Examining the effects of an online intervention promoting isometric exercise in smokers

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Thesis declaration form

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Overview

Cigarette smoking is the leading cause of preventable illness globally (Goldenberg, Danovitch, & IsHak, 2014), and places a huge financial burden on a struggling NHS (BMA, 2016). Despite a wide range of available support, a significant proportion of smokers still struggle to quit and remain abstinent (Zhou, Nonnemaker, Sherrill, Gilsenan, Coste, & West, 2009). As such, further research is needed to develop more effective smoking cessation interventions. This thesis investigates such interventions.

Part one of this thesis is a literature review evaluating 82 free smoking cessation Android apps for their adherence to the Clinical Practice Guidelines for Treating Tobacco Use and Dependence (2008). The strengths and weaknesses of, and primary strategies used by these apps are discussed. Overall, adherence to the clinical guidelines was low, and should be improved in order to best serve those looking to quit smoking.

Part two is an empirical paper investigating the effects of a brief isometric exercise (IE) intervention, delivered online, on smoking urges, negative affect, and the number of cigarettes smoked over the course of 24 hours. Participants were randomised to learn either an IE or body-scanning strategy and asked to apply this over the next 24 hours in response to cravings. Both strategies were found to be equally effective in reducing negative affect, smoking cravings, and the number of cigarettes smoked, in smokers' natural environments.

Part three is a critical appraisal of the research process. This reflects on the process of conducting doctoral research and my thoughts, considerations, difficulties, and decision-making throughout.

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Part 1: Literature Review

A systematic qualitative review of free Android apps for smoking cessation

Abstract

Aims: To systematically review and evaluate the adherence of free Android apps for smoking cessation to the Clinical Practice Guidelines for Treating Tobacco Use and Dependence (2008).

Method: The Google "Play Store" was searched for free Android apps relevant to smoking cessation using the search terms "smoking cessation", "stop smoking", and "quit smoking". 116 free, unique apps were identified, and those not relevant to smoking cessation, not in English, consisting purely of external links, or requiring users to be engaged with another form of treatment were excluded. The remaining 82 apps were evaluated, and a subset of 25 apps was evaluated by a second rater.

Results: Overall adherence to the Clinical Practice Guidelines was poor with a mean score of 11.4 out of a possible 50. Whilst the majority of apps enquired about tobacco use, and presented the risks of smoking and the benefits of quitting, few helped users develop a quit plan, or directed them to external sources of support.

Conclusions: Overall, apps did not score highly for the use of strategies recommended in the Clinical Practice Guidelines. Developers should seek to incorporate a wider range of evidence-based strategies into apps to best serve those seeking to quit smoking.

In 2015 the annual cost of cigarette smoking to society in England alone was estimated to be £13.9 billion (ASH & LeLan Solutions, 2015). Approximately 454,700 hospital admissions and 17% of all deaths of adults aged over 35 years were attributable to smoking (Health and Social Care Information Centre, 2015). Government efforts to reduce smoking have included the introduction of Smoke Free legislation which made smoking in public buildings and enclosed spaces (2007) (SmokeFree England, 2015) and cars carrying children under the age of 18 years (2015) illegal (Gov.UK, 2015), and an 87% increase in tobacco prices from 2004 to 2014 (Health and Social Care Information Centre, 2015). The age restriction on purchasing tobacco products was also increased from sixteen to eighteen years in October 2007 (NHS Choices, 2014). Despite some evidence that healthcare costs rise in the year following smoking cessation, possibly because the quit attempt is preceded by a substantial health event (Bartecchi, MacKenzie, & Schyle, 1994), these costs fall in year two and the reduction is maintained at six-years post-quit (Fisherman, Khan, Thompson, & Curry, 2003).

Overall rates of cigarette smoking in the UK have fallen by 37% in the past thirty years (Gov.UK, 2015a), and attitudes to smoking have shifted. In a 2008-9 survey 62% of non-smokers polled reported concern about their health or the unpleasant smell of cigarettes if someone smoked nearby, and 69% would never allow smoking in their home (Health and Social Care Information Centre, 2014). Of current smokers, two-thirds reported an interest in quitting (ASH, 2015), and 1.8 million prescriptions to aid smoking cessation were dispensed from 2013-2014 (Health and Social Care Information Centre, 2015).

However, despite a wide-range of available support, a significant proportion of individuals still struggle to successfully quit smoking and remain abstinent (Zhou, *et al.*, 2009), endangering their health and contributing to the financial burden on society. Furthermore, those interventions which have been found to be most effective for smoking cessation, for example, face-to-face behavioural counselling (interventions offering advice, discussion, encouragement, and behaviour change techniques (Roberts, Kerr, & Smith, 2013)), typically have the lowest reach, whilst those with greater reach, for example mass media advertising, are amongst the least effective (Raw & McNeill, 1994).

Recent studies have suggested mobile technology may have a key role in smoking cessation, offering tailored interventions at any time or place dependent on the need of the individual (Borrelli, Bartlett, Tooley, Armitage, & Wearden, 2015). Tailored intervention consists of strategies and information intended to meet the unique needs of an individual, and has been found to increase the effectiveness of other low-intensity self-help interventions (Noar, Benac, & Harris, 2007). Whilst tailoring information might historically have involved time-consuming and costly assessment, mobile technology is uniquely placed to gather the relevant personal information using minimal resources. Furthermore, as nicotine cravings are frequently identified as a barrier to quitting (Villanti, Bover Manderaki, Gundersen, Steinberg, & Delnevo, 2016) having immediate access to support and strategies via mobile technology may improve outcomes for those engaged in quit attempts.

Mobile technology is increasingly ubiquitous, with 66% of UK adults now owning smartphones (Ofcom, 2015), and tablets present in 54% of UK households (Ofcom, 2015a). Of those adults using tablets, 86% reported using “apps” (Ofcom, 2015a). The majority of mobile technology is supported by either Apple or Android

operating systems, with Android's market share at 44.05% and Apple's at 44.39% in November 2015 (Statista, 2015). Whilst the market share is approximately equal, Android's users may represent a wider range of the general population with Android operating systems available on both budget and high-end smartphones and tablets (Smith, 2013).

Lower cost Android phones are also reported to be playing a key role in the growth of the use of mobile technology in developing countries, including those in Africa, where Android is the operating system of choice for 30% of the population of smartphone users (Opera Business, 2015). Though 'feature-phones' remain more common than smartphones in many developing countries at present, 167.6 million smartphones were shipped to the Middle East and Africa (Statista, 2015c) in 2015, with an estimated sales value of 44 billion US dollars (Statista, 2015b). It is anticipated that the arrival of low-cost Android smartphones in Africa will contribute to a surge in the number of smartphones, with a forecasted 412 million in use by 2018 (Informa, 2014). With the implementation of the World Health Organisation (World Health Organisation, 2003) Framework Convention on Tobacco Control in 2005 resulting in more restrictive laws and guidelines for smokers in many countries, the tobacco industry has sought new markets in countries where no such legislation exists (The Guardian, 2014). Subsequently, cigarette sales in the Middle East, Africa, and the Asian Pacific region have increased between 2005 and 2014, whilst other areas have seen a decline (Campaign for tobacco-free kids, 2015). With 80% of tobacco related deaths in 2011 occurring in low and middle income countries (Blecher & Ross, 2013), free apps on available technology may have a crucial role to play in educating smokers in developing countries about the associated risks, and supporting them to quit.

The online marketplaces for mobile software, (Apple's "App store" and Android's Google "Play store") offer thousands of apps claiming to support healthier lifestyles (Power & Gordon, 2015), many of which are free to download and are ready to use in under a minute. Studies have shown some apps to be valuable psychoeducational tools (Marley & Farooq, 2015), whilst others have been found to assist users in self-monitoring (Rizvi., Dimeff, Skutch, Carroll, & Linehan, 2011), thus increasing awareness of feelings, behaviours, and any emerging patterns between these and smoking urges and behaviour. A systematic review by Hassandra *et al.* (2015) found self-help materials to be the most effective long-term methods of preventing relapses in smoking cessation, and apps may be a cost-effective way of delivering these (Carter, Burley, Nykjaer, & Cade, 2013).

However, as apps are rarely designed in consultation with either professionals or 'experts by experience', their content may be inappropriate, misleading, insufficient, or even false (Lewis & Wyatt, 2014). Since apps are widely accessible but rarely subject to consumer safety laws and regulations, the potential for iatrogenic harm is significant (Power & Gordon, 2015).

Systematic reviews for both Apple (Abroms, Padmanabhan, Thaweethai, & Phillips (2011); Abroms, Westmaas, Bontemps-Jones, Ramani, & Mellerson (2013)) and Android (Bennett *et al.*, 2015) smoking cessation apps have been conducted previously, rating apps for adherence to proven smoking cessation strategies. In 2008, the US Public Health Service published Clinical Practice Guidelines for Treating Tobacco Use and Dependence (US Public Health, 2008) based on the existing evidence base for smoking cessation, with the intention of ensuring every smoker encountered by a health professional in America would receive an effective smoking cessation intervention. These guidelines suggested the use of a model

known as “the 5As” which provided cues for the five major steps involved in providing a brief smoking cessation intervention in a primary care setting; ask, advise, assess, assist, and arrange. For those presenting with low levels of motivation, a motivational interviewing approach was championed, involving the 5Rs; relevance, risks, rewards, roadblocks, and repetition (US Public Health, 2008).

These guidelines were converted to a checklist of twenty-four clinical strategies by Bock et *al.* (2004) and later Abroms *et al*., (2011) (see table 2), which was accompanied by a rating scale to indicate how well each recommended strategy was demonstrated by a mobile app. This list was later expanded by Bennett *et al*. (2015) who added items (see table 4) relating to the simplicity of use, whether cigarette smoking behaviour and cravings were monitored, and whether the app supported development of a plan to reduce the number of cigarettes. Overall, these reviews (Abroms *et al.*, 2011; Bennett *et al.*, 2015) suggested low levels of adherence to clinical guidance in both Apple and Android apps.

Despite the publication of a recent paper systematically reviewing Android smoking cessation apps (Bennett *et al.*, 2015, based on a search of apps from Jan 2013), further review is warranted by exponential growth in app numbers. For example, the number of available apps more than doubled between April 2013 and November 2015 (Statista, 2015a). With increasing interest in the delivery of health and wellbeing interventions via the internet (Bennett & Glasgow, 2009) and mobile technology (Klasnja & Pratt, 2012) it is crucial to regularly re-evaluate progress and identify areas for improvement. The current review contains details about 82 apps, compared to only 21 reviewed by Bennett *et al.* (2015).

In this study, freely available Android apps for smoking cessation are reviewed. The rationale for focusing on Android apps in particular is outlined above. Similarly, free apps have the potential to reach users with limited financial resources. We draw heavily on the methodology of previous reviews in this field (Abroms *et al.*, 2011, 2013; Bennett *et al*., 2015), hopefully enabling relatively easy comparison across reviews.

This review addresses the following questions:

1. Which smoking cessation strategies are utilised in Android apps?
2. How well do smoking cessation apps adhere to the Clinical Practice Guidelines for Treating Tobacco Use and Dependence?
3. What are the strengths and limitations of free Android smoking cessation apps?
4. In what ways can smoking cessation apps be improved to better assist individuals in their quit attempt?

Methods

In line with previous research methodology (Bennett *et al.*, 2015) a systematic search and evaluation strategy was employed using a smartphone (Samsung Galaxy S6; Samsung Electronics, 2015) to search the Google "Play store" for Android apps relevant to smoking cessation in October and November 2015. The terms "quit smoking", "smoking cessation", and "stop smoking" were entered into the search bar

and retrieved a total of 300 results. The details of each app were reviewed and the list of apps to be rated further refined (see Figure 1).

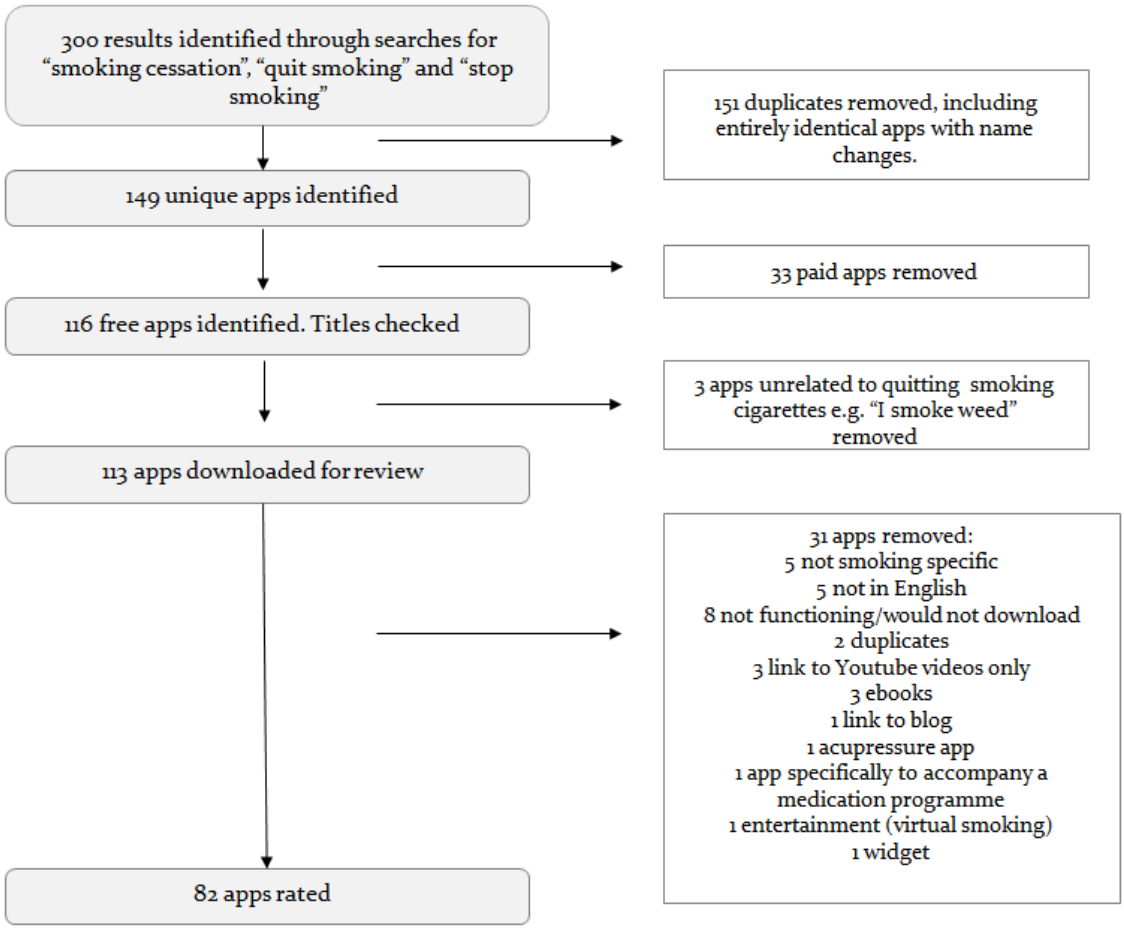

Figure 1. *Flow chart of the review process.*

To be included, the app must be a true app rather than a page of hyperlinks, free to download and use, not designed to accompany another intervention e.g. medication, in English, and intended to aid the cessation of cigarette smoking.

First, lists of apps retrieved by each search were collated and duplicates removed. Of the unique apps identified, paid apps were excluded. The titles of the remaining apps were scrutinised, and apps with titles unrelated to quitting cigarette

smoking, e.g. “I smoke weed” were removed. The remaining 113 apps were downloaded for review and evaluation.

Of the apps downloaded, 31 which did not meet criteria were removed. These were excluded on the basis of being i) not a ‘true’ app, e.g. an eBook, or a list of hyperlinks, ii) not in English, iii) not specific to smoking, e.g. for general health improvement, or promoting acupressure, iv) an app designed to work alongside a specific medication, v) an entertainment app, e.g. a virtual cigarette, vi) a duplicate which was not earlier detected, e.g. an app which had been rebranded under another name, or vii) a standalone widget, e.g. a button which “coughed” when tapped.

Each of the 82 remaining apps was rated against 19 Clinical Strategies for Smoking Cessation from Abroms *et al.* (2011), plus the four additional items added by Bennett *et al.* (2015). The items added by Bennett *et al.* consisted of i) simplicity of use, ii) tracking cigarettes smoked, iii) creating a plan to reduce the number of cigarettes smoked in advance of quitting, and iv) rating cravings or urges to smoke. For the Abroms *et al.* (2011) criteria, apps were rated on a scale of 0 to 2 where 0 = not present at all, 1 = present a little (present but not on the main screen or in the interactive prompts) and 2 = fully present (prominent, on the main screen, or in the interactive prompts). For the Bennett *et al.* (2015) criteria apps were rated on a scale of 0-3 where 0 = poor, 1 = fair, 2= good, and 3= excellent. Apps were awarded a total out of 38 on the Abroms *et al.* (2011) criteria, a total out of 12 on the Bennett *et al.* (2015) criteria, with a combined “grand total” out of a possible 50. All ratings were performed by the author with a randomly selected subset of twenty-five apps independently evaluated by a second rater who accessed the Play store using a PC with a Windows operating system. Where possible, disagreement in ratings was resolved through discussion.

Results

In total, 82 free apps were evaluated, 20.7% of which offered the option of in-app purchases. These ranged in price from £0.50 (a small donation to the app developer) to £38.99 (an upgrade to the 'pro' version of the app). Additional functions offered for a fee were not considered when rating apps.

Poor grammar and/or spelling were a problem for 20.7% of the apps. Apps are available globally, and efforts at translation were often poor. The impact of this was variable, with the meaning of some sentences preserved *(e.g. "why do not you save money daily you'd spent on smoking?"* (ExSmoker - Stop Smoking Now), whilst others were lost ("*since then, as yuou left off smoking, in the World for the reasons bound to smoking suffered already.*" (No Smoking)).

Notifications were offered by 13.4% of apps, most frequently prompting individuals to return to the app to update their progress, or highlighting new achievements, e.g. a reduction in health risk after one week without cigarettes. Widgets were available for 9.7% of apps and were primarily used to self-report smoking with a single tap or to track the time since the last cigarette was smoked (e.g. Cigarette Analytics).

Types of app

Each app was categorised by type, according to the smoking cessation strategy it adopted. Fourteen categories were identified, some of which were formed by the combination of multiple strategies within one app (table 1).

Table 1

Apps by category/type. (See text for detail on categories.)

Type	*n*
Calculator	13
Calendar	4
Rationing	2
Calendar/Calculator	35
Calculator/Rationing/Calendar	2
Coach	5
Gaming/Calendar	1
Rationing/Calculator	1
Hypnosis	9
Psychoeducation	6
Individual strategy	1
Threatening picture	1
Mindfulness	1
Subliminal messaging	1

Apps which performed a "calculator" function tracked money saved or health benefits accrued since the individual's quit date. Calendar apps tracked time; specifically, time since or until the quit date, or since the last cigarette was smoked. Rationing apps sought to limit the number of cigarettes smoked within a certain timeframe, or rationed the time within the day in which smoking was permitted.

Of the 82 apps, the majority (42.7%) were best categorised as "calendar/calculator" types which tracked both time and benefits accrued. This data was often presented visually, for example as graphs, and could provide a large amount of information on one screen, including physical health benefits, financial savings, number of cigarettes not smoked (based on usual number smoked per day), and the time since the quit attempt commenced.

Apps categorised as "coach[ing]" apps provided support resembling techniques from behavioural counselling (Roberts, Kerr, & Smith, 2013), assisting users to set goals, identify potential obstacles, and increase self-efficacy, and often sought to help users overcome obstacles, for example with a "panic" button leading to tips, distraction tasks, and/or a Quitline number (Quit Now: My Quit Buddy).

Hypnosis apps consisted of audio recordings using hypnosis to prompt and maintain a quit attempt, whilst psychoeducation apps provided detailed information about smoking and smoking cessation, usually in written form. Less frequently-used approaches are summarised in table 1.

Popularity

Information about the precise number of downloads for each app is not available in the Play store, where apps are recorded as having surpassed certain download

landmarks (e.g. 10+ downloads; 5000+ downloads etc.). The popularity of the apps included in this study was variable, however the modal category was >10,000 downloads (range: 10+ - 1 million+).

Adherence to Clinical Strategies for Smoking Cessation

Using the methodology developed by Abroms *et al*. (2011) to rate Apple smartphone apps, each app was first rated using items from the Clinical Practice Guidelines for Treating Tobacco Use and Dependence (US Public Health, 2008), with a maximum possible score of 38. Overall adherence to the clinical guidelines was low, with a mean score of 6.9 (SD = 6.52, range 0-27).

Inquiring about tobacco-use. The Clinical Practice Guidelines for Treating Tobacco Use and Dependence (US Public Health, 2008) recommend asking all smokers about their tobacco use, with a view to identifying appropriate support and interventions. The majority (74.4%) of apps enquired about tobacco use, usually obtaining this information by asking the user to enter a quit date, and thus providing binary information about the smoker's current status (e.g. quit/smoking). However, this data is difficult to interpret as no definition of "quit date" was provided by most apps. Smokers may interpret this term differentially, with "quit date" meaning a point beyond which no cigarettes are smoked for some, whilst for others this might mean the point at which they commence rationing or reduction prior to complete abstinence.

Another common approach to identifying current tobacco use was equally problematic. Individuals were frequently asked to input the "number smoked per

day" without further explanation of what was required. As such, someone who had started a quit attempt the previous day might conceivably answer "0" indicating their current use, or "20" to represent their normal smoking habits. If the app took a calculator approach and the user entered "0" this might be taken as a baseline with the app showing no rewards (either financial or health-related) for this abstinence. Conversely, if the same individual's entry represented their previous daily total, e.g. "20", despite currently being abstinent, this would not represent their current tobacco use status. Clearer data could be obtained from apps asking direct questions about the number of cigarettes currently being smoked per day, and for the user's stage in the quit process, e.g. "*I want to quit now",* I *want to quit later*," or "*I have already started trying to quit"* (Smokefree).

Overall, this strategy was rated as fully present (scored 2 points for being prominent, on the main screen, or in the interactive prompts) in 31.7% of apps (table 2).

Table 2

Ratings for Clinical Strategies for Smoking Cessation and additional Bennett et al. (2015) criteria

	Present (scores either 1 or 2)		Strongly present (scores 2)	
Item	**n**	**%**	**n**	**%**
Ask for tobacco use status	61	74.4%	26	31.7%
Assess willingness to quit	8	9.8%	6	7.3%
Advise every user to quit: general message	11	13.4%	1	1.2%
Advise every user to quit: clear message	4	4.9%	1	1.2%

Advise every user to quit: strong message	3	3.7%	1	1.2%
Advise every user to quit: personalised reason	4	4.9%	1	1.2%
Enhance motivation: present risks of smoking	42	51.2%	10	12.2%
Enhance motivation: present rewards of quitting	52	63.4%	11	12.2%
Enhance motivation: Personal relevance	23	28.0%	10	12.2%
Enhance motivation: identifying and addressing roadblocks	17	20.7%	6	7.3%
Assist with a quit plan: Overall	23	28.0%	6	7.3%

Assist with a quit plan: Practical counselling about quitting	22	26.8%	10	12.2%
Assist with a quit plan: Getting social support for quitting	20	24.4%	7	8.5%
Assist with a quit plan: recommend approved medicines	11	13.4%	8	9.8%
Refer to recommended treatment	12	14.6%	6	7.3%
Assist with a quit plan: Provide supplementary information	19	23.2%	9	11.o%
Recommend counselling & medicine	11	13.4%	5	6.1%
Connect to a telephone Quitline	5	6.1%	3	3.7%

Arrange for follow-up	0	0	0	0
	Additional items from Bennett et al. (2015)			
	Fair to excellent (scores 1,2, or 3)		*Excellent (scores 3)*	
	n	**%**	**n**	**%**
Simplicity of use	80	97.6%	72	87.8%
Tracks cigarette smoking	32	39%	13	15.9%
Helps user create a plan to reduce smoking	25	30.5%	5	6.1%
Asks user to rate cravings/urges	11	13.4%	2	2.4%

Assesses willingness to quit. Assessing an individual's willingness to quit, and stage of change is crucial to providing a targeted intervention (US Public Health, 2008) which considers their current attitudes, strengths, and needs (Prochaska & DiClemente, 1983).

Overall, 9.8% of the apps evaluated assessed willingness to quit. Those apps scored as "2" (7.3%) gave users the option to rate their interest or confidence in quitting, or to express varying levels of motivation, in line with the Transtheoretical Model (Prochaska & DiClemente, 1983).

Advises every user to quit. The Clinical Practice Guidelines for Treating Tobacco Use and Dependence (US Public Health, 2008) recommend every smoker is advised to quit. For a "general message" to be rated as present the app must directly advise users to quit. Very few apps overtly advised smokers to quit, with a general message present in just 13.4% of apps, and fully present in just one app (1.2%).

A "clear message" is one in which users are provided with unequivocal information as part of the message to quit, for example by being told that quitting is important and help is available, or that even light smoking is detrimental to their health (US Public Health, 2008). Clear messages were present in 4.9% of apps, and fully present in just one app. Such messages were rated "1" when users were required to leave the app in order to find this information, for example in the case of Smokefree, which clearly and strongly advised users to quit, but only via the NHS website, to which a link was available in-app.

A strong message was one in which the gravity of not quitting was emphasised, for example by stating that quitting smoking was the most important

thing the user could do to protect their health (US Public Health, 2008). This was present in three apps (3.7%) but only fully present in Quit Smoking (BlindheartCreations), which sought to have an emotional impact on smokers.

A personalised reason to quit tied tobacco use to current symptoms, health and financial, or social costs for the individual (US Public Health, 2008), and was present in 4.9% of apps. This was rated as "1" if the app alluded to users identifying personalised reasons for quitting but did not support them to do so or provide the opportunity to record these. One app was scored "2" and offered a checklist and space to enter personalised reasons to quit, plus the option of adding pictures as a visual reminder (SmartQuit: Quit Smoking).

Enhances motivation. The Clinical Practice Guidelines (US Public Health, 2008) emphasise the importance of helping individuals recognise why quitting is important, including the risks of smoking and rewards for abstaining, and the need to increase self-efficacy.

The risks of smoking were presented in 51.2% of apps, and fully present in 12.2%. It was common for risks to be implied rather than plainly stated, e.g. if a benefit of smoking cessation is "reduced risk of lung cancer" then an implied risk of smoking is increased risk of lung cancer. Other apps provided detailed information about risks to one's own health and the health of others, and referred to social and financial costs.

The 'rewards' of quitting smoking were found to be present in 63.4% of the apps, and were frequently focused on health or finances. Apps for which this criterion was scored as being fully present (12.2%) tended to focus on a broader

range of rewards, e.g. health, finances, social acceptance, the health of others, and being a positive role model (Quit Smoking (Axon)), gave detailed information about the benefits of quitting, or allowed individuals to identify their own benefits, for example, what they might spend their newly found time and money on (SmartQuit: Quit Smoking).

The "personal relevance" of quitting pertains to an individual's sense of why quitting is important to them, for example, the health impact for them and their family, and financial costs. This was considered by 28% of apps. Apps which scored 2 (12.2%) took a number of different approaches. Some allowed individuals to record as many reasons as they liked, whilst others allowed users to upload videos and audio recordings of loved ones, photos of things they wanted or valued, and space to write about their motivation (Smokefree).

Efforts to identify and address potential roadblocks in a quit attempt were made by 20.7% of apps. Apps were scored 1 where very general advice was offered, relating for example, to broad strategies for managing stress or to continue with a quit attempt despite lapses. Apps rated as 2 for this criterion (7.3%) helped users to identify potential triggers for cravings or lapses and to think through solutions, developed implementation intentions (Smoke Free, stop smoking help) or enabled users to identify "danger times" when they were more likely to smoke, and to opt to receive proactive support from the app during this period (Quit Now: My Quit Buddy). One app (Quit Pro: stop smoking now) spoke of identifying geographical risk zones (e.g. the local pub) and employed the GPS functionality of the Smartphone which activated proactive support when the device detected it was in this location. However, this facility was only unlocked by a paid upgrade to the full version of the app.

Assists with a quit plan. Assistance with a quit plan involves supporting smokers to set a quit date (ideally within the next two weeks), inform people in their social network, request support, anticipate challenges including nicotine withdrawal symptoms, and take steps to remove tobacco from one's environment (US Public Health, 2008). Overall, 28% of apps were found to assist with a quit plan in some way, with 7.3% of apps rated "2". For apps with a rationing approach this consisted of deciding how many cigarettes would be smoked as the quit day approached, or setting a window within a 24 hr timeframe outside of which smoking was not 'permitted'.

Practical 'counselling' about quitting involved encouraging users to strive for total abstinence, anticipation of triggers or challenges, and encouragement to avoid alcohol or being around smokers. Of the 26.8% of apps which offered practical counselling about quitting, 12.2% were rated 2. These apps offered advice and ways of managing cravings (Smoke Free, stop smoking help), in-app planning tools and space, and explained how and why one might go about a quit attempt, for example by changing brand prior to stopping, or not smoking in places where smoking usually occurs.

Individuals were encouraged to access social support for their quit attempt in 24.4% of apps. Some apps made a single brief statement that users should talk to friends or family, whilst others offered largely inactive and underutilised forums for individuals to access peer support. Some made non-specific statements about "creating a social system", whilst others suggested Facebook as a source of support. The apps in which this criterion was strongly met (8.5%) suggested multiple sources of support, e.g. friends or forums, promoted Quitline, support groups or 'counselling' services, or alluded to 'quit teams' or buddies. One app offered the facility to

identify potential sources of support and send them an email directly from the app requesting assistance in this endeavour (SmartQuit (Quit Smoking)).

Fewer apps (13.4%) recommended approved medications for smoking cessation, but the majority (9.8%) of those that did were rated “2”. Apps sometimes detailed how nicotine-replacement therapy (NRT) works, and who it may and may not work for, the different forms in which it was available (e.g. lozenges, gum, patches, spray, or inhaler), and how and where to obtain it.

Referral to recommended treatment was addressed by 14.6% of the apps, and strongly present in 7.3%. Apps where this criterion was partly met alluded to services or support without clear information about how they could be accessed, whilst the six apps scoring '2' advised users to visit their GP to discuss NRT or counselling, offered the facility to search for local treatment by postcode (R2Q Ready to Quit Smoking) or linked directly to the source of recommended treatment, e.g. smoking cessation services.

Supplementary information, for example, additional materials to support a quit effort, or information about quitlines or non-profit agencies was presented by 23.2% of apps, and strongly present in 11%. Higher rated apps offered more detailed information or signposted individuals to other reliable sources.

Directs to external sources of support. Counselling or medication were recommended by 13.4% of the apps evaluated, with this strategy fully present in 6.1%. Apps which referred to just one type of treatment, e.g. either counselling or medications, were scored 1. Apps which referred to or offered additional information about both were scored 2 as there is strong evidence that combining

counselling with NRT improves outcomes, and wherever possible, smokers should be provided with both (US Public Health, 2008).

Overall, 6.1% of the apps were scored ('1' or '2') as connecting users to a telephone quitline. Those apps which merely directed the user to information about a quitline were rated 1, whilst apps which offered the opportunity to call directly from the app (e.g. by copying the number into the phone's dialler) were rated 2 (3.7%).

Advises to make a follow-up health appointment. None of the 82 apps evaluated advised users to arrange a follow-up appointment with a health professional following their quit date.

Scores by app type. Of the app types presented in this study, the 'subliminal messaging' and rationing apps performed worst against the Clinical Strategies for Smoking Cessation (US Public Health, 2008) criteria (Abroms *et al.*, 2011), whilst coaching apps performed best (table 3).

Table 3

Mean for Clinical Strategies for Smoking Cessation by app type

Type	*n*	*Mean score _/38*
Calculator	13	3.6
Calendar	4	1
Rationing	2	0.5
Calendar/Calculator	35	5.9
Calculator/Rationing/Calendar	2	8
Coach	5	19
Gaming/Calendar	1	1
Rationing/Calculator	1	4
Hypnosis	9	10.1
Psychoeducation	6	11.9
Individual strategy	1	8
Threatening pictures	1	6
Mindfulness	1	17
Subliminal messaging	1	0

Ratings on additional items (Bennett *et al*., 2015).

All apps were further rated against the additional four items (table 2), developed by *Bennett et al.*, (2015) with a maximum possible score of 12. Apps were rated on a scale of 0-3 where 0 = poor, 1 = fair, 2= good, and 3= excellent. The mean score for all apps was 4.5 (SD=1.9, range 0-11).

Simplicity of Use. Overall, the apps evaluated in this study were rated as being simple to use, with 97.6% of apps rated as fair to excellent, of which 87.7% were rated "excellent". Lower rated apps were less easy to navigate, and sometimes had functions and information in unexpected places, for example, in settings menus, making it difficult to locate. One app (Smoking Reduction Trial) offered data which was difficult to interpret, and the origin of which was unclear. The majority of apps were intuitive and easy to use regardless of the complexity of the app itself.

Tracks cigarette smoking. The tracking of cigarette smoking was rated as fair to excellent in 39% of the apps evaluated, and excellent in 15.9%. Higher scoring apps asked users to report when, where, and why they had smoked, with some enquiring as to whether, in retrospect, it had been worth smoking that cigarette (Stop Smoking) or about emotions prior to smoking (Smoking Log). Other apps simplified the process of tracking smoking by introducing widgets which captured the information in seconds. Apps which scored lower on this criterion asked only whether the user was still smoke free, or how many cigarettes they had smoked that day.

Helps user create a plan to reduce smoking. The smoking cessation plans users created using these apps were rated as fair to excellent in 30.5% of cases, and excellent in just 6.1%. Plans rated as excellent were better tailored to the needs of the individual, and allowed planning to occur in-app. They provided more information, and were more responsive to an individual's stage in the quitting process.

Asks user to rate cravings/urges. Of the apps evaluated, 13.4% were rated fair to excellent for asking users to rate cravings or urges. Lower scoring apps assessed cravings just once, for example, at the commencement of a quit attempt, whilst higher rated apps (2.4%, n =2) assessed at several time points. Some apps asked users to record where, when, and why they experienced urges, but offered no solutions, whilst others (QuitCharge - Stop Smoking) asked users to identify a trigger for the craving and rate its intensity before offering an immediate distraction task in the form of a game.

Overall ratings on Bennett *et al.*'s (2015) additional criteria by app type. Of the app types represented by this study, the single rationing/calculator app performed worst against Bennett *et al.'s* (2015) additional criteria, whilst the mindfulness app performed best (table 4).

Table 4

Mean for Bennett et al. (2015) additional criteria by app type

Type	*n*	*Mean score out of a total of 12*	*SD*
Calculator	13	5.0	1.9
Calendar	4	4.3	1.9
Rationing	2	4.5	1.9
Calendar/Calculator	35	4.3	1.9
Calculator/Rationing/Calendar	2	4	1.9
Coach	5	6.8	1.9
Gaming/Calendar	1	2	1.9
Rationing/Calculator	1	1	1.9
Hypnosis	9	3.6	1.9
Psychoeducation	6	4.3	1.9
Individual experience	1	4	1.9
Threatening pictures	1	3	1.9
Mindfulness	1	12	1.9
Subliminal messaging	1	3	1.9

Overall performance against all criteria

Each app's total scores for the Clinical Strategies for Smoking Cessation (US Public Health, 2008) criteria and Bennett *et al.* (2015) additional criteria were summed and grand totals calculated (table 5). Apps developed in partnership with health or governmental bodies (e.g. Quit Now: My Quit Buddy (ANPHA), sponsored by the Australian Government, or Smokefree (NHS Smokefree)) and those developed by researchers (e.g. Smoke Free: stop smoking help (David Crane)) were amongst the highest rated apps, likely reflecting awareness of the clinical guidelines.

Table 5

Overall scores by app

App name (developer)	*Clinical Practice Guidelines (out of a total of 38)*	*Additional items (Bennett et al., 2015) (out of a total of 12)*	*Grand Total (out of a total of 50)*
Quit Now: My Quit Buddy (ANPHA)	27	8	35
ExSmokers iCoach (BrandNewHealth)	27	7	34
SmartQuit (Quit Smoking) (2Morrow, Inc)	24	8	32
Smokefree (NHS Smokefree)	26	6	32
Craving to Quit (goBlue)	17	12	29
Smoke Free, stop smoking help (David Crane)	20	9	29
Quit Smoking (Juan B and Juan H Android Developments)	17	5	22
Quit Smoking Hypnosis (Mindifi)	18	4	22
Quit Smoking Secrets (MobyiApps)	16	5	21

Free From Smoking - Hypnosis (theOBC)	17	4	21
Quit Smoking (Axon)	15	5	20
Stop Cigarettes- Quit Smoking (academiacea)	14	5	19
Stop Smoking Fast Hypnosis App (Mastermind App)	16	3	19
Quit for Life (Alere Wellbeing)	12	5	17
Quit Smoking Helper (Parobin Apps)	13	4	17
R2Q Ready to Quit Smoking WWEST	13	4	17
My Quit Smoking Coach (Andreas Jopp)	12	4	16
Quit Smoking Forever (pi9soft)	12	4	16
Quit Smoking (Bangladesh ICTD Apps)	11	4	15
Quitter (Guardanis)	7	8	15
SmokeLess! (Kroaqs)	9	6	15
Stop Smoking (Andeko)	7	7	14

Stop Smoking Hypnosis (On Beat Limited)	10	3	13
Enjoy! Quit Smoking (Happy Gate)	6	6	12
Stop Smoking (Sun Media Soft)	8	4	12
Stop smoking free, stop switch (Apply games)	5	7	12
Breathe Now - Stop Smoking Free (Peytu)	5	6	11
Let's quit smoking! (4wl.Apps)	4	7	11
myQuitTime - Stop Smoking (Arete Appware)	5	6	11
Quit Pro: stop smoking now (Muslim pro Limited)	5	6	11
Quit Smoking Free (Surf City Apps)	8	3	11
Stop Smoking Hypnosis (Sale) (Hypnosis and Subliminal)	5	6	11
Quit Smoking Nicotine Anon (iByte Apps Limited)	8	3	11

ExSmoker - Stop Smoking Now (Antonio Sanchez Diaz)	5	5	10
Just Quit Smoking Hyperactive (Kostyantin Petrov)	4	6	10
Quit-Smoking Coach Free (Brainlag Studios)	7	3	10
Smoke Aware - Quit Smoking (Callum Hyland)	4	6	10
Stop Smoking in 2 Hours (Juice Master)	7	3	10
Quit Smoking (BlindheartCreations)	6	3	9
Quit Smoking (Medicus Mundi)	3	6	9
Quit Smoking (Studio neko)	5	4	9
Quit Smoking Assistant (Bonanza Road Software	3	6	9
Cigarette Analytics (Alvakos)	4	4	8

Quit Smoking (Azati)	1	7	8
Quit Smoking Course (Diginet Apps)	5	3	8
Smokenote - Quit Smoking (NXCARE)	3	5	8
Stop Smoking (A B Mobile Apps)	2	6	8
Stop! Quit Smoking - LITE (CDdevelopment)	4	4	8
Vaper-App: Stop smoking (SBLMNL)	5	3	8
Kick the Habit: Quit Smoking (IcySpark)	2	5	7
No Smoking (antonfil84)	4	3	7
Quit smoking (Jmscapplications)	4	3	7
QUIT SMOKING (Mastersoft Ltd)	4	3	7
Quit Smoking (NP-Sites - CodeMasterHEISE4)	1	6	7
Quit Smoking! (SpanishApps)	4	3	7
Smoking Cessation - SRIOR (Magna Health Solutions)	2	5	7

Smoking Log (Cory Charlton)	1	6	7
Smotivator - Quit Smoking (Balauris)	4	3	7
Stop Smoking (Drd)	4	3	7
Time To Quit Smoke (VantusMantus)	4	3	7
No Smoking Diary (EONSOFT)	1	5	6
Quit Addiction: iQuit-App (SBLMNL)	3	3	6
Quit Smoking (HC)	3	3	6
Quit Smoking (Luis Salcedo)	3	3	6
Quit Smoking Now: Quit Buddy! (Hqmedia)	3	3	6
Quit Smoking Tips & Quotes (Oristats)	1	5	6
Quit Smoking: Cessation Nation (Ron Horner)	3	3	6
QuitCharge - Stop Smoking (Amplified Technology)	1	5	6
SimpleQuit: Quit Smoking App (Alex Elarbee)	3	3	6

Smoke Free Finally Non Smoking (sg-pages-Marcus Steller)	3	3	6
Qwit (Quit Smoking) (Team Geny)	3	3	6
No Smoking Helper (scmoonsoft)	2	3	5
Quit Smoking (Skywhite)	2	3	5
Smoker Reducer Quit Smoking (Nochino Digital)	4	1	5
Stop Smoking Hypnosis Audio (Vista Concepts LLC)	2	3	5
Quit Smoking - Quit Now! (Fewlaps)	4	0	4
Quit Smoking (VorteX)	1	3	4
Quit Smoking (Webfryslan)	1	3	4
Quit smoking slowly (Motivebite)	0	4	4
Smoking Reduction Trial (hashisoft)	1	3	4

Easy Stop Smoking (GLOBUS)	0	3	3
Quit Smoking 3D (UD4M Games)	1	2	3

Overall, the mean adherence score was just 11.4 out of a possible 50, with a range of 3 to 35 (SD 7.5) points. These substantially varied by app type (table 6).

Table 6

Mean grand total by app type

Type	*n*	*Mean score out of a total of 12*	*SD*
Calculator	13	8.8	7.5
Calendar	4	5.3	7.5
Rationing	2	5	7.5
Calendar/Calculator	35	10.2	7.5
Calculator/Rationing/Calendar	2	12	7.5
Coach	5	25.8	7.5
Gaming/Calendar	1	3	7.5
Rationing/Calculator	1	5	7.5
Hypnosis	9	13.7	7.5
Psychoeducation	6	16.2	7.5
Individual experience	1	12	7.5
Threatening pictures	1	9	7.5
Mindfulness	1	29	7.5
Subliminal messaging	1	3	7.5

Reliability of ratings

For the twenty-five apps which were double rated, interrater reliability was found to be Kappa = 0.73. On review, discrepancies in ratings appeared to relate to the device on which the application was viewed, with some apps being more or less easy to navigate on a smartphone as opposed to a PC. Furthermore, "simplicity of use" appeared to be particularly subjective and depend on the preferences of the user, resulting in lower levels of agreement. Disagreements were resolved with discussion where possible.

Discussion

Cigarette smoking continues to place a huge financial burden on society (ASH & LeLan Solutions, 2015) and result in premature deaths (Health and Social Care Information Centre, 2015). With the most effective treatments, such as face-to-face counselling having the lowest reach (Raw & McNeill, 1994), alternative interventions are needed. With increasing ubiquity, portability, connectivity, and personalisation, mobile phones may provide an answer. As such, this review sought to identify the smoking strategies utilised by smoking cessation apps, how well apps met the Clinical Practice Guidelines for Treating Tobacco Use and Dependence (US Public Health, 2008), the strengths and limitations of these apps, and how they could be improved to better assist individuals making a quit attempt.

Overall, the apps evaluated in this review were not generally consistent with the Clinical Practice Guidelines for Treating Tobacco Use and Dependence (US Public Health, 2008), with a low mean adherence score (11.4/50). Some overall trends in performance were evident, with the majority of apps (74.4%) asking for

tobacco use status, whilst none recommended users seek follow-up support from health care providers. This may reflect a possible intended function of apps as substitutes for professional input.

Of the 82 apps reviewed, fourteen categories were identified based on the strategies used, the majority of which were supported by the evidence base. A combined calendar/calculator strategy enabling self-monitoring was most prevalent. As relapse is frequently associated with learned behaviour and unthinking habits (West & Brown, 2013), allowing users to easily track their smoking behaviour (sometimes with a single tap of a widget) might increase conscious awareness of when, where, and how often they smoke, and assist them in setting a better quality goal for themselves, with improved outcomes as a result (Lorencatto, Erst, Bruguera, Brose, & Michie, 2015). Furthermore, calendar/calculator apps tended to present information in a colourful, easily digestible visual form. Although the aesthetics of the apps were not formally rated in this review, it is worth noting that health information materials judged to be attractive tend to be liked, understood, and acted upon (Bull, Holt, Kreuter, Clark, & Scharff, 2001). Similarly, both raters agreed that apps were simple and intuitive to use, though some individual preference was noted in the ratings.

Whilst the use of a rationing strategy was common in Bennett *et al.*'s (2015) study, this strategy was present in just five of the apps evaluated for this review. A comparison of the apps evaluated in this review with those rated relatively recently by Bennett *et al.* (2015) revealed minimal overlap and also a large increase in the number of available apps (n=21 in Bennett *et al,* (2015) versus n=82 reviewed here). This suggests smoking cessation apps have a limited shelf-life, and are retired and replaced relatively quickly. It is possible that the move away from rationing

strategies might be linked to public health messages that smoking even occasionally is detrimental to one's health (US Public Health, 2008) or the reduced convenience of smoking due to anti-smoking legislation (SmokeFree England, 2015).

In line with the findings of Bennett *et al*. (2015), the majority of apps presented information about the risks of smoking (51.2%) and the benefits of abstinence (63.4%), though the quality of this information was variable. Many apps focused primarily on either health or financial costs and benefits. Whilst there is some evidence that older smokers attend more to health concerns, and younger smokers to monetary costs and rewards (Paay, Kjeldskov, Skov, Lichon, & Rasmussen, 2015), the use of both may be required to cater to needs of the majority of users. Apps which adopted a purely psychoeducational strategy provided generic information about smoking and quitting. Whilst providing such information is crucial, (US Public Health, 2008), the health belief model (Janz & Becker, 1984) suggests individuals must perceive a threat to themselves to change their behaviour, and tailoring might therefore be necessary to prompt users to identify their own personally salient risks, and desirable outcomes of abstinence (Bandura, 1986).

Coaching-based apps commonly employed such tailoring, with generic information provided, followed by prompts for the user to identify their own concerns and goals. For some apps, for example "Quit Now: My Quit Buddy" the highest rated app overall, this invited personalisation, with users able to upload photos, video clips, and audio recordings to remind them of and increase their motivation. As materials perceived as being a better fit for one's own needs and goals are given more weight by individuals (Kreuter, Oswald, Bull, & Clark, 2000), the utilisation of the available technology to enable higher levels of personalisation and tailoring can be considered a strength. Similarly, some apps which enabled users

to enter personal data also allowed them to enter their own goals, in their own words, a commitment strategy which has been found to be effective (US Public Health, 2008). Apps which adopted a coaching framework were rated highest overall, and tended to assist users in identifying and committing to a goal, providing information about ways in which this could be achieved (National Institute of Health and Clinical Excellence, 2007), and normalising and problem-solving potential obstacles and set-backs, all of which has been associated with higher-quality goal setting and a three-fold increase in quit attempts (Lorencatto, Erst, Bruguera, Brose, & Michie, 2015).

A number of apps offered distraction tasks for users who were experiencing smoking cravings. These were often games, for example, digital jigsaw puzzles, a strategy supported by recent studies. The Elaborated Intrusion theory (EI) implicates imagery in cravings (May, Andrade, Panbokke, & Kavanagh, 2010), and recent studies (Skorka-Brown, Andrade, & May, 2014) have found a three-minute game of Tetris to reduce cravings by up to 24% as compared to controls in a wait condition, or up to 13.9% as compared to pre-gaming cravings (Skorka-Brown, Andrade, & May, 2015).

There is limited support for the use of hypnosis in smoking cessation (Barnes, Dong, McRobbie, Walker, Mehta, & Stead, 2010), though hypnosis apps accounted for 11% of the sample. These tended to focus on increasing an individual's sense of agency, which may have increased the likelihood of them engaging in a quit attempt, in line with the Theory of Planned Behaviour (Ajzen & Madden, 1986). Two apps utilised strategies not supported by the evidence base: the use of threatening images, and 'subliminal messages'. As apps are not subject to consumer safety laws the unsupervised use of apps that lack an evidence base or a strong theoretical rationale creates the potential for iatrogenic harm (Power & Gordon, 2015).

One strength of many of the apps was their use of increasingly sophisticated technology, offering users an extensive range of choices and functions (Ubhi, Michie, Kotz, Wong, & West, 2015). Some apps provided push notifications reminding users to track their progress or offering further tips and encouragement throughout the day, which has been suggested as a way of increasing user engagement with an app (Ubhi, Michie, Kotz, Wong, & West, 2015), and therefore the strategy. Some apps urged users to identify "danger" times or locations, and using the device's clock or satellite navigation functions, offered targeted support when the risk of smoking was likely to be higher. For one app (Quit Pro: stop smoking now) users were encouraged to utilise the satellite navigation function; however, the facility was locked to free users, requiring a paid upgrade. Free apps may not therefore represent the full extent of available innovations and strategies. Although apps generally performed poorly with regards to encouraging social support for a quit attempt (24.4%), those that did frequently made use of the phone, linking users to websites and forums, and social networks. More ambitious apps (often those rated as more adherent) allowed users to call Quitlines directly from the app, or to identify and call or email quitting "buddies" to support them.

Overall, apps performed poorly on strategies related to sources of external support. The Clinical Practice Guidelines for Treating Tobacco Use and Dependence (US Public Health, 2008) state that as tobacco dependence is a chronic disease, follow-up interventions are required to reduce the risk of relapse. Even with the use of NRT, only 15% of those making a quit attempt reach 28 days' abstinence (Ubhi, Michie, Kotz, Wong, & West, 2015). However, none of the apps encouraged users to access additional support from a health care provider. Similarly, combined behavioural counselling and pharmacological treatment has been found to be

effective in smoking cessation, with the combination superior to either alone (Lancaster & Stead, 2005). This was recommended by just 13.4% of apps. Though Quitline counselling has been found to be effective, especially where the option of call-back support is offered (Stead, Hartmann-Boyce, Perera, & Lancaster, 2013), this was suggested by just 6.1% of the apps rated. The failure of the majority of these apps to draw on strategies known to be effective in smoking cessation is a considerable weakness, and an area in which app designers should seek improvement to better support those looking to quit.

Very few of the apps reviewed here either assessed a user's willingness to quit (9.8%,) or advised users to quit (13.4%). The Clinical Practice Guidelines for Treating Tobacco Use and Dependence (US Public Health, 2008) suggest all smokers are advised to quit clearly, and strongly, and encouraged to identify personal reasons for doing so. In addition, since a smoker's motivation to change might be contingent on their beliefs about personal relevance of risk-related information (susceptibility) and risk severity (Janz & Becker, 1984), it is important that these are considered by app designers. Furthermore, failure to assess willingness to quit may prevent apps from appropriately targeting an individual's stage of change (Prochaska, DiClemente, Velicer, & Rossi, 1993), resulting in poorer outcomes.

Whilst 85.7% of apps rated by Bennett *et al.* (2015) were found to assist with a quit plan, this was the case for just 28% of the apps rated in this review. This large discrepancy may be accounted for, at least in part, by the substantial shift towards calculator/calendar style apps, the purpose of which is self-monitoring, with limited additional content. These apps may not seek to promote quitting, but rather to support a quit attempt once it is initiated by allowing the user to track their progress.

Though the majority of apps enquired about a user's tobacco use (74.4%), this was sometimes asked in an ambiguous fashion such that the answer did not provide reliable information about the user's stage in a quit attempt. Many of the apps assumed the user's quit date to be on the day the app was downloaded. It has previously been found that users downloading such apps were keen to initiate an attempt immediately (Ubhi, Michie, Kotz, Wong, & West, 2015), however this may not always be the case. Whilst some users may impulsively download an app and begin a quit attempt without prior planning, possibly in line with a specific trigger (e.g. a sudden threat to their health) (West & Sohal, 2006), others may be contemplating a quit and simply reviewing the available support. For the latter group, eliciting a specific quit date would increase the likelihood of them initiating a planned quit attempt (Lorencatto, Erst, Bruguera, Brose, & Michie (2015).

Many apps failed to allow for slips or lapses and offered only dichotomous categories (smoker/quit) dependent on the last time the user had smoked. Some apps reset the quit date if a user declared a lapse, thus expunging their existing progress, whilst others offered no facility to report lapses, and therefore offered a misleading picture of the quit attempt as a whole. User reviews on the Play Store frequently expressed frustration about this, and studies suggest users should be able to update where they are in terms of stage of change and have apps respond to this, since quitting is not a linear process (Noar, Benac, & Harris, 2007).

One other limitation for some of the apps rated in this study was language. These apps represented developers all over the world, including many countries in which English is not the first, and perhaps not even the second spoken language for most people. Although it is understandable that developers would want their app to be available and accessible by as many people as possible, worldwide, it is

problematic for apps to offer information, advice, and support which is incomprehensible due to poor translation, or where the credibility of the content undermined by spelling mistakes (Parker, 2012).

Limitations of this review

The apps evaluated in this study were limited to those freely available in the Play Store (Android operating system). As such, the findings may not be representative of smoking cessation apps as a whole, for example those available on Apple devices, or those with paid content.

Due to the limited availability of data relating to the popularity of apps, it was difficult to draw conclusions regarding user preferences and satisfaction. Furthermore, it is likely that app store ratings would be biased, reflecting the opinions of those who felt strongly enough to rate the apps. The number of downloads is provided as categorical data with a wide range. It has been found that 26% of apps downloaded are only ever opened once, and 75% have been abandoned by the tenth use (Consumer Health Information Corporation, 2014). As such, this review has not sought to draw conclusions regarding user preference or uptake, though this is clearly of interest for future research.

It was also beyond the remit of this review to investigate whether apps were used as standalone interventions, or accompanied formally supported quit attempts. As such, it is unclear whether users seek mobile apps as a standalone intervention, or as a supplement to more formal treatment for tobacco dependence.

Every effort was made to ensure the evaluation was comprehensive and considered every aspect of the apps' functionality, however, due to the device's

limited internal memory no app remained installed for longer than two weeks. There therefore remains the possibility that content unlocked beyond this point may have been missed and thus unrated.

Conclusions

Overall, apps did not score highly for use of Clinical Practice guidelines, with fundamental strategies such as assessing willingness to quit, advising users to quit, and referring users to evidence-based external sources of support rarely present. There has been a noticeable shift in the prevalence of apps using a rationing strategy since the last review of Android apps for smoking cessation (Bennett *et al.*, 2015). Although it seems unlikely the diverse range of apps now available is driven by awareness of developments in smoking cessation research, most apps used strategies at least partly supported by the evidence base, whether by accident or design.

Smoking cessation apps appear to capitalise on advancing technology, utilising the functions of smartphones to record real-time information about users' behaviours, or to respond to a user's reported needs, location, or usual patterns of behaviour.

Many apps were simplistic, and best able to provide simple tracking tools which may improve users' awareness of their smoking behaviours but little more. Though coaching apps performed best overall, they too failed to meet a number of clinical strategies, despite more often being designed by experts or health or governmental bodies (e.g. the NHS, or the Australian government). Though apps appear to have advanced in terms of technology and shifted in terms of preferred

strategies since Bennett *et al.*'s (2015) review, little progress has been made in the way of adherence to the clinical guidelines.

'Smoking cessation apps' may be considered an umbrella term under which a wide range of apps utilising different strategies fall. This variety might fulfil a spectrum of needs, and different types of apps may be used more preferentially as stand-alone interventions or additional support. Of importance, however, are the claims app developers make about the functions of their apps so that users might make informed decisions and download apps with reasonable expectations of their use.

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Part 2: Empirical Paper

Examining the effects of an online intervention promoting isometric exercise in smokers: A pilot study

Abstract

Aims: To investigate the effects of a brief isometric exercise intervention, delivered online, on smoking urges, affect, and the number of cigarettes smoked per day.

Method: Forty-nine participants smoking five or more cigarettes per day were recruited to an online study and randomised to an isometric exercise (IE) or relaxation (body-scan) intervention, which they were asked to use in response to smoking urges over the next 24 hours. Smoking behaviour, smoking urges, mood, affect, and interest and confidence in quitting smoking were assessed pre and post-intervention.

Results: No significant differences were found between IE and relaxation with regards to negative affect or the number of cigarettes smoked in the 24 hours following the intervention, but the reductions in both were highly significant over time. The urge to smoke significantly decreased immediately post-intervention.

Conclusions: Brief IE and relaxation interventions delivered online are equally effective in reducing smoking urges, negative affect, and the number of cigarettes smoked in the 24-hours post-intervention. The mechanisms underlying the effectiveness of these body-focused strategies remain unclear and should be explored in future research.

Cigarette smoking is the leading cause of preventable illness globally (Goldenberg, Danovitch, & IsHak, 2014), accounting for an estimated 5.4 million deaths per year (Civljak, Stead, Hartmann-Boyce, Sheikh, & Car, 2013). Tobacco is responsible for the deaths of approximately half of all users (ASH (Action on Smoking and Health), 2015), and just three cigarettes per day is enough to cause potentially fatal heart disease (WHO (World Health Organisation), 2014). It is well established that cigarette smoke, containing 67 chemicals, is carcinogenic (Goldenberg, Danovitch, & IsHak, 2014).

There are estimated to be 10 million smokers in Great Britain; one sixth of the UK population (ASH, 2015), with the highest rates amongst people aged 25-34 years. From 2013-2014 almost 454,700 hospital admissions and 17% of all deaths of adults aged over 35 years in the UK were attributable to smoking (Health and Social Care Information Centre, 2015). The impact of smoking on physical health is indeed severe, as highlighted by findings that those who had never smoked were twice as likely to survive from age 25 to 79 years, as current smokers (Jha *et al*, 2013).

It is estimated that if current smoking trends continue, tobacco will be implicated in the deaths of over eight million people per year by 2030 (WHO, 2008), due to respiratory, vascular, neoplastic, and other diseases (Jha *et al*., 2013), placing an extreme financial burden on society. In 2015, the annual cost of cigarette smoking in England was estimated to be £13.9 billion (ASH & LeLan Solutions, 2015), with NHS costs of £2.7 billion per year (BMA, 2016). In addition to health concerns and financial strain, smoking has also been found to be associated with lower quality of life, with the children of mothers who smoked ten or more cigarettes per day rated as having a quality of life 2.7% lower than children whose mothers smoked fewer than

three per day (Ventegodt & Merrick, 2003). The children of women who smoke may also be at increased risk of sudden infant death syndrome, or be born prematurely or with low birth weights (Surgeon General, 2014), with consequences for their later well-being and development.

The substantial financial burden of the 'tobacco epidemic' (WHO, 2015) has resulted in global efforts to promote smoking reduction and cessation via increased taxation, evidence-based practitioner training (Brose, West, Michie, & McEwen, 2014), smoking bans (SmokeFree England, 2015) and an increase in the age restriction on tobacco products (NHS Choices, 2014). The NHS offers interventions including nicotine replacement treatment (NRT) and practical and emotional support (NHS Smokefree, 2014), with 1.8 million prescriptions for NRT dispensed in 2013-2014 (Health and Social Care Information Centre, 2015). For those who are able to quit and remain abstinent the impact on physical wellbeing can be profound, with cessation prior to the age of 40 years reducing the risk of death associated with smoking by 90% (Jha *et al*., 2013). However, despite a wide range of available support, a significant proportion of individuals still struggle to successfully quit smoking and remain abstinent (Zhou *et al.*, 2009).

According to a survey by ASH (2015) approximately two-thirds of current smokers report an interest in quitting, but 60% would struggle to last a whole day without smoking. Of those who attempt to quit smoking without professional support or nicotine replacement treatment (NRT), just 3-5% achieve prolonged abstinence (Hughes, Keely, & Naud, 2004). The process of quitting is often lengthy, with the majority of smokers making several attempts before succeeding. In a sample of 146 interviewees most reported having made at least three serious quit attempts (Larabie, 2005). The majority of relapses occur within the first eight days of

smoking cessation (Hughes, Keely, & Naud, 2004), and these frequently result in a full relapse (Brown, Lejuez, Kahler, Strong, & Zvolenksy, 2005), suggesting smokers find it difficult to achieve sustained abstinence.

Medications such as varenicline, bupropion, and NRT are known to be effective smoking cessation treatments with a strong evidence-base, yet many smokers relapse after ending their use of these treatments (Aubin, Lucquiens, & Berlin, 2014). Furthermore, the use of such medications is not without risk. Whilst a standard dose of varenicline doubles the chances of a successful quit attempt (Cahill, Stead, & Lancaster, 2012) it is associated with unpleasant side effects including depressed mood, suicidal thoughts and urges, and agitation, and may increase the risk of cardiac problems in those with a pre-existing vulnerability. As such, some individuals may decide to manage their quitting process without medication (Hughes, Keely, & Naud, 2004), further lowering their chances of a successful quit attempt.

One commonly reported obstacle to quitting smoking is cravings. Smoking cessation is associated with urges to smoke (Cahill, Stead, & Lancaster, 2012), and tobacco withdrawal symptoms are not unlike symptoms of mild depression such as low mood, irritability, poor concentration, and disturbed sleep (Roberts, Maddison, Simpson, & Prapavessis, 2012). The urge to smoke is at its strongest the day after the quit attempt begins, and appears to reduce with time. The strength of this desire to smoke (or craving), is a strong predictor of relapse (Doherty, Kinnunen, Militello, & Garvey, 1995) and may play a crucial role in the high relapse rates within the first eight days of a quit attempt. Wray, Gass, and Tiffany (2013) describe two types of craving which are thought to differentially affect relapse. In particular, "tonic" or background craving is related to the nicotine deprivation arising from abstinence. Alternatively, cue-induced craving is triggered by environmental cues previously

associated with smoking behaviours. Of the two, tonic, but not cue-induced craving is associated with relapse. Cue-induced craving was not significantly related to the outcome of a quit attempt, whilst tonic craving was.

Beyond the neurobiology of addiction, Baker, Piper, McCarthy, and Majeskie (2004) suggest a central role for negative affect. This model emphasises negative reinforcement in the maintenance of addiction. Since withdrawal symptoms are aversive, individuals learn to unconsciously detect early interoceptive cues related to falling substance levels, and respond by re-administering the substance. As the reduction of the aversive emotional state (e.g. low mood or irritability) is rapid, the behaviour is reinforced and the association strengthened, thus maintaining the cycle of addiction. With time this learning generalises, so that any negative affect is managed by self-administration of the substance. In support of this theory, Tiffany and Drobes (1990) found that smoking urges could be triggered even by asking individuals just to imagine a stressful situation.

Following a quit attempt, a smoker may experience high levels of negative affect as a consequence of disturbed sleep, tobacco withdrawal symptoms, and the loss of rewards associated with smoking. This increase in negative affect may increase urges to smoke (Doherty, Kinnunen, Militello, & Garvey, 1995) and make lapses more likely. In line with Baker *et al.'s* model, this behaviour is self-reinforcing, and the individual may subsequently seek the substance with increasing frequency, leading to a complete relapse and failed quit attempt (Piasecki *et al.*, 2000). Smokers have been found to be less effective at coping with negative affect than non-smokers, and may thus be more susceptible to using substances to manage this. Furthermore, those who successfully quit smoking have been found to cope better with intrapersonal challenges than those who subsequently relapsed (Abrams,

Monti, Pinto, Elder Brown, & Jacobus, 1987). As such, it may be crucial for smoking cessation interventions to incorporate techniques for managing negative affect.

Exercise has long been routinely recommended for those engaged in a quit attempt (Ussher, Taylor, & Faulkner, 2012), as part of a healthy lifestyle, and as a way of managing the weight gain associated with smoking cessation (Parsons, Shraim, Inglis, Aveyadr, & Hajek, 2009). Exercise has a positive effect on affect (Reed & Ones, 2006), increases levels of activation and energy (Roberts, Maddison, Simpson, & Prapavessis. 2012), and has been consistently linked with improved mental health outcomes (Brosse, Sheets, Lett, & Blumenthal, 2002), reducing depressive symptoms even in those who are not clinically depressed (Baker *et al.*, 2004). More recently, exercise has been found to reduce smoking cravings (Janse Van Remsburg, Taylor, Hodgson, & Benattayallah, 2009), and to be more effective than passive control conditions at reducing the frequency and strength of desire to smoke (Roberts, Maddison, Simpson, & Prapavessis, 2012).

In one study (Elibero, Janse Van Rensburg, & Drobes, 2011) reductions in urges to smoke, increased positive affect, and decreased negative affect were observed in individuals who completed either 30 minutes of hatha yoga or 30 minutes of cardiovascular exercise (brisk walking) as compared to non-active controls. Exercise has also been found to have a more rapid and consistent effect on tobacco withdrawal symptoms and urges to smoke than oral NRT (West & Shiffman, 2001), which may be preferable for severe cravings with a sudden onset (Ussher, West, Doshi, & Sampuran, 2006), with effects lasting for up to 50 minutes (Taylor, Ussher, & Faulkner, 2007).

Regardless of the duration of the exercise undertaken, many studies found exercise to have a positive impact on withdrawal and cravings, with a resultant two to threefold increase (Taylor, Ussher, & Faulkner, 2007) in the intervals (eight to fifty-seven minutes longer than controls) between cigarettes (Taylor and Katomeri, 2007). This in turn might reduce the number of cigarettes smoked in a day with potential attendant reductions in smoking-related harm. The results of studies on exercise's impact on smoking cessation have been variable, however, with reported findings ranging from a doubled likelihood of abstinence at twelve months post-quit, to no effect (Ussher, Taylor, & Faulkner, 2012). This appears to be related to methodological problems and a wide variability in study designs and measures used.

Although a Cochrane review concluded that "there is strong evidence to recommend exercise as an aid for reducing tobacco withdrawal and cravings" (p10., Ussher, Taylor, & Faulkner, 2012) the mechanisms underlying the benefits of exercise for smoking cessation remain unclear. In an fMRI study (Janse Van Remsburg, Taylor, Hodgson, & Benattayallah, 2009), post-exercise imaging revealed hypo-activation in the parietal lobe, parahippocampal and fusiform gyrus (associated with visual processing), orbitofrontal cortex (motivation), and caudate nucleus (reward) and a shift in activation to Brodmann Area 10. These individuals reported lower cravings during and after exercise than the inactive control group. Janse Van Remsburg *et* al, (2009) theorised that whilst participants in the experimental group may have experienced smoking related images as being more salient due to a period of deprivation and access to their full cognitive resources, those in the control group may have experienced a selective impairment in their pre-frontal dependent cognitive control as a result of the exercise. As the resources allocated to the brain are finite and the maintenance of homeostasis whilst performing exercise is demanding, brain

regions not directly involved in the task might be temporarily inhibited. As such, the reduction in smoking cravings in those who completed exercise might be a result of brain regions such as the reward and motivation centres being temporarily offline.

Other hypotheses for the role of exercise in the reduction of cravings include a suggestion that exercise might be a substitute reinforcer for quitters, improving their self-esteem and perceived ability to cope (Ussher, Taylor, & Faulkner, 2012), and that it may alleviate otherwise obstructive fears about weight gain (Parsons, Shraim, Inglis, Aveyadr, & Hajek, 2009). Exercise might also increase positive affect, acting as a protective factor against cravings (Everson, Daley, & Ussher, 2008). It is also posited that smoking urges are driven by both the need to relax and the need for stimulation, and that exercise can meet both needs by reducing tension and increasing activation, thus mimicking the effects of tobacco (Parrott, 1998).

Studies have reached different conclusions regarding the recommended intensity and duration of exercise for those attempting to quit smoking, with a wide range of intensities appearing to be effective (Roberts, Maddison, Simpson, & Prapavessis, 2012). Although vigorous exercise (corresponding to 60-85% of the age adjusted maximum heart rate reserve (HRR)) has been found to have a positive effect on withdrawal symptoms (Roberts *et al*., 2012), it has also been associated with psychological distress (Everson, Daley, & Ussher, 2008), decreased positive well-being (Roberts *et al*., 2012), and increased desire to smoke during exercise, although this does not persist post-exercise. These findings support Baker *et al.'s* (2004) theory, with the individual responding to the aversive physiological and emotional state induced by the strain of vigorous exercise, with a desire to smoke. This suggests vigorous exercise may not be ideal for those who are addicted, or those who are experiencing the dysphoria associated with tobacco withdrawal. It may also

be difficult for unmotivated and dysphoric individuals to form a new habit which is not positively reinforcing, and for a sedentary smoker to commence exercise at such an intensive level.

Moderate exercise (corresponding to 65-75% of the age-adjusted maximum HRR) has been found to have approximately similar outcomes to vigorous exercise (Scerbo, Faulkner, Taylor, & Thomas, 2010) for cravings and desire to smoke, but without the aversive mood states associated with vigorous exercise. In Roberts *et al*.'s (2012), meta-analysis, vigorous or moderate-intensity exercise had much greater effects on tobacco cravings than light exercise in the short-term, however all significant differences in cravings at thirty-minutes post treatment were for light-moderate intensity exercise. Positive affect increased and negative affect decreased immediately after thirty minutes of moderate-intensity walking (Elibero, Janse Van Rensburg, & Drobes, 2011), or ten minutes' moderate intensity cycling (Everson, Daley, & Ussher, 2008) and brisk walking for ten to fifteen minutes reduced cravings for twenty-minutes post-exercise (Taylor, Ussher, & Faulkner, 2007). Moderate exercise may therefore be more realistic for this population, yet provide similar outcomes.

Light (or low-intensity) exercise such as yoga, has also been linked to significant reductions in smoking cravings in participants presented with smoking-related or neutral images after exercise (Elibero *et al.*, 2011) and evidence suggests light-moderate exercise may help increase the intervals between cigarettes (Roberts *et al*., 2012). Low intensity exercise also has the advantage of being possible for people of all levels of fitness, and is thus achievable and less likely to be aversive. This may make the resultant positive feelings more apparent than in higher-intensity exercise (Conn, 2010). Furthermore, some forms of light-intensity activity, such as

'isometric exercise' (IE), can be used anywhere, are discreet, and are quick and easy to learn (Ussher, West, Doshi, & Sampuran, 2006). IE is a type of exercise in which the muscles are contracted and maintain a constant length in a stationary position, without moving the joints, for example by pressing on the thighs (Ussher *et al*., 2006). It can be completed while seated or standing, without visible movement, and may therefore be well-suited to smokers, who may experience sudden, intense cravings at any point during their day (Taylor, Ussher, & Faulkner, 2007).

Isometric exercise has been found to significantly reduce desire to smoke both immediately and five-minutes post-exercise (Ussher *et al.,* 2006) though the findings are modest. In the first smoking cessation and exercise study conducted primarily through online instruction, Ussher, Cropley, Playle, Mohidin, & West (2009) found both body scanning and isometric exercise to effectively reduce desire to smoke and withdrawal symptoms in temporarily abstinent smokers. However, compared to the control group, participants' cravings remained lower for just five minutes in their normal environments, as compared to thirty minutes in the laboratory. The authors concluded that this may have been due to an insufficient "wash out" period between measures, whereby the effects of the initial intervention in the laboratory had yet to wear off at the time of the second ratings. Whilst more ecologically valid, the findings of this study may have been somewhat confounded by an overlap between the two active conditions, with those in the isometric exercise group receiving a small portion of body scanning guidance also.

Although moderate-intensity exercise may be associated with stronger effects on cravings, leaving the office for a brief episode of cycling or a brisk walk may be disruptive, unlike a relatively unobtrusive short episode of isometric exercise at the desk. For more sedentary smokers, the introduction of a physically demanding

regime in the context of another major health change might also be overwhelming (Ussher, Taylor, & Faulkner, 2012) and result in negative affect, which may in turn increase the risk of relapse. Isometric exercise may thus be better suited to the needs of smokers, which may result in higher levels of uptake and adherence (Roberts, Maddison, Simpson, & Prapavessis, 2012).

In the current economic climate, and with the financial burden of smoking to society being so high, there is an increasing emphasis on low-cost interventions, many of which are delivered online. The internet is now an indispensable part of daily life for people across the world (Civljak, Stead, Hartmann-Boyce, Sheikh, & Car, 2013) and interventions delivered in this way may especially appeal to time-poor individuals and young people. To date, we are aware of just one study (Ussher et al, 2009) which has examined bouts of exercise performed in an individuals' 'normal environment', with the first half of this study being conducted in a laboratory. Further ecologically valid research is required to test the potential for exercise-based interventions for managing smoking cravings and withdrawal symptoms in everyday life, and to identify the challenges and limitations of such approaches.

This study therefore seeks to investigate the effects of a brief isometric exercise intervention, delivered online, on smoking cravings, mood, and the number of cigarettes smoked per day. The online nature of this study will offer increased ecological validity, and permit participants to utilise the intervention in an "as and when" fashion, testing its utility in times of need, rather than at prescribed intervals. It is proposed that by teaching participants this body-focused strategy they may develop a stronger ability to notice and manage craving episodes successfully, thus increasing the interval between cigarettes and improving their chances of a

successful quit attempt, if and when they decide to make one. Based on the findings of Ussher *et al*., (2009), it is hypothesised that compared to a body scan ('relaxation') control group, those who are instructed in the use of isometric exercise will experience a reduction in the negative affect associated with tobacco withdrawal symptoms and reductions in craving post-exercise, which may reduce the number of cigarettes smoked per day.

Methods

Setting

This was an online study using Qualtrics, a secure online survey software, which could be accessed via any internet-ready device. In an effort to increase ecological validity, participants were not required to have any contact with the researchers and could complete the study entirely at home or in any other convenient location. The researchers were based at University College London, and the study received approval from the ethics committee (appendix 1).

Participants

The main analysis was to involve a repeated measures ANOVA with the aim of detecting a within-between factors interaction. A power calculation was conducted using G-Power (Erdfelder, Faul, & Buchner, 1996) and a small effect size (F =0.1) was assumed due to the online nature of the intervention and uncertainty regarding participant adherence to the protocol. Error probability (α) was set at .05. Power (1-β error probability) was set at 0.8. Using these parameters, the power calculation indicated a sample of 200 was required for this study. Unfortunately, due to

difficulties with recruitment, and the time-limited nature of this doctoral research project, this number was not attained and the study was thus underpowered.

This study included 49 participants aged 20-60 years, with a mean age of 30.92 years (SD= 8.91). 31 participants (63.27%) completed the second (follow up) session 24 hours later.

Participants were recruited using social media, including Facebook, Twitter, and Reddit, and through advertisements on Gumtree and via UCL Communications. Posters were also displayed in workplaces, and participation was invited by word of mouth. The inclusion criteria were to be smoking at least five cigarettes per day, regardless of their level of interest in quitting (though this was assessed) and to be at least eighteen years of age. Although no risks were anticipated, pregnant women and anybody with musculoskeletal problems were excluded from this study as a precaution due to the unsupervised use of a low-intensity exercise. Participants provided with an information sheet (appendix 2) and completed a consent form (appendix 3). They were advised to see their GP if they experienced any discomfort during this study. Participation was incentivised by entering all participants who completed both stages of the study into a prize draw for the chance to win one of four Amazon vouchers (2 x £50, 1 x £100, and 1 x £200). All data was stored in line with the Data Protection Act (1998).

Design

This study employed a between-participants, 2x3 repeated measures design. The 'group' factor had two levels (Isometric Exercise or Relaxation (control)) to which participants were randomised by the Qualtrics software. The within-subjects factor of time had three levels (pre and post intervention, and 24 hours later).

Procedure

On accessing the Qualtrics site, participants were provided with brief information about cravings and the study. They were asked to complete a consent form and some screening questions which terminated the session if inclusion criteria were not met or exclusion criteria were met.

All participants answered questions relating to their demographics, smoking behaviour and interest in quitting, mood, and craving before being randomised into one of the two conditions (isometric exercise (IE) (n=25) or relaxation (n=24)) by the Qualtrics software (figure 1). Participants then watched a video dependent on their allocated condition and completed further questionnaires relating to mood, craving, and the credibility of the strategy they were instructed on. Participants were reminded to employ the strategy for the next 24 hours whenever they experienced an urge to smoke. Immediately after completing session one, participants were emailed an instruction sheet (appendix 4, and appendix 5) for their reference, reminding them of the stages of the intervention.

Twenty-four hours later they received an email inviting them to complete the second session of the study, during which they repeated the mood and craving questionnaires, and answered questions relating to their smoking behaviour and use of the strategy in the previous twenty-four hours, their intention to use it in the future, and their interest in quitting.

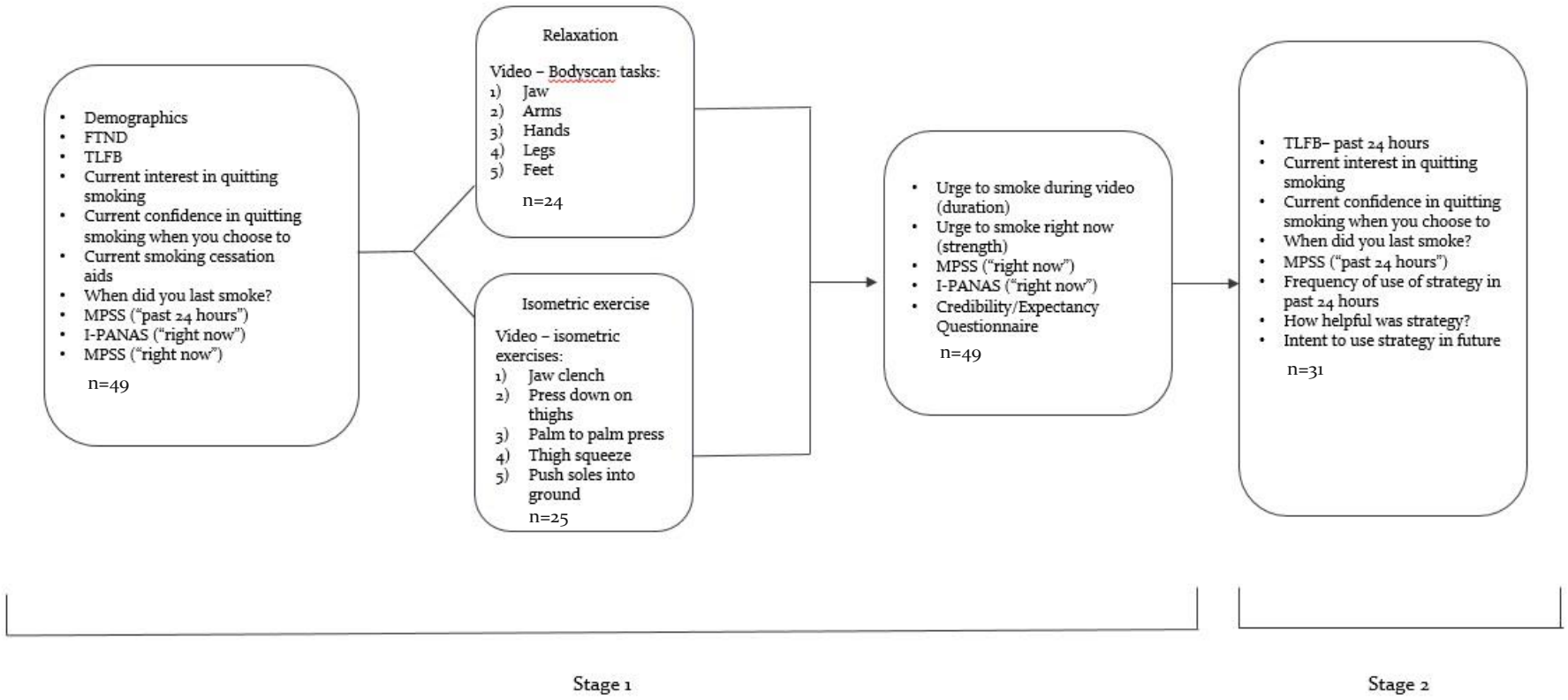

Figure 1: *Study procedure over the course of two sessions*

Experimental Conditions

The relaxation condition consisted of a body-scanning exercise adapted from Ussher, Cropley, Playle, Mohidin, and West (2009). This task was selected for the control group as it allowed participants in both conditions to have as similar an experience as possible, with the exception of the active ingredient; exertion (Isaac & Michael, 1995). No passive control condition was included as this has been found to potentially exacerbate negative affect (Ussher, West, Doshi, & Sampuran, 2006).

To control for any effect of actor's gender, two videos were created for IE and two for relaxation, with one for each condition using a male actor with a female narrator, and one with a female actress and a male narrator. Individuals were randomised to conditions, then actor gender. The instructions included in the videos were delivered via narration and subtitles, and were exactly matched for the number of words for each task in each condition.

Participants were asked to follow along with the video and to utilise the strategy they learned from this whenever they experienced an urge to smoke over the next 24 hours.

Isometric Exercise. Isometric exercise (IE) is an exercise in which the muscles are contracted and maintain a constant length in a stationary position, without moving the joints, for example by pressing on the thighs with the hands (Ussher et al., 2006). Ussher, Cropley, Playle, Mohidin, & West, (2009) found ten minutes of isometric exercise to significantly reduce cravings for up to 30 minutes in a laboratory setting, and five minutes in an individual's 'normal' environment.

In this study, individuals were introduced to IE by a short video (approximately seven minutes long) in which they were asked to follow along as an actor demonstrated five different exercises. The video was narrated, and accompanied by subtitles. Participants were asked to ensure they were seated comfortably before they began. Subsequent to the initial orientation to the task, participants spent one minute on each exercise before being asked to rest briefly, then begin the next exercise. The exercises were i) jaw clenching, ii) pressing the palms of the hands down onto the thighs, iii) pressing the palms together, iv) squeezing the thighs together, and v) pressing the soles of the feet into the floor. Each tense, press, or squeeze was held for three seconds before releasing and repeating over the course of one minute.

Body scan. Body scanning is a mindfulness technique used to bring attention to the present moment and focus entirely on bodily sensations and breathing. This too has been found to be effective in reducing tobacco cravings, though it was used for a longer period of time (ten minutes) (Ussher, Cropley, Playle, Mohidin, & West, 2009).

In this condition, participants were introduced to 'relaxation' (body-scanning) using the same method as in the IE condition. The video focused on five areas of the body matched to those targeted by the IE condition, starting with the jaw, then the arms, then hands, legs, and feet. Each part of the body was focused on for one minute, during which individuals were instructed to focus on any sensations in this area, be it temperature, tingling, or tension.

After the videos, all participants were asked to complete further questionnaires about their mood and cravings, and their confidence in the exercise. They were asked to use the strategy they had just learned for five minutes whenever they experienced an urge to smoke over the next 24 hours. This session of the study took approximately fifteen minutes to complete, including the videos. All participants were automatically emailed a reminder sheet detailing how to complete each stage of their strategy, and after 24 hours, were sent an automatic invitation to complete the second session of the study.

The second session of the study consisted of questions about their smoking, cravings, mood, and use of the strategy in the past 24 hours, and took no more than five minutes to complete. All participants who completed the second half of the study were automatically entered into a prize draw to win Amazon vouchers.

Measures

Demographics. Participants were asked to report their age, gender, and highest level of education.

Smoking-related parameters. Participants were asked about smoking and first completed the six item Fagerstrom Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) to assess their level of dependency on cigarettes. As accurate data about the number of cigarettes smoked at each time point was required for this study, the multiple choice responses to the question "How many cigarettes do you smoke per day?" were replaced with a free text option. Participants' responses were scored using the original scoring criteria,

with a score of 1-2 indicating low dependence, 3-4 low to moderate dependence, 5-7 moderate dependence, and 8+ high dependence.

To establish a baseline for their usual rate of smoking, participants were asked to report how many cigarettes they had smoked each day over the past seven, using a Timeline Follow-back (TLFB) approach (Sobell *et al.*, 1980). They were encouraged to try to remember how many cigarettes they had smoked each day using any special events or memorable occasions as cues, and to make a best guess or estimate for those days when they were uncertain. Participant smoking behaviour was assessed using the TLFB method in both the first and second sessions. The seven day TLFB was used descriptively, and the 24 hr TLFB for the first and second sessions as an outcome measure.

Interest in quitting or reducing current levels of smoking was gauged using a scale ranging from "none" to "total interest". Participants' confidence in their ability to quit when they chose to was gauged in the same way, with a scale ranging from "not at all confident" to "extremely confident". All participants were asked whether they were currently using any smoking cessation aids, and to record the time since their last cigarette.

Withdrawal and craving. Participants completed the MPSS (Mood and Physical Symptoms Scale) (West & Hajek, 2004) before the video. The three items pertaining to physical health complaints (e.g. "have you experienced any of the following over the past 24 hours?": sores in the mouth, constipation, cough/sore throat) were not included as they were not deemed to be relevant to this study. Participants were required to report the intensity of their depressive, anxious, and irritable feelings and how much they had experienced restlessness, hunger, poor

concentration and poor sleep at night on a scale from “not at all” to “extremely”, as well as rating the frequency (from “not at all” to “all the time”) and strength (“no urges” to “extremely strong”) of their urges to smoke in the past 24 hours. They were asked to repeat this questionnaire in the second session of the study, again pertaining to how they had felt in the past 24 hours.

Prior to viewing the video, participants were also asked to rate how strongly they felt depressed, anxious, irritable, restless, and hungry, their urge to smoke, and how much they felt they were experiencing poor concentration and poor sleep at night, “right now”. This measure was repeated directly after the video to capture any change.

Before watching the video, participants completed the I-PANAS (the international positive and negative affect schedule, short-form) (Thompson, 2007). The question was reworded to ask participants “to what extent do you currently feel...?” upset, hostile, alert, inspired, nervous, determined, afraid, attentive, or active, on a scale from “very slightly or not at all” to “extremely”.

After they had viewed the video, participants were asked how much of time they had felt the urge to smoke while viewing, and how much they felt the desire to smoke *right now* (post-video). They then repeated the I-PANAS to report how they felt “right now”, allowing the immediate effects of the intervention to be assessed.

Finally, all participants were asked to complete the Credibility/Expectancy Questionnaire (Devilly & Borkovec, 2000) to assess their conviction that the intervention could influence their smoking behaviour. This required them to rate how logical the strategy seemed to them, from “not at all logical” to “very logical”, how successful they thought the strategy would be in helping them manage their cravings, from “not at all useful” to “very useful”, how much improvement they

expected to see in their smoking cravings over the next 24 hours if using the strategy (from 0-100%), how much they really *felt* the strategy would help them manage their smoking cravings (from "not at all" to "very much"), and how much improvement they really *felt* would occur in their smoking cravings over the next 24 hours (from 0-100%).

In the second session of the study, participants were asked how often they had responded to cravings using the strategy they had learned, on a scale of 0-100, with 0 representing "not at all" and 100 "all the time". They were also asked how useful they had found the strategy on a scale of 0-100 with 0 being "not at all" and 100 "extremely". Participants were asked how much they intended to use this strategy in future, with 0 being "not at all", and 100 being "fully" and provided with space for free text to explain why.

Results

Participants took an average of 13.75 minutes (SD=4.91) to complete session one of the study, and 4.02 minutes (SD=2.14) to complete session two.

Demographics and smoking baseline

The two groups did not significantly differ in terms of demographics or baseline smoking characteristics (see table 1). Independent *t*-tests found no significant differences between groups for age (*t*=-0.03, df=47, p=0.97), or years of education (t=-1.73, df=47, *p*=0.09), and chi-squared tests revealed no significant differences for gender (χ^2=0.48, *p*=0.57), ethnicity (χ^2=5.08, *p*=0.40), or use of smoking cessation aids (χ^2=0.71, *p*=1.00).

Further independent *t*-tests found no significant differences between groups for baseline scores on the Fagerstrom Test for Nicotine Dependence (FTND) (t=1.50, df=47, p=0.14), the minutes since the last cigarette was smoked (t=-0.16, df=47, p=0.87), the number of cigarettes smoked the day before participating in the study (24 hr TLFB) (t=0.69, df=47, p=0.49), interest in quitting (t=0.07, df=47, p=0.95), confidence in quitting (t=-0.89, df=47, p=0.38), or total cigarettes smoked in the past seven days (t=1.50, df=47, p=0.14).

Table 1

Demographic information and smoking baseline

	Isometric Exercise (IE) (*n*=25)	Relaxation (*n=24)*
Male	9	11
Female	16	13
White British	9	10
Asian British	0	2
Mixed British	1	1
White Other	11	10
Asian Other	1	1
Other Ethnicity	3	0
Using Smoking Cessation Aid	6	5
	Mean (SD)	*Mean (SD)*
Age	30.96 (6.85)	30.88 (10.98)
Years of education	16.44 (2.06)	15.33 (2.41)
FTND Score	3.80 (4.71)	4.71 (1.99)
Minutes since last cigarette	283.72 (551.29)	256.38 (624.38)
Cigarettes smoked yesterday	10.40 (8.33)	11.88 (8.33)
Interest in quitting	76.48 (28.74)	77.00 (25.91)
Confidence in quitting	42.96 (22.10)	37.71 (19.30)
Cigarettes smoked in past 7 days (TLFB total)	79.96 (43.51)	90.50 (54.37)

Demographics and smoking baseline of participants who completed both sessions compared with those who did not

The two groups did not significantly differ in terms of demographics or baseline smoking characteristics (see table 2). Independent *t*-tests found no significant differences between groups for age (*t*=31.03, df=47, p=0.91), or years of education (t=0.15, df=47, *p*=0.88), and chi-squared tests revealed no significant differences for gender (χ^2=0.04, *p*=0.83), ethnicity (χ^2=4.67, *p*=0.46), or use of smoking cessation aids (χ^2=0.46, *p*=0.50).

Further independent *t*-tests found no significant differences between groups for baseline scores on the Fagerstrom Test for Nicotine Dependence (FTND) (*t*=1.34, df=47, *p*=0.63), the minutes since the last cigarette was smoked (*t*=0.50, df=47, *p*=0.37), the number of cigarettes smoked the day before participating in the study (24 hr TLFB) (*t*=-0.91, df=47, *p*=0.37), interest in quitting (*t*=0.74, df=47, *p*=0.46), or total cigarettes smoked in the past seven days (*t*=-0.83, df=47, *p*=0.41). There was a significant difference in confidence in quitting (*t*=2.18, df=47, *p*=0.04) between those who completed and those who did not complete both sessions of the study.

Table 2

Demographic information and smoking baseline for completers vs. non-completers

	Completers (*n*=31)	Non-Completers (*n=18)*
Male	13	7
Female	18	11
White British	14	5
Asian British	1	1
Mixed British	1	1
White Other	13	8
Asian Other	0	2
Using Smoking Cessation Aid	6	5
	Mean (SD)	*Mean (SD)*
Age	31.03 (9.48)	30.92 (8.41)
Years of education	15.94 (2.46)	15.83 (2.01)
FTND Score	3.94 (2.19)	4.78 (2.02)
Minutes since last cigarette	302.03 (651.51)	215.72 (450.57)
Cigarettes smoked yesterday	10.39 (6.68)	12.39 (8.61)
Interest in quitting	78.94 (24.60)	72.94 (22.21)
Confidence in quitting	45.00 (22.21)	32.44 (15.41)
Cigarettes smoked in past 7 days (TLFB total)	80.68 (44.90)	92.78 (55.65)

Acute effects of intervention

Repeated measures ANOVAs were used to analyse the immediate impact of the interventions. Prior to watching the intervention videos, the mean rating for urge to smoke 'right now' (MPSS) was 1.50 (SD=1.14) for the relaxation group, and 1.72 (SD=1.28) for the IE group, indicating both groups were experiencing 'slight' smoking urges. Post-video the relaxation group mean decreased to 1.13 (SD=1.19), and the IE group mean decreased to 1.24 (SD=0.97). The main effect of time ($F(1,47)=6.39$, $p=0.02$) was significant. However, there was no interaction between time and group ($F(1,47)=0.10$, $p=0.76$).

Prior to watching the intervention videos, the relaxation group mean for negative affect (IPANAS) was 9.08 (SD=3.92), whilst the IE group mean was 9.04 (SD=3.79). Post-video the relaxation group mean decreased to 7.33 (SD=3.50), whilst the IE group mean decreased to 8.04 (SD=4.10). The main effect of time was again significant ($F(1,47)=12.78$, $p=0.001$), however there was no significant interaction of time and group ($F(1,47)=0.95$, $p=0.34$).

Pre-video means for positive affect (IPANAS) were 11.92 (SD=3.69) for the relaxation group, and 11.88 (SD=4.01) for the IE group. Post-video, positive affect decreased very slightly for both groups, with group means of 11.67 (SD=3.47) for the relaxation group, and 11.36 (SD=3.78) for the IE group. There was no main effect of time ($F(1,47)=0.94$, $p=0.34$), nor a significant interaction between time and group ($F(1,47)=0.16$, $p=0.74$) for positive affect.

Effects of intervention at 24-hour follow-up

Further repeated measures ANOVAs were used to analyse the impact of the intervention on smoking in the previous 24 hours. At session one the relaxation

group mean for ratings on the MPSS relating to the past 24-hours was 25.63 (SD=7.97) out of a possible 45, whilst the group mean for IE was 23.93 (SD=6.52). At session two, after twenty-four hours of learning the strategy, the relaxation group mean MPSS rating score had decreased to 19.31 (SD=7.74), whilst the IE group mean had decreased to 18.87 (SD=7.18). The main effect of time was highly significant ($F(1,29)=18.21$, $p=0.00$), however, there was no interaction between time and group ($F(1,29)=0.22$, $p=0.64$).

At session one the relaxation group mean for confidence in their ability to quit when desired was 41.81 (SD=20.52) whilst the IE group mean was 48.40 (SD=24.12). At session two, the relaxation group's mean confidence rating had increased to 49.19 (SD=20.39) whilst the IE group's mean confidence rating had decreased to 44.47 (SD=24.45). However, the interaction between time and group was not significant ($F(1,29)=1.91$, $p=0.18$). There was no main effect of time ($F(1,29)=0.18$, $p=0.68$).

At session one the relaxation group mean for interest in quitting smoking was 76.94 (SD=23.24), whilst the IE group mean interest rating was 81.07 (SD=26.53). At session two, both groups' mean levels of interest in quitting had slightly reduced, with the relaxation group mean at 73.25 (SD=23.25) and the IE group mean 74.53 (SD=29.70). There was no main effect of time ($F(1,29)=3.17$, $p=0.09$) and no interaction between time and group ($F(1,29)=0.25$, $p=0.62$).

There was a significant main effect of time ($F(1,29)=8.79$, $p=0.01$) on the number of cigarettes smoked in the 24-hours prior to session one, compared to session two. In session one, the relaxation group mean for cigarettes smoked was 10.50 (SD=7.59), decreasing to 6.75 (SD=5.31) at session two. At session one the IE group mean for cigarettes smoked in the past 24-hours was 10.27 (SD=5.82),

decreasing to 5.93 (SD=6.15) by session two. There was no interaction between time and group ($F(1,29)=0.05$, $p=0.83$).

Use of the strategies

At the 24-hour follow up, participants in the IE ($n=15$) and relaxation ($n=16$) conditions reported having used the strategy 56.67% (SD =23.69) and 56.88% (SD=30.02) of the time when experiencing craving, respectively. An independent samples *t*-test found no significant difference in the reported use of the strategy between the two groups ($t=0.02$, df=29, $p=0.98$).

The mean rating for the relaxation intervention was 51.19 (SD=27.11), whilst the mean score for the IE intervention was 55.40 (SD=25.03). An independent *t*-test found no significant difference ($t=0.45$, df=29, $p=0.66$).

When asked how much they intended to use the prescribed strategy to manage their smoking cravings in future, where o was 'not at all' and 100 was 'fully', the mean rating for the relaxation intervention was 58.75 (SD=29.71), whilst the mean score for the IE intervention was 63.53 (SD=21.30). An independent *t*-test found no significant difference between the two group means ($t=-0.51$, df=29, $p=0.61$).

The relationship between negative affect and cigarettes smoked

The reduction in negative affect did not significantly correlate with the number of cigarettes smoked overall ($r(31) = 0.24$, $p=0.19$), nor for the relaxation group ($r(15) = 0.18$, $p=0.51$) or IE group ($r(16) =0.12$, $p=0.40$) individually.

Discussion

Based on previous studies (Ussher *et al*., 2009), it was hypothesised that isometric exercise (IE) would result in a greater reduction in negative affect and urge to smoke, and an attendant reduction in the number of cigarettes smoked per day compared to the body-scan strategy used by the relaxation[1] group. Overall, no significant differences were found between the IE and relaxation groups with regards to either negative affect or the number of cigarettes smoked in the twenty-four hours after the intervention video was viewed, though the reductions in both were highly significant over time. The urge to smoke significantly decreased for both groups immediately following the intervention video, but there was no significant change in positive affect for either group. Neither strategy had a significant effect on confidence or interest in quitting. There were no significant differences between groups with regards to how often the strategies were used, how helpful they were perceived to be, or how much participants intended to use them in future. Those who did not complete the second session of the study were noted to have reported significantly lower levels of confidence in their ability to quit smoking than those who did, which may have informed their decision not to attempt to implement the suggested strategies.

This study supports previous findings that isometric exercise (IE) and body scan interventions are equally effective for reducing smoking cravings and the number of cigarettes smoked (Ussher *et al.,* 2009). Whilst Ussher *et al.*'s (2009) IE

[1] It is recognised that the term 'relaxation' in regard to BS may be a misnomer. However, this is used to ensure consistency with previous studies in this field by Ussher *et al.* (2006;2009) and to describe the intervention in an accessible way for participants.

condition included elements of body-scanning, the IE condition in this study did not, suggesting no benefit to combining IE and body-scanning techniques.

Whilst the majority of previous research has been conducted at least partly in a laboratory (Ussher *et al.,* 2006; Ussher *et al.,* 2009) this study sought to increase ecological validity by asking participants to complete the study entirely in their natural environments, with no enforced period of abstinence. As such, the results may provide valuable information about the effectiveness of the interventions in the context of smokers' everyday lives, as well as an indication of how often the techniques are likely to be used. This in turn may assist us in fine-tuning these interventions to better meet the needs of the intended users. Whilst studies asking participants to abstain prior to utilising the target strategies can draw conclusions as to the usefulness of these for abstaining smokers who are currently engaged in a quit attempt, this study extends these findings by suggesting the strategies may also be useful for smokers who are contemplative and looking to reduce their nicotine consumption rather than quitting completely, at this stage.

Both strategies reduced negative affect immediately post-video to a significant degree. The mechanism by which this change occurred is not clear, and it is possible that negative arousal associated with anticipated smoking abstinence and uncertainty about the nature of the interventions, may have contributed to relatively high pre-intervention negative affect.

It has been theorised that through a process of operant conditioning, smokers learn to respond to negative affect by administering nicotine (Baker, Piper, McCarthy, & Majeskie, 2004) which reduces the unpleasant sensations, thus negatively reinforcing the behaviour. This theory was not supported by this study, where negative affect was not found to be correlated with the number of cigarettes

smoked. However, as the sample size was small, it is possible there was a small effect, but the study was not sufficiently powered to detect it.

As there was not a passive control group in this study, it is important to consider the possibility that the number of cigarettes smoked would have reduced as a result of increased self-monitoring or the Hawthorne effect, as suggested to occur in brief alcohol-related and other behaviour change interventions (McCambridge, Witton, & Elbourne, 2014). In this study, participants were asked to attend to their affect, cravings, and smoking behaviour in a way they may not have done previously. For those engaged in quit attempts, relapses are frequently associated with learned behaviour and habits (West & Brown, 2013) and improving self-awareness can therefore result in better outcomes. Though participants in this study continued to smoke, around one fifth were currently using some form of quitting aid, be it nicotine replacement treatment (NRT), or an online support forum, and the average rating for interest in quitting at baseline was 79 out of a possible 100, where 100 was total interest. As such, highlighting their smoking behaviour may have served to facilitate change for those who were motivated to quit or reduce smoking, independent of the strategies themselves. In order to further investigate this, future research should incorporate a passive control group against which change can be compared.

The mechanism by which IE and body scanning reduce smoking cravings and negative affect is unclear, though it has been suggested that distraction may be involved (Ussher *et al.*, 2006). Simple distraction does not appear to account for the effects of these strategies, however, as smokers frequently attempt to distract themselves without apparent success (Ussher *et al.*, 2006) and the superiority of both IE and body scanning to reading has been demonstrated (Ussher *et al.*, 2009).

A previous study found that during a body scan exercise a number of physiological changes occurred in healthy adults, including decreased respiration rate and increased heart-rate variability, consistent with changes associated with meditation (Ditto, Eclache, & Goldman, 2006). During IE, the heart rate increases when muscles are contracted, and decreases towards baseline between contractions (Leite *et al.,* 2010), and respiration increases in proportion to the level of exertion (Imms & Mehta 1989). It is unclear whether variation in heart rate and respiration might moderate smoking urges and negative affect, however it is of note that hyperventilation is frequently associated with negative affect (anxiety) and slow, deep breaths are prescribed to counteract this. As such, the increased respiration rates associated with IE are unlikely to reduce negative affect. Further clarification on the effects of physiological variables will likely rely on lab-based, rather than internet-based experiments.

Although no specific instructions are given regarding the management of thoughts during these strategies, it is possible that they both invite a level of mindfulness; focusing on particular aspects of experience (breathing, limbs, and sensations) in the present moment and without judgement (Kabat-Zinn, 1994). Indeed, the body scan is a technique often used in mindfulness, for example in the mindfulness component of dialectical behavioural therapy (DBT) (Linehan, 1993) to reduce the distress associated with negative affect by removing the element of judgement or evaluation. Furthermore, a number of studies have found mindfulness to be beneficial to those attempting to quit smoking (Davis, Fleming, Bonus, & Baker, 2006; Brewer *et al.*, 2011; Elwafi, Witkiewitz, Mallik, Thornhill, & Brewer, 2013). Further investigating the relationship between IE and mindfulness may therefore be an avenue for further research.

In line with the idea of increased mindfulness, it is possible that attending to smoking behaviour and cravings can increase participants' awareness of the difficulty involved in quitting, thus, potentially reducing motivation. Although there was a small and non-significant decrease in interest in quitting, it seems unlikely that these impacted on the other outcomes assessed here. For example, smoking urges were rated as lower during session two of the study. It is also possible that despite a reduction in cravings and the number of cigarettes smoked, participants found the strategies to be laborious, and were discouraged by the amount of effort a quit attempt would appear to involve, though again, this is unclear.

As a pilot study, this study lacked the power to detect smaller effects. As such, it is possible that there is a difference between the effectiveness of body scanning and IE which would be detected by a study with a larger sample size. However, given the absence of even a slight, trend-level difference in the results, this seems unlikely, suggesting body scanning and IE are equally effective in reducing negative affect, smoking urges, and consequently, smoking. However, establishing their effectiveness will rely on studies using a suitable non-intervention control group. Whilst internet-based studies are potentially more ecologically valid it is also less possible to control all potential variables, for example, how well participants attended to the instructional videos. Although data relating to the time spent on each page of the study was not collected, and it is thus not possible to determine whether participants watched the videos in their entirety, the average survey completion time of 13.75 minutes suggests they had adequate time to do so. Future studies should include an integrated timer to address this issue; however, it would remain unclear whether all participants followed the instructions as directed.

In common with other online smoking intervention studies, this study relied on self-report measures, as compared to the biometric data collected by Ussher *et al.* (2009), for example, by breathalysing participants. As such, the results are more susceptible to rater error (e.g. in recalling their recent smoking pattern for the timeline follow back) and rater bias, with participants "faking good" in line with the perceived goals of the researcher.

Participants in this study were predominantly young (mean age of approximately 30 years), white British, and highly educated (with the mean level of education at second-year degree level). The mean level of dependency on the FTND was also low, indicating that the majority of smokers in this study were not very strongly addicted. In 2013, 12% of adults in professional or managerial posts smoked, as compared to 29% of those in manual or routine occupations (ASH, 2015). Those with lower levels of education were also amongst the highest smokers, with 34% of those whose highest academic attainment was GCSEs at grade D-G smoking, as compared to 10% of those with a degree (Office for National Statistics, 2014). Rates of smoking are particularly high amongst black Caribbean men (37%), and black Caribbean women (22%) who were not represented in this sample. Though the mean number of cigarettes smoked by our sample was close to the national average of 12.2 per day for men, and 10.5 per day for women (ASH, 2016), this sample cannot be considered to be representative of the British public as a whole, and the results may not therefore generalise.

The demographics of the sample may relate to the method of recruitment, with the primary means being via social media and advertisements on websites. In order for posts to be seen on social media one must either search for a word included in the post, visit a page on which the link was posted, or be known to or "following"

either the researcher or someone in the researcher's network who had shared the post. With limited presence on social media, recruitment can be slow, and those smokers who seek to engage in research with no guaranteed compensation or reward for their time may differ from those who do not. Future recruitment strategies may therefore be improved by offering all participants a small but guaranteed financial reward for their participation, in lieu of an entry into a draw for a bigger prize.

Future research in this area may be improved by the inclusion of a passive control group who are simply monitored to provide comparison with the active control groups. Exploration of the mechanisms underlying the effectiveness of these body-focused strategies remains a priority.

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Part 3: Critical Appraisal

This critical appraisal reflects on the process of conducting doctoral research, and my thoughts, considerations, and learning throughout. A particular emphasis is placed on issues around recruitment as this stage of the process was by far the most stressful, and one on which I have reflected extensively. The implications of this study for the field as a whole are considered.

Choice of topic

Prior to commencing this study, I had little familiarity with the literature on either smoking cessation or the effects of exercise on cravings. Having worked in mental health for some years, however, I was aware of both the high levels of nicotine dependence in clinical populations (Lasser *et al.*, 2000), and the effects of nicotine on both the effectiveness of medications (Lyons, 1999) and the health and lifespan of clients with severe mental illness (Lawrence, Mitrou, & Zubrick, 2009). I had also witnessed high levels of distress in inpatients on wards where clients were not permitted to smoke and had limited opportunities to leave the grounds to do so. Furthermore, I was increasingly aware of peers and colleagues seeking and struggling to quit, perhaps indicating a shift in the social acceptability of smoking. I was therefore interested in the idea that there might be simple, self-initiated ways of managing smoking cravings, which could help those dependent on nicotine to reduce or quit smoking, and reduce the distress associated with involuntary abstinence.

I had not conducted an experimental piece of research since my undergraduate degree some seven years previously, and was concerned that my lack of experience would hinder the design of this study. In an effort to address this, I read widely around the topics of nicotine addiction, management of cravings, and the impact of exercise, to familiarise myself with both the field and the methodology. In

doing so, I found there to be many unanswered questions regarding the mechanisms by which exercise affects smoking cravings, and quite why nicotine addiction is so difficult to overcome. These questions both further piqued my interest, and assured me research in this area would be valuable.

Design considerations

Acutely aware that the methodological choices I made could have a significant impact on the outcome of this study, I liaised closely with my research supervisors throughout the design process. Early on, I began to contemplate what was reasonable to require of a participant who had volunteered for a study for no financial gain. Weighing the demand on participants against the design of an ideal study strongly influenced my decision making, and sometimes led me to question my priorities: was it better to ask more of clients (e.g. recording their cravings immediately before and after each use of the strategy) in order to achieve a richer, more precise data set; or to accept the limitations of a doctoral research study and require less of participants (e.g. an overall rating of cravings in the past 24 hours) resulting in less precise, detailed data, but better recruitment with reduced burden on participants? Ultimately, I worried recruitment would be difficult, and participants were therefore asked to do the minimum I felt necessary to answer my research question, with a view to conducting a full-scale study at a later date should it be indicated by the results of this pilot study.

The design of this study was heavily informed by that of Ussher, Cropley, Playle, Mohidin, and West (2009), and sought to extend their findings. Whilst Ussher *et al,* (2009) concluded that both body scanning and isometric exercise might

be beneficial for managing desire to smoke, they noted that their isometric exercise condition had incorporated elements of body scanning, and future studies may therefore seek to further separate the two. They also recommended further research testing exclusively in a smoker's own environment. To achieve as high a level of ecological validity as possible, we agreed on an online intervention, something increasingly used for behaviour change (Wantland, Portillo, Holzemer, Slaughter, & McGhee, 2004).

Recruitment

Recruiting participants to this study revealed itself to be as difficult as I had feared. As an online study with a potentially small effect size, a large number of participants (250-300) would be needed to achieve adequate power. Although this was a pilot study, I still hoped to recruit as many participants as possible in order to evaluate the potential of further research. As it was possible a strategy designed to manage cravings could help even those who were not seeking to quit during times when smoking was not permitted, I did not want to focus purely on clinical populations or those currently engaged in a quit attempt. I was also concerned that were I to focus purely on those engaged in quit attempts, there would be a large number of confounding variables, including the treatment they were receiving, level of support from friends and family, etc. In combination with concerns about the lengthy process of applying for ethical approval to access clinical populations within the NHS, the decision was made to recruit participants online or via posters in workplaces rather than via smoking cessation services or the like. Social media

seemed the best vehicle for this, and a Facebook page was created, along with a Twitter account, and advertisements on Reddit, UCL Communications, and Gumtree.

Whilst I perceived the studies of my peers which comprised questionnaires alone to be far easier to recruit to, participants appeared to be deterred by the longer period of commitment required by this study. When recruitment was slow from the launch of my study on Qualtrics, my anxiety levels rose. I re-posted my advert weekly on Facebook, both in groups and on my own wall, pleading with friends and contacts to share on their pages and promote the study by word-of-mouth to any smokers they knew. I regularly posted on Gumtree and Reddit, tweeted on Twitter, and asked friends and family to display advertisement posters at work, but the uptake remained excruciatingly low. Though Qualtrics recorded 146 individuals opening the information page of the study, the majority did not continue, with just 49 completing the whole of session one. Beyond this, participants were asked to utilise the strategy they had used in their own environment, in response to smoking cravings, and to return to complete very brief questionnaires twenty-four hours later. Just 31 did.

When the time came to analyse the data I reflected a little on this. The demographics of my participants were not representative of smokers as a whole, with a mean age of approximately 30 years, and an average education level equivalent to the second year of a degree course. In order for my posts to have been seen on either Facebook or Twitter, the viewer would have to have been a) known to me, b) known to someone I know, c) searching by a term used in my post, or d) directed to the Facebook page by Facebook itself, via recommendations based on user preferences, which was unlikely for such a new page with a small number of "likes".

Recruitment via social media therefore felt very dependent on me, personally, and the demographics of those with whom I interact. It is possible that given that participants were asked to volunteer 24 hours of their time for no financial gain, the people who were most likely to either participate or to share my post were those who felt the strongest affiliation to me (Foster & Michon, 2014); for example, my close friends and family members, members of my cohort, or colleagues at work. Though I am from a very deprived London borough (Newham, London Regeneration and Property Directorate, 2010), my current social circle does not reflect this, formed primarily of other professionals or people I have met in higher education. By relying on my own social network to initiate what I hoped would become a snowball effect in recruitment, I may have inadvertently biased the sample, thus resulting in a high mean level of education which does not reflect the demographics of many smokers (ASH, 2015). If my post was visible primarily to fellow professionals and smoking is most prevalent in lower socioeconomic groups (ASH, 2015), this may have contributed to difficulties with recruitment.

Beyond the restrictions of my own social network, there is evidence that participants in web-based research tend to be younger people with higher levels of education, from households with relatively high incomes (Andrews, Nonnecke, & Preece, 2007). I questioned whether this was something I addressed adequately in my design, and whether my incentivisation strategy was at fault: would offering a small but guaranteed financial reward to every participant have been more successful than entry into a prize draw? Lottery draws have been found to be effective in boosting online participation in surveys (Tuten, Bosnnjak, & Brandilla, 2000), but this study required more of participants than simply completing online questionnaires, and I

wondered why people were willing to engage in a task over the course of 24 hours (albeit sporadically) for no tangible reward.

There is some evidence that people participate in research dependent on their own perceived level of expertise and the value of their contribution (Foster & Michon, 2014). This appeared to be the case for people who showed interest in advertisements on Reddit, with individuals considering or currently engaged in quit attempts often very vocal about the study and their experiences, offering me anecdotal evidence about what had helped them or others (e.g. positive thinking or distraction) in order to help me understand the needs of smokers.

On Gumtree, advertisements were placed in sections for job opportunities, research, and volunteering, requiring someone to either search by a word used in my advertisement, or to be actively browsing these sections of the site. Though some participants may have been motivated by the possibility of a financial reward, especially if they were in the process of seeking work when they happened across my post, others may have found the advertisement in the research or volunteering sections and participated for altruistic reasons or for the intrinsic rewards of contributing to a body of research (Foster & Michon, 2014).

On reflection, were I to replicate this study, I might consider broadening my recruitment strategy to include smoking cessation services or GP surgeries. This would increase the likelihood of my advertisements being seen by smokers, which might in turn improve recruitment and ensure a larger, more diverse sample and more adequately powered study with higher validity.

Non-significant results

Having struggled so much with recruitment, I was initially very frustrated by the results of this study, which did not support the hypothesis. My impression was of having invested heavily in a fruitless endeavour, and I immediately began to wonder what I had done wrong. On reflection, however, I realised the data was valuable despite it not supporting the hypothesis. The study was methodologically sound, and the results did support previous findings by Ussher *et al*. (2009). The non-significant results for my hypothesis did not suggest isometric exercise (IE) was ineffective for managing smoking cravings and reducing negative affect and the number of cigarettes smoked; rather, they suggested both IE and body scanning were equally effective, even when used entirely in a smoker's natural environment, with no direct contact with a researcher. With the underlying mechanism/s unclear, this suggested a direction for further thought and research.

Although I was able to find merit in my results, this study may not be easy to publish, given that the hypothesis was not supported. This highlighted to me the importance of sharing scientific findings, and not perceiving null findings as personal or professional failures. I wondered if Ussher *et al.*'s (2009) study might actually have been repeatedly replicated, unbeknownst to me or anyone not involved in these studies, because like me, they had found the original study to be compelling, but their own study data did not support the hypotheses. In this way, I realised, by not making non-significant findings available, we might perpetuate a cycle of relentless unrecognised replication which wastes time and resources (Matosin, Frank, Engel, Lum, & Newell, 2014).

Strengths and weaknesses

One strength of this study was the close matching of the two conditions. To control as best as possible for extraneous variables, the number of words used in the instructions for each condition was exactly matched, and the same actors and narrators used for both. To control for any effects of gender, half of the participants in each condition saw a male actor with a female narrator, and the other half saw an actress with a male narrator. The interventions were also matched for body parts, with participants in the body scan condition focusing on their feet whilst the IE condition pressed the soles of their feet into the floor. As an inexperienced researcher, these details were not something I would have considered. The importance of controlling for extraneous variables to increase confidence in the conclusions I might draw from the results was impressed upon me by my supervisors and will inform any future research I conduct.

As afore mentioned, seeking to minimise the level of burden on participants did place restrictions on the data I could collect, and the conclusions I could reach in this study. Whilst it was possible to determine that both interventions effected change, reducing negative affect, cravings, and the number of cigarettes smoked over the 24-hour period, it was unclear for how long the effects of the intervention lasted before the intervention needed to be repeated. Although gathering real-time data (e.g. asking participants to note the experience of craving when it recurred) would be preferable, this would also place undue focus on the experience of cravings, and may thus introduce an attentional bias, skewing ratings. To gain clearer information I might therefore ask participants to estimate the duration of relief from cravings post-use of the strategies during session two, something I did not do in this study.

During data analysis I was frustrated to discover I could not verify how long participants had spent on each page of the Qualtrics survey. This was something that had been discussed during the design stage, and I had spoken to a member of staff at Qualtrics who had advised me this information would be readily available when the study was completed, when in fact this would have required me to insert a timer widget on the necessary pages. This miscommunication meant I was unable to ascertain how long participants had spent viewing key pages, such as the information sheet, or the intervention video. Although it would not have been possible to determine how well they had attended to these, or whether they had actively followed along with the intervention, this would have provided valuable information as to whether the video was at least played in its entirety, and thus whether it was suitably engaging. Future research in this field may benefit from the inclusion of this feature.

As this study was based online, it was very dependent on self-report. It was not possible to use biometric measurements to check whether reporting on smoking behaviour was likely to be accurate or honest, nor was it possible to ensure participants had used the interventions as often as they claimed to have or for the full five minutes each time. I wondered whether being anonymous was likely to increase the likelihood of people misrepresenting their levels of engagement with the study or to increase their confidence in admitting they had not used it. Though I suspected there would be a disparity in the impact of social desirability on and offline, a recent meta-analysis found there to be no significant difference (Dodou & de Winter, 2014).

If I were to replicate or extend this research, I would seek to investigate the effects of the strategies over a longer period of time. Though I initially planned to include two follow-up time points (one at 24 hours, and one at 7 days) this seemed

likely to further deter potential participants, resulting in a single follow-up session. Though this may have slightly improved recruitment (something of which we cannot be sure), the short duration of this study did not allow participants to become very familiar with their strategies, and as such could not tell us whether the effects might improve with practice, or decrease with the reduction in novelty. My personal experience of mindfulness tasks such as the body scan suggests this is not something one can use optimally the first time it is tried, and that mindfulness requires practice. This being the case, if the mechanism underlying the effectiveness of these two strategies is in any way connected to awareness of one's own body, or mindfulness, the effectiveness of the body scan strategy may improve over time as smokers become more familiar with the technique. This finding is of particular importance in establishing the direction of further research in this area.

Clinical implications

This study demonstrated that a low-intervention guided self-help strategy for smoking cessation, delivered online, could be effective in reducing smoking cravings, negative affect, and the number of cigarettes smoked over the course of 24 hours. Though the sample size is too small to confidently draw conclusions, this suggests further study in this field is warranted. With nicotine dependence placing a substantial financial burden (BMA, 2016) on an under-resourced NHS, such interventions may become increasingly important over time, and it is therefore important to identify the minimum level of intervention required to produce optimum outcomes.

My difficulty recruiting participants to this study, and the demographics of those I did recruit suggest my strategy could be improved. Though social media has

the potential to reach millions, this might be quite dependent on the reach of the original poster, and the level of interest this post generates. This was a key learning point for me, and something which should be considered by other researchers contemplating the use of a similar strategy.

The findings of this study support previous evidence (Ussher *et al.*, 2009) that isometric exercise and body scanning are equally effective in the management of smoking cravings, and extend these to show they remain effective in a smoker's own environment. Future research may seek to identify the mechanism/s underlying this so as to better understand both the nature of cravings and the active ingredients in effective interventions.

Conclusions

It is interesting to reflect on how much I have learned over the past three years; be it about nicotine dependence, smoking cravings, and smoking cessation interventions; or about research as a whole. The experience of conducting this research study has highlighted to me the value of a well-considered design, and the contribution of even non-significant results to scientific thought.

I have come to believe strategies such as these are most likely to be developed as an adjunct to evidence-based interventions such as behavioural counselling and nicotine-replacement therapy (NRT) (Lancaster & Stead, 2005), helping individuals to manage their cravings and thus reduce the risk of relapse. I am intrigued to see both how this will be implemented, and how the effects will be explained.

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Appendices: Empirical Paper

Appendix 1: Ethical approval.

UCL RESEARCH ETHICS COMMITTEE

UCL

Amendment Approval Request Form

1	**Project ID Number:** 0760/002	**Name and Address of Principal Investigator:** Dr Sunjeev Kamboj, Research Dept Clinical, Educational and Health Psychology
2	**Project Title:** Craving changes? How do verbal and visuospatial strategies modify craving experiences in heavy smokers and drinkers	
3	**Type of Amendment/s (tick as appropriate)** ☒ Research procedure/protocol (including research instruments) ☐ Participant group ☐ Sponsorship/collaborators ☒ Extension to approval needed (extensions are given for one year) ☒ Information Sheet/s ☐ Consent form/s ☐ Other recruitment documents ☐ Principal researcher/medical supervisor* ☐ Other * *Additions to the research team other than the principal researcher, student supervisor and medical supervisor do not need to be submitted as amendments but a complete list should be available upon request.	
4	**Justification** (give the reasons why the amendment/s are needed) The current study examines the effect of online instructions for isometric exercise (IE) on craving in smokers. IE simply involves sequentially contracting and briefly holding muscles in a stationary position and is thought to be an acceptable, accessible, low intensity form of exercise which may reduce craving (Ussher et al., 2006). Light to moderate exercise has been found both to improve mental health outcomes (Scerbo et al., 2010) and to reduce smoking cravings (Elibero, Janse Van Rensburg, & Drobes, 2011). As smoking cravings may occur at any time, isometric exercise may be particularly well-suited to smokers, who can implement this strategy periodically, with very minor disruption to their day. Previous studies (Brendreyen, Drozd, & Kraft (2008)) have found online instructions to have a positive effect on rates of smoking cessation and reduction. This study therefore aims to test the idea that providing internet-delivered instructions for minimally supported IE will reduce craving. This in turn may increase self-efficacy and increase periods of abstinence, with a potentially positive effect on any subsequent quit attempts.	
5	**Details of Amendments** (provide full details of each amendment requested, state where the changes have been made and attach all amended and new documentation) Participants will be randomised to the isometric exercise (IE) condition, in which they will be instructed to respond to smoking cravings by repeating a brief set of isometric exercises (as outlined in Ussher et al, 2006). These involve sequentially contracting and relaxing muscle groups throughout the body while seated. Instructions will be provided on-screen and via audio recording delivered through the Qualtrics Survey platform. Examples include fist clenching, pressing inner thighs together, pushing down on thighs with palms, pushing hands together at chest level, or pressing the soles of the feet down onto the floor, for approximately ten seconds per muscle. This is repeatedly for five minutes during training and participants will be instructed to complete this cycle once whenever they experience cravings for a cigarette. Alternatively, participants will follow control instructions which simply involve noticing and relax the same muscle groups. The control will be provided with closely matched instructions asking them to notice and relax each of the above muscle group for the same period of time during training and to repeat the relaxation procedure whenever they experience cigarette cravings. Instructions will also be closely matched for total number of words, number of craving-related words and reading age.	

	The dependent variables will be frequency/time spent responding to cravings as instructed, desire to smoke, symptoms of low mood, and cigarettes smoked. These will be measured using standardised measures (e.g. HADS for depression: Zigmond & Snaith, 1983; PANAS for general mood; Watson, Clark, & Tellegan, 1988; MPPS for craving; West & Hajek, 2004). The Credibility/Expectancy Questionnaire (Devilly & Borkovec, 2000) will also be used to determine how credible these strategies appear to participants. Due to the large number of participants required to sufficiently power this study (N=300), individuals will not be paid to participate, however all participants who complete the study will be entered into a prize draw for Amazon vouchers. This will provide one first prize of £200, one second prize of £100, and two £50 prizes, which is essential to improved uptake and retention.
6	**Ethical Considerations** (insert details of any ethical issues raised by the proposed amendment/s) Participants in the active (IE) condition will be asked to undertake gentle exercise in response to cravings. These exercises are very low impact and so highly unlikely to be associated with any potential health risk or injury. All participants will be advised that any exercise causing unusual discomfort should be discontinued. To reduce any unintended risks, pregnant women and people with musculoskeletal problems will be excluded from the study, and all participants will be asked to sign an electronic declaration indicating that they understand this. Should any difficulties arise participants will have the opportunity to contact the researcher with their concerns.
7	**Other Information** (provide any other information which you believe should be taken into account during ethical review of the proposed changes)
	Declaration (to be signed by the Principal Researcher) • I confirm that the information in this form is accurate to the best of my knowledge and I take full responsibility for it. • I consider that it would be reasonable for the proposed amendments to be implemented. • For student projects I confirm that my supervisor has approved my proposed modifications. Signature: [redacted] Date: 23/03/2015
	FOR OFFICE USE ONLY: Amendments to the proposed protocol have been ...approved... by the Research Ethics Committee. Signature of the REC Chair, Professor John Foreman: [redacted]..... Date: ...16/4/2015.

Appendix 2: Participant information sheet.

Examining the effect of an online intervention on the promotion of isometric exercise in smokers.

This study has been approved by the UCL Research Ethics Committee (Project ID:0760/002)

Researcher name: Sapphire Weerakone

Work address: Research Department of Clinical, Educational, and Health Psychology, UCL, 1-19 Gower Street, London, WC1E 6BT.

Contact Details: [redacted]

We would like to invite you to participate in this research project.

Details of the study:

This study aims to investigate the impact of an online intervention on cravings for cigarettes. Research has showed that focusing on various parts of the body can help people manage cravings. You will be asked to use one of two types of 'body-focused strategies' to see if they are equally effective. This will help us to discover more about the experience of cravings and may contribute to the development of more effective management strategies for such experiences.

Who can take part?

To participate in this study, you must be over eighteen years of age and smoke five or more cigarettes per day. As a precaution we cannot include pregnant women or those with musculoskeletal problems in the study.

What will happen to me if I take part?

If you decide to participate in the study you may wish to save a copy of this information sheet and will be asked to complete a consent form. This is an online study and you will not be required to meet the researcher face-to-face at any time. You will be asked to complete a number of brief questionnaires about your mood and cravings (which is not anticipated to take longer than ten to fifteen minutes), and provided with online instructions for body-focused strategies which can be used when you are craving a cigarette. You will be asked to use these for a period of 24 hours.

You will be asked to complete further questionnaires 24 hours after learning the strategy. These will ask about the strategy, your mood, and your cravings, and should not take more than five minutes.

Are there any risks in taking part?

There are no known risks involved in completing the questionnaires or strategies, however, as we are using low-impact body-focused strategies we are taking the

additional precaution of excluding pregnant women and those with musculoskeletal problems from the current study.

Should you experience any physical or mental health problems during the course of this study, please contact your GP.

Are there any benefits to taking part?

You might not benefit directly from participating in this research, but your participation will help us to gain a better understanding of the nature of craving. This may lead to the development of better coping strategies for those who have such experiences.

Participation in this study is entirely voluntary and you maintain the right to withdraw from the research at any time without providing a reason. Please contact the researcher should you have any queries or concerns.

By way of thanks, all participants who complete the study and follow-up questionnaires will be entered into a prize draw with prizes of two £50 Amazon vouchers, one £100 voucher, and one £200 voucher.

All data will be collected and stored in accordance with the Data Protection Act 1998.

During the active phase of this study participants will be identified by the email address they provide. Beyond this point, the data will be anonymised and it will not be possible to identify you. All data will be kept securely in line with the Data Protection Act (1998). You have the right to withdraw from the research at any time without providing a reason. Please contact the researcher should you have any queries or concerns.

Data from this study will be analysed and included in a doctoral thesis for Clinical Psychology. This is expected to be submitted for publication in an academic journal.

Should you be interested in the outcome of this study, this will be available once the research is complete.

Please retain a copy of this information sheet for your records.

Appendix 3: Participant consent form.

Informed Consent for Participants

Please complete this form after you have read the information provided on the previous page.

Title of Project: Examining the effect of an online intervention on the promotion of isometric exercise in smokers.

This study has been approved by the UCL Research Ethics Committee (Project ID:0760/002).

Thank you for your interest in participating in this study. Please take the time to familiarise yourself with the information provided. Should you have any further questions, please contact the researcher at [redacted] before consenting to participate.

Please save a copy of this form for your records.

I have read the information sheet and understand what participation in this study entails.

- Yes
- No

I understand that I may withdraw my consent and participation at any time, without explanation, by informing the researcher.

- Yes
- No

I understand that I must not participate if I have any reason to believe a low-intensity 'body-focused strategy' may be dangerous to my health, am a pregnant woman, or have musculoskeletal problems.

- Yes
- No

I am over eighteen years of age and smoke five or more cigarettes per day.

- Yes
- No

I understand that my data will be confidential and anonymous, and handled in line with the Data Protection Act (1998).

- Yes
- No

I understand that there is no way I could be personally identified by the data I provide, and consent to the processing and inclusion of this data in a research paper which will be submitted for publication.

- Yes
- No

I understand that I must complete the study and follow-up questionnaires 24 hours later to be eligible for entry into the prize draw for Amazon vouchers.

- Yes
- No

Appendix 4: Instruction sheet sent to participants in the relaxation condition after session one.

Relaxation Reminder Sheet

Whilst seated, find the position which is most comfortable for you. Breathe freely, and deeply, and keep your legs uncrossed. Notice your breath flowing in and out of your body.

Jaw – 1 minute

Focus on your jaw. Is it tight, or relaxed? Are your upper and lower teeth touching or resting apart? Focus on any sensations. Allow any other thoughts to drift in and out without engaging with them.

Arms– 1 minute

Now turn your attention to your arms. Notice any sensations. Recognise any tightness in your arms and your shoulders. Are your arms in contact with each other or resting separately? Are they resting on your lap or the arm of the chair? Are they warm, or cold in thus moment? Recognise any sensations in your joints; at your wrists and your elbows.

Hands – 1 minute

Place your hands on your lap, and focus on them. Notice any sensations. Are they cold, or warm, or clammy? Perhaps they are tired from working? Notice any tightness in the joints or sensations in your fingertips. What can you feel under your hands?

Legs

Focus on your legs. Notice the pressure of the seat under your thighs or against the back of your knees or calves. Recognise any sensations in your legs. Perhaps they are tingling? Are the muscles tight or relaxed? Can you feel the fabric of your clothes, or perhaps the sun or a draught against your legs?

Feet – 1 minute

Bring your attention to your feet. Can you feel the ground beneath them? Perhaps only parts of your feet are touching the ground? Notice any sensations in your soles, toes, heels, and ankles. How do your feet feel in your shoes? Pay attention to your toes, wriggling them if need be.

Appendix 5: Instruction sheet sent to participants in the isometric exercise condition after session one.

Exercise Reminder Sheet

Whilst seated, find the position which is most comfortable for you. Breathe freely, and deeply, and keep your legs uncrossed. Notice your breath flowing in and out of your body.

Jaw – 1 minute

Bring your attention to your jaw. Clench tightly for a count of three seconds, then release. As you clench your jaw, feel the tension in your jaw muscles. Notice any sensations as you release your jaw.

Arms– 1 minute

Now place your palms on the tops of your thighs. Push your hands down firmly against your thighs and hold for a count of three seconds. Then release. Push down with your hands again for three seconds, and then release. As you push down, notice any tension in your hands, arms, and shoulders. Notice any sensations as you release your hands.

Hands – 1 minute

Now put your palms together. Push your palms firmly together and hold for a count of three seconds, and then release. As you press your hands together, notice any tension in your hands, arms, and shoulders. Notice any sensations as you release your hands

Legs

Now bring your attention to your legs. Firmly squeeze your thighs together and hold for a count of three seconds. Then release. Squeeze your thighs together again for three seconds. And release. As you squeeze your thighs together, notice the tension in your legs. Notice any sensations as you release your legs.

Feet – 1 minute

Now bring your attention to your feet and legs. Firmly push the soles of your feet into the floor and hold for three seconds. Then release. Keep repeating the exercise. As you push down, notice any tension in your feet, legs, and buttocks. Notice any sensations as you release your feet.