To examine the effects of the 'Healthy School and Drugs' project, a Dutch school-based drug prevention project." | Quasi-experimental study<br><br>Pretest, 1-year posttest, 2-year posttest, and 3-year posttest | School:<br>12 schools | n = 1930 students, mean age 12.4 years | Healthy School and Drugs: School-based drug prevention project | Control group | The intervention did not result in any changes in self-efficacy regarding tobacco use. |

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| **TURHAN A, ONRUS SA, TEN KLOOSTER PM, PIETERSE ME 2016 NETHERLANDS** | ”To test the effectiveness of the Healthy School and Drugs (HSD) programme on tobacco and alcohol use in Dutch secondary special education (SE) schools.” | Quasi-experimental design<br><br>Baseline and 5-month follow-up | School: 13 secondary special education schools | n = 405 students, 12–16 years old, mean age 13.9 years | Healthy School and Drugs: Programme on tobacco and alcohol prevention adapted for special education | Usual curriculum | There were no programme effects found on self-efficacy to refuse smoking (p = 0.640). However, students attending schools with a high level of fidelity in implementing the programme exhibited a positive shift in self-efficacy, contrasting with students in low-fidelity schools (p = 0.015). |
| **PALACHEEWA N, TIANSAWAD S, SRISUPHAN W, WHATTANANARONG K, DUFFY 2014 UNITES STATES OF AMERICA** | To develop an interactive interned-based tobacco prevention program and test its feasibility. | Developmental research with feasibility testing<br><br>Baseline, immediate post-test, 7-day follow-up | School: 2 public secondary schools | n = 30 students in 7th grade for feasibility testing | Internet-based Tobacco Smoking Prevention Program: Programme for male adolescents | None | Significant increases in self-efficacy scores for refusing smoking were observed between the pre-test and post-test (p<.05). Further analysis indicated significant increases in self-efficacy scores at baseline, immediate post-test, and Day 7 follow-up (p<.05). |
| **CÔTÉ F, GODIN G, GAGNÉ C 2006 CANADA** | To evaluate the outcomes of ”an intervention designed to reinforce tobacco abstinence among elementary schoolchildren in a school transition period”. | Quasi-experimental longitudinal design<br><br>Baseline, 2-month post-intervention, 8-month post-intervention | School: 32 elementary schools | n= 1173 students in 5th grade, age, 10–12 years | Intervention to Promote and Reinforce Tobacco Abstinence Among Elementary Schoolchildren in a School Transition Period | Control group | The intervention had an impact on perceived self-efficacy, but this impact had a dual nature. Among students who initially believed they couldn't resist smoking, those in the experimental group scored higher at the 8-month follow-up than those in the control group (p < 0.05). On the other hand, among respondents who started with a high baseline perceived self-efficacy, those in the control group maintained a higher level at the 8-month follow-up compared to the experimental group (p < 0.05). |
| **WESER VU, DUNCAN LR, PENDERGRASS TM, FERNANDES C-** | ”To test the preliminary impact and participant | Pre/post design | Home | n = 47 adolescents, | Invite Only VR: Virtual reality game for | None | While there were no observable change in adolescents’ self-efficacy for refusing e-cigarettes (effect size |

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| **S, FIELLIN LE, HIEFTJE KD 2021 UNITES STATES OF AMERICA** | experience/satisfaction of Invite Only VR: A Vaping Prevention Game (Invite Only VR)." | Pre- and post-intervention | | mean age 14.23 years | adolescent e-cigarette prevention | | 0.135, non-significant) during the study period, the adolescents already had high self-efficacy scores at the beginning. |
| **WESER VU, DUNCAN LR, SANDS BE, SCHARTMANN A, JACOBO S, FRANÇOIS B, HIEFTJE KD 2021 UNITES STATES OF AMERICA** | "To test preliminary efficacy and acceptability of Invite Only VR: A Vaping Prevention Game (Invite Only VR)." | Non-equivalent control groups design<br><br>Baseline, post-intervention, 3-month follow-up, and 6-month follow-up | School: 3 middle schools | n = 285 adolescents, 11–14 years old, mean age 12.45 years | Invite Only VR: Virtual reality e-cigarette game for adolescents | Treatment as usual | Despite no significant changes being evident in either the experimental or control groups, all participants consistently exhibited a high level of self-efficacy in refusing e-cigarettes (mean score = 3.80) throughout the study period. |
| **ZOLLINGER TW, SAYWELL RM, MUEGGE CM, WOOLDRIDGE JS, CUMMINGS SF, CAINE VA 2003 UNITES STATES OF AMERICA** | To assess "the impact of the Life Skills Training curriculum on Marion County, Ind., middle school students' knowledge, attitudes, and ability to make good lifestyle decisions" specifically concerning the use of tobacco. | Repeated panel design<br><br>Baseline data collected in 1997 on 6$^{th}$ grade students; in 1998, 6$^{th}$ and 7$^{th}$ grade students were surveyed, and in 1999 and 2000 all 6$^{th}$, 7$^{th}$, and 8$^{th}$ grade students | School: 12 schools | n = 1598 students in 8$^{th}$ grade | Life Skills Training curriculum: Youth smoking prevention and intervention programme | No intervention | The majority of students (85.4 %) indicated that it would not pose any difficulty to refuse a cigarette offer. Notably, a higher percentage of students who were twice exposed to the intervention reported that refusing would not be difficult (82.7 % for no exposure versus 87.4 % for twice exposure, p = 0.05). Similarly, a larger proportion of female students who were exposed to the intervention twice expressed refusing a cigarette offer would not be a difficult. |
| **KUPERSMIDT JB, SCULL TM, WEINTRAUB AUSTIN E 2010 UNITES STATES OF AMERICA** | To "evaluate the effectiveness of a more-comprehensive, theory-based, developmentally appropriate, third-through fifth-grade media literacy | Randomised controlled trial<br><br>Pretest and 2-week posttest | School: 12 elementary schools | 723 students, 7–13 years old, mean age 9.40 years | Media Detective (MD) Program: Elementary school substance use prevention programme | Waiting list | An interaction effect emerged between previous substance use and the intervention. Among students who had used alcohol or tobacco before, those in the intervention group displayed higher levels of self-efficacy in resisting these substances compared to their |

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| | education program for substance use prevention". | | | | | | peers in the control group. No significant differences were observed between the intervention and control groups for students who did not have previous experiences with alcohol or tobacco; both groups had similarly high levels of self-efficacy to refuse substances. |
| **LANGLOIS MA, PETOSA R, HALLAM JS 1999 UNITES STATES OF AMERICA** | To test "construct validity of an effective psychosocial smoking prevention curriculum on the mediating variables considered responsible for decreasing adolescent initiation of cigarette smoking". | Nonequivalent comparison group design<br><br>Pretest and posttest 4 weeks after completing the intervention | School: 10 sixth-grade classes | n = 161 students in 6th grade | Minnesota Smoking Prevention Program: psychosocial smoking prevention curriculum | Knowledge-based health instruction | The smoking prevention programme yielded statistically significant results, demonstrating its influence on students' refusal skill-efficacy (p = 0.019). After the intervention, the intervention group's mean score for refusal skill-efficacy only experienced a minimal decrease of 0.46 points, reaching a mean score of 48.72. In contrast, the mean score of the comparison group decreased significantly by 3.78 points, resulting in a mean score of 43.20. |
| **KAIROUZ S, O'LOUGHLIN J, LAGUË J 2009 CANADA** | "To evaluate the impact of a smoke-free class competition in elementary schools." | Quasi-experimental study design<br><br>Baseline (6th grade 6), follow-up (7th grade), and 6 months after implementation of the intervention | School: 84 elementary schools | n = 2056 students in 6th grade | Mission TNT.06: Smoke-free class competition programme in elementary schools | Comparison schools | The programme did not seem to influence self-efficacy in resisting social pressure to smoke (if someone insist, p = 0.78; if made fun of, p = 0.77, if best friends asks to smoke, p = 0.96). |

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| **DE VRIES H, BACKBIER E, DIJKSTRA M, VAN BREUKELEN G, PARCEL G, KOK G 1994 NETHERLANDS** | To examine "the effects of a peer-led smoking prevention program on video for eighth grade Dutch vocational and high school students". | Quasi-experimental approach<br><br>Pre-test, 9-month posttest, and 12-month posttest | School: 6 vocational and 8 high schools. | n = 1529 students in vocational and high schools, 13–14 years old | Peer-led smoking prevention program: Peer-led social influence smoking prevention approach | Control group | Programme effects on self-efficacy were not observed at either of the post-tests. Nevertheless, intervention effects were evident among smokers, as smoking students in the intervention group demonstrated higher self-efficacy at 9 months compared to their counterparts in the control group ($p < 0.001$). Conversely, among non-smokers, the control group exhibited greater self-efficacy than the intervention group at 12-months ($p < 0.02$). However, by the 12-month post-test, there were no statistically significant differences in self-efficacy among the smoking students in both groups. |
| **DIJKSTRA M, MESTERS H, DE VRIED H, VAN BREUKELEN G, PARCEL GS 1999 NETHERLANDS** | To examine "the short-term and long-term results of a randomized smoking prevention trial". | Randomised trial<br><br>Pre-test, 6-month posttest, 12-month posttest, and 18-month posttest | School: 52 schools | n = 4060 students, 13–15 years old | Peer-led smoking prevention program: Peer-led social influence smoking prevention approach<br><br>Social influence program with additional decision-making component | Control group | At 6 months post-test, there were no significant effects for self-efficacy. |
| **LOTREAN LM, DIJK F, MESTERS I, IONUT C, DE VRIES H** | To "assess the effects of a school-based smoking prevention | Study design not reported (2 groups, random | School: | n = 1196 students from 7$^{th}$ grade, 13– | Peer-led smoking | Control group | Adolescents in the experimental group indicated greater levels of social self-efficacy in comparison to |

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| **2010<br>ROMANIA** | programme that used both a video and peer-led discussion groups among Romanian junior high school students aged 13–14 years". | allocation, baseline and follow-up measures)<br><br>Pretest, post-test 6-7 months after intervention | 55 classes from 20 schools | 14 years old, mean age 13.7 years | prevention program: Peer-led social influence smoking prevention approach | | their peers in the control group ($p < 0.05$). There were no statistically significant differences in terms of emotional or situational self-efficacy. |
| **MOHAMMED M, EGGERS SM, ALOTAIBY FF, DE VRIES N, DE VRIES H<br>2016<br>SAUDI ARABIA** | "To examine the efficacy of a smoking prevention program which aimed to address smoking related cognitions and smoking behavior among Saudi adolescents age 13 to 15." | Randomised controlled trial<br><br>Baseline, 6-month post-intervention | School: 19 secondary schools | n = 1416 students, mean age 13.9 years | Peer-led smoking prevention program: Peer-led social influence smoking prevention approach | Usual curriculum | Students in the intervention group reported significantly higher levels of self-efficacy compared to the control group ($p < 0.001$). |
| **KIEWIK M, VANDERNAGEL JEL, KEMNA LEM, ENGELS RCME, DEJONG CAJ<br>2016<br>NETHERLANDS** | 1) To "undertake a cluster randomised control trial to test the efficacy of the e-learning program among 12- to 15-year old students with mild and borderline intellectual disability in secondary special-needs schools" .<br>2) To "examine the tobacco and alcohol use for this population". | Cluster randomised control trial<br><br>Baseline, follow-up 3 weeks after working with the intervention | School: 5 special-needs schools | n = 210 students in 1st or 2nd grade with a borderline or mild intellectual disability, 12-16 years old, mean age 13.6 years | PREPARED ON TIME: Substance use prevention programme for adolescents | Treatment as usual | The intervention did not significantly improve the students' self-efficacy not to smoke ($p = 0.166$). |
| **DEBENHAM J, GRUMMITT L, NEWTON NC,** | To "examine the efficacy of Preventure in reducing tobacco | Cluster randomised controlled trial | School: 14 schools | n = 1005 year 8 students, 13–14 years | Preventure Selective personality- | Control group | While no intervention effects at the group level were observed regarding self-efficacy to resist peer |

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| **TEESSON M, SLADE T, CONROD P, KELLY EV 2021 AUSTRALIA** | smoking in secondary school students". | Baseline, 6-, 12-, 24 and 36-months post-baseline | | old, mean age 13.4 years | targeted prevention programme | | pressure to smoke tobacco (p = 0.431), secondary analysis revealed that adolescents with internalising traits who participated in the Preventure programme exhibited an increased perception of self-efficacy in resisting peer pressure over time compared to those in the control group (p = .02). |
| **BELL RM, ELLICKSON PL, HARRISON ER 1993 UNITED STATES OF AMERICA** | To examine the durability of outcomes following a multisite drug prevention programme. | Study design not reported (3 groups, random allocation, baseline & follow-up measures)<br><br>Pre-test and 24-month posttest | School: 30 schools | n = 6527 students in 7th grade | Project ALERT: School-based substance use prevention programme<br><br>Either delivered by teacher alone, or teen leaders assisted the teacher | Control group | The results on resistance self-efficacy favoured teen leader schools. These schools showed better results compared to control schools, especially for students in lower risk categories. Among these lower risk groups, the teen leader programme yielded better results 11 out of 12 times, with 3 instances being statistically significant. However, in the highest risk group, the teen leader programme showed slightly worse results 5 or 6 times, though none were statistically significant.<br><br>In teacher-only schools, high-risk students tended to perform worse than controls, while lower-risk students tended to do better. However, there were only marginal significance in two cases, one positive and one negative. |
| **ELLICKSON PL, MCCAFFREY DF, GHOSH-DASTIDAR B, LONGSHORE DL** | To evaluate "the revised Project ALERT drug prevention program across a wide | Randomised trial<br><br>Baseline, 18-month posttest | School: 55 middle schools | n = 4276 students | Project ALERT: School-based substance use | Control group | Only baseline data collected on cognitive risk factors, such as resistance self-efficacy (data not available). |

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| **2003**<br>**UNITED STATES OF AMERICA** | variety of Midwestern schools and communities". | | | | prevention programme<br><br>Either with or without booster lessons in 9th and 10th grades | | |
| **ORLANDO M, ELLICKSON PL, MCCAFFREY DF, LONGSHORE DL**<br>**2005**<br>**UNITES STATES OF AMERICA** | To "examine whether and to what extent the enhanced ALERT curriculum achieved its effects on past month cigarette use and alcohol misuse through the program-targeted attitudes and beliefs about drug and alcohol use". | Mediation analyses using longitudinal data in structural modeling framework<br><br>Baseline, 1 year later | School: 55 middle schools | n = 4277 middle school students | Project ALERT: School-based substance use prevention programme | Control group | The structural model for cigarette use exhibited strong indications of good model fit ($\chi^{2}$(674, N = 4, 277) = 4150.57, CFI = 0.959, RMSEA = .035).Furthermore, the model accounted for varying proportions of variance in the dependent variables, as follows: resistance self-efficacy (explained 22% of variance), positive beliefs (explained 24% of variance), negative beliefs (explained 19% of variance), peer influence (explained 42% of variance), intentions (explained 69% of variance), and use (explained 60% of variance). |
| **KOVACH CLARK H, RINGWALT CL, HANLEY S, SHAMBLEN SR**<br>**2010**<br>**UNITES STATES OF AMERICA** | To examine "examined Project ALERT's effects on adolescents' intentions to use substances in the future, beliefs about substance use consequences, normative beliefs, and resistance self-efficacy". | Cluster randomised controlled trial<br><br>Pretest, posttest at 7th grade, posttest 1 year later | School: 34 schools | n = 5799 students in 6th grade | Project ALERT: School-based substance use prevention programme | Control group | During both posttests, students who withdrew from the study tended to exhibit a more unfavourable resistance self-efficacy beliefs, intentions to use, and beliefs about consequences. There was no indication of a significant positive impact on students' resistance self-efficacy related to cigarette smoking from Project ALERT at either posttest. At the first posttest, the adjusted mean for control was 2.73 and intervention 2.69 (t = -1.10). At |

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| | | | | | | | the second posttest, the adjusted mean for control was 2.62 and intervention 2.58 (t = -0.89). |
| **PERRY CL, STIGLER MH, ARORA M, REDDY KS 2009 INDIA** | To assess " the effectiveness of a 2-yearn multicomponent, school-based intervention designed to reduce tobacco use rates among adolescents in an urban area of India". | Group-randomised trial<br><br>Baseline (in 2004),1-year posttest (in 2005), 2-year posttest (in 2005) | School: 32 schools | n = 11748 students in 6th and 8th grades | Project MYTRI (Mobilizing Youth for Tobacco Related Initiatives in India): multicomponent, school-based intervention designed to reduce tobacco use rates among Indian adolescents | Delayed intervention control | There were no statistically significant differences in over time in intervention and control group students' refusal skills self-efficacy (p = 0.20). |
| **STIGLER M, PERRY CL, SMOLENSKI D, ARORA M, REDDY KS 2011 INDIA** | To examine the mechanisms through which the tobacco prevention programme succeeded in reducing students' intentions and behaviours related to tobacco use. | Group-randomised, controlled trial<br><br>Pre-intervention (in 2004), posttest between year 1 and 2 of the intervention (in 2005), and posttest after completing the intervention (in 2006) | School: 32 schools | n = 11748 students in 6th and 8th grades | Project MYTRI (Mobilizing Youth for Tobacco Related Initiatives in India): 2-year, school-based, multiple-component tobacco prevention programme | Delayed intervention control | The calculated mediated effect (αβ) did not achieve statistical significance for certain variables. For both tobacco use behaviours and intentions, nonsignificant mediators included refusal skills self-efficacy. |
| **MESHACK AF, HU S, PALLONEN UE, MCALISTER AL,** | To "examine how intensity of anti-smoking media | Quasi-experimental study, a nested | School: 11 middle schools | n = 3618 students in 6th grade, mean | Project Towards No Tobacco Use (TNT) | No programme | The changes in self-efficacy were relatively subtle. The decrease in self-efficacy before and after the |

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| **GOTTLIEB N, HUANG P 2004 UNITED STATES OF AMERICA** | campaigns and differing types of anti-smoking community-based programs influence young adolescents' tobacco use and related psychosocial variables". | cross-sectional pre-test–post-test design<br><br>Pre- and post-intervention | | age 11.8 years in pre-intervention<br><br>n = 3374 students in 6th grade, mean age 11.6 years in post-intervention | curriculum with media campaigns<br><br>Delivery with or without intensive of low media condition | | intervention amounted to 2.8%. Consequently, none of the eight different conditions yielded significant results. |
| **SHADEL WG, FRYER CS, THARP-TAYLOR S 2009 UNITED STATES OF AMERICA** | 1) To test "whether the appeal of actors -- used in antismoking public service announcements (PSAs) interacts with adolescents' risk of future smoking to predict adolescents' smoking resistance self-efficacy".<br>2) To test "whether the antismoking messages in the PSAs further moderate this relationship". | Mixed-model design<br><br>Posttests (after exposure to each PSA) | Laboratory | n = 110 adolescents 11–17 years old, mean age 14.1 years | Public service announcements (PSAs): Televised anti-smoking messages | None | Adolescents with a lower overall future smoking risk reported higher levels of self-efficacy in resisting smoking when exposed to anti-smoking PSAs (mean score of 8.0 compared to 7.3). PSAs that highlighted the long-term effects of smoking were linked to the highest scores in smoking resistance self-efficacy, followed by PSAs emphasising short-term smoking effects, and finally, PSAs focusing on tobacco industry manipulation (all with p-values < .05). |
| **THARP-TAYLOR S, FRYER CS, SHADEL WG 2012 UNITED STATES OF AMERICA** | To "examine whether race moderates responses to decontextualized anti-smoking messages and to anti-smoking PSAs that use those messages among adolescents". | Correlational design<br><br>Posttests (after exposure to each PSA) | Laboratory | n = 110 adolescents, mean age 14.1 years | Public service announcements (PSAs): Televised anti-smoking messages | None | The primary influence of racial group on smoking resistance self-efficacy ratings was non-significant (p = 0.148). PSAs emphasising long-term health consequences were linked to significantly elevated smoking resistance self-efficacy ratings in comparison to all other types of anti-smoking PSAs (all p values < 0.0001). Conversely, PSAs |

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| | | | | | | | focused on tobacco industry manipulation were associated with the lowest smoking resistance self-efficacy ratings (all p values < 0.0001). |
| **HELME DW, DONOHEW RL, BAIER M, ZITTLEMAN L 2007 UNITED STATES OF AMERICA** | To test the suitability of an activation model of information exposure and an associated sensation-seeking targeting approach for developing anti-smoking campaigns tailored to at-risk youth. | Two-by-two factorial design<br><br>Baseline, post-test 2-3 weeks after completing the intervention | School: Public schools | n = 1272 middle school students, 12–14 years old, mean age 12.3 years | Public service announcements (PSAs): Television campaign on adolescent smoking | None | Message sensation value had a significant interaction with self-efficacy, indicating that messages with high sensation value (HSV) were more effective in promoting self-efficacy to resist smoking (p = .0048). Time, representing the change from pretest to post-test, was also significant (p < .0001), indicating that self-efficacy for resisting smoking would significantly increase at post-test. |
| **NAGLER EM, LOBO P 2019 INDIA** | To examine the experiences and perceptions of adolescents aged 13 to 15 years between schools with and without Salaam Bombay Foundation tobacco use prevention programme for comparison. | Qualitative descriptive study | School: 8 municipal schools | n = 80 economically disadvantaged students in 8th and 9th grades, 13–15 years old | The Salaam Bombay Foundation (SBF) life skills programme: Multiyear, multicomponent life skills education programme | Non-SBF | Participants from non-SBF schools expressed low self-efficacy to abstain from tobacco use. In SBF schools, long-term mentoring relationships were established between students and staff which built students' trust and self-efficacy. SBF students learned refusal skills that helped them say 'no' to tobacco. While all young people benefitted from the programme, girls reported having benefitted more than boys. |
| **HIEMSTRA M, RINGLEVER L, OTTEN R, VAN SCHAYCK OCP, ENGELS RCME 2013** | To "evaluate the short-term effects of a home-based smoking prevention program called 'Smoke-free Kids' on | Cluster randomised controlled trial | Home | n = 1398 children, 8–12 years old, mean age 10.11 years, | Smoke-free Kids: Home-based smoking prevention programme | A fact-based intervention | Significant group-related impact on self-efficacy (p = 0.02) were identified. In the intervention group, children exhibited lower self-efficacy compared to the control condition. |

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| **NETHERLANDS** | antismoking socialization and smoking-related cognitions and the moderating role of parental smoking". | | | and their mothers | | | |
| **HIEMSTRA M, ENGELS RCME, VAN SCHAYCK OCP, OTTEN R 2016 NETHERLANDS** | To examine "the effects of the intervention programme on the development of these smoking-related cognitions from baseline to 36-month follow-up". | Cluster randomised controlled trial<br><br>Baseline, 6-month posttest, 12-month posttest, 24-month posttest, and 36-month posttest | Home | n = 1398 children, 9–11 years old, mean age 10.10 years, and their mothers | Smoke-free Kids Home-based smoking prevention programme | Fact-based programme | The intervention did not influence the starting point or the progression of self-efficacy. |
| **MCGEE CE, TRIGWELL J, FAIRCLOUGH SJ, MURPHY RC, PORCELLATO L, USSHER M, FOWEATHER L 2016 UNITED KINGDOM** | To evaluate "the effects of a sport-for-health smoking prevention programme (SmokeFree Sports) on smoking-related intentions and cognitions among primary school children from deprived communities". | Non-randomised-controlled trial<br><br>Pre-intervention, 8-post-intervention, and 1-year post-intervention | School: 43 primary schools | n = 1143 children in 5th grade, 9–10 years old, mean age 9.6 years | SmokeFree Sports: Sport-for-health smoking prevention programme | Usual routines | Children had strong self-efficacy to refuse cigarettes. There were no significant intervention effects observed for refusal self-efficacy between pre-intervention and 8 months ($p = 0.17$) or 1-year post-intervention ($p = 0.13$). However, sex moderated the intervention effects on cigarette refusal self-efficacy between pre-intervention and 8 months. There was a positive effect in girls ($p < 0.01$) but not in boys ($p = 0.54$). |
| **DUNCAN LR, HIEFTJE KD, PENDERGRASS TM, SAWYER BG, FIELLIN LE 2018** | 1) To "determine the preliminary efficacy of smokeSCREEN by exploring changes in knowledge, self-efficacy, attitudes, | One-group pretest-posttest design<br><br>Baseline, 2-week post-intervention, | Home | n = 25 adolescents, 11–14 years old who had never tried smoking | smokeSCREEN: Videogame aimed at the primary prevention of | None | While the Wilks' Lambda statistic for cigarettes did not reach the threshold for significance, the enhancement in self-efficacy scores related to cigarettes exhibited a noticeable trend in the positive |

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| **UNITED STATES OF AMERICA** | perceived norms, and intentions related to the use of cigarettes and marijuana".<br>2) To "evaluate the overall experience of participants' gameplay". | and 12-week follow-up | | cigarettes or marijuana | cigarette and marijuana use | | direction (baseline mean 2.98, post mean 3.40, follow-up mean 3.44). |
| **RAFIEE Z, ASSARROUDI A, ZARE M, HEIDARIAN MIRI H, BEHBOUDIFAR A, HESHMATI NABAVI F 2018 IRAN** | To "investigate the effects of a school-based interventional program on smoking refusal self-efficacy in adolescent females". | Randomised controlled trial<br><br>Baseline and 1-month post-intervention | School | n = 53 adolescent females in 10th grade, 16 years old | Smoking prevention program: School-based programme on smoking refusal self-efficacy in adolescent females | Routine interventions | The intervention's effect on smoking refusal self-efficacy was non-significant (p = 0.17). There was no difference in self-efficacy scores between control and intervention groups before the intervention (p = 0.95). However, at post-intervention, the intervention group scored significantly higher (p = 0.02). |
| **GUO S-E, CHEN M-Y, OKOLI C, CHIANG Y 2022 TAIWAN** | To determine "the effectiveness of a school-based prevention program in enhancing knowledge, attitudes, and anti-smoking exposure self efficacy among seventh-grade non-smoking students". | Quasi-experimental design<br><br>Baseline and post-intervention | School: 2 junior high schools | n = 385 students in 7th grade, mean age 12.6 years | Smoking prevention program: School-based smoking prevention programme | Usual care | Following the intervention, there were no significant improvements in secondhand smoke (SHS) avoidance self-efficacy. However, both the intervention and control groups showed significant decreases in anti-smoking self-efficacy. No differences in anti-smoking self-efficacy were found between the two groups. |
| **FLAY BR, BRANNON BR, JOHNSON CA, HANSEN WB, ULENE AL, WHITNEY-SALTIEL DA, GLEASON LR, SUSSMAN S, GAVIN MD, GLOWACZ KM,** | "To present a program development model for similar field efficacy trials that involve multiple program components and require collaborative efforts of disparate gatekeeper groups." | Pilot study, pretest-posttest<br><br>Pretest and posttest | School: 1 middle school | n = 145 students in 7th grade, 12–13 years old) | Social Resistance Classroom curriculum: Classroom-delivered psychosocial smoking prevention for | None | Students showed significant improvements in their understanding of adolescent smoking prevalence rates, peer pressure definitions, effective social resistance strategies, assertiveness definitions, and the physiological effects caused by smoking when comparing their pretest and post-test knowledge. |

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| **SOBOL DF, SPIEGEL DC<br>1988<br>UNITED STATES OF AMERICA** | | | | | 7th grade students<br><br>Social Resistance Classroom curriculum combined with a mass-media intervention | | |
| **FLAY BR, MILLER TQ, HEDEKER D, SIDDIQUI O, BRITTON CF, BRANNON BR, JOHNSON A, HANSEN WB, SUSSMAN S, DENT C<br>1995<br>UNITED STATES OF AMERICA** | To examine "the effects of "a large-scale smoking prevention and cessation trial, Television, School, and Family Project (TVSFP) on student smoking and mediating variables". | Quasi-experimental design<br><br>Pretest, posttest, 1-year follow-up, and 2-year follow-up | School: 47 schools | n = 7351 students in 7th grade, 12–13 years old | Social Resistance Classroom curriculum: Classroom-delivered psychosocial smoking prevention for 7th grade students<br><br>Social Resistance Classroom curriculum combined with a mass-media intervention | A media (television) curriculum<br><br>A health-information-based attention-control curriculum<br><br>No classroom curriculum | There were no significant effects on refusal self-efficacy, except for a contrary trend observed in the San Diego Social Resistance Classroom sample during the post-test. This may be attributed to either the suboptimal execution of television programming or the inconsistency in the delivery of classroom curriculum. |

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