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**Evaluating and comparing the efficacy of the 'trans-theoretical model' and 'theory of planned behavior' on smoking cessation. A systematic review of the current literature**

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## SYSTEMATIC REVIEW

## EVALUATING AND COMPARING THE EFFICACY OF THE 'TRANS-THEORETICAL MODEL' AND 'THEORY OF PLANNED BEHAVIOR' ON SMOKING CESSATION. A SYSTEMATIC REVIEW OF THE CURRENT LITERATURE

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**Abstract**

**Introduction:** Smoking has been a deadly and disease-linked hazardous habit worldwide, resulting in overall decrease in quality of life. Global numbers are growing and aims on reduction are not met. The application of 'Trans-Theoretical' (TTM) and 'Theory of Planned Behavior' (TPB) models on smoking may provide assistance on reduction and maintenance.

**Aim:** Therefore, a systematic review of the current literature took place in order to evaluate and compare the efficacy of TTM and TPB against smoking. The outcome may assist field practitioners in their designs and practice.

**Methods:** An electronic research was conducted in 5 electronic databases. 3,871 initial titles were located and retrieved. The titles retrieved were then accessed using inclusion/exclusion criteria and then were evaluated using 10 main criteria to answer and meet the research aims.

**Results:** Research for titles resulted in the inclusion of 10 studies, of which 5 used TTM and 5 TPB as a behavior change model on smoking cessation. The quality and efficacy of papers was almost identical, while only one out of the overall 10 studies was efficient on smoking cessation.

**Conclusion:** The review may provide some strong implications on low efficacy for both TTM and TPB, while there might be a need for new change-of-behavior models against smoking. Practitioners who design individual interventions against smoking may have to seek for alternative to TTM and TPB models of behavior change.

**Keywords:** Smoking Cessation, tobacco use, change of behavior, transtheoretical model, theory of planned behavior.

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## INTRODUCTION

According to the World Health Organization (WHO) 'tobacco use' is a hazardous habit resulting in deaths and sickening, thus decreasing the quality of life and reducing severely life expectancy.<sup>1</sup> It was estimated that only in 2017 approximately 8 million people globally diseased due to tobacco use, and unfortunately this number is estimated to be growing in the foreseeable future.<sup>1</sup> The global aim is the reduction of tobacco use by 30%, taking as measurement the prevalence ratios between 2000 and the forthcoming 2025.<sup>1</sup> However, in WHO's latest report it is communicated that thus far only 8.4% decrease is shown in the global average ratio between 2000 and 2015, while it is estimated that by 2025 the according ratio will be just 12.4% from 2000 to 2025.<sup>1</sup>

In Health Psychology and Behavioral Medicine, quitting smoking may be one of the most popular and researched topics.<sup>2</sup> Interventions by practitioners in the field, concern the application of 'change-of-behavior' models. Two of the most commonly used models against smoking are the 'Trans-Theoretical Model' (TTM) –otherwise known as 'Stages-of-Change'<sup>3</sup> and which was initially introduced for smoking behaviors<sup>4</sup>– and the 'Theory of Planned Behavior' (TPB).<sup>5</sup>

Regarding TTM, the theory supports that five progressive stages, including 'pre-contemplation', 'contemplation', 'preparation', 'action', and 'maintenance' will result in behavioral changes for any in question behaviors that need to be changed, and will eventually lead to the 'termination' or 'relapse' stage.<sup>5</sup> Throughout the years TTM has been commonly used for stress management<sup>6</sup>, adherence-to-treatment<sup>7-8</sup>, prevention of depression<sup>9</sup>, weight management<sup>10</sup> and probably most commonly for smoking cessation.<sup>11-15</sup> According to background literature, it is reflected that the strengths of the model include (i) that its rationale is the actual basis for assessment, (ii) that it develops a sense of privacy and confidentiality, and that (iii) that feedback is provided in terms of each stage.<sup>16-18</sup> Accordingly, the weakness of TTM may be (i) that only few interventions are actually theory driven, (ii) that very few interventions are planned and initially designed to be personalized, and (iii) that TTM interventions are empirically based and tailored.<sup>16-18</sup>

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With regard to TPB, the theory supports that individual beliefs named as 'attitudes', 'subjective norms', 'perceived behavior control' will influence 'intention', and the later belief will lead to a specific behavioral change, as of 'change-of-behavior' standards.<sup>5</sup> Progressively, the model has been used for condom use practices,<sup>19-20</sup> leisure choice,<sup>21</sup> physical exercise,<sup>22</sup> weight management<sup>23</sup> and smoking.<sup>24-28</sup> In continuous, the strengths of TPB include that (i) it may explain through its structure non-volitional behaviors for change-of-behavior, (ii) it may explain theoretically the interaction between behavioral intention and the seeable/obtained behavior, and (iii) it includes accurately the theory of 'social norm' in the model.<sup>29</sup> On the contrary, the negative critics incorporate (i) that TPB is more of a cognitive model of processing than a change-of-behavior one for health problems since it does not explain the need for change, (ii) that there is nothing explained in TPB theory about the role of emotions, and (iii) that the key elements of 'attitudes', 'social norms', 'perceived behavioral control' and 'intentions' are very likely to swift quickly since the model is more social than psychological.<sup>30-31</sup>

## Rationale & Significance

After considering the hazardous effects of smoking, the high prevalence ratio in WHO's third report<sup>1</sup> and the forthcoming missing aims to reduce tobacco use by 2025, it is of common sense that smoking should be effectively addressed by practitioners. The effectiveness of both TTM and TPB as change-of-behavior models in health-related issues in Health Psychology and Behavioral Medicine have been proven to show some result.

Consequently, this systematic review will compare the two respective models for their efficacy on smoking cessation. The conclusive outcome upon the efficacy of TTM and TPB as well as which of the two models is more efficient for smoking cessation will provide practitioners with appropriate evidence in order for them to design their interventions in the field of their individual practice.

## AIM

The primary aim of the present systematic review was to examine and compare the effectiveness of TTM and TPB on smoking

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cessation. The secondary aim was to critically evaluate the quality of the methodology of the following papers in Table 1.

## METHODOLOGY

### Paper Selection / Data Basis & Keywords

For the paper selection process five databases were used. These include 'PubMed', 'PsychINFO', 'SCOPUS', 'Cochrane' and 'Web of Science'. The key words used for the identification of the papers were as follows: 'randomised control trial', 'randomized control trial', 'RCT', 'smoking', 'smoking cessation', 'tobacco use', 'Transtheoretical model', 'TTM', 'Stages of Change', 'Theory of Planned Behavior', 'Theory of Planned Behaviour' and 'TPB'.

### Eligibility Criteria

The selection criteria that were used were 4. Firstly, the papers had to be randomized controlled trials (RCTs), secondly it had to be clear that the intervention is TTM- or TPB- based, thirdly that the targeted behavior is 'smoking cessation', and lastly that the papers had to be fully available for reading and accessing.

### Evaluation Criteria

The final selected papers will be evaluated by 10 criteria. 9 out of the 10 criteria were retrieved from properties from Schultz et al.<sup>32</sup> study as presented in the '*CONSORT 2010 checklist of information to include when reporting a randomised trial*' (p. 699). One criterion, i.e. criterion 4, was created after merging properties of the same checklist. The final 10<sup>th</sup> criterion was created and 'report of baseline and follow-up data' after taking into consideration the RE-AIM checklist for systematic reviews.<sup>33</sup> The criteria and the properties from which they were created are found and explained in the checklist below.

- Criterion 1: Eligibility criteria for participation.
- Criterion 2: How, when and what were the measures that present the pre- and post- intervention results.
- Criterion 3: Sample size and how it was determined.
- Criterion 4: Randomization. How allocation was achieved. Method, Type, Mechanisms, Steps, Who designed and decided the allocation.
- Criterion 5: Allocation. Number of participants in each group

- Criterion 6: Drop-out rates, with reasons if possible
- Criterion 7: Demographics and Characteristics of each group at least before the intervention.
- Criterion 8: Effect size, clearly demonstrated.
- Criterion 9: Benefits and Harms. A discussion of benefits and harms that is consistent to the results of the study, preferably with outcomes that would allow further considerations and further research questions.
- Criterion 10: Baseline and Follow-up. A clear and consistent report of findings between the differences in the scores pre- and post- intervention.

Lastly, it should be clearly communicated that the present systematic review was conducted solely for 'smoking cessation'. Any results in RCTs that are presented by the authors as successful outcomes and include irrelevant findings such as 'enrolling to programs against smoking' or 'tobacco use reduction', or any other non-clearly stated outcome that the intervention was successful to 'smoking cessation', the RCT outcome was considered as a failed one.

## RESULTS

### Results of Electronic Research

Electronic research in the five databases in section 2.1 resulted in 3,871 titles. Some titles were the same, therefore excluded, and a total sum of 3,123 titles remained. Retrospectively, 3,058 titles were removed since they were obviously irrelevant to 'smoking cessation'. The remaining 65 titles were opened as full-texts and assessed according to the 'eligibility criteria' in section 2.2. The papers remained for the systematic review to be evaluated under the criteria in section 2.3 were finalized at the sum of 10. The flow diagram in Figure 1 below illustrates the procedure.

### Effectiveness of Interventions

#### TTM

Regarding TTM, in Aveyard et al.<sup>11</sup> study the intention was to test whether the TTM interventions by midwives on 918 pregnant women smokers in the UK would be effective. The control group just received a stop smoking leaflet. The outcome shows that TTM intervention moved women through the stages of TTM with significant differences in the mean scores between

the intervention and control group. However, it did not result in smoking cessation.

Furthermore, in De Silva et al.<sup>12</sup> study 80 first year undergraduate Malaysian male smokers were assigned for a brief single TTM based intervention -up to 3 minutes- on the harm of smoking in order to enroll to a 'Quit Smoking Line' program. The control group just received the 'Quit Smoking Line' leaflet. 6 months after the intervention it was found that more than half participants in the intervention group were registered in the Quit Line in contrast to none from the control group. No data on quitting smoking are given.

Moreover, in Huang et al.<sup>13</sup> study 355 pregnant women and mothers of children younger than 3 years old recruited from the gynecological and pediatric departments in 4 Taiwanese hospitals were assigned. The intervention group received a TTM based educational program and telephone counseling by registered nurses. The control group received just the due hospital care. The results show that the intervention was statistically successful on processing through the stages of TTM but there was no quitting.

In addition, in Lawrence et al.<sup>14</sup> study 918 pregnant women - who smoked for at least 10 weeks before enrollment to the study- were recruited from West Midlands in the UK. Two intervention groups received TTM based intervention by midwives and other pregnant women who were trained for 2 up to 3 days by licensed practitioners for TTM delivery. The first group received TTM based self-help manuals and the second received the same manuals and sessions with a computerized TTM-based intervention. The control group received a simple advice on quitting smoking. The results show a slight but doubtful benefit on intending quitting smoking after 30 weeks gestation and 10 weeks postnatal.

Finally, in Li et al.<sup>15</sup> study 557 patients with type-2-diabetes who smoked were recruited in 9 major hospitals in Hong Kong. The intervention group received a 35-to-45-minute smoking cessation counseling based on TTM model by nurse counselors and a leaflet for smoking and diabetes. The control group received a brief advice and the leaflet. The results show no significant differences between the two groups in smoking abstinence after 12 months.

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### **TPB**

Regarding TPB, in Epton et al.<sup>24</sup> study 1,445 prospective undergraduate students at Sheffield University in the UK participated. Their health behaviors were measured, including their smoking status. The intervention group received TPB based online intervention, and 6 months post intervention the number of current smokers had significantly been reduced.

Further, in Hassandra et al.<sup>25</sup> study 44 regular smokers were recruited in a community health care unit in Finland. The intervention group received a mobile application giving instructions on their physical activity in order to quit smoking and deal with relapses and cravings. The control group was given only guidance to develop an action plan. The findings summarize qualitatively that some participants found the intervention helpful to reduce the amount of cigarettes smoked per day 12 months post intervention.

To continue, in Lakerveld et al.<sup>26</sup> study 622 participants with high risk of type-2-diabetes and cardiovascular disease from the Netherlands took part in this 2 year follow-up study. The intervention group received TPB based counseling, while the control received a health brochure. The results show no statistical differences in the mean scores in smoking between the two groups.

Additionally, in Neil-Sztramko et al.<sup>27</sup> study 557 non cancer Canadians aged above 40 years old were included for a 12-week intervention. The intervention group received a TPB based electronic intervention in which they were primarily informed for behaviors preventing cancer including smoking. Regarding the control group, authors do not exactly explain what the participants did. No smoking differences were found between the two groups.

Lastly, in Zhao et al.<sup>28</sup> study a TPB based intervention for adolescents was accessed. 207 10<sup>th</sup> grade participants from two high schools in Kunming, China were recruited. The intervention group received a 4 session TPB based intervention for one week. The paper does not address accurately what the control group did. The results illustrate that within the intervention group there were no significant changes in smoking behaviors 6 months post intervention.

Table 2 summarizes the findings of this section.

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## Quality Assessment

Quality assessment found the following results.

To begin with, 'criterion 1/ eligibility criteria' was found in 9 out of 10 studies.<sup>11-15, 24-27</sup> Eligibility criteria were explained accurately and when not scored, they were obvious.

Furthermore, 'criterion 2/ pre- and post- intervention measures' was spotted in 7 out of 10 studies.<sup>12,14,24-28</sup> Qualitatively though, the measures were not explained thoroughly overall.

Moreover, 'criterion 3/ sample size' was seen in 4 out of 10 studies.<sup>13-15,28</sup> Unfortunately, without much explained on sample sizes, it cannot be understood the power of the review.

In addition, 'criterion 4/ how randomization was achieved' was detected in 6 out of 10 studies.<sup>14-15,24-27</sup> This criterion was considered quite important, and if not thoroughly explained it was not scored.

Additionally, 'criterion 5/ allocation' was read in 9 out of 10 studies.<sup>11-13,15,24-28</sup> Randomization was thoroughly explained when appropriate, and when not scored it was obvious.

Further, 'criterion 6/ drop-out rates' was found in 4 out of 10 studies.<sup>11,15,25,27</sup> Unfortunately, much explanations and rates missed, thus not providing enough ideas on the real application of the intervention.

Also, 'criterion 7/ demographics' was appropriately placed in 9 out of 10 studies.<sup>11-15,24-27</sup> Demographics were thoroughly explained when appropriate and when excluded they were not much harmful for the outcome.

In retrospect, 'criterion 8/ effect size' was marked in 7 out of 10 studies.<sup>11-12,24-27</sup> The effect size was included in most papers, however probably due to failure of most interventions or because it was small, it was not found in some papers.

Furthermore, 'criterion 9/ benefits and harms' was spotted in 6 out of 10 studies.<sup>11,13,15,26-28</sup> Benefits and harms in most cases were thoroughly explained, while in cases where it was not met the language was not explicatory but rather confusing.

Last but not least, criterion 10 'baseline and follow-up data' was seen in 9 out of 10 studies.<sup>11-15,24-28</sup> This criterion enabled the outcome to be shown accurately and when it was not met it was qualitatively explained that the smoking results were not significant.

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Finally, all criteria met in all papers can be found in Table 3.

## DISCUSSION

### Summarizing the Findings

Considering TTM and TPB on smoking cessation, the sum of findings indicates that the higher quality model is TPB. After applying the marking criteria on the quality of the studies the mean score for TPB was found at 7.2 out of 10, while for TTM was 6.8 out of 10. Additionally, none of TTM interventions were affective to smoking cessation -0 out of 5-, and only one of TPB ones -1 out of 5.

### Synthesis of the Findings

To begin with, in Aveyard et al.<sup>11</sup> study the authors presented that the TTM intervention increased the likelihood for the pregnant women to proceed quitting smoking and retain that idea 30 weeks after the intervention. This may be due to the key elements of TTM. To explain TTM is a method that uses stages of change.<sup>4</sup> In this case pregnant women had a cognitive arousal for quitting smoking and doing so by registering in the study meeting the criteria/stages of TTM between pre-contemplation and action.<sup>4</sup> However, the outcome of the study shows that they did not quit smoking; consequently, they may fit in the relapse stage or still being in the action phase fighting against their cravings and relapses. According to a recent systematic review and meta-analysis<sup>34</sup>, it is shown that quitting smoking during pregnancy includes many predictors and it is more complicated that it was thought. These factors include education, income, quality of support or otherwise empathy and personal support, social support on community and public domains, physical and mental health. These factors are not explained accurately in TTM.<sup>3-4</sup> Rather, the people who deliver the intervention have to have the competencies and the background to understand and synthesize unique interventions for each person.<sup>35</sup>

The same rationale and critique concern Lawrence et al.,<sup>14</sup> study. It is quite likely that Aveyard et al.,<sup>11</sup> study used the database that Lawrence et al.,<sup>14</sup> used from two recruitment stages firstly between 1998 and 2001 and secondly from 1999 and 2000, since the population and the design are identical. However, Lawrence et al.,<sup>14</sup> stated that TTM intervention was deliv-

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ered by midwives, as exactly explained in Aveyard et al.<sup>11</sup> study, and from other pregnant women which was not mention in Aveyard et al.<sup>11</sup> study. In this case the issue concerns in both studies that the delivery was not made by professionals, but rather by people who were trained 2 days for the delivery. The main idea is that throughout the delivery the non-professionals may have been not trained to deliver any behavioral change techniques which might had been important for the final outcome.<sup>36</sup>

In contrast to the two studies above, in Li et al.<sup>15</sup> the intervention outcome of the study was that 12 months after the intervention there was no improvement on smoking cessation. However, the results of the study are supported from other studies<sup>37-41</sup> in which smoking cessation has been discussed to be quite challenging since in patient and pregnant populations smokers consider their lifestyle habits healthy although there is an opposite case.

Similarly, in Huang et al.<sup>13</sup> study when pregnant women and mothers of less than 3-year-olds were compared with the control group after 2-week telephone intervention by nurses it was found that there was no significant change between the stages of change in TTM model. This finding is supported by Aveyard et al.<sup>11</sup> and Lawrence et al.<sup>14</sup> study that were included in the review as well as by the idea that the population was already been a smoker long after pregnancy was announced<sup>41</sup> such as in Aveyard et al.<sup>11</sup> and Lawrence et al.<sup>14</sup>

The only outcome that was presented significant in this review was found in De Silva et al.<sup>12</sup> study. The population was not related to any health condition, but only on being smokers. More specifically, undergraduate students in Malaysia were invited and included in the two control groups. The rationale of the study was to test if a brief up to 3 minutes TTM intervention on smoking harms would raise enough awareness to allow the participants from pre-contemplation stage to reach action by registering themselves in a quit smoking line program. The authors conducted that 6 months after the intervention the difference was significant since more than half participants in the intervention group were registered into the program in contrast to none from the control. This finding is also supported by other studies in which a brief in person intervention in Pilafas et al.

creased the likelihood to lead to some awareness and action in contrast to computerized and text messaging interventions.<sup>42-44</sup> This may provide some thoughts regarding social dynamics in smoking cessation.

To highlight the key findings for the TTM based interventions in all studies considered in the review, it is shown that TTM based interventions are not likely to stop smoking. However, several concerns have risen. Firstly, it is quite unlikely to help patients with type-2-diabetes to activate themselves to stop smoking.<sup>15</sup> This may be a reasonable result since before the intervention they were already that smoking harms and worsen their condition and they had already had a conscious decision on not quitting it. The same rationale follows with pregnant women who decided not to make an effort on quitting smoking by the time they were announced pregnant.<sup>13</sup> Retrospectively the same happened with mothers of less than 3 year olds who accordingly made the decision not quitting it before delivering the baby.<sup>13</sup> Secondly, an important finding in TTM based intervention is that TTM intervention is not more or less successful when it is delivered by non-professional and experts as in the case of midwives in Aveyard et al.<sup>11</sup> and Lawrence et al.<sup>14</sup> studies when compared to fully equipped professionals such as registered nurses and counseling nurses in Huang et al.<sup>13</sup> and Li et al.<sup>15</sup> studies. In addition, TTM based intervention was found ineffective on smoking cessation in clinical population and pregnant women<sup>11,13-14</sup> while it was found affective enough on a male non-clinical university population to proceed to 'action stage'.<sup>12</sup> This outcome might have implication on health condition, or in other words it might be much promising to try quitting in order to prevent serious conditions in contrast of quitting for not worsening the already existing ones. Otherwise it might be related to age which again gives some thoughts on preventing for lifespan conditions. Unfortunately, the societal part of smoking and the role of social norms and social dynamics were indeed not at all explained in any paper. TTM interventions were mostly designed on individual health and almost ignored critiques in which smoking is thought to have much social aspects.<sup>42-44</sup> On this aspect, TPB interventions may provide some answers.

To begin with, in Lakerveld et al.<sup>26</sup> study randomly assigned

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participants with high risk of type-2-diabetes and cardiovascular disease in the Netherlands showed no significant difference after 2 year from a TPB based intervention. Twelve 30-minute interventions were delivered by nurses who were trained by licensed psychologists using the TPB model, motivational interviewing and problem-solving treatment. In this study there was also targeted to increase physical activity and adaptation of healthier diet which were as well not achieved. The enhancement of social aspect in this study was not found in Li et al.<sup>15</sup> diabetic patients in Hong Kong in TTM, consequently it might be unlikely that the social and motivational aspect in change of health behavior may lead to smoking cessation in clinical and highly prospective clinical populations.

Another TPB study included in the review is the Neil-Sztramko et al.<sup>27</sup> trial in which non cancer Canadians above 40 years old were randomly allocated. The intervention group received a 12-week online TPB intervention based on cancer prevention acknowledgments regarding physical exercise, healthy diet, alcohol drinking and smoking. The outcome of the study, 3 months post intervention, showed no significant differences on smoking cessation. The outcome was in contrast to studies that presented that social online sources are likely to improve health behaviors in older adults.<sup>45-48</sup>

In contrast to Neil-Sztramko et al.,<sup>27</sup> trial on older adults, younger participants in Epton et al.<sup>24</sup> study using a mobile app on physical health had a significant effect. To elaborate, the intervention group downloaded a mobile app in which physical health advice based on TPB was sent to them regarding physical activity, alcohol drinking, healthy eating and smoking. 6 months post intervention smoking habits had been significantly been reduced. The idea of young people using technology for health promotion was introduced in Webb et al.<sup>49</sup> study.

However, when Hassandra et al.<sup>25</sup> used a new mobile app on physical health advice based on TPB regarding physical activity, alcohol drinking, healthy eating and smoking to 44 regular smokers to manage their cravings it was found that there were no significant differences after the intervention. Participants received 57 messages on cigarette poisoning, 49 on motivation and 64 on physical activity. The insignificance of messages refers back to the bibliography of TTM in which studies theorized Pilafas et al.

that in person intervention increased awareness and action in contrast to computerized and text messaging interventions.<sup>42-44</sup> Indeed, in two studies the results were significant; however, it was unknown if that would apply on using a mobile app.<sup>50-51</sup>

The last TPB paper concerns an intervention in China.<sup>28</sup> 207 10<sup>th</sup> grade high school students were randomly allocated. It is noteworthy that the study does not make clear if the students were smokers, or the intervention aimed on the prevention of any smoking behavior. The intervention was designed based on TPB models for reducing smoking in high school populations.<sup>52-53</sup> The intervention lasted one week in which four 40-minute sessions took place. 6 months later it was found that the intervention was not significant on intention and willingness of smoking behavior, in contrast to theoretical background that supported that would be a change in behavior<sup>54</sup>, since TPB was found to reduce significantly high-school stress and social influence for not stopping smoking.<sup>55-57</sup>

Considering all studies included for TPB, the obvious conclusion to be drawn is that TPB intervention worked only in one study.<sup>24</sup> It was shown that it was not effective to people in high likelihood of developing type-2-diabetes and cardiovascular disease<sup>26</sup> as well as in healthy older adults through a mobile app.<sup>27</sup> However, mobile app did increase smoking cessation in a healthy undergraduate population.<sup>24</sup> The same result was not found for high school students in China who received an in person intervention.<sup>28</sup> Unfortunately, there was no study on healthy adults who received in person intervention, since mobile apps might be more acceptable to younger non-clinical population and in person interventions to older non-clinical people.

Finally, comparing TTM and TPB interventions, it was found in this review that both are equally effective on smoking cessation since only one intervention for each model had a significant alteration in the smoking behavior. For both models this was found in late adolescences –first year undergraduate students. What is equally important to highlight was that both model failed to change smoking behavior in clinical populations, or people in high likelihood of developing type-2-diabetes and cardiovascular disease.<sup>26</sup> Much criticism has arisen for TTM considering that the model does not cover social parts of be-



haviors, while concerns about TPB discuss the elements of the method can swift very quickly due to high social origin of the method. It would have been interesting if an intervention would had combined TPB and use TTM in order to make the social structure more concrete and durable in time, or the five stages.

### Limitations

The main limitation –known as ‘publication bias’- is that papers that shown significant differences between the intervention and control groups are more likely to get published in contrast to studies that show no -or even adverse- results.<sup>58</sup> Still, it is noteworthy that almost all studies -9 out of 10- included were not significant in smoking cessation. It is likely that the review would have included more non-significant interventions.

### CONCLUSION

The present systematic review tested the efficacy of two change-of-behavior models, TTM and TPB, on smoking cessation. After the application of 10 criteria on 10 RCTs -5 for TTM and 5 for TPB published from 2003 to 2019-, it was found that TPB average score was slightly higher than the relevant score for TTM model -7.2 against 6.8 out of 10. TPB was found most effective on smoking since 1 out of 5 studies showed effective results, in contrast to none out of 5 TTM interventions. It would have been interesting if a future RCT study would combine TPB and TTM against smoking to test if the social structure would be more concrete and durable in time through the five stages.

### CONFLICTS OF INTEREST & DECLARATIONS

All authors declare no conflict of interest. Furthermore, the study received no funding by any source.

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The present work is dedicated to Mrs. Annita Patrikiadou, who quitted smoking after 35 years of daily intensive tobacco use. Her achievement in real life tells us that smoking cessation is not impossible.

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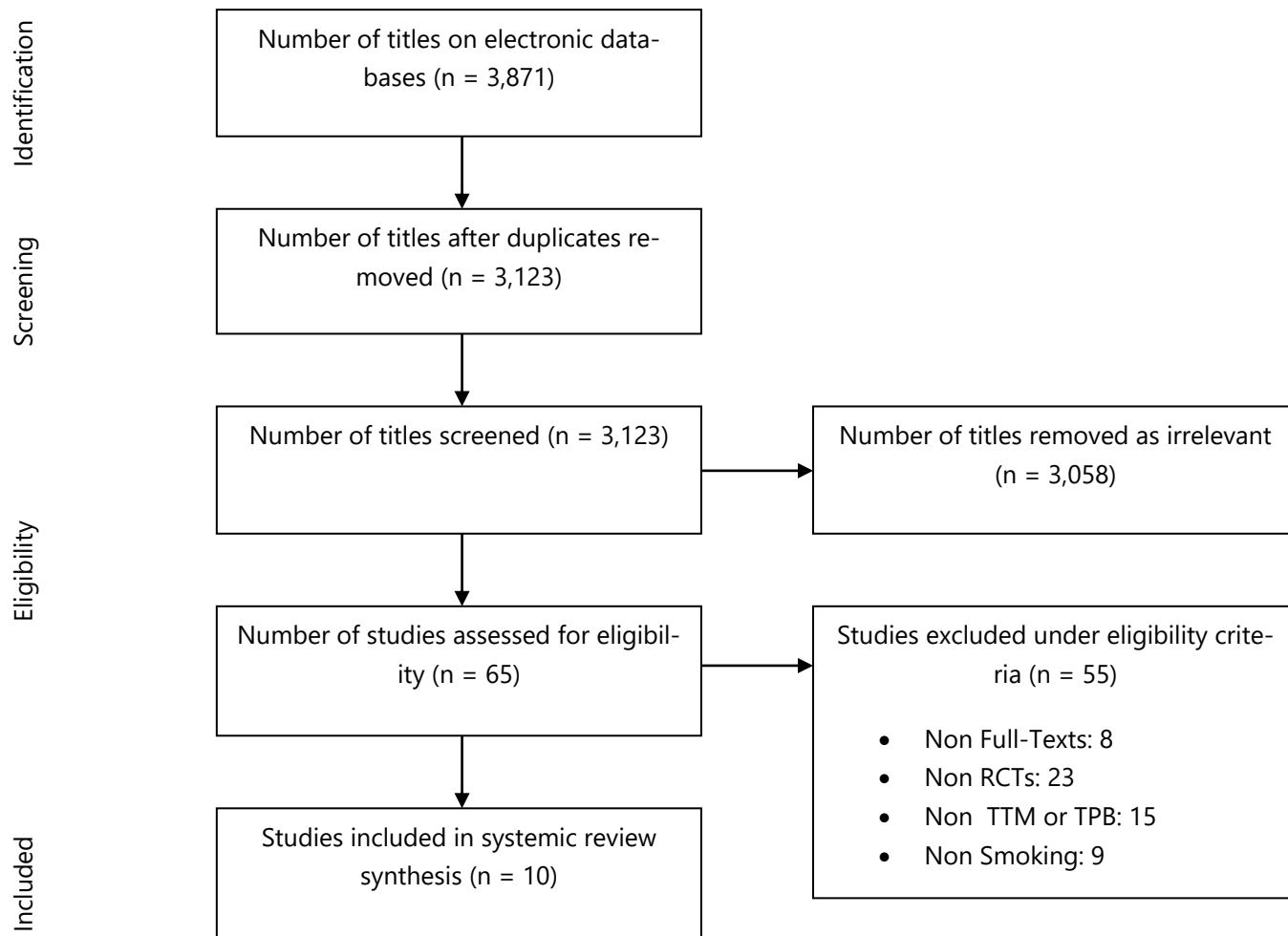
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## ANNEX

**FIGURE 1.** Flow Diagram based on PRISMA guidelines for systematic reviews (see Moher et al., 2009)

**TABLE 1.** Framework for Systematic Review Questions. PICO table.

<b>P</b> (Population)	<b>I</b> (Intervention)	<b>C</b> (Comparative Intervention)	<b>O</b> (Outcome)
General Population	TTM or TPB	Control group	Smoking



**TABLE 2.** APICO table for systematic review

<b>A</b> (Author/s)	<b>P</b> (Population)	<b>I</b> (Intervention)	<b>C</b> (Comparative Intervention)	<b>O</b> (Outcome)
Aveyard et al., 2006	918 pregnant women smokers in the UK	TTM delivered by non-expert midwives and other pregnant women	Control group	Failed / Measurements: unknown
De Silva et al., 2016	80 first year undergraduate male students in Malaysia	TTM brief information (less than 3 min) on negative outcomes of smoking	Control group	Unknown, intervention group registered for 'action phase' / Measurements: how many where registered to the 'Quit Line Smoking'
Huang et al., 2013	355 pregnant women and mother of children younger than 3 years old from 4 Taiwanese hospitals	TTM education program and counseling delivered by registered nurses	Control group	Failed/ Measurements: newly designed questionnaire on TTM and Self-Efficacy
Lawrence et al., 2003	918 pregnant women who smoked for at least 10 weeks before recruitment from West Midlands in the UK	TTM delivered by non-expert by non-expert midwives.	Control group	Failed/ Measurements: unknown
Li et al., 2017	557 patients with type-2-diabetes who smoked from 9 major hospitals in Hong Kong	TTM 30-45 minute intervention	Control group	Failed/ Measurements: unknown
Epton et al., 2014	1,445 prospective undergraduate university students at Sheffield University in the UK	TPB mobile app 'U@Uni'	Control group	Successful on quitting/ Measurements: short form International Physical Activity Questionnaire (IPAQ-SF) and 'Health Survey for England' variables on smoking (unknown questionnaire)
Hassandra et al., 2017	44 regular smokers from a community health care unit in Finland	TPB mobile app 'mHealth, PhoS'	Control group	Failed/ Measurements: System Usability Scale (SUS) and International Physical Activity Questionnaire (IPAQ)
Lakerveld et al., 2013	622 participants with high risk of type-2-diabetes and cardiovascular disease from the Netherlands	TPB based intervention by professionals	Control group	Failed/ Measurements: Activity Questionnaire for Adolescents & Adults (AQuAA)
Neil-Sztramko et al., 2019	557 non cancer participants above 40 years old in Canada	TPB 12 week online intervention	Control group	Failed/ Measurements: Tobacco Questions for surveys tool by WHO
Zhao et al., 2019	207 10 <sup>th</sup> grade high school students in China	TPB based counseling, 4 cessation	Control group	Failed/ Measurements: newly designed questionnaire properly explained

**TABLE 3.** Scoring table of the final RCTs included.

Authors	Criterion										Score
	1	2	3	4	5	6	7	8	9	10	
Aveyard et al., 2006	✓				✓	✓	✓	✓	✓	✓	<b>7</b>
De Silva et al., 2016	✓	✓			✓		✓			✓	<b>5</b>
Huang et al., 2013	✓	✓	✓		✓		✓		✓	✓	<b>7</b>
Lawrence et al., 2003	✓		✓	✓			✓	✓		✓	<b>6</b>
Li et al., 2017	✓		✓	✓	✓	✓	✓	✓	✓	✓	<b>9</b>
Epton et al., 2014	✓	✓		✓	✓		✓	✓		✓	<b>7</b>
Hassandra et al., 2017	✓	✓		✓	✓	✓	✓	✓			<b>7</b>
Lakerveld et al., 2013	✓	✓		✓	✓		✓	✓	✓	✓	<b>8</b>
Neil-Sztramko et al., 2019	✓	✓		✓	✓	✓	✓	✓	✓	✓	<b>9</b>
Zhao et al., 2019		✓	✓		✓				✓	✓	<b>5</b>