

Online motivational interviewing counselling approach to reduce tobacco use

PhD thesis

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List of publications

1. List of full papers directly related to the subject of the thesis

- I. **Pócs D**, Adamovits O, Watti J, Kovács R, Kelemen O. Facebook Users' Interactions, Organic Reach, and Engagement in a Smoking Cessation Intervention: Content Analysis. *Journal of Medical Internet Research*. 2021 Jun;23(6):e27853. [IF: 5,034, D1 - 2019]
- II. **Pócs D**, Kovács R, Óvári T, Erdős C, Kelemen O. Tobacco reduction on Facebook among 14–35-year-olds [A dohányzás visszaszorítása a Facebook segítségével a 14–35 éves korosztály körében]. *Orvosi Hetilap*. 2019 Feb;160(6):220-227. [IF: 0,497, Q3 - 2019]
- III. **Pócs D**, Hamvai Cs, Kelemen O. Health behavior change: motivational interviewing [Magatartás-változtatás az egészségügyben: a motivációs interjú]. *Orvosi Hetilap*. 2017 Aug;158(34):1331-1337. [IF: 0,322, Q4 - 2017]
- IV. **Pócs D**, Barabás K, Kelemen O. Interventions in medical practice to reduce tobacco use among adolescents [Intervenciók az orvosi gyakorlatban a serdülőkorú dohányzás visszaszorítására], *Orvosi Hetilap*. 2018 Apr;159(15):593-602. [IF: 0,564, Q3 - 2018]
- V. **Pócs D**, Óvári T, Watti J, Hamvai Cs, Kelemen O. How to create Social Media Contents based on Motivational Interviewing Approach to support Tobacco Use Cessation? A Content Analysis. *Journal of Substance Use*, 2021, under review.

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2. Other full paper

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Table of contents

1. List of abbreviations.....	5
2. Summary	6
3. Introduction	7
3.1. Epidemiology of tobacco use among 14–35-year-olds	7
3.2. Overview of smoking cessation management among adolescents and adults	8
3.3. Treatment options of tobacco dependence	10
3.3.1. Physical dependence and pharmacological treatment	10
3.3.2. Psychological dependence and behavioral counselling.....	10
3.4. Motivational interviewing as a counselling method.....	11
3.4.1. The theory of motivational interviewing.....	11
3.4.2. General principles and basic skills	13
3.4.3. Relational and technical strategies	14
4. Gaps in current knowledge: goals of the thesis.....	15
4.1. Internet-based interventions for smoking cessation among 14–35-year-olds	15
4.2. Online application of motivational interviewing.....	16
4.3. Specific aims of the present work	17
5. Materials and methods	18
5.1. The investigated FB-based smoking cessation intervention	18
5.2. Analysis of the target population’s habits, knowledge and attitudes	19
5.2.1. Participants	19
5.2.2. Design and procedure	19
5.2.3. Online survey	19
5.3. Analysis of intervention contents and delivery	21
5.3.1. Intervention contents	21

5.3.2. Primary outcomes.....	23
5.3.3. Secondary outcomes.....	25
5.4. Statistical analysis	27
6. Results.....	28
6.1. Target population’s habits, knowledge and attitudes	28
6.1.1. Sociodemographic data	28
6.1.2. Changes in habits, knowledge and attitudes.....	28
6.1.3. Smoking habits	30
6.1.4. Motivational stages of smoking cessation.....	30
6.1.5. Frequency and duration of exposure	31
6.2. Intervention contents and delivery	33
6.2.1. Contents based on motivational interviewing	33
6.2.2. Relational and technical strategies separately	34
6.2.3. Interactions, engagement, and organic reach	36
7. Discussion	38
7.1. New findings	38
7.2. Major practical implications.....	39
7.3. Limitations of our studies	42
8. Conclusions.....	43
9. Acknowledgement	44
10. References.....	45

1. List of abbreviations

ANOVA: analysis of variance

CAT: commitment, activation, taking steps

CBT: cognitive-behavioural therapy

CT: change talk

DARN: desire, ability, reasons, need

DEARS: develop discrepancy, express empathy, avoid argumentation, roll with resistance, support self-efficacy

FB: Facebook

GDPR: General Data Protection Regulation

HSD: honestly significant difference

MI: motivational interviewing

OARS: open question, affirmation, reflective listening, summary

PACE: partnership, acceptance, compassion, evocation

READS: roll with resistance, express empathy, avoid argumentation, develop discrepancy, support self-efficacy

RULE: resist the righting reflex, understanding your client's motivation, listen to your client, empower your client

SPSS: Statistical Package for the Social Sciences software

ST: sustain talk

TTFC: time to first cigarette

2. Summary

Background and purpose:

In this work, we assessed a smoking cessation intervention, which applied the motivational interviewing (MI) approach and targeted 14–35-year-old smokers on Facebook (FB). Our 1st research aimed to analyse the potential effects of this intervention on the target group's smoking habits, smoking cessation knowledge and attitudes. Our 2nd research sought to identify which types of social media content could achieve positive differences in the target population's interactions. Finally, our 3rd research highlighted how FB users' interactions correlate with the reach and engagement of the intervention.

Experimental approaches:

In the 1st research, we collected data using an online questionnaire among 14–35-year-old FB page followers (N=332). In the 2nd research, we categorized FB posts (N=701) into different groups according to MI strategies (study group) and other techniques (control group). Outcomes were content reach, FB users' interactions, and smokers' motivational language. In the 3rd research, we analysed smoking cessation support contents (N=1025) to assess the correlations between FB post data (reach, interactions, engagement).

Key results:

Smokers who visited the FB page more frequently or for longer duration reported that their self-confidence about quitting significantly increased ($p < .05$). Social media contents which used MI strategies were associated with significantly more positive interactions ($p < .05$) and more motivational utterances about cessation ($p < .001$), compared to the control group. Lastly, 'like' reaction was sharply separated by significant negative correlations from organic reach, negative FB interactions, 'wow', 'sad', 'angry' reactions, and comments ($p < .001$).

Conclusions:

We found that using MI approach in an internet-based smoking cessation intervention seems to stimulate positive interactions with young smokers, change their cessation knowledge and attitudes, and support their motivational language about smoking cessation. Primary FB-based public health interventions could gain benefits from our results; however, further research should be conducted to investigate the use of MI strategies in other online platforms.

3. Introduction

3.1. Epidemiology of tobacco use among 14–35-year-olds

Worldwide, more than six million deaths are caused by tobacco use directly annually, and tobacco use is one of the most important modifiable risk factors for premature death [1]. An increase in tobacco-related mortality is anticipated without acute and persistent interventions [2]. The smoking prevalence in Hungary (27%) was only 1% higher than the European average (26%) in 2017 according to Eurobarometer [3]. However, the age-specific smoking prevalence (39%) was 10% higher among Hungarian 15–24-year-olds compared to European youth at the same age (29%) [3]. The age distribution of smoking habits in Hungary is illustrated in Figure 1 according to the European Public Health Survey [4]. Age-specific smoking prevalence gradually rises and peaks among 15–34-year-olds, and then slowly decreases in the older age groups [4]. At the same time, it is well known in the literature that shorter duration of smoking is associated with an increased chance of a successful cessation attempt [5]. This predicts higher cessation efficiency among adolescents and young adults [5]. Nevertheless, cessation attempts are less frequent among 15–34-year-olds compared to older age groups [4]. Unfortunately, there are only a few good-quality clinical trials exploring age-specific smoking cessation support interventions for adolescents and young adults [6].

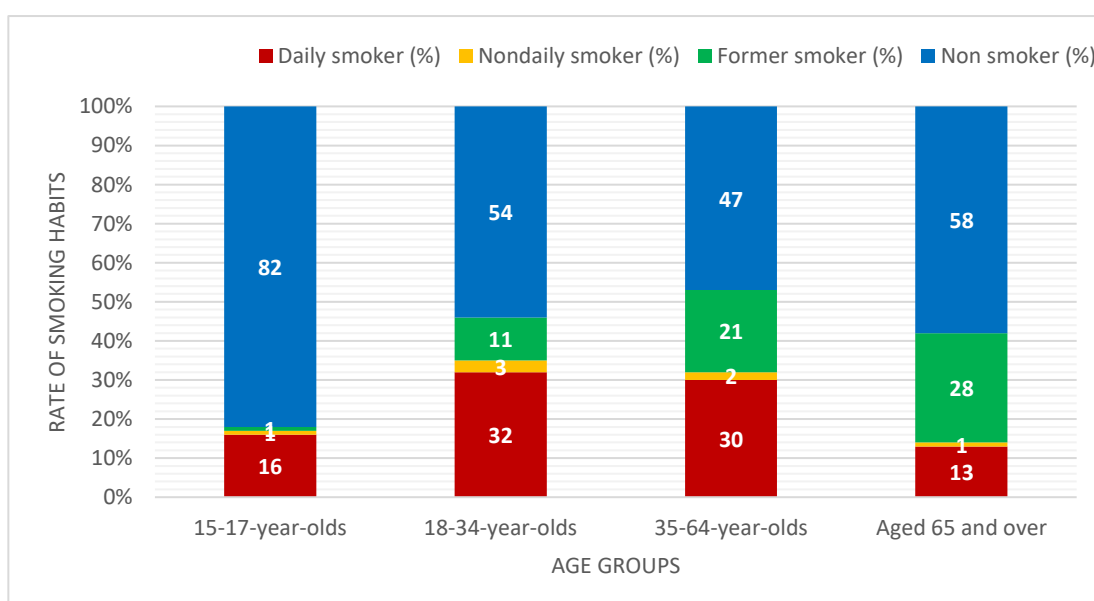


Figure 1 Smoking habits in Hungary according to age distribution [4]

According to the Global Youth Tobacco Survey, in 2016 the adolescent smoking prevalence was 25.5% among Hungarian students between 7th and 9th grades. Fifty-one percent tried to quit smoking at least once in the past year [7]. However, only 32% of smoker participants received some help to quit [7]. The Hungarian Smoking Cessation Support Guideline does not explain in detail the practical steps of cessation support for teenage smokers [8]. It also should be mentioned that many knowledge gaps exist in the Hungarian literature of adolescent smoking cessation support. Therefore, we summarised this topic in a Hungarian review called 'Interventions in medical practice to reduce tobacco use among adolescents'. In the next section, due to the length framework of the PhD thesis, we discuss only the closely related part of this review.

3.2. Overview of smoking cessation management among adolescents and adults

Many differences can be identified between adult and adolescent smoking, however, in the review mentioned above we sought to present those that are essential in medical practice. Firstly, while adult smokers typically use only one tobacco product, adolescents tend to try and use two or more [9]. Therefore, it is important to draw adolescents' attention to the harmful effects of alternative tobacco products as well. Secondly, adolescents are susceptible to mistaken belief about the use of tobacco products [10]. For example, there is a misconception about the direct weight-loss effect of smoking, which mainly urges adolescent girls to use tobacco products [11]. It is true, that smoking cessation can lead to weight gain of a few kilograms, however, smoking does not directly cause weight loss [12]. Thus, we should give precise and correct information specifically focusing on the lifestyle of the teenagers.

Thirdly, one of the most common cessation motivations is health gain [13]. Instead of chronic diseases, adolescent smokers are more sensitive to the short-term effects of smoking. That is why, medical advice about acute illnesses, nicotine withdrawal symptoms or cosmetic effects should be preferred when supporting tobacco cessation among adolescents [14]. Fourthly, various smoking cessation programs are available for adults and adolescents in Hungary [8]. Public-funded individual and group cessation support programs are typically available over the age of 18 [8,12,15]. Under the age of 18 it is difficult to seek effective cessation programs due to the need for parental consent. Therefore, adolescents should be directed primarily to the Hungarian telephone specialist care (06-80-44-20-44). This option is particularly advantageous for adolescents because it is free and anonymous [8,15].

Furthermore, it is advisable to recommend the use of professionally accepted internet-based platforms for adolescents (e.g., www.leteszemacigit.hu) [8,16].

Fifthly, a wide range of pharmacological treatments are proposed for adults and adolescents for tobacco dependence [12,17]. Although little data are available about the administration of medicines as stop smoking treatment under the age of 18, the use of nicotine replacement therapy is recommended in adolescents under professional supervision with the consent of the legal representative [17]. Varenicline is currently considered to be the most effective cessation aid, but only limited number of clinical trials are available to support its safe use among adolescents [8,15]. Finally, compared to adults, who are generally casual or regular smokers with developed smoking habits, however adolescent smoking is characterized by progression [18]. Therefore, prevention efforts should also be targeted at non-smoker adolescents, especially those for whom predictors of smoking initiation can be identified [9]. Table 1 highlights the differences between adult and adolescent smoking habits, characteristics, and smoking cessation interventions.

Adults	Adolescents
Usually use of only one tobacco product .	Typically use of two or more tobacco products .
Misconceptions about smoking are not typical.	Their age-specific characteristics are misconceptions about smoking.
Typical cessation motivations: long-term effects (chronic conditions or their sudden worsening).	Typical cessation motivations: short-term effects (acute illness, withdrawal symptoms, cosmetic effects)
Available cessation program in Hungary: individual, group and telephone-based cessation support.	Available cessation program in Hungary: only telephone and internet -based cessation support.
Recommended pharmacotherapy: varenicline or NRT .	Recommended pharmacotherapy: nicotine replacement therapy (NRT) .
A smoking habit has developed (interventions for smokers).	Progression of smoking (interventions for smokers and non-smokers)

Table 1 Major differences between adult and adolescent smoking habits, characteristics, and smoking cessation interventions [Pócs D, Barabás K, Kelemen O. *Interventions in medical practice to reduce tobacco use among adolescents*. Orvosi Hetilap. 2018 Apr;159(15):593-602]

3.3. Treatment options of tobacco dependence

Tobacco dependence is a substance use disorder, which has two components: physical and psychological dependence [8,15]. Physical dependence (nicotine addiction) is caused by nicotine, and it is treated with nicotine replacement therapy (NRT) or other pharmacological agents [15]. Psychological dependence can develop when tobacco use is associated with daily routine, social contacts, and situations, and this behaviour sustains dependence [15]. Treatment includes behavioural therapy to address these routines and triggers [15].

3.3.1. Physical dependence and pharmacological treatment

The primary goal of pharmacological treatment is to reduce the nicotine withdrawal symptoms, which supports smoking cessation and harm reduction [19,20]. Nicotine withdrawal symptoms usually manifest themselves in regular smokers who smoke more than 10 cigarettes a day, or light a cigarette within an hour after waking up in the morning [15]. Withdrawal symptoms can occur either when smoking is suddenly stopped (smoking cessation), or when it is decreased (harm reduction) [19,20]. Pharmacological therapy can be divided into two groups based on evidence of their efficacy: first-line medications (varenicline, NRT, bupropion) and second-line quit smoking medications [8,15,19]. The detailed explanation of these pharmacological treatments goes beyond the scope of the present dissertation, which focuses primarily on behavioural therapy.

3.3.2. Psychological dependence and behavioural counselling

Behavioural treatment is based on the hypothesis that psychological dependence is influenced by operant and classical conditioning. Additionally, smoking behaviour is sustained by cognitive processes, manipulated by the individual's own personal values, and the imagined functionality of tobacco consumption [15]. Two counselling approaches for managing psychological dependence of tobacco use are supported by evidence: cognitive-behavioural therapy (CBT) and motivational interviewing (MI) [15]. MI approach is the focus of the present thesis, and it is discussed in the next section. We believe that this approach would be highly important for many fields in medicine. Hence, we summarised the theoretical and practical background in a manuscript, called 'Health behaviour change: motivational interviewing'. This review can provide a deeper insight into MI-based counselling.

3.4. Motivational interviewing as a counselling method

MI is a person-centred, goal-oriented counselling method designed to help people change their health behaviour [21]. This method was developed and first used by clinical psychologists William R. Miller and Stephen Rollnick, initially among alcohol-dependent patients [22]. MI combines different counselling methods used in psychological and psychiatric practice [21,22]. It does not require a psychotherapy degree, because MI is not a special form of psychotherapy. The effectiveness of MI is not influenced by higher education qualifications, for example it was successfully applied by doctors, dentists, psychologists, health professionals, and educators after proper training [23]. Some studies have demonstrated significant improvements in obesity using MI to increase physical activity [24] and to develop a healthy diet [25]. Other studies suggest that MI is effective in increasing adherence and improving the quality of life in a variety of chronic diseases, such as heart failure [26], multiple sclerosis [27], chronic renal failure [28], schizophrenia [29], or chronic obstructive pulmonary disease [30]. Overall, MI applied in substance use disorders has been supported by evidence [31], however, MI for use in obesity and other chronic diseases needs further research.

3.4.1. The theory of motivational interviewing

To understand the MI theory, it is worth comparing MI-based counselling to persuasion-based counselling. The main difference between them is the real focus. In persuasion counselling the focus is on the information while in MI the focus is on the other person. In MI other people's perspective is sought in order to help them to find their own special answers. Client involvement could be beneficial, because self-motivated behaviour change is more lasting than behaviour change motivated externally [32,33]. This focus is summarised in the so called "spirit of MI". These include partnership, acceptance, compassion, and evocation; or PACE as an acronym. [34,35]. Partnership suggests that the physician functions as a partner, collaborating with the client's own expertise [35]. Acceptance means that the physician recognizes and communicates the client's values, feelings, autonomy, strengths, and efforts [35]. Compassion highlights that the physician promotes the client's welfare, giving priority to the client's needs [35]. Evocation suggests that the physician elicits the client's own perspectives and motivations [35].

From this starting point it is understood that the role of the patient is highly different: in MI it means the clients' active role while in persuasive counselling the client is passive [21]. The style of persuasion is on the physician's reasoning, while MI-based counselling is aimed at evoking the client's motivations ('evocation') [32]. The communication style of the MI approach is based on the development of collaboration ('guiding' style), as opposed to methods when the conversation is directed solely by the physician ('directing' style) or only by the client ('following' style) [21,22]. The 'directing' style used in persuasion-based counselling breeds resistance and hinders the client in behaviour change [34]. On the contrary, MI aims to reduce resistance and suggest rolling with it and avoiding argumentation (see 'READS' in the next chapter). Finally, persuasion-based counselling is usually instinct driven, and unstructured. A conscious usage of MI counselling provides an opportunity to structurally apply these person-centred methods [21]. For comparability, Table 2 summarizes the key differences between persuasion-based and MI-based counselling.

	Persuasion	Motivational interviewing
Client's role	Passive	Active
Communication	Directing	Guiding
Partnership	Giving information with the physician's expertise	Collaborating with the client's own expertise
Acceptance	Focus on physician's values, judgment, and reasoning	Focus on client's values, feelings, autonomy, strengths, and efforts
Compassion	Giving priority to the physician's opinion	Giving priority to the client's needs
Evocation	Eliciting perspectives, motivation according to the physician	Eliciting the client's own perspectives and motivation

Table 2 Major differences between persuasion-based counselling and motivational interviewing approach [Pócs D, Hamvai Cs, Kelemen O. *Health behavior change: motivational interviewing*. Orvosi Hetilap. 2017 Aug; 158(34):1331-1337.]

3.4.2. General principles and basic skills

The founders of the MI approach compiled certain principles with a view to providing a kind of framework [21]. Five principles were published in 2002, which are referred to in the literature by the acronym 'READS' or 'DEARS' [21]. The 'Roll with resistance' principle highlights the fact that the client's sense of competence reduces his or her resistance [21,36]. 'Express empathy' draws attention to the fact that understanding and reflecting the client's feelings and perspectives helps behaviour change [21]. 'Avoid argumentation' means that the conversation should be guided with the client's reasoning, not the physician's argumentation [21,37]. 'Develop discrepancy' suggests that behaviour change is aided by recognizing the discrepancies between the current harmful behaviour and the client's personal goals and values [21]. Finally, 'Support self-efficacy' highlights that self-efficacy is a client's perceived ability to successfully achieve a goal or perform a task, which could promote behaviour change [35,38]. Further development of the method was introduced in 2008, when the founders of the MI approach classified the principles with similar content but different aspects, called 'RULE' [39]. 'Resist the righting reflex' principle means that the client's autonomy and the partnership are more important than the physician's natural desire to set things right and prevent harm [35,39]. 'Understanding your client's motivation' suggests that the motivation which aids behaviour change comes from the client, not from the physician [39]. 'Listen to your client' highlights that listening in MI is an active process and gives time to structured communication [39]. Lastly, the 'Empower your client' principle draws attention to the fact that the physician can never question whether the client is capable of behaviour change, because every change is self-change [39]. Based on the literature, the disturbance of the MI spirit and MI principles leads to a negative outcome in behaviour change [40].

Based on these core principles, certain basic skills were created: open question, affirmation, reflection, and summary (OARS) [21,39]. Open-ended questions require more attention, but they make it easier for the client to express their own motivation [35,39]. Affirmation emphasizes the client's real and concrete positive efforts, qualities, or behaviours [35,39]. Reflection expresses what the client is saying, especially the meaning of the sentences [35,39]. The summary is a special reflection which expresses the meaning of a longer conversation and aids behaviour change [35,41]. These basic skills are essential for the acquisition of MI communication strategies [39], which are discussed in the next paragraph.

3.4.3. Relational and technical strategies

The MI communication strategies can be divided into two groups: relational and technical strategies [42]. Relational strategies focus on strengthening the doctor-patient relationship and utilizing well-known and widely used methods in psychological practice, such as active listening or conflict management methodology [15,43]. However, technical strategies focus on behaviour change, and use a new method which is specific for MI [21,43]. To understand the difference between relational and technical strategies, it is worth examining the client's resistance. The MI approach distinguishes between two types of resistance in the client's speech: 'sustain talk', which is the resistance to behaviour change, and 'discord', which is the resistance to the physician [35]. Technical MI strategies are recommended to manage the intrapersonal conflict within the client, while relational MI strategies are proposed to reduce interpersonal conflict between the client and the physician [39,43].

Technical strategies are based on a new, specific hypothesis of the MI approach, which suggests that the client's motivational language could predict behavioural outcomes [21,42]. The client's motivational language is basically divided into two groups: 'change talk' and 'sustain talk' [21,35]. Change talk is any client speech that favours movement toward the behaviour change, in contrast to sustain talk, which is the verbalization of status quo and cons for behaviour change [35,42]. Sustain talk could be associated with negative behavioural outcomes [44], while change talk could be linked to positive behavioural outcomes [40], however, further high-quality research is needed for full certainty [45]. Seven subtypes of change talk and sustain talk are distinguished: desire, ability, reason, need (DARN) and commitment, activation, taking steps (CAT) [35,42]. DARN linguistic categories are thought to be used at the early stages, while CAT utterances could be applied at the late stages of behaviour change [42]. That is why 'DARN change talk' is mostly called 'preparatory change talk' and 'CAT change talk' is generally called 'mobilizing change talk' [35,42]. The aim of technical MI strategies is to 'cultivate change talk' and to 'soften sustain talk' [43]. For example, affirmative strategies can elicit change talk and reduce the strength of sustain talk [46]. Finally, behaviour change could be stimulated if competing motivations for and against change appear in the conversation at the same time, which is called 'ambivalence' [35]. The exploration and conscious understanding of ambivalence can also lead to positive behavioural outcome [40].

4. Gaps in current knowledge: goals of the thesis

As we mentioned it before, the prevalence of smoking gradually rises and peaks among adolescents and young adults [4]. At the same time, cessation attempts are less frequent, but more successful in this age group compared to over 35-year-olds [4,5]. This is the reason why the investigation of age-specific tobacco reduction interventions is so important. In this thesis we focused on an internet-based smoking cessation intervention, which used the MI approach and targeted 14–35-year-olds. Our 1st research sought to reveal the potential effects of the investigated Hungarian Facebook (FB) page on the target group's smoking habits, smoking cessation knowledge and attitudes. Our 2nd research aimed at identifying which types of intervention content could achieve positive differences in the target population's interactions between contents with and without MI strategies. Finally, our 3rd research highlighted how FB users' interactions correlate with the reach and engagement of the intervention.

4.1. Internet-based interventions for smoking cessation among 14–35-year-olds

Internet-based interventions may be new opportunities in smoking cessation among 14–35-year-olds regarding easy access, free usage, and the large number of young internet users [47,48]. Interactive web-based interventions could be more effective than non-active controls, according to a systematic review [47]. Internet users are usually more interactive in social media platforms than in other internet surfaces [47,49]. For example, social media contents about the advantages of quitting could evoke internet users' interactions [49]. Therefore, interactivity on social media could increase the preliminary effectiveness of smoking reduction interventions [50]. These findings have opened an exciting direction for our research to reveal internet users' interactions to social media contents. FB is one of the most widely available social media platforms in the 14–35-year-old age group [51]. FB could be a potential surface of smoking cessation support among young adults considering its popularity and daily usage [51]. At the same time, FB as a virtual community could help FB users' health issues with social support [52]. Another advantage of social network is that sharing of smoking cessation stories could be triggered on FB, which could make quitting popular during normative influence [48]. In addition to supporting smoking cessation, internet-based interventions can also play a key role in tobacco use prevention [15,53]. Unfortunately, various tobacco marketing content are shared in the social media sponsored by

tobacco companies [53]. This also confirms that anti-tobacco contents on social network are necessary [15,53]. A research among adolescents in Hungary has shown that low media awareness can be associated with smoking initiation [54]. However, the Hungarian smoking cessation guideline describes individual, group and telephone cessation support opportunities, and does not contain descriptions of internet-based interventions [8]. During the review of the Hungarian literature, we could not find any studies dealing with internet cessation support. This is still a field to be researched in Hungary. The present work seeks to fulfil this gap.

4.2. Online application of motivational interviewing

Traditionally, MI is applied offline, in individual or group counselling [21,39]. However, the online application of MI strategies was examined by some studies in medical education [55] and in health behaviour change [56]. For example, regular smokers who do not intend to stop smoking were targeted in a MI-based, online intervention to help them in reducing the number of cigarettes per day [57]. Nevertheless, little is known about how MI-based social media contents are associated with internet users' interactions. The usage of MI strategies in social media content creation probably could be different from traditional MI usage [56,57]. While only one client's motivational speech is usually in the focus of MI strategies in a face-to-face situation [42], several smokers' motivational language could be accentual in an online MI-based intervention. Therefore, some traditional MI strategies are not suitable for an online context (e.g., 'summary') [35]. At the same time, some MI strategies may have a broader perspective (e.g., 'affirming' or 'reflecting') [35]. It is also important to mention that internet users' cumulative interactions are collected from different people, rather than only one person. That is the reason why a cumulative ratio between change talk and sustain talk comments is impossible to analyse (e.g., 'proportion change talk'), even if it could be a useful predictor for behaviour change [58]. There is also a lack of research regarding the major MI linguistic categories (change talk, sustain talk, DARN, CAT) in FB-based smoking cessation interventions. Finally, some of the specific online data about internet users' interactions could be new indicators of MI approach. For example, in this online context negative interactions (e.g., unlike of page or post hides) can be interpreted as a 'discord' (e.g., interrupting or ignoring) [35].

4.3. Specific aims of the present work

The following aims, hypotheses and research questions were addressed to fulfil the mentioned gaps in the current knowledge:

- **Analysis of the target population's habits, knowledge, and attitudes (1st research)**
 - *Main Aim: To evaluate the advantages of the Hungarian FB page in changing the followers' habits, knowledge, and attitudes.* The hypotheses are:
 - Smokers who visit the FB page more frequently will report significantly more positive changes in habits, knowledge, and attitudes.
 - Smokers who are following the FB page for a longer period of time will report significantly more positive changes in habits or attitudes.
 - *Secondary Aim: To evaluate the impact of this FB page on the followers' motivational stages of smoking cessation.* The research questions are:
 - How are habits, knowledge, and attitudes influenced by different motivational stages of smoking cessation?
 - What is the relationship between the motivational stages of smoking cessation, and the frequency or the duration of FB page visiting?
- **Analysis of intervention contents and delivery (2nd and 3rd research)**
 - *Main Aim: To assess the usefulness of MI strategies in an online context.* The hypotheses are:
 - MI strategies will gain significantly higher engagement rate, fan–total reach ratio, and less negative feedback compared to other strategies.
 - MI strategies will evoke significantly more change talk and less sustain talk compared to other strategies used with the control group.
 - *Secondary Aim: To assess the correlations between FB users' interactions, the reach, and the engagement of an MI-based smoking cessation intervention.* The research questions are:
 - What is the relationship between reach and FB interactions on a post level during a smoking cessation intervention?
 - How does the strength and direction of correlations change between FB users' interactions which express positive and negative emotion during a smoking cessation intervention?

5. Materials and methods

5.1. The investigated FB-based smoking cessation intervention

The 'Cigarette break' FB page (www.facebook.com/cigiszunet) is a public Hungarian FB-based smoking cessation intervention. It was launched on March 7, 2017. This intervention has adopted the 'MI spirit' and is trying to use MI adherent strategies in post creation. Accordingly, empathetic, collaborative, and motivational contents are used on the FB page, while discriminative and frightening contents are avoided. To our knowledge, this is the first non-profit FB page in Hungary that supports quitting using MI adherent contents. Students and educators manage the FB page and create social media contents within the framework of a university course by the Department of Behavioural Sciences, Faculty of Medicine, University of Szeged. The educational goal was to offer students a deeper understanding of the smoker population, and to help harm reduction and smoking cessation effectively. Furthermore, this FB-based intervention seeks to reach not only current smokers, but also non-smokers and former smokers. Therefore, it also addresses issues related to the social perception of smoking: e.g., protection from second-hand smoke or the ethics of smoking policies. Additionally, the focus among former smokers was how to prevent relapse. The intervention was promoted by paid advertising through FB ads which are designed to get more FB followers with smoking and cessation interest, and boosted FB posts which are designed to increase engagement. Social media contents have been usually published daily since the beginning.

The 1st research about the target population's habits, knowledge, and attitudes was performed from June 24, 2018 to July 8, 2018. In this research period (on June 27, 2018), the FB page had 3,278 likes. A 'FB page like' means interest and support for the page, and a 'page fan' is a FB user who liked the page. In all, 49% of the FB page fans were women and 51% were men. The mean age of the FB page fans was 26 years. 'Facebook Insights' page data for the analysis of intervention contents and delivery was exported on March 23, 2019 (2nd research) and on August 14, 2020 (3rd research). At the time of the 2nd research, the FB page had 5,935 likes. In all, 54% of the FB page fans were women and 46% were men. The mean age of the FB page fans was 27 years. At the time of the 3rd research, the investigated Facebook page had 10,098 'Facebook fans'. Fifty-three percent were women, and 47% were men, and 84% were between the ages of 18 and 34 years.

5.2. Analysis of the target population's habits, knowledge, and attitudes

5.2.1. Participants

We collected data using an online questionnaire over a two-week time interval (June 24, 2018 to July 8, 2018). A total number of 358 responses was received. We included internet users who followed the investigated FB page. The youngest participant was 14 years old. We excluded those who were 36 years of age or older. Therefore, 332 responses were analysed (N=332), and the participants were in the 14–35-year-old age group.

5.2.2. Design and procedure

An online survey seemed to be a good opportunity for reach internet users who are following of the investigated FB Page. A common method of social media research is the usage of FB advertising and sweepstakes [50], which we also applied. In addition, we had drawn the FB followers' attention to the possibility of participating in the research using the contents of the FB page. The language of the questionnaire was Hungarian. The participation was voluntary, based on informed consent. We reached summarized and anonymized data from the Goggle company using 'Google Forms' software. We did not record or store personally identifiable data or sensitive data according to the General Data Protection Regulation (GDPR). Our research ethics license was granted by the Ethics Committee, Albert Szent-Györgyi Health Centre, University of Szeged (reference number: 3805-96/2016-SZTE).

5.2.3. Online survey

Firstly, we explored demographic characteristics which were relevant to the research: gender, age, place of residence, occupation, highest level of education, and nationality. In the next step, participants were classified according to their smoking status: non-smokers, former smokers, and smokers. Individuals who have never smoked or have smoked less than 100 cigarettes during their life were considered non-smokers. People who did not smoke at the time of the survey, and had never smoked more than 100 cigarettes were regarded as former smokers [59]. Finally, people who declared themselves to be smokers at the time of the survey were considered smokers. Among smokers, we assessed the usage of alternative tobacco products, attempts to quit for more than 24 hours in the past, and the length of time they had been smoking. Thereafter, smokers were grouped according to three additional

criteria: smoking frequency, nicotine dependence, and motivational stages of smoking cessation. We distinguished between regular smokers and occasional smokers according to their smoking frequency (daily or less than daily smoking). We made a difference between nicotine dependent smokers and non-dependent smokers based on the time to first cigarette (TTFC). Nicotine dependent smokers used a tobacco product within 30 minutes after waking up in the morning [60,61]. Finally, we also categorised current smokers and former smokers using their motivational stages of smoking cessation: 'precontemplation' (not planning to quit), 'contemplation' (planning to quit within 6 months), 'preparation' (planning to quit within 30 days), 'action' (less than 6 months of abstinence), 'maintenance' (6–12 months of abstinence) [15,62]. We used the next questions to determine the first three stages among currently smokers: 'Are you planning to quit smoking? And if you are planning to quit, when? Within 30 days or within 6 months?'. Furthermore, we applied this question to determine the last two stages among former smokers: 'When did you quit smoking: within 6 months, within 12 months, or more?' [15,62].

In the next step, we measured the frequency and the duration of exposure to the investigated FB page. We distinguished three groups according to the frequency of exposure: daily, weekly, or less frequent visits the social media contents ('How often do you visit the contents of the FB page?'). We also separated three groups according to the duration of exposure: internet users who followed the social media contents less than 1 month, 1-6 months, or more than 6 months ('How long have you been following the contents of the FB page?'). Then, we assessed the participants' habits, knowledge, and attitudes about tobacco use and smoking cessation based on their own admissions. Among smokers, we examined the participants' new knowledge about quitting ('What kind of smoking cessation methods did you learn through the FB contents?' Answer: e.g. 'cessation medications'). Positive changes in smoking habits were also assessed ('Have you changed your smoking habits since you started following the FB page?' Answer: e.g. 'I reduced smoking'). Finally, we explored the positive changes in attitudes about quitting: importance and self-confidence ('Has quitting become more important to you since you started following the FB page?' and 'Has your self-confidence about quitting increased since you started following the FB page?'). Among former smokers, we examined the cessation support effect of the social media contents ('Have you stopped smoking since you started following the FB page? Have the FB contents helped

you with quitting?'). We also assessed the relapse prevention effect of the social media contents ('Have the FB contents helped you with staying smokefree?'). Among non-smokers, we also examined the positive changes in attitudes: smoking cessation support and self-protection from second-hand smoke ('Has it become more important for you to help smokers quit since you started following the FB page?' and 'Has it become more important for you to protect yourself from second-hand smoke since you started following the FB page?').

5.3. Analysis of intervention contents and delivery

5.3.1. Intervention contents

An ethics permission of the content analysis was also obtained from the Ethics Committee, Albert Szent-Györgyi Health Centre, University of Szeged; reference numbers: 3805-96/2016-SZTE (2nd research), 4794-107/2020-SZTE (3rd research). It should be emphasized that social media users agree to the terms and conditions of the FB platform by creating FB profiles. These conditions include clauses on accessing their data by third parties, including researchers. It also should be noted that all data which were examined in the present work were collected from our publicly available, open FB page, where our academic researcher identity was transparent.

Firstly, the content analysis of the 2nd research is presented. Social media content data posted on FB between March 7, 2017 and March 7, 2019 was analysed. We made 816 posts in these two years. In all, 55 admin's contents, 6 boosted posts, 7 MI non-adherent contents, and 47 posts which were targeted at non-smokers and electronic cigarette users were excluded. Therefore, we included 701 posts (N=701). The included social media contents were targeted at smokers, they followed the MI spirit, and they were not financed. In the next step, these social media contents were classified into 8 types using MI terms: four technical MI strategies, two relational MI strategies, and two types for the control group. These MI strategies are described in Table 3 [35,43]. Two hundred included contents were classified separately by four raters into 8 categories to validate the classification (Fleiss kappa value of 0.847). In a second round, all the 701 included contents were categorized again separately by the same four raters (Fleiss kappa value of 0.860). Four hundred and forty-three social media contents which used MI strategies formed the study group, while 258 contents which did not use MI strategies, but followed the MI spirit formed control group.

1) Technical Motivational Interviewing Strategies

- a) *Cultivating change talk*. Each post shows a marked effort to increase the depth, strength, or momentum of the smokers' language in favour of tobacco use cessation or smoking behaviour control. This type of strategies includes: 'elaborating', 'affirming', 'reflecting' (EAR).
 - i) *Elaborating change talk*. These posts used asking strategies about tobacco use cessation or smoking behaviour control: 'evocative questions', 'asking for elaboration or examples', 'exploring decisional balance', 'exploring goals and values', 'looking forward'.
 - ii) *Affirming change talk*. These posts emphasized something positive and genuine in tobacco use cessation or smoking behaviour control: smokers' efforts and strengths ('affirmation'), ability to make decisions and self-determination ('emphasizing personal control'), ability to succeed ('support self-efficacy').
 - iii) *Reflecting change talk*. These posts captured and illustrated to smokers something about tobacco use cessation or smoking behaviour control: emotions ('simple reflection'), role models for success ('normalizing'), and efficient cessation methods ('planning').
- b) *Softening sustain talk*. Each post shows a marked effort to decrease the depth, strength, or momentum of the smokers' language in favour of remaining a tobacco user or failing to control smoking behaviour. This type of strategies includes: 'amplified reflection', 'double-sided reflection' and 'reframing'.

2) Relational Motivational Interviewing Strategies

- a) *Building partnership*. Each post conveys an understanding that expertise and wisdom about important issues of tobacco use reside mostly within the smoker ('request for opinion'). Themes: social acceptability of smoking, tobacco control policies, tobacco marketing.
- b) *Expressing empathy*. Each post shows evidence of deep understanding of the smokers' point of view, both the smokers' explicit statement and implication ('empathic reflection'). Themes: smokers' stigmatization, nicotine withdrawal, smoking relapse.

3) Control group

- a) *Giving information without confrontation*. Each post gives general and neutral information without persuading, advising, or warning. Typically, the aim of these posts is informing and not changing behaviour or making relationships.
- b) *Entertaining without confrontation*. Each post provides enjoyable content for the audience without ridiculing, labelling, blaming, moralizing, or arguing. Typically, the aim of these posts is entertaining and not changing behaviour or making relationships.

Table 3 Definitions of social media content types used in the present work (2nd research).

Secondly, the content analysis of the 3rd research is shown. In all, 1269 social media contents were made between March 7, 2017 and August 14, 2020. We excluded 244 FB posts following the exclusion criteria: 69 admin's contents, 60 boosted FB posts, 7 MI non-adherent contents, 84 non-cessation social media contents, and 24 video posts. After exclusion, 1025 original posts were included (N=1025), which all followed the spirit of motivational interviewing, supported smoking cessation, were targeted at smokers, and did not use specific advertising. We did not use any other classification of the intervention contents in the 3rd research. FB users' different interactions given to the same stimulus were evaluated. The stimuli were smoking cessation support contents on a public Facebook page, regardless of the MI strategy used. It should be emphasized that only original Facebook posts were analysed. Therefore, shared Facebook posts were ignored, because in these cases, Facebook users' responses could have been influenced by other stimuli (e.g., the Facebook profile of the person who shared the content), which may have resulted in a higher rate of interactions than the original content.

5.3.2. Primary outcomes

Specific FB post data were used as primary outcomes, which are summarized and defined in Table 4. This database contains anonymized and aggregate data; that is why, FB users cannot be identified. In this paragraph, post data for the 2nd research are described: engagement rate, negative feedback and fan-total reach ratio. The engagement rate was calculated by dividing the number of reactions, comments, shares, and clicks by the total organic reach (the number of people who saw the non-paid post). The total number of negative FB interactions is negative feedback (e.g., post hides or unlike of page). The fan-total reach ratio was calculated by dividing fan reach (the number of fan FB users who had liked the FB page before they saw the post) by the total reach (the total number of people who saw the post). Summarizing the above, a high engagement rate could suggest how the content stimulated the usage of the FB-based smoking cessation intervention, while a large number of negative feedback seems to imply an inhibition. On the other hand, the fan-total reach ratio may show who is more interactive: FB page fans or non-fans. A high fan-total reach ratio could mean how it appealed to the audience of the FB page. These data were exported from 'Facebook Insights' data on March 23, 2019.

1) Non-paid (organic) reach

The number of people who saw the given non-paid social media content.

- i) *Fan reach*. The number of people who had liked the FB page before they saw the given non-paid social media content.
- ii) *Non-fan reach*. The number of people who had not liked the Facebook page before they saw the given non-paid social media content.
- iii) *Fan–total reach ratio*. The number of fan FB users who had liked the FB page before they saw the post (fan reach) divided by the total number of people who saw the post (total reach).

2) Facebook users' interactions

Any action on specific buttons that the user performed in relation to content.

a) Engagement

The usage of the public health intervention as a group of the following FB interactions: reactions, share, comment, and clicks.

- i) *Reactions*. The number of people who used a 'like', 'love', 'haha', 'wow', 'sad', or 'angry' reaction button under a given social media content to express their emotions.
- ii) *Share*. The number of people who used the 'share' button under a given social media content to send the content with optional privacy settings to others.
- iii) *Comment*. The number of people who used the 'comment' button under a given social media content to publish a text or an image message.
- iv) *Click*. The number of people who used any other actions on a given social media content, for example, to select a website, to view the Facebook page profile, or to expand photos to full screen.
- v) *Engagement rate*. The number of people who used 'reactions', 'share', 'comment' buttons, or clicked on the post divided by the number of people who saw the post (total reach).

b) Negative feedback

The total number of negative Facebook interactions.

Negative Facebook interactions. The number of people who used the following functions: post hides, hides of all posts, reports of spam, unlike of page.

Table 4 Definitions of primary outcomes (2nd and 3rd research).

In the following, separate post data for the 3rd research are presented: fan reach, non-fan reach, reactions, shares, comments, clicks, and negative FB interactions. The definitions of these special FB post data are summarized in Table 4. We collected these data from the 'Post Details' and they belonged to the same social media content (same stimulus). It should be highlighted that we used multiple post data in the 2nd research (e.g., fan–total reach ratio or engagement rate), however, we analysed simple and separate post data in this 3rd research (e.g., 'like' reaction or 'share' interaction). Moreover, the FB users' interactions were available separately in the 'Post Details', except negative FB interactions, which cover multiple action buttons (e.g., post hides or reports of spam). The strength and the direction of correlations between these separate post data were in the focus of this research. It should be noted that these data were summarized, and post data could arrive from different users or the same FB user. Nevertheless, the positive correlation of the reactions on the same content (e.g., 'like' and 'love' reactions) indicates different Facebook users, because one Facebook user must have chosen only one reaction.

5.3.3. Secondary outcomes

The FB users' initial comments were analysed to identify MI comments, which were the secondary outcomes in the 2nd research. Comments on shared posts were ignored, because sharing in private messages, closed or secret FB groups made it impossible to analyze these comments. Subsequent comments on the initial comments were also excluded, because subsequent comments could be responses to FB users' interactions related to the initial comments, and not directly to the social media contents. Only initial comments on the original FB page's posts were included, because they may indicate the relevant influence of the social media contents. In all, 516 initial comments were collected between March 7, 2017 and March 7, 2019. The comments about the social media users' feelings, experiences and opinions were written voluntarily and free from any external pressure. These comments did not involve personal data (e.g., personal number) or sensitive data (e.g., racial or ethnic origin). However, the texts of the cited comments in the present work were modified to avoid the possibility of later retrieval and identification. In the next step, the initial comments were classified using the MI approach to receive secondary outcomes, which are described in Table 5.

Motivational interviewing comment categories

- i. *Change talk*. Any smoker's comment that favours movement toward tobacco use cessation.
- ii. *Sustain talk*. Any smoker's comment that favours remaining a tobacco user rather than movement toward tobacco use cessation.
- iii. *DARN language*. Any smoker's comment that expresses motivation or demotivation for tobacco use cessation or using tobacco:
 - a. Desire (e.g., want, wish, like),
 - b. Ability (e.g., can, could, able),
 - c. Reason (e.g., specific causes of action),
 - d. Need (e.g., need, have to, got to, must).
- iv. *CAT language*. Any smoker's comment that expresses action or inaction towards tobacco use cessation or using tobacco:
 - a. Commitment (e.g., will, do, going to),
 - b. Activation (e.g., ready, willing, considering),
 - c. Taking steps (e.g., an action already taken).

Table 5 Definitions of secondary outcomes (2nd research).

The secondary outcomes were change talk, sustain talk, DARN language, and CAT language. In the present work, smoker's comments that express motivation for or action towards tobacco use cessation are called change talk, e.g. 'I have many reasons to quit.' or 'I started to reduce smoking.' Smoker's comments that express demotivation for or inaction towards tobacco use cessation are called sustain talk, e.g. 'I wish I could smoke again.' or 'I bought a pack of cigarette.' Smoker's comments that express motivation or demotivation for tobacco use cessation are called DARN (desire, ability, reason and need) language, e.g. in the case of 'desire': 'I wish I could quit smoking.' or 'I like to smoke cigarettes.' It should be mentioned that DARN language is usually applied at the early stages of smoking cessation [42]. Finally, smoker's comments that express action or inaction towards tobacco use cessation are called CAT (commitment, activation and taking steps) language, e.g. in the case of 'taking steps': 'I bought a nicotine patch.' or 'I smoked my friend's cigarette.' It should be pointed out that CAT language is most commonly used at the late stages of smoking cessation [42]. All the 516 first comments were classified separately by two raters (Cohan kappa value of 0.964). 312 neutral (non-MI) comments were excluded. The total number of MI comments was 204 (n=204). MI comments were found both in FB posts created with MI strategies and FB post created without the MI approach.

5.4. Statistical analysis

We used the Statistical Package for the Social Sciences (SPSS) software for all analyses. A statistically significant effect was indicated by the p value of less than 0.05, and a highly significant effect was shown by the p value of less than 0.001.

In the 1st research, Pearson's chi-square test, Welch's t-test, and independent two-sample t-test were applied for the analysis of the target population's habits, knowledge, and attitudes. The conditions of Pearson's chi-square test were met; categorical and independent variables were used, the expected value of sample observations in each level was at least 5. Welch's t-test and independent two-sample t-test were performed depending on the equality of variances, at the normally distributed sample mean.

In the 2nd research, we also used Welch's t-test and independent two-sample t-test to find statistical differences between the study group and the control group. Non-parametric Kruskal–Wallis H test and parametric one-way analysis of variance (ANOVA) were performed to compare each MI strategy to the control group. Dunn's test adjusted with the Bonferroni correction was applied for non-parametric post hoc analysis, and Tukey's honestly significant difference (HSD) test was used for parametric post hoc analysis.

In the 3rd research, correlation was performed rather than regression, because the cause-and-effect relationship between the investigated variables was unclear. We used the non-parametric Spearman correlation, rather than Pearson correlation, because of the non-normal distribution of the data. The conditions of Spearman correlation were met; variables were measured on interval or ratio scale, variables represented paired observations, and monotonic relationship was detected between the variables using scatterplot test.

Finally, it should be mentioned that the FB users' interaction data in the 3rd research had to be corrected for the organic reach. For the statistical analysis, we divided the number of each interaction data by the number of people who saw the non-paid post (organic reach). This correction was necessary, because if more Facebook users see the post, they are more likely to use interaction buttons. Moreover, a higher performance of the content automatically increases the organic reach. Therefore, organic reach and interaction data affect each other directly ('higher reach means more interactions') and indirectly ('more interactions have a high impact on content algorithmic ranking'). In conclusion, we used 'interaction rate' rather than the total number of interactions for statistical analysis.

6. Results

6.1. Target population's habits, knowledge, and attitudes

6.1.1. Sociodemographic data

The mean age of the study population was 22.57 +/- 5.08 years (N=332). Regarding gender distribution, 61% of the participants were women and 39% were men. By place of residence, 18% of the study population lived in the capital, 19% in a county seat, 39% in a city, 23% in a village, and lastly 1% in homestead. In terms of occupation, 45% of the participants were students, 45% were workers, and finally 10% were not studying or working (e.g., receiving childcare allowance). Regarding the highest level of education, 15% of the study population possessed a university or college degree, 58% had completed secondary school or grammar school, 23% had completed primary school, and lastly 4% had other educational attainment or did not have any formal degree of education. According to nationalities, 94% of the participants declared themselves to be Hungarian, 4% to be Romany, and 2% other nationalities. With regard to their smoking history, 65% of the participants were smokers, 12% were former smokers, and 23% were non-smokers.

6.1.2. Changes in habits, knowledge and attitudes

Based on their own admissions, 59% of the smokers had gained new knowledge about quitting through the FB contents: e.g., applications, websites, medications, intensive programs which support smoking cessation. Furthermore, 53% of the smokers reported some positive change in their smoking habits since they had started to follow the FB page: e.g., some of them reduced the number of daily cigarettes or stopped smoking temporarily. We also found remarkable positive changes in the smokers' attitudes about quitting. 49% of the smokers reported that quitting had become more important for them. In addition, 52% of the smokers reported that their self-confidence about quitting had increased since following the FB page. It is also important to highlight former smokers' attitude changes. 36% of the former smokers stopped smoking since they had started to follow the FB page, and 27% reported that the social media contents were helpful in quitting. Moreover, 73% of the former smokers reported that following the FB page supported them to prevent relapse. Finally, the non-

smokers' attitude changes are described. 61% of the non-smokers reported some positive changes in their attitudes toward smoking since following the FB page: e.g., for 40% of the non-smokers it became more important to help smokers quit, 46% thought it had become more important to protect themselves from second-hand smoke, lastly, for 29 % of the non-smokers it became more important to protect others from second-hand smoke.

We compared demographic characteristics and the changes in habits, knowledge, and attitudes. Significantly more non-smokers who lived in villages reported some positive change in their attitudes towards smoking than non-smokers who lived in larger settlements ($\chi^2(4)=13.883$, $p<.05$). Among non-smokers, we found a similar significant correlation regarding educational attainment, whereby a lower level of education was associated with significantly more attitude changes ($\chi^2(2)=9.398$, $p<.05$). These results are illustrated in Figure 2. Furthermore, similar positive attitude changes were reported by younger non-smokers (mean age: 21.02 +/- 4.11) compared to non-smokers, who had no attitude changes (mean age: 23.78 +/- 5.24). This difference was found to be significant using two-sample t-test ($t(68)=-2,45$, $p<.05$). We did not observe any other significant differences between demographic characteristics and the changes in knowledge, habits, and attitudes.

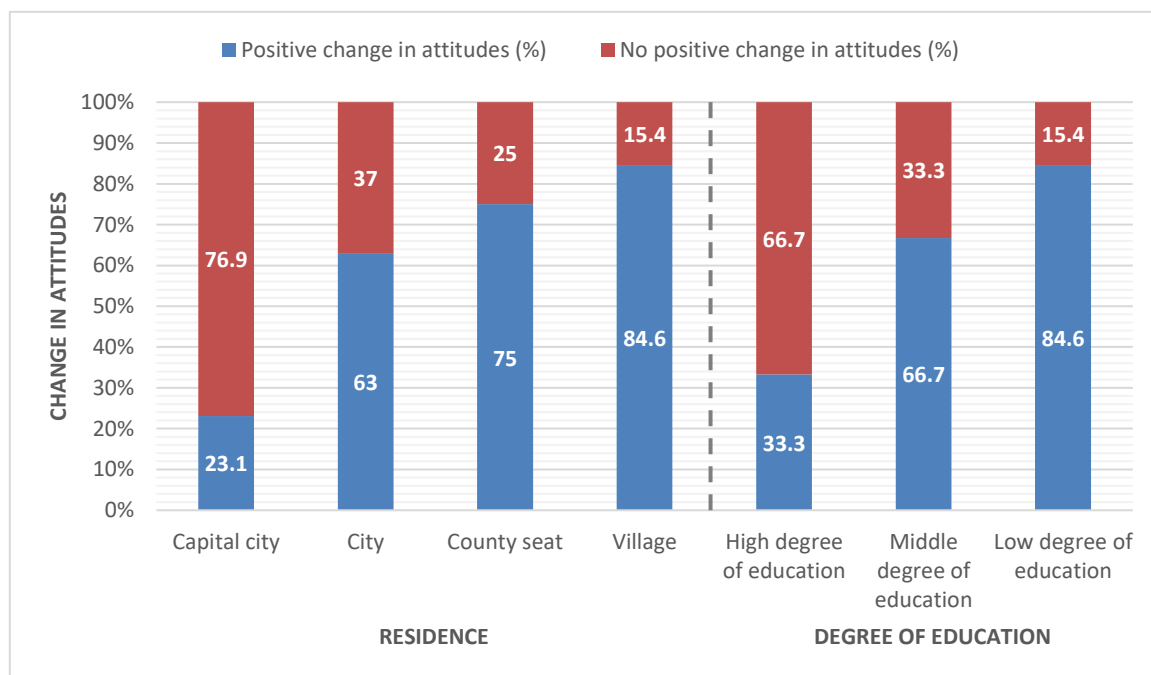


Figure 2 Positive attitude changes of non-smokers according to place of residence and the level of education

6.1.3. Smoking habits

The smokers had been smoking for an average of 7 +/- 5 years, and 94% of them smoked daily ('regular smokers'), 6% of them smoked less than daily ('occasional smokers'). The most commonly used tobacco product was cigarette (98%), followed by e-cigarette (32%), hookah (20%), cigar and cigarillos (6%, 6%), and lastly snus, pipe, and snuff (2%, 2%, 2%). Regarding the variance of tobacco use, 59% of the smokers used only one type of product, while 41% used several products at the time of the survey. Moreover, 30% of smokers were 'dual users', who favoured cigarettes and e-cigarettes together. Regarding tobacco dependence, 55% of the smokers were nicotine dependent according to TTFC. However, 53% of the smokers had a more than 24-hour attempt to quit within one year, and 26% of them made such an attempt more than a year. Finally, 21% of the smokers never tried to quit for more than 24 hours. During the statistical analysis, we found only one remarkable association between the duration of smoking and the new knowledge about quitting. Smokers who reported more new knowledge about smoking cessation started smoking significantly earlier ($t(215)=2.24$, $p<.05$). We did not find any other significant differences between smoking habits and the changes in habits, knowledge, and attitudes.

6.1.4. Motivational stages of smoking cessation

Thirty-five percent of the smokers did not plan to quit ('precontemplation' stage), 53% of the smokers planned to quit within 6 months ('contemplation' stage), and 12% of the smokers planned to quit within 30 days ('preparation' stage). In addition, 55% of the former smokers were abstinent for less than 6 months ('action' stage), while 20% of the former smokers were abstinent for 6-12 months ('maintenance' stage). We compared the motivational stages of smoking cessation and the changes in habits, knowledge, and attitudes. The number of items in the first three motivational stages ('precontemplation', 'contemplation', 'preparation' stages) met the conditions of Pearson's chi-square test. Therefore, these three stages were analysed, and the significant results are presented in Figure 3. The smokers who were planning to quit in the near future reported that quitting had become more important to them ($\chi^2(2)=63.827$, $p<.05$), their self-confidence about quitting had increased ($\chi^2(2)=36.681$, $p<.05$), and they had changed their smoking habits positively since following the FB page

($\chi^2(2)=35.091$, $p<.05$). In addition, a close trend of significance was observed. Smokers who were more motivated in quitting (who were at a higher motivational stage) visited the social media contents more frequently ($\chi^2(8)=14.943$, $p=.06$).

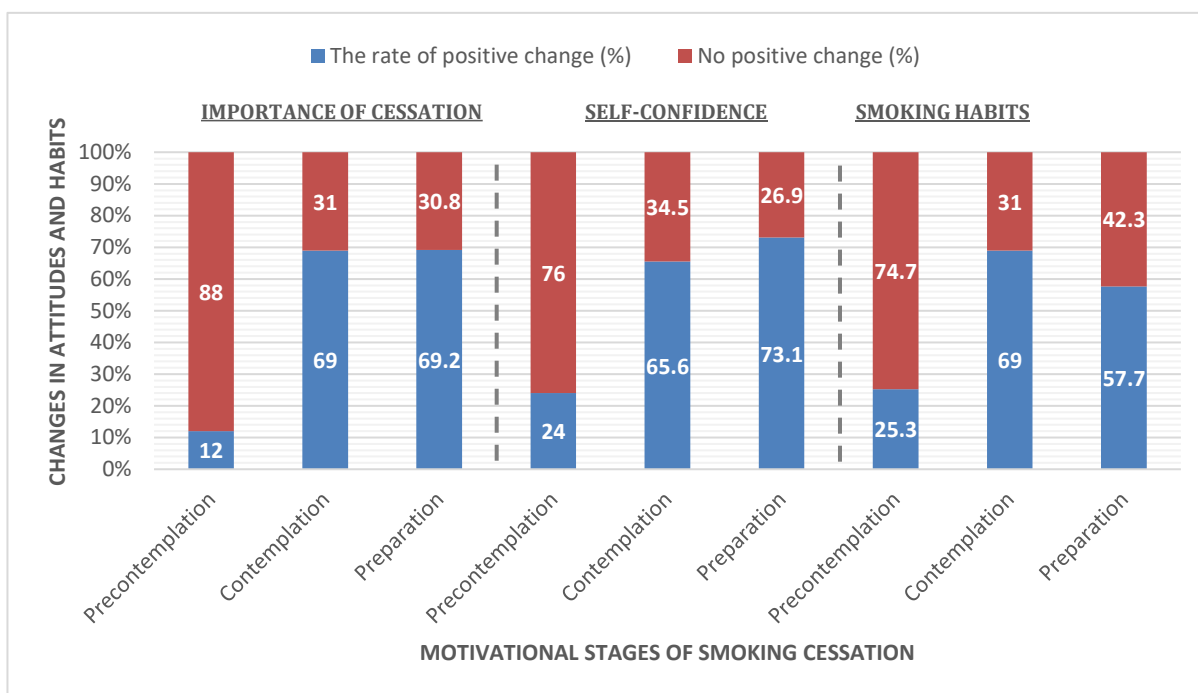


Figure 3 Changes in attitudes and smoking habits of current smokers compared to motivational stages of smoking cessation

6.1.5. Frequency and duration of exposure

Regarding the frequency of exposure, 39% of the participants visited the FB posts daily, 43% of the participants visited the FB posts weekly, and 18% of the participants visited less frequent. According to the duration of exposure, 20% of the participants followed the FB posts for less than 1 month, 54% of the participants followed the FB posts between 1-6 months, and 26% of participants followed the social media contents more for than 6 months. We found a significant relationship between the frequency of exposure and the changes in attitudes, which are presented in Figure 4. The smokers who visited the social media contents more frequently reported that quitting had become more important to them ($\chi^2(2)=17.260$, $p<.05$), their self-confidence about quitting had increased ($\chi^2(2)=23.814$, $p<.05$), and lastly, they had changed their smoking habits positively since following the FB page ($\chi^2(2)=9.265$, $p<.05$).

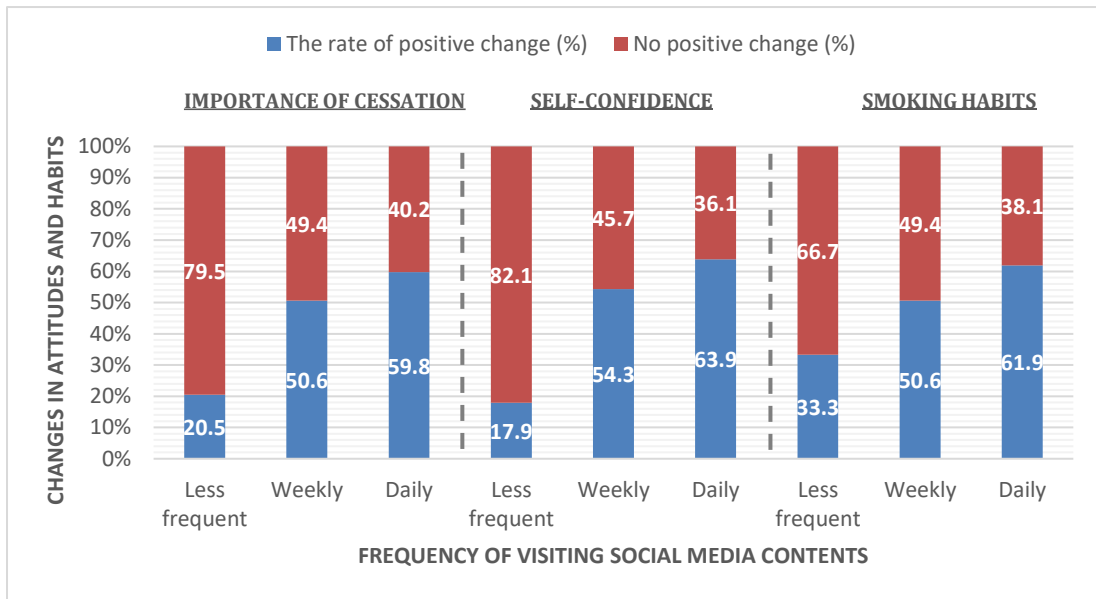


Figure 4 The frequency of exposure according to the changes in habits and attitudes

We found similar, significant correlations between the duration of exposure and the changes in habits and attitudes (Figure 5). The smokers who had been following the FB posts longer reported that their self-confidence about quitting had increased ($\chi^2(2)=7.533, p<.05$) and they had changed their smoking habits positively ($\chi^2(2)=8.140, p<.05$). Among former smokers and non-smokers, we found no significant differences between the frequency and duration of exposure and the changes in knowledge, habits, and attitudes.

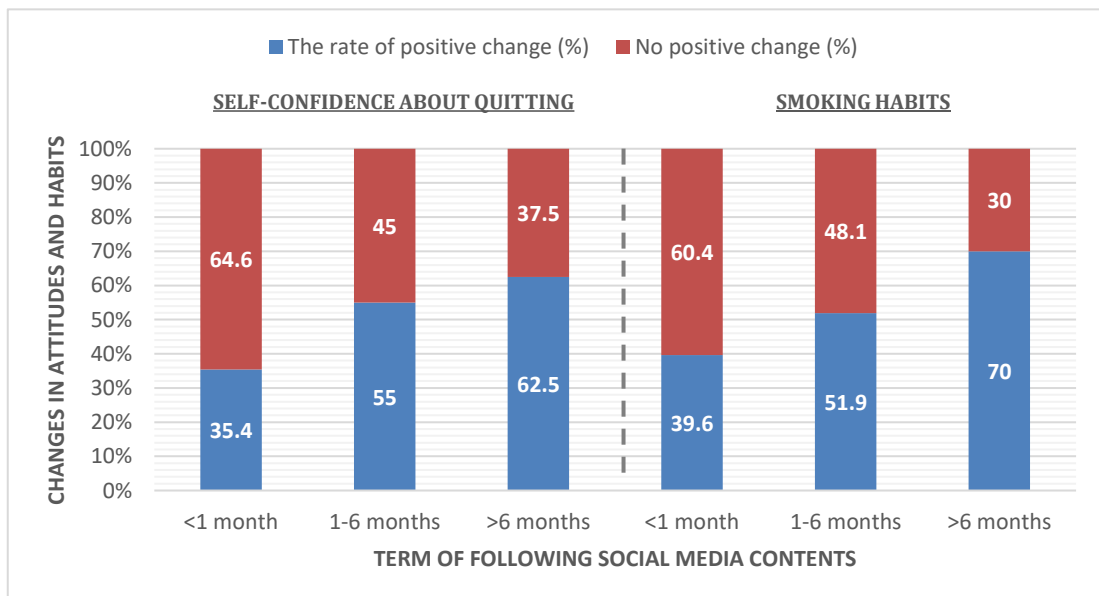


Figure 5 The duration of exposure compared to the changes in habits and attitudes

6.2. Intervention contents and delivery

6.2.1. Contents based on motivational interviewing

Firstly, all MI-based social media contents were compared with the control group to evaluate MI strategies in an online context. As we mentioned it before, we hypothesized that MI strategies will receive a significantly higher engagement rate and fan–total reach ratio than the control group. Our analysis confirmed that MI-based social media contents were associated with a significantly higher engagement rate ($t(653)=2.60$, $p<.05$) and a significantly higher fan–total reach ratio ($t(699)=4.29$, $p<.001$). This result suggests that MI strategies can stimulate more interactions and seem to appeal more to the audience of the FB page than informative or entertaining techniques. Another hypothesis was that MI strategies will elicit significantly more change talk. Our results support this hypothesis. Significantly more change talk ($t(623)=4.03$, $p<.001$), DARN ($t(648)=2.84$, $p<.05$), and CAT comments ($t(644)=2.97$, $p<.05$) were observed in the social media contents where MI strategies were used. These results highlight that MI strategies may help smoking cessation at both the early and late motivational stages. Statistical differences between the MI strategies and the control group according to the outcomes are shown in Table 6.

Post categories	N ^a	Primary outcomes			Secondary outcomes			
		ER ^b	NF ^b	FTRR ^b	CT ^c	ST ^c	DARN ^c	CAT ^c
	n (%)	Mean (SD)			Mean (SD)			
MI strategies								
	443 (63)	9.99 (7.95)	0.17 (0.42)	59.21 (19.65)	0.24 (0.83)	0.14 (0.61)	0.21 (0.80)	0.18 (0.76)
Control group								
	258 (37)	8.61 (6.01)	0.15 (0.43)	52.51 (20.47)	0.06 (0.32)	0.08 (0.32)	0.08 (0.34)	0.05 (0.31)
P-values								
		.010 ^d	.506 ^e	<.001 ^e	<.001 ^d	.057 ^d	.005 ^d	.003 ^d

a, Total number of posts (N).

b, Primary outcomes: engagement rate (ER), negative feedback (NF), fan–total reach ratio (FTRR).

c, Secondary outcomes: change talk (CT), sustain talk (ST), DARN language (DARN), CAT language (CAT).

d, Welch's t-test was applied.

e, Independent-samples t-test was applied.

Table 6 Statistical differences between the control group and motivational interviewing (MI) strategies together.

6.2.2. Relational and technical strategies separately

Secondly, the relationship between the control group and each MI strategy was analysed to assess the influence of MI strategies separately (Table 7). In the following, the primary outcomes will be in the focus of the analysis. One of our hypotheses was that ‘relational MI’ strategies will receive a significantly higher engagement rate compared to the control group. We found a statistically significant difference in the engagement rate between the different social media content types using Kruskal-Wallis H test ($\chi^2(5)=45.27$, $p<.001$). We performed Dunn’s pairwise tests to identify the significant difference. ‘Relational MI’ strategies were associated with a significantly higher engagement rate than the control group ($p<.001$). This result shows that ‘relational MI’ strategies seem to stimulate interactions.

A statistically significant difference in the fan–total reach ratio was found between the different FB post categories using one-way analysis of variance ($F(5,695)=7.44$, $p<.001$). Using Tukey’s HSD test, a significantly higher fan–total reach ratio was noticeable in the social media contents where ‘reflecting change talk’ strategies ($p<.001$) and ‘affirming change talk’ strategies ($p<.05$) were applied compared to the control group. These findings highlight that ‘reflecting change talk’ and ‘affirming change talk’ strategies seem to be popular among the audience of the FB page. On the other hand, no significant correlation was found in negative feedback between the social media content types. This result could suggest that the inhibition of interactions was at the same level in the social media contents where MI strategies or other techniques (e.g., entertaining) were applied.

In the next step, the secondary outcomes were assessed. We hypothesized that ‘elaborating change talk’ strategies will elicit significantly more change talk than other strategies of the control group. A significant difference was found in the number of change talk comments between the social media content types using Kruskal-Wallis H test ($\chi^2(5)=29.68$, $p<.001$). Significantly more change talk comments were elicited in the social media contents where ‘elaborating change talk’ strategies ($p<.001$) and ‘affirming change talk’ strategies ($p<.05$) were used, compared to the control group. These findings could suggest that ‘elaborating change talk’ and ‘affirming change talk’ strategies seem to be useful in FB-based smoking cessation interventions. We found a statistical difference between social media contents in the case of DARN ($\chi^2(5)=16.43$, $p<.05$) and CAT language ($\chi^2(5)=19.20$, $p<.05$). Significantly more DARN utterances were elicited by ‘elaborating change talk’

strategies compared to ‘reflecting change talk’ strategies according to Dunn’s pairwise tests ($p < .05$). However, ‘elaborating change talk’ strategies were not significantly different in the number of DARN comments, compared to the control group ($p = .063$). Lastly, more CAT utterances were evoked by ‘affirming change talk’ strategies, compared to the control group ($p < .001$). These findings may suggest that due to the increased number of DARN utterances, ‘elaborating change talk’ strategies seem to be effective at the early stages of smoking cessation. On the other hand, ‘affirming change talk’ strategies could be useful at the late stages, based on the fact that they provoke more CAT comments. Contrary to our hypothesis, ‘softening sustain talk’ strategies did not generate significant differences in primary or secondary outcomes between the control group and MI strategies.

Post categories	N ^a	Primary outcomes			Secondary outcomes			
		ER ^b	NF ^b	FTRR ^b	CT ^c	ST ^c	DARN ^c	CAT ^c
	n (%)	Mean (SD)			Mean (SD)			
Elaborating CT^d								
	121 (17)	10.62 (8.21)	0.20 (0.48)	57.61 (19.34)	0.36* (0.96)	0.21 (0.81)	0.36 (1.18)	0.21 (0.93)
Affirming CT^d								
	87 (12)	8.36 (6.15)	0.14 (0.38)	60.70* (20.69)	0.32* (1.25)	0.10 (0.43)	0.12 (0.42)	0.31* (1.07)
Reflecting CT^d								
	89 (13)	6.94 (4.32)	0.17 (0.38)	66.32* (18.92)	0.10 (0.54)	0.08 (0.43)	0.06 (0.38)	0.12 (0.58)
Softening ST^d								
	57 (8)	10.51 (9.51)	0.16 (0.37)	55.36 (18.88)	0.16 (0.45)	0.21 (0.82)	0.28 (1.03)	0.09 (0.34)
Relational MI^d								
	89 (13)	13.44* (9.37)	0.17 (0.43)	55.32 (18.56)	0.18 (0.47)	0.12 (0.39)	0.19 (0.54)	0.11 (0.38)
Control group^d								
	258 (37)	8.61 (6.01)	0.15 (0.43)	52.51 (20.47)	0.06 (0.32)	0.08 (0.32)	0.08 (0.34)	0.05 (0.31)
P-values^d								
		<.001 ^e	.820 ^f	<.001 ^f	<.001 ^e	.423 ^e	.006 ^e	.002 ^e

a, Total number of posts (N).

b, Primary outcomes: engagement rate (ER), negative feedback (NF), fan–total reach ratio (FTRR).

c, Secondary outcomes: change talk (CT), sustain talk (ST), DARN language (DARN), CAT language (CAT).

d, Motivational interviewing (MI) strategy: elaborating change talk (CT), affirming change talk (CT), reflecting change talk (CT), softening sustain talk (ST), and relational MI strategies.

e, Kruskal-Wallis H test was applied.

f, One-way analysis of variance was applied.

*Significantly higher value compared to the control group using Dunn’s and Tukey’s post hoc tests.

Table 7 Statistical differences between the control group and each motivational interviewing (MI) strategy.

6.2.3. Interactions, engagement, and organic reach

The statistical significance of Spearman correlation was assessed for the primary outcomes and these correlations are shown in Table 8. Firstly, the intercorrelations among engagement indicators (reactions, shares, comments, clicks) are discussed in this paragraph. We found highly significant negative correlations between 'sad' and 'like' reactions ($r_s = -.120$, $p < .001$), 'angry' and 'like' reactions ($r_s = -.136$, $p < .001$). The significant negative correlations between 'wow' and 'like' reactions ($r_s = -.077$, $p = .013$), and 'comment' and 'like' interactions ($r_s = -.130$, $p < .001$) were also interesting. In summary, negative correlations between the engagement indicators can indicate that the integrity of engagement should be assessed cautiously. Therefore, these results can be explained by the FB users' negative emotions, rather than the usage (engagement) of the MI-based intervention. On the other hand, the positive correlations related to negative FB interactions can provide important insights into FB interactions which lead to activities against the engagement of the FB-based intervention (e.g., reports of spam or unlike of page). Significant positive correlations were found between 'wow' reaction and negative FB interactions ($r_s = .076$, $p = .016$), or 'sad' reaction and negative FB interactions ($r_s = .091$, $p = .003$). In contrast to these results, many highly significant positive correlations support the concept of engagement, for example, positive correlations between 'comments' and 'clicks' ($r_s = .417$, $p < .001$), 'love' and 'wow' reactions ($r_s = .204$, $p < .001$) or 'comments' and 'haha' reaction ($r_s = .174$, $p < .001$).

Secondly, the correlations between organic reach and FB interaction are described. These data are showed in the lower part of Table 8. Mostly positive correlations were found, except for correlations with 'like' reaction and 'share' interaction. A highly significant negative correlation of the 'like' reaction with total reach ($r_s = -.418$, $p < .001$), fan reach ($r_s = -.352$, $p < .001$), non-fan reach ($r_s = -.332$, $p < .001$) was the most surprising result, which can highlight the widespread misconception of 'more FB likes reflect higher reach'. Additionally, a non-significant difference between 'share' interaction and total organic reach was found, although the correlational analysis was nearly significant ($r_s = .059$, $p = .057$). However, the significant negative correlation between 'shares' and fan reach ($r_s = -.174$, $p < .001$), or the significant positive correlation between 'shares' and non-fan reach ($r_s = .388$, $p < .001$) should be noted. The opposite directions of these correlations can explain the non-significant difference between 'share' interaction and total organic reach. Finally, the highly significant positive

correlation between negative FB interactions and total organic reach was also an interesting result ($r_s = .124, p < .001$). It is suspected that the FB users could express their aversions related to the given content with these negative FB interactions. In summary, these results highlight the impact of FB users' interactions on algorithmic content ranking and the calculation of organic reach.

Facebook users' interactions										
Reactions							Share	Com ^a	Click	Neg ^b
Like	Love	Haha	Wow	Sad	Angry					
Spearman correlation coefficients										
Like										
	1.00	.008	.063*	-.077*	-.120*	-.136**	.094*	-.130**	.147**	-.064*
Love										
		1.00	.141**	.204**	.063*	.008	-.090*	.123**	-.007	.009
Haha										
			1.00	.132**	.140**	.080*	-.049	.174**	.002	.052
Wow										
				1.00	.104*	.122**	-.055	.145**	.087*	.076*
Sad										
					1.00	.302**	-.011	.196**	.070*	.091*
Angry										
						1.00	.004	.165**	.097*	.032
Share										
							1.00	-.105*	.097*	.029
Com^a										
								1.00	.417**	.059
Click										
									1.00	.066*
Neg^b										
										1.00
T-reach^c										
	-.418**	.264**	.396**	.164**	.231**	.160**	.059	.368**	.076*	.124**
F-reach^d										
	-.352**	.310**	.457**	.169**	.245**	.173**	-.174**	.393**	-.005	.089*
N-reach^e										
	-.332**	.135**	.153**	.096*	.144**	.103*	.388**	.192**	.135**	.104*

a, Comment.

b, Negative Facebook interactions.

c, Total reach (organic).

d, Fan reach (organic).

e, Non-fan reach (organic).

*Significant, $p < .05$ (2-tailed).

**Highly significant, $p < .001$ (2-tailed).

Table 8 Spearman correlation matrix for the comparison between Facebook interactions and between Facebook interactions and organic reach (N=1025).

7. Discussion

We assessed an online smoking cessation intervention, which was targeted at young people aged 14–35 and based on the MI approach. In the 1st research, our main aim was to evaluate the impact of this FB-based intervention on the followers' smoking habits, cessation knowledge, and attitude changes. In the 2nd research, our main aim was to assess the usefulness of the MI strategies in an online context. Lastly, the correlations between FB users' interactions, the reach and engagement of the intervention were analysed in our 3rd research.

7.1. New findings according to our hypotheses

- The smokers who visited the investigated FB page more frequently and for a longer term reported significantly more positive changes in habits, knowledge, and attitudes.
- The smokers who were more motivated in quitting reported significantly more positive changes in habits, knowledge, and attitudes since they had started following the investigated FB page.
- The social media contents which used MI strategies achieved a significantly higher engagement rate, fan–total reach ratio, and elicited significantly more change talk, DARN and CAT utterances compared to the control group.
- ‘Elaborating change talk’ strategies evoked significantly more change talk and DARN utterances, while ‘affirming change talk’ strategies generated significantly more change talk and CAT utterances.
- ‘Relational MI’ strategies achieved significantly higher engagement rate, while ‘affirming change talk’ strategies and ‘reflecting change talk’ strategies gained a significantly higher fan–total reach ratio.
- Negative FB interactions, negative emotional comments, and reactions ('wow', 'sad', 'angry') would reduce the engagement of FB smoking cessation interventions.
- Some reactions ('like', 'love', 'haha'), shares, positive comments, and clicks would raise the engagement of FB smoking cessation interventions.
- 'Like' reaction would decrease the total organic reach, while 'share' interaction would increase the non-fan reach, and decrease the fan reach of smoking cessation support contents on a public FB page.

7.2. Major practical implications

At the beginning, the analysis of the target population's habits, knowledge, and attitudes (1st research) is discussed. According to the demographic data, the investigated FB page successfully addressed 14–35-year-old smokers, who accounted for two-thirds of the participants. Overall, around 50% of the smokers reported a positive change in smoking habits, cessation knowledge and attitudes. Some studies suggested that the activity and commitment of the FB users could facilitate the positive changes in smoking habits and quitting [63]. Our 1st research seems to support this conception, because smokers who visited the FB page's contents more often and for a longer period reported significantly more positive changes in their smoking habits and smoking cessation attitudes. In the next paragraph, we discuss the findings of the content analysis (2nd research) for the MI approach versus the control group (Figure 6).

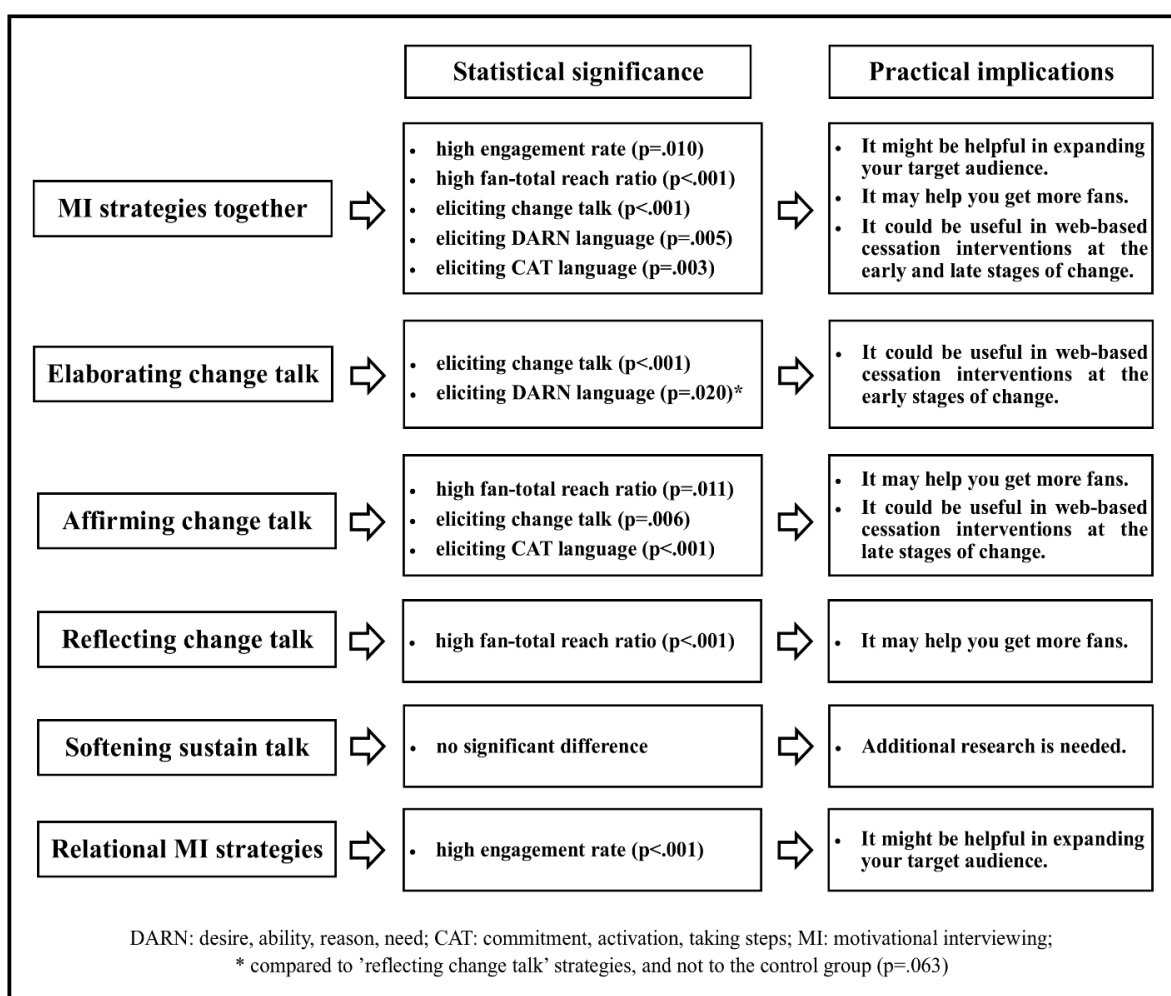


Figure 6 Practical implications of the content analysis in the 2nd research

Significantly more change talk, DARN, and CAT utterances about smoking cessation were elicited by MI-based social media contents compared to the control group, which was hypothesized in previous studies [46,64,65]. Our findings can confirm that the MI approach could play an important role in FB-based smoking cessation interventions. At the same time, significantly more interactions were stimulated by the MI approach among the FB fans than in the control group. These results are also similar to the findings of a prior study which suggested that the engagement on FB could be increased by some MI strategies (such as ‘decisional balance’ technique) [49]. Furthermore, we could not find a significant difference in negative feedback between the MI approach and the methods used with the control group. The small number of negative feedbacks may also be attributed to the MI approach. These findings might highlight the fact that FB interactions could be not inhibited by MI strategies.

Additionally, we discuss the association between each MI strategy and the control group (2nd research), which are also illustrated in Figure 6. A high number of change talk utterances about smoking cessation could be elicited by ‘elaborating change talk’ and ‘affirming change talk’ strategies. In extended internet-based interventions, these strategies could be remarkable. Regarding the high fan–total reach ratio, high retention of the target audience was achieved by ‘affirming change talk’ and ‘reflecting change talk’ strategies, which could be useful in long lasting interventions. ‘Relational MI’ strategies stimulated positive interactions with non-fan FB users illustrated by the high engagement rate and the low fan–total reach ratio. These strategies could be also practicable in other comprehensive interventions in order to expand the target audience.

Furthermore, we discuss the practical implications for stage-based interventions. Some studies have suggested that internet-based interventions based on different motivational stages of smoking cessation could increase abstinence [51,66]. Our findings highlighted that ‘elaborating change talk’ strategies could be useful at the early stages because of the high DARN utterances rate; meanwhile, ‘affirming change talk’ strategies could be impressive at the late stages of smoking cessation because of the high CAT utterances rate. Therefore, these strategies could be advantageous in stage-based smoking cessation interventions (Figure 7). However, stage-based interventions seem to be neither more nor less effective than non-stage-based interventions [67], as we mentioned it before. Additional research is needed to investigate the different strategies, which could be applicable to other online platforms.

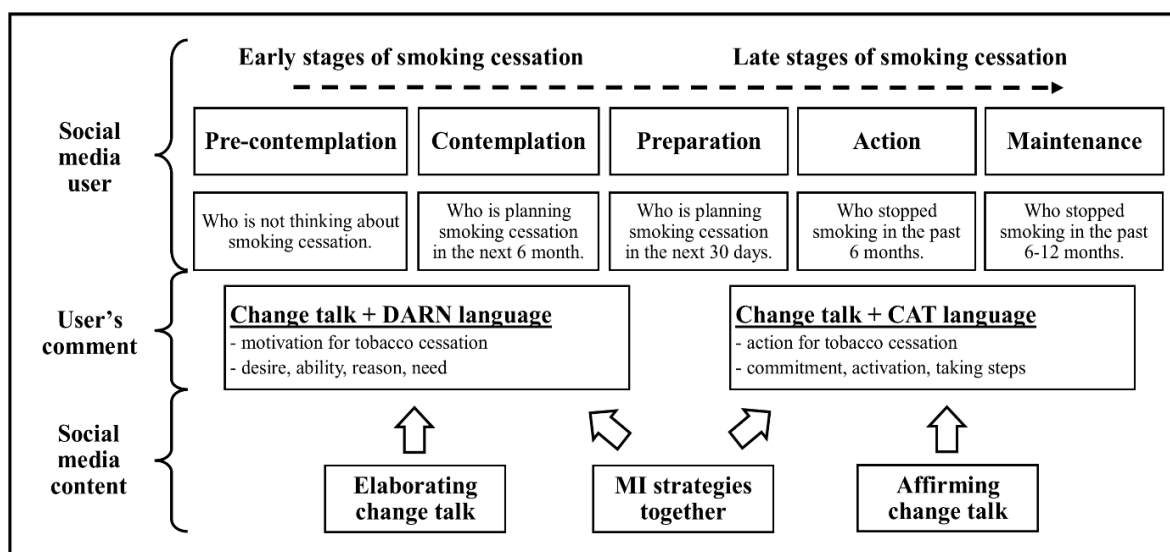


Figure 7 Practical implications of the content analysis for stage-based interventions

Finally, the correlations between engagement, organic reach and FB users' interactions are discussed (3rd research). Negative emotional reactions ('wow', 'sad', 'angry' reactions) and comments were sharply separated from the other engagement indicators owing to the opposite direction of correlations. Firstly, significant negative correlations were found between 'like' reaction and 'wow', 'sad', 'angry' reactions, and comments. Secondly, a high rate of 'wow' or 'sad' reactions were associated with negative FB interactions. Further research is needed to determine the role of these interactions in other Facebook-based public health campaigns with different aims. As we mentioned it before, 'sad' reaction or a negative emotional comment in addictology may indicate a resistance to the smoking cessation intervention. On the other hand, the same interactions in cancer prevention may express FB users' engagement as a response to stories by cancer patients.

Another potentially useful finding of our research is that the usage of FB-based smoking cessation interventions could be increased by certain interactions, which can be considered a real indicator of engagement. Our results suggest that these interactions seem to be 'like', 'love', 'haha' reactions, shares, positive comments, and clicks. Future investigations should assess the impact of these FB interactions on other dimensions of engagement (e.g., the amount or duration of usage), or self-report questionnaires might be used to explore the popular combinations of engagement indicators. Our findings highlight many combined interactions (e.g., 'comments' and 'clicks') which can improve some practical implementations.

For example, if public health professionals want to increase the rate of 'clicks' (e.g., to selecting a website), the usage of social media contents which generate 'comments' may be more advantageous, than the usage of contents which evoke reactions. This can also be an important issue for future research.

Finally, the correlational analysis between organic reach and FB interactions can highlight the presence of a 'brake effect' in algorithmic content ranking. 'Like' reaction seems to decrease the organic reach of social media contents on a public Facebook page. Consequently, FB may evaluate 'like' reaction as a negative element in content ranking, because this is one of the most popular interaction among FB users. In addition, the lack of significant relationship between total organic reach and 'share' interaction may also be explained by a 'brake effect' in the calculation of organic reach. 'Share' has a unique function among interactions, because sending the given content to others can lead to an increase in organic reach directly. Our results suggest that 'share' interaction may correlate positively with non-fan reach, and negatively with fan reach. This positive correlation indicates that the Facebook users who applied the 'share' button usually sent the content to non-fan Facebook users, which led to higher non-fan reach. However, FB might decrease the fan reach in response to the notable increase in non-fan reach, because a negative correlation was found between 'shares' and fan reach. In conclusion, 'like' and 'share' interactions may inhibit the total reach and fan reach of social media contents on a public FB page.

7.3. Limitations of our studies

Some major limitations of the present work should be acknowledged. In the 1st research, we tried to counterbalance the disadvantages of online data collection (e.g., unknown participants or non-random sampling) by using tailored channels for the recruitment of FB page followers. The primary limitation of the 2nd and 3rd research may be the heterogeneous (smoker and non-smoker) audience of the FB page. However, the majority (65%) of the FB followers were smokers, and contents which were targeted at non-smokers were excluded. Finally, FB advertising can indirectly raise the organic reach and the number of interactions during the advertising period. On the other hand, this potential indirect growth affected all FB posts equally, and paid FB posts were excluded to avoid the direct effects of advertising.

8. Conclusions

Regarding our findings, we found that using the MI approach in FB post creation seems to stimulate interactions with young smokers and generate change talk about smoking cessation. The key strengths of this work are the large size of the intervention content dataset and the long duration of the MI-based smoking cessation support program. Primary FB-based public health interventions could gain benefits from our results; however, further research should be done to investigate the use of MI strategies in other online platforms.

We recommend ‘elaborating change talk’ and ‘affirming change talk’ strategies to create smoking cessation support FB posts or other public health contents. ‘Relational MI’ strategies should be used to expand the target audience. Furthermore, ‘affirming change talk’ and ‘reflecting change talk’ strategies can be advantageous in long lasting interventions which need a high retention rate. Overall, we recommend implementing the MI approach in online health behaviour change and smoking cessation interventions. ‘Elaborating change talk’, ‘affirming change talk’ and ‘relational MI’ strategies could be beneficial in extended web-based interventions, such as websites, blogs, or social media pages.

The correlational analysis of FB interactions can shine new light on the engagement of FB-based smoking cessation interventions. A novel classification of the engagement indicators should be considered. Negative FB interactions; negative emotional comments; ‘wow’, ‘sad’, and ‘angry’ reactions may decrease the engagement, while ‘like’, ‘love’, ‘haha’ reactions, shares, positive comments, and clicks may increase the engagement of these interventions. Based on our findings, we suggest implementing the continuous evaluation of FB interactions during smoking cessation interventions.

Lastly, the correlations between FB users’ interactions and organic reach may be also informative for the design of FB-based interventions. This is the first study to report a disadvantage of ‘like’ reaction and highlight the advantages of other interactions in algorithmic content ranking on FB. Moreover, our results suggest the need for further categorization of fan-specific and non-fan-specific FB interactions. The generalizability of these results is wide, because these correlations depend only on the algorithmic content ranking, which does not contain demographic data, smoking status, or other health risks. We tried to explore the relationship between the algorithmic content ranking and FB users’ interactions, nevertheless, further research is needed.

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