Tehran University of Medical Sciences

Nursing Practice Today

2023; Volume 10, No 2, pp. 108-123

Original Article

Effect of cigarette smoking cessation educational intervention based on the trans-theoretical model using motivational interviewing on Egyptian males' smoking knowledge and behavior: A randomized controlled trial

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ARTICLE INFO

Received 05 February 2023
Accepted 30 April 2023

Available online at:
http://npt.tums.ac.ir

Keywords:
transtheoretical model;
cigarette smoking cessation;
smoking knowledge;
nicotine dependence

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DOI:
10.18502/npt.v10i2.12832

ABSTRACT

Background & Aim: The trans-theoretical model suggests that stage-matched interventions improve the effectiveness of behavior changes such as quitting. This study aims to examine the effect of stage-matched smoking cessation educational intervention based on the trans-theoretical model using motivational interviewing on Egyptian males' knowledge, stage movement, and smoking cessation rate.
Methods & Materials: A randomized controlled trial was conducted in the main building of Damanhour University, Egypt. The participants were selected using simple random sampling (N=165), then allocated to both experimental (N=82) and control (N=83) groups using the randomization block technique. Data was collected using a structured interview schedule. The instrument contained five parts: Personal Characteristics and Smoking data, Fagerstrom Tolerance Questionnaire, Tobacco Cessation Readiness Scale, Smoking Knowledge Scale, and trans-theoretical Model constructs questionnaire. The experimental group received ten months of educational intervention using face-to-face and phone-based motivational interviewing.
Results: A significantly higher stage movement was revealed among the experimental group post-intervention (80.5%); 35.4% transitioned to the preparation stage, 32.9% were in the action stage, and 12.2% were in the maintenance stage. According to the ANCOVA test, significant negative mean differences post-intervention was achieved for nicotine dependence and decision pros (P=0.000) with a large effect size (η^2=0.341, η^2=0.503). However, significant positive mean differences were proved for other variables (knowledge, tobacco cessation readiness, and TTM constructs) (P<0.05) with a large effect size (η^2>0.14). Stage analysis revealed significant mean differences in most studied variables, where the action stage had the highest significant mean improvements (P<0.05).
Conclusion: The trans-theoretical model-based educational intervention using motivational interviewing effectively improves smoking knowledge and facilitates quitting with successful stage movement among Egyptian male smokers.

Introduction

Tobacco use is a growing epidemic and public health threat that kill over 8 million people yearly, with about 1.2 million deaths caused by environmental tobacco smoke. Cigarette smoking is a highly popular method of tobacco use. The World Health Organization (WHO) 2020 proved that 22.3% of the population globally consumed tobacco, where 36.7% are men and 7.8% are women. Greater than 80% of tobacco users live in low- and middle-income countries with a greater burden of tobacco-associated illness and death (1, 2). In Egypt, the Central Agency for Public Mobilization and Statistics (CAPMAS) in

Please cite this article as: Sayed S.H, El-Sakkar S.M, Elsaka S.A, El-Houfey A.A. Effect of cigarette smoking cessation educational intervention based on trans-theoretical model using motivational interviewing on Egyptian males' smoking knowledge and behavior: A randomized controlled trial. Nursing Practice Today. 2023; 10(2):108-123

2020 estimated that 17.7% of Egyptians were smokers where 35.6% were males, and 0.3% were females. The highest percentage of those smokers are in the young and adult age period, which mirrors the increased risk of the Egyptian workforce, which further can drain the country's resources and reduce its productivity (3).

Smoking is a well-established risk factor for many diseases such as tuberculosis, several eye diseases, and immune system diseases. Moreover, it has several adverse health effects, such as various types of cancers, heart diseases, stroke, lung diseases, diabetes, chronic obstructive pulmonary diseases, and erectile dysfunction in men. However, it is still a leading cause of preventable diseases, disabilities, and deaths (4). Thus, this conveys hope and necessitates immediate action to cut down the associated economic wastage and human capital loss. Consequently, the WHO Framework Convention on Tobacco Control (FCTC) develops effective strategies for reducing the demand and supply of tobacco. One of the most emphasized and cost-effective strategies is education and increasing public awareness (2). The theory-guided intervention is a powerful strategy for behavioral change. Prochaska and colleagues have validated the trans-theoretical Model (TTM) or "Stage of Change" model that was initially applied to smoking behavior (5). It comprises four components: the stage of change: an individual's thoughts and behaviors regarding behavior; processes of change: the cognitive and behavioral methods used while the individual progress through stages; self-efficacy to resist the smoking desire; and decisional balance: the pros and cons of the behavior and the change advised. The TTM explains behavioral change through the successful stage movement while effectively using processes of change, maintaining higher self-efficacy, and developing a negative attitude toward smoking to reach the decision to quit (6, 7).

The TTM assumes that smoking cessation involves an individual's advancement through five stages of change. Precontemplation stage: no desire to quit during the next six months with no plan for change and unawareness of the negative consequences of smoking. The contemplation stage: initial thinking about quitting in the next six months due to awareness of the associated hazards but with no readiness for change. The preparation stage: readiness for smoking cessation within the next month by taking initial steps. In the action stage, quitting was achieved for at least six months while the maintenance stage indicates quitting for six or more months with the intent to prevent relapse (7, 8). Throughout moving on stages, the individual often goes back and forward before reaching the final one, where many situational, emotional, social, and environmental factors interfere with this process. Hence, it would be better to simultaneously illuminate the effect of those factors in each stage to effectively construct a stage-specific education (5, 7).

The ten change processes help in facilitating and maintaining quitting. The cognitive or experiential processes incorporate consciousness-raising (recognizing the extent of the smoking behavior), dramatic relief (recognizing and expressing positive or negative emotions about smoking), self-reevaluation (reassessing cognition and emotions concerning smoking), environmental re-evaluation (appraising and realizing the effects of smoking on the physical and social environment), and social liberation (realizing the available environmental opportunities and social support for quitting). The behavioral processes comprise reinforcement management (rewarding positive progress to quitting while discouraging relapse), counterconditioning (substituting smoking behaviors and thoughts with healthy alternatives), helping relationships (discovering supportive relationships that inspire quitting), self-liberation (commitment for change and

belief in the possibility of quitting), stimulus control (restructuring the environment to support and inspire quitting and eradicate smoking related tools) (6, 8).

The efficiency of the delivery technique of the smoking cessation intervention is essential for efficient implementation to encourage stage movement, change pros, and inspire self-efficacy. Consequently, not only the smoking cessation rate is the endpoint of interest of the intervention, but also the stages and processes of smoking behavior change. The motivational interview (MI) technique proved great efficiency with the TTM-based education for facilitating positive smoking behavior change with targeted stage-matched intervention. It is a democratic collaboration between the counselor and the client to provoke self-motivation and behavioral change. It also reflects a helping, directive, and counseling technique that assists the client in resolving the ambivalence hindering the realization of the intended goals of the change process. Thus, MI directs people to discover and confront their harmful behavior rather than just tell them what to do. The effective conduction of MI has four main directing principles: expressing empathy using active listening, developing discrepancy between clients' goals or values and their current smoking behavior, adjusting to clients' resistance instead of directly opposing it, and supporting optimism and self-efficacy for quitting. MI is developed based on the assumptions of motivational psychology, client-centered approach, and stages of change. Current evidence focuses on using the TTM in MI to assess the client's level of readiness for behavior change, then helping them through conversations and stage-matched intervention to support and initiate this behavior change (9-11).

The effectiveness of the TTM-based educational intervention in smoking behavior modifications was controversial. A recent systematic review proved the low efficacy of the TTM-based intervention for smoking cessation and recommended seeking an alternative model (12). Conversely, another systematic review proved the effectiveness of the TTM in smoking cessation with a more satisfactory result (13). These could be attributed to numerous covariates or extraneous variables that confounded the measurement of the TTM effect on smoking behavior such as smoking duration, employment status, age of smoking initiation, having a smoker friend, and peer pressure (14). Moreover, the effectiveness of using MI in smoking cessation is questionable depending on the intensity and duration of interviewing or whether MI was used alone or in combination with other behavioral approaches (11). The joint effect of TTM and MI on tobacco smoking was rarely examined in recent literature but it is still lacking (15). However, it was examined on smokeless tobacco and proved its effectiveness (10). Therefore, the present study aims to examine the effect of stage-matched smoking cessation educational intervention based on TTM using MI on Egyptian males' knowledge, stage movement, and smoking cessation rate. It will help in resolving the conflicting findings regarding the TTM-based education on smoking behavior through accurately measured effect size after controlling the evidenced covariates using the ANCOVA test. Besides, highlights the role of MI in facilitating behavioral change.

Methods

Study design

A randomized controlled educational trial was registered in one of the primary registries in the WHO registry network; the Iranian Registry of Clinical Trials (IRCT20210612051555N4).

Setting and participants

This study was accomplished in Damanhour University's main building in El-Beheira Governorate/ Egypt. It targeted the

smoking males working in the main building of Damanhour University (nearly 335 employees, where about 300 of them were active smokers). They were selected using a simple random sampling technique after obtaining the sample frame (employees list) using the following inclusion criteria: being habitual/daily smokers of minimally 10 cigarettes, with a smoking duration of at least one year, being in the stages of pre-contemplation, contemplation, and preparation based on TTM, being aged at least 20 years, and being enthusiastic to quit. However, those who were occasional smokers used another type of nicotine than smoked cigarettes, actively shared in other smoking quitting programs, and those who reported addiction to any other drugs were excluded from the study.

Sample size

The sample size was evaluated using numerous parameters: standardized effect size (0.5), the standard deviation of the outcome (1.0), the proportion of participants in both groups (0.5), type II error/β (0.2), type I error/ $\alpha = 0.05$ (16). Thus, a minimum sample size of 60 smokers in each group was generated. Due to the high desire of all smokers in the study setting to participate in the educational intervention, they were invited, and those who met the pre-specified criteria were incorporated into the study. Thus, the total sample size of 165 smokers was incorporated into the experimental (82) and control (83) groups.

The participants were allocated to both groups using the randomization block technique. Firstly, the researchers established a list of numbers of eligible smokers from 1 to 176; then, each number was written on a small piece of paper and was warped to be kept hidden. Each piece of paper was held in an opaque and properly locked envelope that was sequentially numbered. All 176 envelopes were randomly split into 22 blocks/8 per each, and from each block, four envelopes were pulled out to be randomly allocated to the experimental group (88), and the other four envelopes were allocated to the control group (88). A code was written in each envelope representing the group type where "A" for the experimental and "B" for the control" and they were kept until the initiation of data collection. Thus, the allocation sequence was completely concealed from both researchers and participants to eliminate bias. Besides, the researcher who did the allocation was not involved in the intervention (17).

Measurement

A structured interview questionnaire was used to collect data which included five parts:

Part I: Personal Characteristics and smoking data: age, education, marital status, residence, presence of health problems, smoking initiation, smoking family member, and previous medical advice for quitting and joining any smoking program.

Part II: Fagerstrom Tolerance Questionnaire (FTQ): was initially developed by Fagerstrom in 1972 and revised in 1991(18). It consists of six questions to assess the nicotine dependence level with varying scoring systems: how soon started smoking after waking up (0-3), difficult cigarettes to give up (0-1), and refrain from smoking in public places (0-1), number of smoked cigarettes per day (0-3), and increased smoking during the morning (0-1) or illness (0-1). The total score was 0 -10, where a higher score reflected a higher nicotine dependence.

Part III: Smoking Knowledge Scale: It was developed by the researchers after thoroughly reviewing relevant literature (2, 4). It assessed the participants' knowledge about smoking and its hazards, negative health consequences, and effects on the self and others. It comprised 28 items scored as yes (1), no, or do not know (0). The total score was 0-

58, where a higher score signified a better knowledge level.

Part IV: Tobacco Cessation Readiness Scale: It was adopted from Maryland's Tobacco Resource Center (TCRC), USA (19). It contained seven items measured using a ten-graded readiness ruler. The total score was (7-70), and items 2 and 3 had reversed scores. Higher scores indicate higher readiness for quitting.

Part V: The TTM constructs questionnaire:

It has four constructs that were adopted from the TCRC (19):

- ***Stages of Change Scale (SCS):*** A staging algorithm first established by Prochaska and DiClemente (1982). It contained five statements and the participants nominated the statement that best denoted their current smoking behavior and categorized it under the five change stages: "pre-contemplation" (did not desire to quit in the following six months), "contemplation" (desired to quit in the following six months), "preparation" (plan to quit within the next month), "action" (did not smoke for less than six months), and "maintenance" (sustained quitting for six months or more) (5, 20).
- ***Processes of Change Scale (PCS):*** A self-reported instrument containing 20 items assessing the experiential/cognitive (10 items) and behavioral (10 items) processes of change. Participants specified the frequency of using every thought or situation to support quitting within the preceding month. It used a five-point Likert scale from never (1) to repeatedly (5). The total score of every change process was 10-50, where higher scores represented better levels of the respective processes for moving through the stages of change (6-8).
- ***Decisional Balance Scale (DBS):*** It had six items measuring the perception of the pros (3 items) and cons (3 items) of smoking. The participants judge the significance of every item to their smoking decision on a 5-point Likert scale from not important at all (1) to extremely important (5). High pros scores signify no decision to quit; however, high cons scores imply a decision to quit (21).
- ***Abstinence Self-Efficacy Scale (ASES):*** It had nine items distributed over three subscales/three items each; negative affect, social/positive, and habitual/craving. The participants rated their confidence level for facing smoking temptation on a five-point Likert scale from not confident at all (1) to extremely confident (5). Higher scores signified higher self-efficacy (22).

Survey validity and reliability

The instrument (Part I and III) was designed by the researchers based on credible evidence, while parts II, IV, and V were adapted after Arabic translation using the DeepL Translator software. A different researcher conducted a back translation to guarantee the accuracy of the overall instrument. The instrument's content was further agreed upon by a panel of six community and public health experts at Damanhour University. They rated the items according to their wording, ordering, and scoring. It was further revised and modified based on their feedback and revealed a satisfactory total Scale–Content Validity Index (0.85) and per item (0.7 to 1.0). Pilot testing of the questionnaire was intended to make certain of its clarity and applicability by deploying it to about 10% of the total sample size who were omitted from the main study sample. Consequently, the needed adjustments were performed. The reliability was judged using Cronbach's Alpha coefficient test (α) and seemed satisfactory (part II=0.75, part III=0.83, part IV=0.85), and part V; SCS=0.81, PCS=0.79, DBS=0.82, ASES=0.80).

Intervention

The data collection process was carried out over one year, from February 2022 to January 2023. The participants' recruitment and pre-test were conducted in February 2022,

while a follow-up assessment was carried out after 10 months in January 2023. After clarifying the study's aims, formal approval for its execution was acquired from Damanhour University.

Firstly, the researchers visited the participants in their work to break the ice and establish a trustful relationship with them. Besides, assessing eligibility and recruiting them after clarifying the study's aims. The researchers also compiled the participants' phone numbers to ease communication and follow-up, given that they agreed to participate in the study. Secondly, the researchers started assessing the participants' educational and motivational needs and stage of change through a pre-test. This helped in developing baseline data for the latter comparison, and this data was also used as a base for the program's content development (23).

Thirdly, the researchers designed the educational intervention based on TTM considering the recent and reliable literature (10,12,13,19) using digitally assisted multimedia (PPT, informational brochures, educational videos, social media). These materials were evaluated and approved by external peer reviewers, and the required modifications were considered. The participants were split into groups according to their assessed stage of change. Stage-matched WhatsApp groups were designed for the experimental group to facilitate follow-up, communication, sharing of stage-specific cues, and scheduling the next meeting.

Fourthly, the educational intervention was initially implemented using MI (March 2022) and repeated after three, six, and nine months at the group level, while it was conducted at the individual level monthly using phone interviews (11,12). Each Face-to-Face educational session took about 30-40 minutes, and all sessions were held in the conference room in the participants' workplace during their rest time (Four Face to Face group sessions: initially, then in the third, sixth, and ninth months) while phone interviews were performed ten times for each participant monthly. The educational activities were tailored to the stage of change while considering the psychological constructs of the TTM model and applying the MI principles. For example, those in the pre-contemplation stage were instructed about the negative consequences of smoking to enhance their readiness to quitting. Moreover, the other stages offered functionally feasible strategies to foster quitting and enhance their smoking-resistant techniques and problem-solving skills, as summarized in Appendix 1. A weekly motivating message was delivered using WhatsApp to sustain contact and motivation and boost their self-efficacy.

Fifthly, follow-up was performed after ten months (posttest) to ensure that the participants maintained the quitting behavior to aid in comparison with the pretest results. The control group initially received the pre-test and post-tests after ten months, using the same survey and at the end, they received the educational resources and media to maximize the benefits and to save their moral and ethical rights.

Blinding

The researchers who analyzed the data were not involved in the data collection process. Those who collected the data conducted the data entry on the SPSS program and were further contacted after analyzing the data and finalizing the results to interpret the codes of both groups: experimental group "A" and control group "B."

Ethical considerations

The study was approved by the ethical committee of the Faculty of Nursing, Damanhour University, Egypt (No. 53-d322022). Informed oral consent was gained from each participant before the study's conduction. All the acquired data were kept anonymous and confidential and employed

only for scientific research purposes. The participants also were notified about their exclusive right to unrestricted withdrawal at any time from the study.

Data analysis

Data were fed into the Statistical Package of Social Science (SPSS) software, version 27. The number, percent, arithmetic mean, and standard deviation were employed as descriptive statistics to summarize data. The significance of the differences between both groups (categorical variables) was examined by the Chi-square or Fisher's exact tests. Mean differences between both groups, before and post the educational intervention, were explored by the Analysis of Covariance (ANCOVA) test. The rule of thumb trial for evaluating the effect size using the partial Eta squared (η2) was small (0.01), medium (0.06), and large (0.14) effects (24). The ANCOVA test was also deployed to compare the mean differences in the studied variables by stages of change to control covariates between groups. Besides, the Bonferroni correction was used to control the likelihood of type I error. The Tukey post hoc test was done to explore which stage of change differed from others through pairwise comparisons while controlling familywise error. The cut-off value (P-value) of the significance was $p< 0.05$.

Results

Notably, six participants were excluded from the experimental group (three skipped many educational sessions, two missed the follow-up, and one had missing data during analysis). Five participants were excluded from the control group (two lost communication, one withdrew, and two had missing data during analysis). Finally, 82 participants remained in the experimental group and 83 in the control group (Diagram 1).

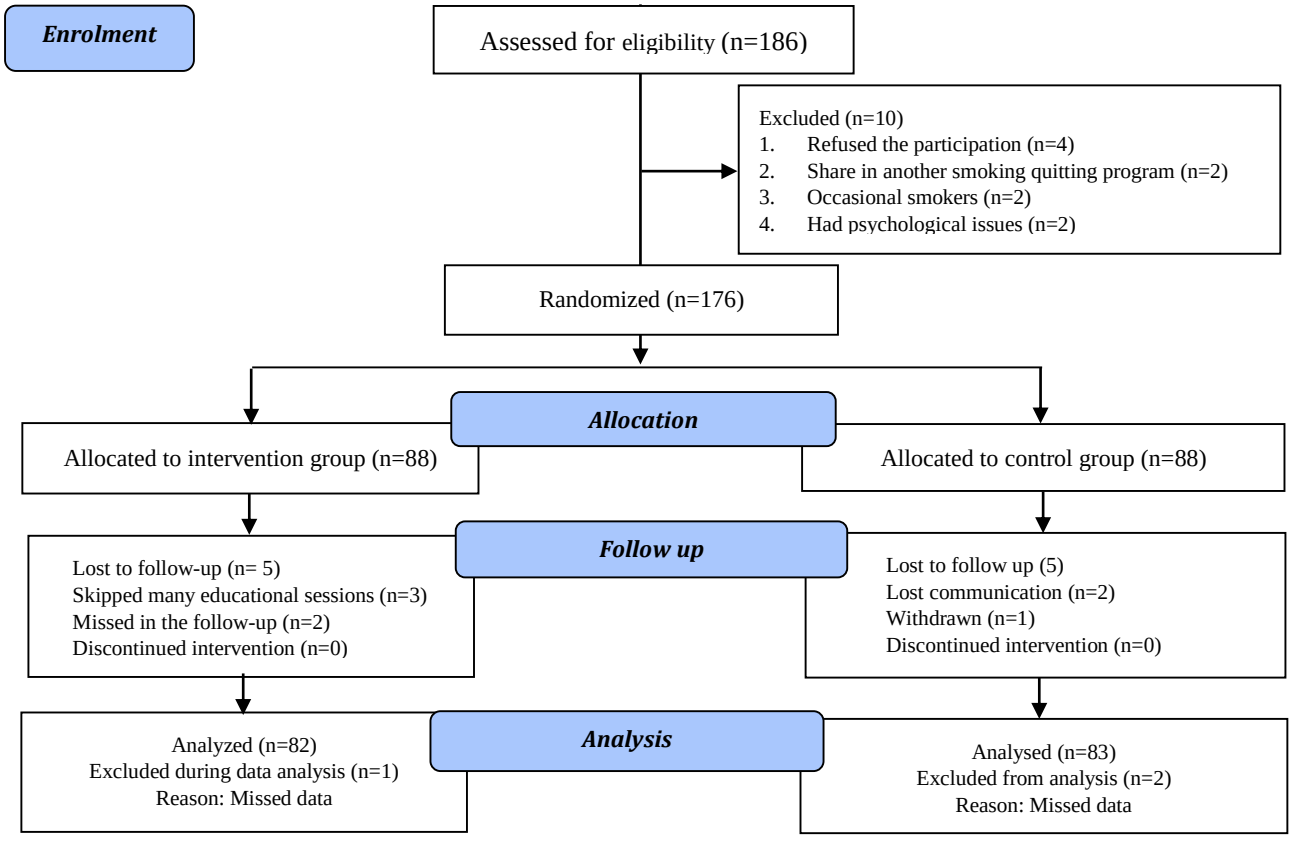

Diagram 1. CONSORT flow diagram

Personal characteristics and smoking data

Table 1 illustrates the homogeneity of both groups was confirmed by the lack of statistically significant differences in all basic data (P> 0.05). The mean age of the experimental (41.37±10.18) and control (40.63±9.97) groups. Most of both the experimental and control groups were married (92.6%, 80.8%) and secondarily educated (51.2%, 39.8%), urban residents (53.7%,63.9%), and had no health problems (62.2%, 67.5%), respectively. Long smoking duration of 10 to 20 years (61.0%, 53.0%) and having a smoker family member (64.6%, 69.9%) were reported by most of both groups, respectively. Most of them received medical advice to quit smoking (72.0%, 66.3%) and did not previously participate in smoking programs (86.6% 90.4%), respectively.

Table 1. Personal characteristics and smoking-related data of both groups

	Experimental group (n=82) N(%)	Control group (n=83) N(%)	P-value
Age (years)			
20-30	12(14.6)	12(14.5)	0.420 *
31-40	31(37.8)	29(34.9)	
41-50	19(23.2)	28 (33.7)	
51-60	20 (24.4)	14 (16.9)	
Mean ± SD	41.37±10.18	40.63±8.97	
Marital status			
Married	76(92.6)	67(80.8)	0.437**
Divorced or widowed	3(3.7)	7(8.4)	
Single	3(3.7)	9(10.8)	
Education			
Basic education	9(10.9)	16(18.0)	0.353**
Secondary education	42(51.2)	33(39.8)	
University education	29(35.4)	31(37.3)	
Postgraduate	2(2.4)	4(4.8)	
Residence			
Urban	44(53.7)	53(63.9)	0.120*
Rural	38(46.3)	30(36.1)	
Chronic diseases			
No	51 (62.2)	56(67.5)	0.454 *
Hypertension	6(7.3)	8(9.6)	
Bronchial asthma	12(14.6)	10(12.1)	
Diabetes	13(15.9)	9(10.8)	
Duration of smoking (years)			
<10	10(12.2)	11(12.3)	0.319 *
10-20	50(61.0)	44(53.0)	
21-31	22(26.8)	28(33.7)	
Having a smoking member in the family			0.472 *
Yes	53(64.6)	58(69.9)	
No	29(35.4)	25(30.1)	
Receiving medical advice to quit smoking in the last year			0.429 *
Yes	59(72.0)	55(66.3)	
No	23(28.0)	28(33.7)	
Previous participation in smoking education or quitting programs			0.447 *
Yes	11 (13.4)	8(9.6)	
No	71(86.6)	75(90.4)	

* Chi-square test **Fisher Exact Test

Stage of change and movement pre- and post-intervention

Table 2 portrays a significant stage change post-intervention among the experimental group than the control group (P=0.001). The highest percent of the experimental group transitioned to the preparation (35.4%) and action (32.9%) stages and 12.2% was in the maintenance stage compared to (12.0%, 2.4%, and 0.0%, respectively) among the control group. Besides, none of the experimental group was left behind in the precontemplation phase, while 19.5% were in the contemplation stage compared to 50.6% and 34.9% among the control group, respectively.

Table 2. Stage of change of the experimental and control group pre- and post-intervention

TTM Stage of change		Experimental group (n=82)	Control group (n=83)	P-value*
		N (%)	N (%)	
Pre-intervention	Precontemplation	45(54.9)	39(47.0)	0.323
	Contemplation	27 (30.5)	29(34.9)	
	Preparation	10(14.6)	15(18.1)	
	Action	0(0.0)	0(0.0)	
	Maintenance	0(0.0)	0(0.0)	
Post-intervention	Precontemplation	0(0.0)	42(50.6)	0.001
	Contemplation	16(19.5)	29(34.9)	
	Preparation	29 (35.4)	10(12.0)	
	Action	27 (32.9)	2(2.4)	
	Maintenance	10(12.2)	0(0.0)	

*Fisher Exact Test

Figure 2 depicts a significant stage movement from pre-intervention to post-intervention among the experimental group than the control group (P=0.000). Most (80.5%) of the experimental group had stage progress compared to 6.0% of the control group who remained stationed (90.4%) compared to 19.5% of the experimental group. The ANCOVA analysis of mean scores of the studied variables pre-and post-intervention.

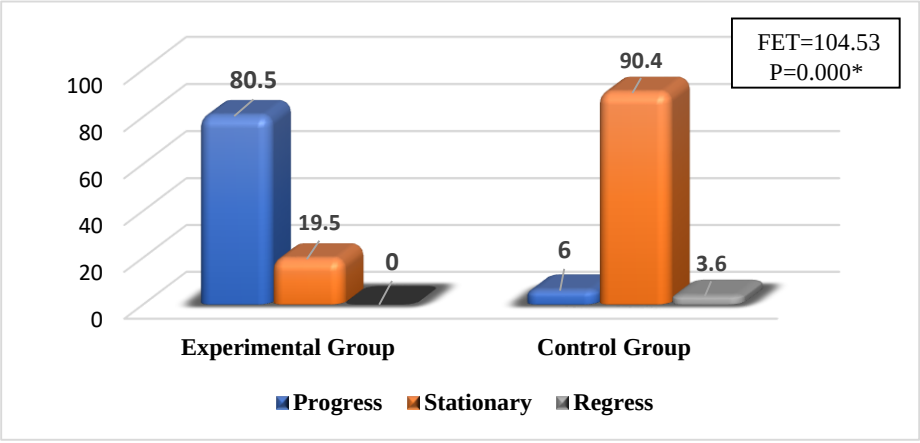

Figure 2. Stage movement from pre-intervention to post-intervention in both groups

Table 3 illustrates no statistically significant difference between the experimental and control groups pre-intervention (P<0.05) except for the social/positive domain of self-efficacy (P>0.05). However, a significant mean difference change was revealed in all the studied variables post-intervention in the

experimental group than the control group (P>0.05) after controlling the covariates (pre-test scores, age, education, marital status, and smoking duration). A significant negative mean difference was achieved for nicotine dependence level and decision pros post-intervention (P=0.000) with a large effect size (η2=0.341, η2=0.503, respectively). However, a significant positive mean difference was proved for all other studied variables post-intervention (P<0.05) with a large effect size (η2>0.14), while a medium effect size was proved for helping relationships domain of the behavioral processes of change (η2=0.046).

Table 3. ANCOVA analysis of mean scores of the studied variables pre and post-intervention, after controlling covariates[a]

Variables	Min-Max	Pre		P value	Post		P value	Main effect		
		Experimental Mean (SD)	Control Mean (SD)		Experimental Mean (SD)	Control Mean (SD)		Mean difference (SE)	P value [b]	Partial η2
Nicotine dependence (FTQ)	0-10	5.35 (1.54)	5.81 (2.55)	0.169	4.19 (1.09)	5.72 (1.19)	0.000*	-1.529 (0.170)	0.000*	0.341
Smoking Knowledge	0-58	18.85 (7.66)	20.90 (6.69)	0.069	27.17 (4.33)	20-60 (4.31)	0.000*	6.570 (0.619)	0.000*	0.418
Readiness to cessation	7-70	49.78 (5.18)	48.22 (7.98)	0.138	56.19 (5.03)	48.35 (5.00)	0.000*	7.837 (0.714)	0.000*	0.434
TTM constructs										
Experiential processes (Total)	10-50	27.22 (4.70)	27.80 (3.93)	0.352	34.314 (3.67)	28.124 (0.365)	0.000*	6.166 (0520)	0.000*	0.472
Consciousness-raising	2-10	5.34 (1.50)	5.42 (1.42)	0.709	7.42 (1.00)	5.53 (1.00)	0.000*	1.892 (0.142)	0.000*	0.530
Dramatic relief	2-10	5.59 (1.41)	5.65 (1.23)	0.752	7.48 (1.43)	5.94 (1.42)	0.000*	1.534 (0.202)	0.000*	0.269
Environmental re-evaluation	2-10	5.83 (1.29)	5.90 (1.24)	0.706	6.92 (1.17)	6.01(1.16)	0.001*	0.915 (0.165)	0.000*	0.164
Self-reevaluation	2-10	5.71 (1.44)	5.82 (1.34)	0.606	6.72 (1.30)	5.96 (1.30)	0.006*	0.755(0.185)	0.000*	0.096
Social liberation	2-10	4.76 (1.89)	5.01 (1.23)	0.303	5.70 (1.07)	4.78 (1.06)	0.001*	0.917 (0.152)	0.000*	0.188
Behavioral processes (Total)	10-50	24.57 (7.50)	25.19 (6.57)	0.573	29.47 (2.58)	25.32 (2.56)	0.000*	4.137 (0.365)	0.000*	0.450
Reinforcement management	2-10	4.20 (1.97)	4.58 (1.95)	0.211	5.85 (1.16)	4.23 (1.16)	0.000*	1.617 (0.165)	0.000*	0.379
Counter conditioning	2-10	4.48 (1.75)	4.59 (1.62)	0.662	5.65 (1.15)	4.86 (1.14)	0.012*	0.760 (0.163)	0.000*	0.121
Helping relationships	2-10	5.35 (2.23)	5.43 (2.05)	0.811	5.73 (0.780)	5.43 (0.780)	0.463	0.304 (0.111)	0.007*	0.046
Self-Liberation	2-10	6.04 (1.67)	5.87 (1.75)	0.526	6.71 (0.970)	5.98 (0.960)	0.000*	0.726 (0.138)	0.000*	0.151
Stimulus control	2-10	4.51 (1.85)	4.72 (1.68)	0.444	5.50 (0.890)	4.80 (0.880)	0.018*	0.698 (0.126)	0.000*	0.164
Decisional balance										
Pros	3-15	9.07 (2.15)	9.18(2.68)	0.777	5.92 (1.78)	9.10 (1.77)	0.000*	-3.187 (0.253)	0.000*	0.503
Cons	3-15	8.39 (1.84)	8.96(2.29)	0.078	11.07 (1.40)	8.99 (1.39)	0.000*	2.075 (0.199)	0.000*	0.410
Abstinence self-efficacy (Total)	9-45	22.41 (7.03)	24.53(7.30)	0.060	32.44 (4.80)	24.03 (4.77)	0.000*	8.41 (20.684)	0.000*	0.491
Negative affect	3-15	7.39 (2.31)	7.98(2.18)	0.096	10.60 (1.75)	8.06 (1.74)	0.000*	2.546 (0.249)	0.000*	0.401
Social/Positive	3-15	6.59 (2.44)	7.41(2.63)	0.039*	11.15 (1.86)	7.66 (1.85)	0.000*	3.492 (0.266)	0.000*	0.524
Habitual/Craving	3-15	7.77 (2.16)	8.16 (2.18)	0.252	11.35 (1.79)	8.34 (1.78)	0.000*	3.016 (0.254)	0.000*	0.474

[a]: Pre-test scores, age, education, marital status, and smoking duration were included as covariates in analyses.
[b]: Adjustment for multiple comparisons: Bonferroni.
SE: Standard Error of the mean difference among the experimental group from the pre-test
*Significant at P ≤0.05 ANCOVA: Analysis of Covariance η2= Eta Squared (effect size)

Table 4 illustrates a significant mean difference by stage of change among the experimental group in all the studied variables except many subdomains (dramatic relief, social liberation, reinforcement management, helping relationships, and self-liberation) (P>0.05). In addition, Table 5 depicts a significant mean difference in the action stage when compared with the preparation stage in all the studied variables (P<0.05) except for the same subdomains (P>0.05). When compared to the contemplation stage the consciousness-raising subscale was added (P>0.05). However, in comparison with the maintenance stage, no significant mean differences were seen except for the consciousness-raising and self-efficacy subscales (negative affect, social/positive, and habitual craving) (P<0.05).

Table 4. Analysis of the post-test scores of the studied variables by the stages of change among the experimental group

Variables	Contemplation stage (n=16)	Preparation stage (n=29)	Action stage (n=27)	Maintenance stage (n=10)	F test	P value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
Nicotine dependence (FTQ)	4.69 ±0.793	4.83 ±0.602	3.96±0.898	3.60±0.966	9.609	0.000*
Smoking knowledge	19.31±4.54	19.52± 4.45	27.19±1.64	28.0± 0.112	36.018	0.000*
Readiness to tobacco	53.94± 2.29	53.93± 3.84	59.70± 3.90	61.60± 1.58	23.681	0.000*
TTM constructs						
Experiential processes (Total)	32.13± 5.79	31.41± 3.30	38.00± 4.34	39.50± 4.06	16.953	0.000*
Consciousness-raising	7.38± 1.09	6.62 ± 1.12	8.15± 1.13	9.20± 0.632	18.086	0.000*
Dramatic relief	6.88± 1.86	7.21± 1.84	7.70± 2.04	7.90± 1.45	0.997	0.399
Environmental re-evaluation	5.75± 1.73	6.62± 0.979	8.26± 1.03	8.30± 1.49	18.721	0.000*
Self-reevaluation	6.19± 1.05	6.28±1.85	8.07± 0.958	8.20± 1.32	18.446	0.000*
Social liberation	5.19± 1.42	5.76± 1.50	5.52± 1.81	6.10± 1.73	0.775	0.511
Behavioral processes (Total)	28.38± 5.93	27.28± 4.88	34.74± 4.03	35.30± 3.56	16.163	0.000*
Reinforcement management	5.50± 2.10	5.86± 2.01	5.89 ± 1.72	5.10± 1.52	0.559	0.643
Counter conditioning	4.88± 1.41	4.83 ±1.54	7.11± 1.12	7.10± 1.73	17.406	0.000*
Helping relationships	6.13± 2.28	5.38± 2.16	6.07± 2.48	5.00± 1.94	0.940	0.426
Self-liberation	6.94± 1.34	6.45± 1.70	6.96± 1.56	7.10± 1.60	0.738	0.533
Stimulus control	4.88± 1.15	5.28± 1.07	7.56±0.641	8.30± 1.57	44.854	0.000*
Decisional balance						
Pros	6.56± 1.21	6.21± 1.11	5.07± 1.11	4.60± 1.43	10.217	0.000*
Cons	9.44± 0.512	9.24± 1.27	11.41± 1.01	11.70± 1.57	25.799	0.000*
Abstinence self-efficacy (Total)	28.31± 5.87	29.52± 7.39	37.48 ± 5.96	39.60± 7.32	12.659	0.000*
Negative affect	9.50±1.97	8.90± 1.50	12.44± 1.40	14.50± 0.850	49.947	0.000*
Social/Positive	9.50±0.816	9.52±0.949	12.11±1.55	13.60±1.17	46.956	0.000*
Habitual/Craving	10.44± 1.50	9.38± 0.775	12.41±1.39	13.70± 1.25	46.561	0.000*

* Analysis of Covariance (ANCOVA)

Table 5. Post-hoc test of the scores of the studied variables by the stages of change among the experimental group

Variables	Action-Contemplation	Sig.	Action-Preparation	Sig.	Action-Maintenance	Sig.
	Mean difference (SE)		Mean difference (SE)		Mean difference (SE)	
Nicotine dependence (FTQ)	-0.725 (0.250)	0.001*	-0.865* (0.212)	0.025*	0.363 (0.293)	0.605
Smoking knowledge	7.873 (1.091)	0.000*	7.668 (0.924)	0.000*	-0.815 (1.28)	0.920
Readiness to tobacco	5.766 (1.078)	0.000*	5.773 (0.913)	0.000*	-1.896 (1.264)	0.442
TTM Constructs						
Experiential processes (Total)	5.875 (1.359)	0.000*	6.586 (1.152)	0.000*	-1.500 (1.595)	0.783
Consciousness-raising	0.773 (0.338)	0.110	1.527 (0.287)	0.000*	-1.052 (0.397)	0.047*
Dramatic relief	0.829 (0.590)	0.501	0.497 (0.500)	0.754	-0.196 (0.693)	0.992
Environmental re-evaluation	2.509 (0.390)	0.000*	1.639 (0.330)	0.000*	-0.041 (0.457)	0.998
Self-reevaluation	1.887 (0.357)	0.000*	1.798 (0.303)	0.000*	-0.126 (0.414)	0.990
Social liberation	0.331 (0.512)	0.916	-0.240 (0.434)	0.945	-0.581 (0.601)	0.768
Behavioral processes (Total)	6.366 (1.485)	0.000*	7.465 (1.259)	0.000*	-0.559 (1.783)	0.988
Reinforcement Management	0.389 (0.595)	0.914	0.027 (0.504)	0.998	0.789 (0.698)	0.672
Counter conditioning	2.236 (0.445)	0.000*	2.284 (0.378)	0.000*	0.011 (0.523)	0.989
Helping relationships	-0.051 (0.717)	0.997	0.695(0.607)	0.664	1.074 (0.841)	0.580
Self-liberation	0.025 (0.498)	0.995	0.515 (0.422)	0.616	-0.137(0.584)	0.995
Stimulus control	2.681 (0.328)	0.000*	2.280 (0.278)	0.000*	-0.744 (0.385)	0.222
Decisional balance						
Pros	-1.488 (0.369)	0.001*	-1.133 (0.313)	0.003*	0.474 (0.433)	0.694
Cons	1.970 (0.353)	0.000*	2.166 (0.300)	0.000*	-0.293 (0.415)	0.895

Abstinence Self-Efficacy (Total)	9.169 (2.098)	0.000*	7.964 (1.779)	0.000*	-2.119 (2.462)	0.825
Negative affect	2.944 (0.476)	0.000*	3.548 (0.404)	0.000*	-2.056 (0.559)	0.002*
Social/Positive	2.611(0.376)	0.000*	2.594(0.318)	0.000*	-1.489 (0.449)	0.006*
Habitual/Craving	1.970 (0.384)	0.000*	3.028 (0.325)	0.000*	-1.293 (0.450)	0.027*

* Mean difference is significant at 0.05 based on the Tukey test

Discussion

The present study confirmed the effectiveness of a stage-specific educational intervention based on TTM using MI in improving smoking knowledge and facilitating behavioral change among smokers with successful stage movement and higher smoking cessation. Besides, increasing the level of readiness for quitting and reducing nicotine dependence.

The present study proved a significant increase in the mean score of smoking knowledge among the experimental group, post-intervention, with a large effect size ($\eta 2>0.14$). Likewise, Tseng et al. (2022) (25) proved a significant increase in the proportion of correct knowledge about smoking hazards among Taiwanese coastal workers post-intervention. In addition, Abdelsalam & Said (2018) (26) portrayed a significant increase in the mean score of smoking knowledge, post-TTM-based intervention, among Egyptian secondary school male students.

The current study portrayed a significant stage movement, post-intervention, among the experimental group, where most of them progressed compared to a minority of the control group, who mainly remained stationed or even regressed. The highest percentage of the experimental group transitioned to the preparation (35.4%), action (32.9%), and maintenance (12.2%) stages. Thus, TTM stage-specific education using MI effectively facilitated stage movement where 45.1% succeeded in quitting. This was also supported by a significant positive increase in the mean scores of the readiness for tobacco cessation post-intervention with a large effect size ($\eta 2>0.14$).

A similar figure was proved by Tseng et al. (2022) (25) among Taiwanese coastal workers who showed significant stage movement among male workers, where 34.9% of them stopped smoking after six months. A six-month study among high school students by Erol et al. (2018) (15) proved the effectiveness of the TTM in inducing significant stage progress among the participants, where the highest percentage of them were in both action (26.5%) and preparation (34.5%) stages. A lower trend of smoking cessation (18.0%) was depicted by Solaimanizadeh et al. (2019) (27) among Iranian automobile workers' factories with more participants transitioning from the preparation to the action stage. An Egyptian study among secondary school male students by Abdelsalam & Said (2018) (26) revealed that 32.0% of the experimental group had significant movement to a higher stage of change, and 13.9% reached the action-maintenance stage compared to 1.9% among the control group. Moreover, Bakan & Eric (2018) (28) conducted a study to compare the effectiveness of smoking cessation training using the TTM and Health Belief Model (HBM) among male and female nurses. They proved the higher effectiveness of TTM in inducing significant stage movement where 18.7% of the studied nurses moved to action (7.0%) and maintenance (11.6%) stages compared to 15.0% in the HBM group reached the action stage and none in the maintenance stage. However, it revealed that two participants regressed to the contemplation stage and attributed that to their exposure to stressful situations and weight increase. It was evident by their decreased self-efficacy scores and increased temptation scale scores.

Controversial findings were shown in a one-year TTM-based training intervention among Turkish university students by Tumer et al. (2018) (29). It revealed an average effect of

the intervention on the smoking cessation rate, where it was 15.0% at the end of the program, while 40.0% of the students were still in the preparation stage, and none of those who were in the pre-contemplation stage quit smoking. It can be attributed to the significant difference between groups before the intervention concerning the smoking initiation duration and the nicotine dependency level in Tumer's study, as highlighted by the authors. This result was not online with the current study as both groups were not significantly varied in nicotine dependency level based on the FTQ scores. Moreover, Tseng et al. (2022) (25) confirmed that the short-term effectiveness of the TTM in promoting smoking quitting was substantial but weakened on long-term measurement after four years. Thus, the effectiveness of TTM-based education varied according to the sample characteristics and their homogeneity, and the duration of intervention.

The current study proved a significant increase in the mean scores of the TTM constructs among the experimental group: processes of change (cognitive and behavioral), smoking cons, and abstinence self-efficacy with a large effect size for almost all the studied variables ($\eta 2>0.14$). However, the smoking pros significantly decreased. Specifically, significant mean improvements were proved by moving through the stage of change in most of the studied variables. Besides, the post hoc test proved that the action stage showed the highest significant mean improvements in most of the studied variables in comparison with the preparation and contemplation stage while in comparison with the contemplation stage, the consciousness-raising subscale was also added. However, no significant mean differences were seen between the action and maintenance stages, except for the consciousness-raising and self-efficacy subscales. These findings illustrate the varied and effective use of the cognitive and behavioral processes by the participants to facilitate behavior change. Besides, highlights the need for continuing education and capacity building among quitters to maintain quitting. Consequently, we can confer that the TTM-based educational intervention and individualized MI equipped the participants with sufficient information and negative attitudes toward smoking while decreasing the positive ones. Consequently, they become more self-confident in facing smoking temptation situations and effectively cope with them by using successful behavioral and cognitive processes to progress through stages of change.

In concordance, Solaimanizadeh et al. (2019) (27) explored a significant decrease in smoking temptation and an increase in decisional balance and processes of change post-intervention among the studied automobile factory workers. Bakan & Eric (2018) (28) reflected that post-intervention, the TTM group exhibited diminished smoking temptation and positive attitudes toward smoking. However, a significant increase was revealed in behavioral processes of change, self-efficacy, and negative attitudes toward smoking. Conversely, Erol et al. (2018) (15) found no statistically significant difference between the pre-post mean scores of the decisional pros and self-efficacy. These findings may be attributed to the difference in study designation, where this conflicting study used one group pre-posttest design. Besides, the lower age of the participants and the inclusion of girls (12.0%). However, Erol's study revealed a significant increase in self-efficacy among the participants while progressing through the stages of change. Besides, the post hoc test proved that the participants in the action stage had the greatest score than other stages which is in line with the current study.

Moreover, an Iranian community-based study by Orouji et al. (2017) (30) revealed significant changes in all the constructs of the TTM among the intervention group members who quit (action stage) and those who did not (all preceding stages), except for the barriers and benefits subscales. However, an earlier one-year study in the United Kingdom by Aveyard et al.

(2009) (31) revealed an insignificant effect of the stage-matched educational intervention based on TTM on smoking behavior. This may be attributed to the fact that this trial was built on data from a previous trial which was based on the health practitioner's assessment of the smokers' behaviors. In addition to, the prevailing slight positive but not significant stage movement among the intervention group in this conflicting study.

Evidently, the current study proved a significant decrease in the nicotine dependence level post-intervention among the experimental group with a large effect size ($\eta 2 > 0.14$) based on the FTQ scores. These findings can be attributed to the significant stage movement and satisfactory smoking cessation rate (45.1%) associated with TTM-based education. Thus, a hopefully promising future for stage movement and maintenance of quitting. Two studies detected similar findings; Erol et al. (2018) (15) and Bakan & Eric (2018) (28). The former also revealed a significant decrease in nicotine dependence among the participants while progressing through the stages of change where the action stage had the lowest score. Moreover, a prospective cohort study in south Asia by Chawla et al. (2020) (32) proved that stage-matched counselling using the TTM was effective in achieving higher smoking abstinence rates as evidenced by lower nicotine dependence levels among those in the action and maintenance stage than other stages.

Conclusion

The present study confirmed the effectiveness of stage matched educational intervention based on the TTM using motivational interviewing in improving smoking knowledge and facilitating smoking cessation with successful stage movement. Besides, reducing the nicotine dependence level and increasing readiness for quitting among Egyptian adult male smokers. A significant stage movement was revealed where the highest percentage of the experimental group had progressed to the preparation, action, and maintenance stage, with none left behind in the pre-contemplation stage.

Significant improvements were achieved in all constructs of the TTM with a large effect size attributed to the intervention. Moreover, significant mean improvements were proved among the participants while moving through the stage of change in most of the studied variables. Besides, the action stage achieved significantly greater mean improvements in comparison with the preparation and contemplation stages. However, no significant differences were shown when comparing the action and maintenance stages, except for the consciousness-raising and the three self-efficacy subscales. These highlight the effectiveness of TTM-based intervention using MI, even if used for a short duration (six months), and the role of knowledge and self-efficacy in the maintenance of change.

This study is one of the pioneer studies that apply the TTM-based educational intervention using MI on adult male smokers in Egypt while considering the nicotine dependence level and the covariates affecting the outcome. However, focusing on the self-reported assessment with a lack of laboratory analysis (urine or saliva test) limits the significance of the results. Besides, a long-term follow-up is required to track the maintenance stage of quitting behavior.

Acknowledgments

The authors would like to thank Damanhour University and its employees for facilitating the accomplishment of this study.

Conflict of interests

The authors declare no conflict of interest.

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