The European Journal of Public Health, Vol. 27, No. 1, 129–134

doi:10.1093/eurpub/ckw105 Advance Access published on 24 July 2016

External validation of the Motivation To Stop Scale (MTSS): findings from the International Tobacco Control (ITC) Netherlands Survey

Karin Hummel[1], Jamie Brown[2], Marc C. Willemsen[1,3], Robert West[4], Daniel Kotz[4,5,6]

1 Department of Health Promotion, CAPHRI School for Public Health and Primary Care, Maastricht University, Maastricht, The Netherlands
2 Research Department of Clinical, Educational and Health Psychology, University College London, London, UK
3 Dutch Alliance for a Smokefree Society, The Hague, The Netherlands
4 Cancer Research UK Health Behaviour Research Centre, University College London, London, UK
5 Institute of General Practice, Medical Faculty of the Heinrich-Heine-University Düsseldorf, Düsseldorf, Germany
6 Department of Family Medicine, CAPHRI School for Public Health and Primary Care, Maastricht University, Maastricht, The Netherlands

Correspondence: Karin Hummel, Department of Health Promotion, CAPHRI School for Public Health and Primary Care, Maastricht University, P. Debyeplein 1, 6229 HA Maastricht, The Netherlands, Tel: +31 43 388 2400, Fax: +31 43 367 1032, e-mail: karin.hummel@maastrichtuniversity.nl

Background: The Motivation To Stop Scale (MTSS) is a single-item instrument which has been shown to predict quit attempts in the next 6 months in a previous validation study conducted in England. The aim of the current study was to determine the external validity of the MTSS among Dutch smokers in predicting quit attempts in the next 12 months. A secondary aim was to compare the discriminative accuracy of the MTSS with that of a Stages of Change assessment. **Methods:** We analysed data from three consecutive waves of the International Tobacco Control (ITC) Netherlands Survey ($n = 1272$). We conducted logistic regression analyses with the baseline score of the MTSS (measured in 2012 or 2013) predicting a quit attempt in the next 12 months (measured in 2013 or 2014). We furthermore compared the area under the Receiver Operating Characteristics (ROC_{AUC}) curves of the MTSS and a Stages of Change measure. **Results:** A total of 450 smokers (35.4%) made a quit attempt between baseline and 12-month follow-up. The regression analysis showed a positive relationship between scoring on the MTSS and quit attempts (odds ratio = 18.15, 95% confidence interval = 8.12–40.58 for the most vs. least motivated group). The discriminative accuracy of the MTSS ($ROC_{AUC} = 0.68$) was marginally higher than that of a Stages of Change assessment ($ROC_{AUC} = 0.65$), but not statistically significant ($P = 0.21$). **Conclusion:** The MTSS is an externally valid instrument to predict quit attempts in the next 12 months.

Introduction

Previous research has shown that intention to quit smoking is one of the most important predictive markers of future quit attempts.[1–3] There are additional factors that play a role in predicting quit attempts, including beliefs that one should stop or motivation-related indicators like enjoying smoking.[4–6] Previous studies used different ways to establish these predictive relationships.[7–9] It is important to have one valid instrument to measure the motivation to quit smoking which can be applied in various studies. In recognition of this need, the Motivation To Stop Scale (MTSS) was developed and internally validated.[10]

The MTSS is a 7-level single-item instrument which incorporates intention, desire and belief to quit smoking.[10] This instrument was developed for use in large scale tracking surveys by R.W. in collaboration with the English Department of Health and Central Office of Information, and is based on the PRIME Theory.[10,11] An important aspect of the MTSS is that it combines these different concepts and is therefore cost-effective compared with other instruments which split them into separate items. The initial validation study of the MTSS was conducted with data from the 'Smoking Toolkit Study', an ongoing monthly household survey in England using computer-assisted face-to-face interviews.[12] This study showed a strong linear association between the response categories of the MTSS and quit attempts in the next 6 months. However, the instrument requires external validation before it can be applied with confidence in future research. Such external validation should take place using independently collected data from a different setting than used to develop and internally validate the instrument.[13] We therefore used data from the International Tobacco Control (ITC) Netherlands Survey for the present study.[14] The ITC Netherlands Survey follows a longitudinal cohort design in which smokers and quitters are surveyed each year using computer-assisted web interviews. The most important differences between the studies are therefore the study populations (Dutch instead of English smokers), the survey mode (web instead of face-to-face interviews) and the length of follow-up (12 months instead of 6 months). Furthermore, as the MTSS was translated into Dutch for the present study, it was tested whether it would perform comparably in a different language than the one it was developed. The MTSS does not include any country- or culture-specific elements. Therefore, no differences in scoring on the MTSS as a function of culture were expected.

Another measure of motivation which has been frequently applied in smoking cessation studies is the 'Stages of Change'.[15] A PubMed search ('Stages of Change' AND 'smok*') yielded >360 publications. The Stages of Change is based on the Transtheoretical Model (TTM)[16] and was primarily developed to tailor interventions to respondents in each stage specified by the model. However, the Stages of Change is also often used as an indicator of intention to quit smoking. For this, smokers are allocated into one of three stages: (i) not planning to quit (precontemplation), (ii) planning to quit within the next 6 months, but not within the next 30 days (contemplation) or (iii) planning to quit within the next 30 days (preparation).[17] While it is often used, previous research indicated that the validity of the Stages of Change is not very well established. For example, the stages do not seem to be distinct categories, different

algorithms to form the stages exist which have not been compared empirically, and they underestimate the motivation to quit smoking in comparison with other measures of motivation.[18–21] It would be useful to assess the validity of the Stages of Change in predicting future quit attempts and to compare it with the MTSS.

The primary aim of this study was to investigate the predictive validity of the MTSS in a different language and setting and over a longer time interval than in the initial validation study. In addition, we aimed to compare the accuracy of the MTSS and the Stages of Change in discriminating between smokers who did and who did not attempt to stop during follow-up.

Methods

Design and sample

Data were collected by the longitudinal ITC Netherlands Survey.[14] Dutch smokers aged 16 years and older were selected from a probability-based web database.[22] Participants were classified as smokers if they had smoked at least 100 cigarettes in their lifetime and were currently smoking cigarettes at least monthly. We used data from three survey waves: wave 6 (2012), wave 7 (2013) and wave 8 (2014). Respondents who were lost to attrition were replenished by recruiting new respondents from the same database.[23] Drop-out of smokers between wave 6 and wave 8 was 31.4%, and younger smokers were more likely than older smokers to drop out of the sample.

Respondents were included into the analyses if they were smoker and answered the MTSS question (see below) in wave 6 and the quit attempt question (see below) in wave 7 ($n = 215$), or if they were smoker and answered the MTSS question in wave 7 and the quit attempt question in wave 8 ($n = 1057$). The MTSS was added only to the replenishment survey of wave 6; therefore, the sample which could be included from this wave was smaller. In wave 7, the MTSS was administered to the whole sample (recontact and replenishment). These groups were combined into one sample ($n = 1272$).

Measurements

Quit attempt

All smokers were asked: 'Have you made any attempts to stop smoking in the last year?' (yes/no). We used data from this question from wave 7 and wave 8.

MTSS

The MTSS was initially developed and validated in English.[10] To apply it to the ITC survey, it was translated into Dutch independently by three tobacco research experts who are skilled in both languages (see Supplementary table S1 for the Dutch translation). Inconsistencies in the translation were discussed until consensus was reached.

To assess the motivation to stop smoking, smokers in wave 6 and wave 7 were asked: 'Which of the following describes you?' Response options were: (i) 'I don't want to stop smoking', (ii) 'I think I should stop smoking but don't really want to', (iii) 'I want to stop smoking but haven't thought about when', (iv) 'I REALLY want to stop smoking but I don't know when I will', (v) 'I want to stop smoking and hope to soon', (vi) 'I REALLY want to stop smoking and intend to in the next 3 months' and (vii) 'I REALLY want to stop smoking and intend to in the next month'. This ordering reflects: (i) absence of any belief, desire or intention, (ii) belief only, (iii) moderate desire but no intention, (iv) strong desire but no intention, (v) moderate desire and intention, (vi) strong desire and medium-term intention and (vii) strong desire and short-term intention.[10]

Stages of Change

An assessment of the Stages of Change was measured in wave 6 and wave 7 by asking smokers: 'Are you planning to quit smoking…' with four response categories: (i) 'within the next month', (ii) 'within the next 6 months', (iii) 'somewhere in the future, beyond 6 months' and (iv) 'no, never'. This question was combined with the question whether smokers had made a quit attempt in the previous year to define the Stages according to the most recent algorithm published by the founders of the TTM.[24,25] Smokers who chose the first response option and had made a quit attempt in the previous year were categorised into the preparation stage of the TTM. Smokers who chose the first option but made no previous quit attempt were classified into the contemplation stage, as were smokers who chose the second response option. Smokers who chose the third and fourth option were classified into the precontemplation stage.

Covariates

Covariates were age, sex, monthly gross household income, level of completed education, daily vs. occasional smoking status, and the Heaviness of Smoking Index (HSI).[26] Age was categorised into: 16–24 years, 25–39 years, 40–54 years, and 55 years and older. Monthly household income was categorised into three levels: low (< 2000 euro), moderate (2000–3000 euro) and high (> 3000 euro). Respondents who did not answer the income question ($n = 390$) were recorded in a separate category. Completed education was categorised into three groups: low (primary education and lower pre-vocational secondary education), moderate (middle pre-vocational secondary education and secondary vocational education) and high (senior general secondary education, (pre-) university education and higher professional education). The HSI was used as indicator of the level of nicotine dependence. This index is the sum of the categorised number of cigarettes smoked per day and the time to the first cigarette of the day.[26] The HSI ranges from 0 to 6, with a higher score indicating higher nicotine dependence.

Analyses

We tested differences between mean scores on the MTSS among socio-demographic subgroups using one-way analyses of variance (ANOVA) with Tukey HSD *post hoc* tests. Next, we determined the predictive validity of the MTSS on making a quit attempt in the next 12 months. We did this first with a χ^2 test for a linear-by-linear association between the MTSS and making a quit attempt, and second with simple as well as multiple logistic regression analyses. We adjusted the multiple regression analysis for age, sex, income, education, smoking status and HSI. We also adjusted for the time a respondent participated in the cohort because previous research has shown that responses can vary as a function of time in sample.[27] We calculated the area under the Receiver Operating Characteristics (ROC_{AUC}) curves for the MTSS and the Stages of Change to assess the discriminative accuracy. For the primary comparison, we applied the most recently published algorithm which includes previous quit behaviour to form the Stages of Change. A sensitivity analysis without previous quit behaviour and without combining response categories of the Stages of Change question was performed because previous studies frequently used algorithms subdividing the precontemplation stage and without previous quit behaviour.[28–31] We separately tested differences between the ROC_{AUC} of the MTSS and the ROC_{AUCs} of both assessments of the Stages of Change by using the DeLong test.[32]

Missing values ('refused' or 'don't know') occurred for education ($n = 11$, 0.9%), HSI ($n = 71$, 5.6%) and Stages of Change ($n = 95$, 7.5%). Respondents who chose these response options were excluded from the multiple regression analysis, resulting in a sample size of 1192 smokers for this analysis. All analyses were conducted with SPSS version 20.0, except for the comparison of the ROC_{AUCs} which was done using R.[33]

Ethics

The surveys were cleared for ethics by the Research Ethics Board of the University of Waterloo and the Central Committee on Research Involving Human Subjects in the Netherlands.

Results

Sample description

The baseline characteristics of the 1272 included smokers are displayed in table 1. Comparing the Dutch ITC sample with the English sample from the Smoking Toolkit Study,[10] respondents were similar with respect to socio-demographic and smoking-related characteristics, but differed regarding their scores on the MTSS. Almost one-third of the smokers ($n = 402$, 31.6%) in our sample stated that their motivation to stop was at level 2 ('I think I should stop smoking but don't really want to'), whereas most smokers in the initial validation study answered the MTSS question with level 4 ('I REALLY want to stop smoking but don't know when I will', 23.8%) or level 1 ('I don't want to stop smoking', 20.7%). In the current study, 6.8% ($n = 86$) of smokers scored the two highest levels of motivation, while this was 18% in the Smoking Toolkit Study.

Smokers from the Smoking Toolkit Study were significantly more motivated to quit smoking (mean MTSS score = 3.63, SD = 1.97) than smokers from the ITC sample (mean MTSS score = 2.88, SD = 1.55), $t(3143.05) = 12.75$, $P < 0.001$. Three-quarter of smokers ($n = 883$) in our sample were categorised into the precontemplation Stage of Change.

Table 2 shows the mean MTSS scores for the different socio-demographic subgroups. *Post hoc* tests revealed that smokers aged 25–39 years were more motivated to stop smoking than smokers of the other age groups. Low-educated smokers were less motivated to quit than smokers with a moderate or high educational background.

Table 1 Baseline characteristics of included smokers ($n = 1272$)

	Included smokers
Sex	
Male, % (*n*)	51.4 (654)
Age group, % (*n*)	
16–24 years	22.2 (282)
25–39 years	26.7 (340)
40–54 years	29.0 (369)
55 years and older	22.1 (281)
Education, % (*n*)	
Low	27.9 (352)
Moderate	46.0 (580)
High	26.1 (329)
Income, % (*n*)	
Low	21.7 (276)
Moderate	18.3 (233)
High	29.3 (373)
Not reported	30.7 (390)
Daily smoker, % (*n*)	90.6 (1153)
Heaviness of Smoking Index, mean (SD)	2.3 (1.5)
MTSS score, % (*n*)	
1: 'I don't want to stop smoking'	18.7 (238)
2: 'I think I should stop smoking but don't really want to'	31.6 (402)
3: 'I want to stop smoking but haven't thought about when'	18.1 (230)
4: 'I really want to stop smoking but I don't know when I will'	16.3 (207)
5: 'I want to stop smoking and hope to soon'	8.6 (109)
6: 'I really want to stop smoking and intend to in the next 3 months'	3.3 (42)
7: 'I really want to stop smoking and intend to in the next month'	3.5 (44)
Stage of Change, % (*n*)	
Precontemplation	75.0 (883)
Contemplation	21.3 (251)
Preparation	3.7 (43)

Performance of the MTSS

A total of 450 smokers (35.4%) had made a quit attempt between baseline and 12-month follow-up. Figure 1 presents the percentage of smokers who made a quit attempt, stratified by their baseline MTSS score. Comparable to the initial validation study, the MTSS showed a linear increase: smokers with higher baseline MTSS scores tended to be more likely to have made a quit attempt (linear-by-linear association: $\chi^2(1) = 127.154$, $P < 0.001$). More smokers who scored level 5 ('I want to stop smoking and hope to soon') than level 6 ('I REALLY want to stop smoking and intend to in the next 3 months') of the MTSS made a quit attempt in the present study, but this difference was not statistically significant ($\chi^2(1) = 0.831$, $P = 0.36$). Smokers scoring level 6 were still more likely to make a quit attempt than smokers scoring level 4 ('I REALLY want to stop smoking but I don't know when I will').

Table 3 shows the unadjusted and adjusted associations between scoring on the MTSS and making a quit attempt in the next 12 months. In both analyses, the odds to make a quit attempt tended to increase with increasing motivation. For example, the odds ratio of making a quit attempt was 18.15 [95% confidence interval (CI) = 8.12–40.58] for the most vs. least motivated group in the unadjusted analysis. The linear relationship between scoring on the MTSS and making a quit attempt can also be seen in the log transformation of the adjusted odds ratios in Supplementary figure S1.

Table 2 Mean MTSS scores among socio-demographic subgroups (range: 1 = low motivation to stop, 7 = high motivation)

	Mean (SD) MTSS score	Group differences
Sex		
Male	2.9 (1.6)	
Female	2.9 (1.5)	$F(1)=0.17$, $P=0.68$
Age group		
16–24 years	2.8 (1.4)	
25–39 years	3.2 (1.7)	
40–54 years	2.8 (1.5)	
55 years and older	2.7 (1.6)	$F(3)=5.06$, $P<0.01$
Education		
Low	2.7 (1.5)	
Moderate	3.0 (1.5)	
High	3.0 (1.6)	$F(2)=5.26$, $P<0.01$
Income		
Low	2.8 (1.6)	
Moderate	2.9 (1.6)	
High	3.0 (1.6)	
Not reported	2.8 (1.5)	$F(3)=1.12$, $P=0.34$

Comparison of the MTSS with the Stages of Change

Three ROC curves were calculated to investigate the accuracy of the MTSS and two Stages of Change measures (Supplementary figure S2). The MTSS discriminated between smokers who made any vs. no quit attempt with an ROC_{AUC} of 0.68 (95% CI = 0.65–0.71), which is comparable to the ROC_{AUC} of the MTSS in the Smoking Toolkit Study (0.67). The ROC_{AUC} of the Stages of Change using the latest published algorithm including previous quit behaviour and combining two response categories was 0.65 (95% CI = 0.62–0.69). The ROC_{AUC} of the Stages of Change using the most frequently used algorithm without previous quit behaviour and without combining response options was 0.68 (95% CI = 0.65–0.71). The ROC_{AUC} of the MTSS did not differ significantly from the ROC_{AUCs} of both measures of the Stages of Change ($P = 0.21$ and $P = 0.82$, respectively).

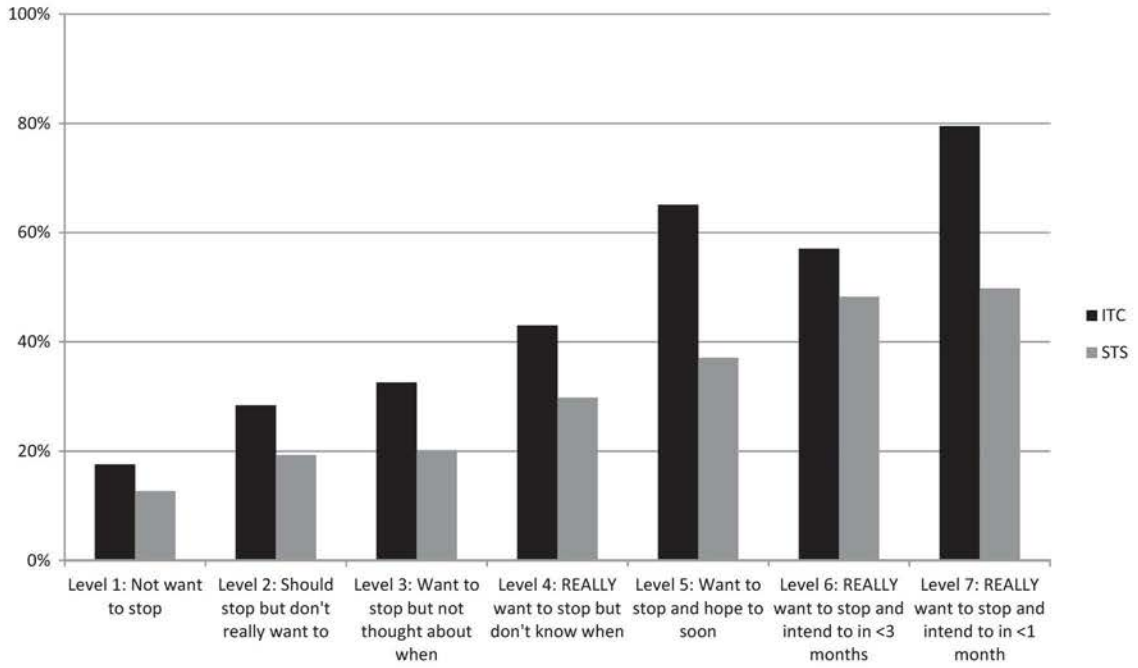

Figure 1 Percentage of smokers who made a quit attempt in the next 12 months in the current Dutch sample [International Tobacco Control (ITC) Survey; black bars] and in the next 6 months in the initial English validation sample [Smoking Toolkit Study (STS); grey bars], stratified by MTSS score

Table 3 Odds ratio (OR) and adjusted odds ratio (aOR[a]) of making a quit attempt in the next 12-month follow-up (any vs. none) for the various levels of motivation

Level of motivation at baseline	OR (95% CI) (n =1272)	aOR[a] (95% CI) (n =1192)
1: 'I don't want to stop smoking'	1.00	1.00
2: 'I think I should stop smoking but don't really want to'	1.85 (1.24–2.75)	1.71 (1.13–2.57)
3: 'I want to stop smoking but haven't thought about when'	2.26 (1.47–3.48)	2.00 (1.27–3.14)
4: 'I really want to stop smoking but I don't know when I will'	3.52 (2.29–5.42)	3.34 (2.14–5.22)
5: 'I want to stop smoking and hope to soon'	8.72 (5.21–14.61)	7.65 (4.45–13.14)
6: 'I really want to stop smoking and intend to in the next 3 months'	6.22 (3.10–12.48)	5.78 (2.77–12.07)
7: 'I really want to stop smoking and intend to in the next month'	18.15 (8.12–40.58)	14.15 (5.93–33.77)

[a]OR adjusted for age, sex, income, education, Heaviness of Smoking Index, daily vs. occasional smoking status, and time in sample.

Discussion

We conducted an external validation study of the MTSS to investigate its usefulness in predicting quit attempts in the next 12 months in a sample of Dutch smokers. In addition, we compared the MTSS with two assessments of the Stages of Change, another frequently used instrument to measure smokers' intention to quit.[15] The MTSS showed a linear increase in the percentage of smokers who made a quit attempt with increasing motivation and also increasing odds to make a quit attempt.

An unexpected finding was that the percentage of smokers who scored level 6 of the MTSS ('I REALLY want to stop smoking and intend to in the next 3 months') and subsequently made a quit attempt was slightly lower than that of smokers scoring level 5 ('I want to stop smoking and hope to soon') in our sample. A possible explanation for this is that respondents understood these response categories in a different way than expected and differently than in the original English version. For example, smokers may have interpreted level 5 as being sooner in time than level 6, resulting in a higher probability to make a quit attempt. It is also possible that smokers who scored level 5 were actually more motivated than smokers who scored level 6, but that those smokers were reluctant to make a commitment when exactly they will quit as stated in level 6. Future research using the Dutch version of the MTSS should take this into consideration and possibly examine the underlying reasons for this unexpected pattern. Another possible explanation is the smaller sample size of our study compared with the initial validation study. Smokers were categorised into one of seven MTSS groups and some of these were quite small in our sample. Future studies with a larger sample could be used to compare the patterns.

We furthermore found some subgroup differences in scores on the MTSS. Smokers aged 25–39 years were more motivated to quit compared with the other age groups, and smokers with a low educational background were less motivated than smokers with a high or moderate education. Previous studies about subgroup differences in motivation to quit found mixed results.[34–36]

The discriminative accuracy of the MTSS was as good as or marginally better than the two different assessments of the Stages of Change. An advantage of the MTSS is that the distribution of its scores was more towards normal than that of both measures of the Stages of Change; three-quarters of smokers in our sample were allocated into the precontemplation stage. Furthermore, the Stages of Change categorises smokers into three or four groups while the MTSS has seven groups. This means that the MTSS can distinguish subgroups of smokers more sensitively than the Stages of Change.

However, survey instruments should ideally be tested and compared using several methods. Future research should focus on other validation tests in addition to predictive validity for different instruments that measure motivation to quit smoking.

Smokers from our sample scored differently on the MTSS compared with the initial validation study sample as fewer smokers in the ITC sample scored the high levels of motivation to quit and they were less motivated to quit.[10] The association with subsequent quit attempts is difficult to compare between the initial and the external validation studies because the time to follow-up was twice as long in our study. Future research could compare these proportions with the same follow-up duration (either using the STS sample with 6 months or the ITC sample with 12 months follow-up). Nevertheless, it is useful to know that the MTSS also performed well after a different time interval than used in the Smoking Toolkit Study. The ROC_{AUC} of the MTSS was 0.68 in our sample and 0.67 in the initial validation study which is close to the acceptable threshold of 0.70.[37] This similarity is a sign of a stable validity and also reassuring as previous research indicated that other external validation studies often show weaker performance of predictive measurement instruments than in the derivation studies.[38]

Limitations and strengths

A limitation of this study is that, due to time constraints, the MTSS was not translated as systematically as recommended for example by Wild et al.[39] This would have reduced the chance that differences on scoring would be due to linguistic misconceptions. By translating it independently and discussing it by three researchers, we aimed to minimise this risk. A second limitation was that more young smokers dropped out of the sample between the three used survey waves. Our results may therefore not be generalisable to the whole population of Dutch smokers.

External evaluation in addition to internal validation of measurement instruments is clearly desirable in order to determine their generalisability.[13] One important strength of the present study is that, to the best of our knowledge, this is the first study which examined the external validity of an instrument to measure motivation to stop smoking. Other strengths include the relatively large sample size of the current study and use of a probability-based sampling approach which improves the representativeness of our findings.

Conclusion

The MTSS performed well when validated in an external sample, in a different language and with a longer time interval than in the original validation setting. Our results are in accordance with those of the initial validation study with respect to all psychometric assessments.

Supplementary data

Supplementary data are available at *EURPUB* online.

Acknowledgements

Several members of the ITC Project team at the University of Waterloo have assisted in all stages of conducting the ITC Netherlands surveys, which we gratefully acknowledge. In particular, we thank Geoffrey Fong, the Chief Principal Investigator of the ITC Project, and Thomas Agar, the Project Manager of the ITC Europe Project. The results of this study were presented at the 16th annual meeting of the Society for Research on Nicotine and Tobacco (SRNT) Europe, 10–12 September 2015 in Maastricht, The Netherlands.

Funding

This work was supported by a grant from the Netherlands Organisation for Health Research and Development (ZonMw) (200130002), and by Cancer Research UK to R.W. The funders had no involvement in the design of the study, the collection, analysis and interpretation of the data, the writing of the article or the decision to submit the article for publication.

Conflicts of interest: J.B. and D.K. received an unrestricted grant from Pfizer for a smoking cessation study. R.W. undertakes research and consultancy for companies that manufacture smoking cessation medications.

Key points

- The Motivation To Stop Scale (MTSS) is a new tool to assess motivation to quit smoking.
- The current study investigated the external predictive validity of the MTSS.
- External validations of instruments to measure motivation to quit are rarely done.
- Our results confirmed the strong predictive validity in an external sample.
- The validity was similar to that of an assessment of the Stages of Change.

References

1 Topa G, Moriano JA. Theory of planned behavior and smoking: meta-analysis and SEM model. *Subst Abuse Rehabil* 2010;1:23–33.

2 Vangeli E, Stapleton J, Smit ES, et al. Predictors of attempts to stop smoking and their success in adult general population samples: a systematic review. *Addiction* 2011;106:2110–21.

3 Hyland A, Borland R, Li Q, et al. Individual-level predictors of cessation behaviours among participants in the International Tobacco Control (ITC) Four Country Survey. *Tob Control* 2006;15(Suppl 3):iii83–94.

4 Borland R, Yong HH, Balmford J, et al. Motivational factors predict quit attempts but not maintenance of smoking cessation: findings from the International Tobacco Control Four country project. *Nicotine Tob Res* 2010;12(Suppl):S4–11.

5 Smit ES, Fidler JA, West R. The role of desire, duty and intention in predicting attempts to quit smoking. *Addiction* 2011;106:844–51.

6 Yong HH, Borland R. Functional beliefs about smoking and quitting activity among adult smokers in four countries: findings from the International Tobacco Control Four-Country Survey. *Health Psychol* 2008;27:S216–23.

7 Sciamanna CN, Hoch JS, Duke GC, et al. Comparison of five measures of motivation to quit smoking among a sample of hospitalized smokers. *J Gen Intern Med* 2000;15:16–23.

8 Yzer M, van den Putte B. Control perceptions moderate attitudinal and normative effects on intention to quit smoking. *Psychol Addict Behav* 2014;28:1153–61.

9 Savoy E, Reitzel LR, Scheuermann TS, et al. Risk perception and intention to quit among a tri-ethnic sample of nondaily, light daily, and moderate/heavy daily smokers. *Addict Behav* 2014;39:1398–403.

10 Kotz D, Brown J, West R. Predictive validity of the Motivation To Stop Scale (MTSS): a single-item measure of motivation to stop smoking. *Drug Alcohol Depend* 2013;128:15–9.

11 West R, Brown J. *Theory of Addiction*, 2nd edn. Oxford: John Wiley & Sons, Ltd., 2013.

12 The Smoking Toolkit Study. 2011 [27.10.2015]. Available at: www.smokinginengland.info.

13 Altman DG, Royston P. What do we mean by validating a prognostic model? *Stat Med* 2000;19:453–73.

14 ITC Project. 2015. Available at:www.itcproject.org. (27 October 2015, date last accessed)

15 Bully P, Sanchez A, Zabaleta-Del-Olmo E, et al. Evidence from interventions based on theoretical models for lifestyle modification (physical activity, diet, alcohol and tobacco use) in primary care settings: a systematic review. *Prevent Med* 2015; 76:Supplement, Pages S76-93.

16 Prochaska JO. diClemente CC. The transtheoretical approach. In: Norcross JC, Goldfried MR, editors. *Handbook of Psychotherapy Integration*, 2nd edn. New York: Oxford University Press, 2005: 147–71.

17 DiClemente CC, Prochaska JO, Fairhurst SK, et al. The process of smoking cessation: an analysis of precontemplation, contemplation, and preparation stages of change. *J Consult Clin Psychol* 1991;59:295–304.

18 Herzog TA. Analyzing the transtheoretical model using the framework of Weinstein, Rothman, and Sutton (1998): the example of smoking cessation. *Health Psychol* 2008;27:548–56.

19 Sutton S. Back to the drawing board? A review of applications of the transtheoretical model to substance use. *Addiction* 2001;96:175–86.

20 West R. Time for a change: putting the Transtheoretical (Stages of Change) model to rest. *Addiction* 2005;100:1036–9.

21 Brug J, Conner M, Harre N, et al. The Transtheoretical Model and stages of change: a critique: observations by five commentators on the paper by Adams, J. and White, M. (2004) why don't stage-based activity promotion interventions work? *Health Educ Res* 2005;20:244–58.

22 Nagelhout GE, Willemsen MC, Thompson ME, et al. Is web interviewing a good alternative to telephone interviewing? Findings from the International Tobacco Control (ITC) Netherlands survey. *BMC Public Health* 2010;10:351.

23 Zethof D, Nagelhout GE, de Rooij M, et al. Attrition analysed in five waves of a longitudinal yearly survey of smokers: findings from the ITC Netherlands survey. *Eur J Public Health* 2016 (In press).

24 Velicer WF, Fava JL, Prochaska JO, et al. Distribution of smokers by stage in three representative samples. *Prev Med* 1995;24:401–11.

25 Cancer Prevention Research Center. Smoking: adult stage of change (short form) 2015 [22.10.2015]. Available at: http://web.uri.edu/cprc/smoking-adult-stage-of-change-short-form/.

26 Heatherton TF, Kozlowski LT, Frecker RC, et al. Measuring the heaviness of smoking: using self-reported time to the first cigarette of the day and number of cigarettes smoked per day. *Br J Addict* 1989;84:791–9.

27 Driezen P, Thompson ME. *Comparing Policy Measures across Multiple ITC Countries: Adjusting for Time-in-Sample*. Waterloo, Ontario, Canada: University of Waterloo, 2011.

28 Nagelhout GE, de Vries H, Fong GT, et al. Pathways of change explaining the effect of smoke-free legislation on smoking cessation in The Netherlands. An application of the international tobacco control conceptual model. *Nicotine Tob Res* 2012;14:1474–82.

29 Yong HH, Borland R, Thrasher JF, et al. Mediational pathways of the impact of cigarette warning labels on quit attempts. *Health Psychol* 2014;33:1410–20.

30 Thyrian JR, Panagiotakos DB, Polychronopoulos E, et al. The relationship between smokers' motivation to quit and intensity of tobacco control at the population level: a comparison of five European countries. *BMC Public Health* 2008;8:2.

31 Prenger R, Pieterse ME, Braakman-Jansen LM, et al. A comparison of time-varying covariates in two smoking cessation interventions for cardiac patients. *Health Educ Res* 2013;28:300–12.

32 DeLong ER, DeLong DM, Clarke-Pearson DL. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. *Biometrics* 1988;44:837–45.

33 Robin X, Turck N, Hainard A, et al. pROC: an open-source package for R and S+ to analyze and compare ROC curves. *BMC Bioinformatics* 2011;12:77.

34 Siahpush M, McNeill A, Borland R, Fong GT. Socioeconomic variations in nicotine dependence, self-efficacy, and intention to quit across four countries: findings from the International Tobacco Control (ITC) Four Country Survey. *Tob Control* 2006;15(Suppl 3):iii71–5.

35 Reid JL, Hammond D, Boudreau C, et al. Socioeconomic disparities in quit intentions, quit attempts, and smoking abstinence among smokers in four western countries: findings from the International Tobacco Control Four Country Survey. *Nicotine Tob Res* 2010;12(Suppl):S20–33.

36 Kotz D, West R. Explaining the social gradient in smoking cessation: it's not in the trying, but in the succeeding. *Tobacco Control* 2009;18:43–6.

37 Hosmer DW, Lemeshow S. *Applied Logistic Regression*, 2nd edn. New York: Wiley, 2000.

38 Siontis GC, Tzoulaki I, Castaldi PJ, Ioannidis JP. External validation of new risk prediction models is infrequent and reveals worse prognostic discrimination. *J Clin Epidemiol* 2015;68:25–34.

39 Wild D, Grove A, Martin M, et al. Principles of Good Practice for the Translation and Cultural Adaptation Process for Patient-Reported Outcomes (PRO) Measures: report of the ISPOR Task Force for Translation and Cultural Adaptation. *Value Health* 2005;8:94–104.