

# Messages to promote physical activity: Are descriptors of required duration and intensity related to intentions to be more active?

Emily C. L. Knox<sup>1</sup>, Stuart J. H. Biddle<sup>1,2</sup>, Ian M. Taylor<sup>1</sup>, Amy E. Latimer-Cheung<sup>3</sup>, Oliver J. Webb<sup>4</sup>, Lauren B. Sherar<sup>1</sup>

<sup>1</sup>School of Sport, Exercise and Health Sciences, Loughborough University, Loughborough, <sup>2</sup>The NIHR Leicester-Loughborough Diet, Lifestyle and Physical Activity Biomedical Research Unit, Leicester and Loughborough, Leicestershire, <sup>4</sup>Academic Policy and Standards, University of Exeter, Exeter, UK, <sup>3</sup>School of Kinesiology and Health Studies, Queen's University, Kingston, Canada

## ABSTRACT

**Introduction:** Mass-media campaigns such as, “Change4Life” in the UK and “get active America” in the US, promote physical activity (PA) recommendations of at least 150 min/week of moderate-to-vigorous PA (MVPA). We investigated whether different messages used in MVPA campaigns were associated with intention to engage in more MVPA. **Materials and Methods:** Theory of planned behavior (TPB) constructs; subjective norms, affective attitudes, instrumental attitudes and perceived behavioral control (PBC) were applied to explain the associations between campaign messages and intentions to engage in more MVPA. **Results:** A total of 1412 UK adults completed an online survey on MVPA and TPB. The sample was 70% female and 93% white with 23% reporting meeting PA guidelines. Participants received one of three messages: A walking message either with or without the 150 min/week threshold (WalkT; WalkNT); a physiological description of MVPA with the 150 min/week threshold (PhysT). ANCOVA examined group differences in intention. Path analysis evaluated mediation by TPB variables. ANCOVA identified lower intentions to increase MVPA in group PhysT relative to WalkT and WalkNT ( $P < 0.001$ ). PBC mediated this relationship in WalkT ( $\beta = 0.014$ , 95% confidence interval [CI] = 0.004–0.028) whereas affective attitudes mediated this relationship in WalkNT ( $\beta = 0.059$ , 95% CI = 0.006–0.113). **Conclusions:** Campaigns promoting MVPA guidelines need to choose their messages carefully. Messages which exemplified MVPA through walking were associated with higher intentions to increase MVPA than messages using a physiological description. Further, PBC was enhanced when the 150 min/week threshold was promoted alongside the walking exemplar. Future exemplars should be investigated to inform adults how to meet MVPA guidelines.

**Key words:** Health promotion, mass-media messages, physical activity, theory of planned behavior

## INTRODUCTION

Physical activity (PA) guidelines for the four UK home countries unified in 2010.<sup>[1]</sup> Dissemination plans have begun

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

**For reprints contact:** [reprints@medknow.com](mailto:reprints@medknow.com)

**This article may be cited as:** Knox EC, Biddle SJ, Taylor IM, Latimer-Cheung AE, Webb OJ, Sherar LB. Messages to promote physical activity: Are descriptors of required duration and intensity related to intentions to be more active?. *J Edu Health Promot* 2015;4:77.

**Address for correspondence:** Dr. Emily C. L. Knox, Office 2.57 National Centre for Sport and Exercise Medicine, Loughborough University, Epinal Way, LE113TU, UK. E-mail: [e.knox@lboro.ac.uk](mailto:e.knox@lboro.ac.uk)

### Access this article online

#### Quick Response Code:



**Website:**  
[www.jehp.net](http://www.jehp.net)

**DOI:**  
10.4103/2277-9531.171790

in countries such as the US<sup>[2]</sup> and Canada<sup>[3]</sup> but a strategy of messaging these guidelines to the general public has yet to be developed in the UK. Mass-media messages in the UK and abroad center on moderate-to-vigorous PA (MVPA) guidelines, e.g., “just 150 min a week is all you need to get yourself going...”<sup>[4]</sup> While this correctly reports current PA recommendations<sup>[1]</sup> it is unknown whether communicating this duration and intensity will provide the motivational impetus required for behavioral change.

Moderate-to-vigorous physical activity can be illustrated through physiological descriptions, e.g., raised heart rate, breathlessness.<sup>[5]</sup> PA campaign messages have tended to steer away from connotations of sweat and exertion associated with earlier exercise guidelines<sup>[6]</sup> as such messages may be motivationally dissuading.<sup>[7]</sup> More moderate activities such as walking<sup>[8]</sup> have instead been used by campaigns promoting MVPA; “It’s important to do 150 active minutes each week. Can you find 10 min to squeeze in a brisk walk today?”<sup>[9]</sup> Walking has become, especially prominent due to its accessibility and association with health benefits.<sup>[10]</sup>

The theory of planned behavior (TPB)<sup>[11]</sup> is useful for predicting whether PA messages are likely to be successful. TPB proposes three primary determinants of behavioral intention: Attitude, subjective norms, and perceived behavioral control (PBC). Self-efficacy can also be considered as part of the model.<sup>[12]</sup> According to TPB, believing in positive outcomes (e.g., improved health), perceived validation from important others (e.g., spouse, friend) and belief in one’s own power over change, will result in a greater intention to be active. The role of TPB construct in PA promotion has been supported in the literature. Hagger *et al.*<sup>[13]</sup> conducted a meta-analytic review of 72 studies employing TPB constructs in the investigation of PA. The authors concluded that the TPB accounted for a significant amount of variance in PA intentions and behavior. All constructs, including self-efficacy, were found to make important contributions to the model with attitudes being the strongest influence.

Stage theories help us to predict how an individual is likely to respond to messages, depending on their stage in the behavior change process. The precaution adoption process model (PAPM)<sup>[14]</sup> suggests that individuals will not change their behavior unless they are aware that their current behavior is sub-optimal and makes them susceptible to severe negative outcomes. Thus, an individual who is not meeting MVPA guidelines may hold positive attitudes toward MVPA, feel supported and in control, but have no plans to engage in more MVPA because they believe they already do enough and so do not feel imminent risk to their health. The PAPM could, therefore, add insight to help partly explain the variance in relationships between TPB constructs and intention. While the PAPM is relatively underexplored regarding the topic of PA, several studies have examined the association between awareness of personal engagement with PA and intention to engage in PA. These studies have all identified lack of awareness to be motivationally damaging.<sup>[15-17]</sup> Combining

both theories should, therefore, provide greater insight into the motivational implications of messages promoting MVPA.

Using tenets of TPB, walking requires little technical skill and can be performed almost anywhere. In this way, walking messages may increase self-efficacy and PBC. However, for many individuals walking is an incidental activity already engaged in regularly, even if normally at a low intensity.<sup>[18-20]</sup> Messages promoting walking may therefore be less likely than messages promoting less incidental activities, such as jogging, to help those individuals who are not meeting MVPA guidelines realize that their PA levels are inadequate. As suggested by the PAPM, these individuals may subsequently be less likely to feel susceptible to severe negative consequences and intend to engage in more MVPA.

Previous research suggested that MVPA messages, which use a threshold of 150 min/week may not be motivationally optimal.<sup>[21]</sup> The present study builds on this research by investigating the communication of guidelines through both duration and intensity aspects of MVPA. The primary purpose of this paper was to investigate the association between MVPA messages with different descriptions of intensity and duration, and intentions to increase MVPA. Further, this study explored whether relationships could be partly explained using TPB and PAPM constructs.

## MATERIALS AND METHODS

Ethical approval in accordance with the Declaration of Helsinki was granted by the host university. An online survey was developed using an online survey software and questionnaire tool ([www.surveymonkey.com](http://www.surveymonkey.com)). The survey was disseminated via JISC mailing lists to UK adults (aged 18 and above) in February and March 2013. Subscribers 152 lists which ranged in topic from societal lists, e.g., minority ethnic groups to occupational, e.g., masonry, were sent an E-mail inviting them to complete a survey of measures from the extant literature. Adults were assigned to one of three experimental message groups. Group assignment was determined by the first letter of the participants last name (A-I, Group WalkT; J-R, Group PhysT; S-Z, Group WalkNT). All groups received the same survey. Each group received one of three messages which were presented within the survey. Each group received a different message adapted from existing MVPA campaigns. Measures are reported below in the order in which they were completed by participants.

### Demographic factors

Participants reported their age, gender, ethnicity, health status, marital status, employment status and education level.

### Current physical activity

A single-item validated by Milton *et al.*,<sup>[22]</sup> was used; “In the past week, on how many days have you done a total of 30 min or more of PA, which was enough to raise your breathing rate? This may include sport, exercise and brisk walking or cycling for recreation or to get to and from places, but should not include housework or PA that may be part of your job.”<sup>[23,24]</sup>

### Physical activity messages

Group WalkT received a walking threshold message taken from the mass-media campaign Change4Life;<sup>[4]</sup> “regular PA, such as walking, protects your health. Each week, adults should accumulate 150 min of PA.” Group PhysT received a physiological threshold message based on the description of MVPA provided in guideline documents and the descriptive detail of PA campaign messages;<sup>[1,5]</sup> “regular PA that makes you feel warmer, breathe harder and makes your heart beat faster protects your health. Each week, adults should accumulate 150 min of PA.” Group WalkNT received a walking message without a threshold; “regular PA, such as walking, protects your health. Each week, adults should accumulate as much PA as possible.” This message was based on existing PA campaigns such as “do-Groove,”<sup>[24]</sup> which provide generic messages.

### Precaution adoption process model measures

#### Awareness

Participants responded on a five-point scale to the statement; “my level of PA is \_\_\_\_.” with the responses “very low”, “somewhat low”, “sufficient”, “somewhat high” or “very high”<sup>[25]</sup>. This was considered alongside self-reported PA to determine whether individuals over-estimated, correctly estimated or under-estimated their personal PA behavior relative to PA guidelines.

#### Severity

Participants rated on a nine-point Likert scale (definitely not necessary-definitely necessary); “to what extent do you feel that you need to engage in more MVPA in the next 6 months?”

#### Susceptibility

Participants rated on a nine-point Likert scale (extremely unlikely-extremely likely); “How likely do you think you are to experience or develop the following (heart disease, cancer, ill health and weight gain) at some time in the future, because of the amount of PA you do?”<sup>[26]</sup>

### Theory of planned behaviour measures

Guidelines of Ajzen were followed when selecting items.<sup>[27]</sup> All items were answered on a seven-point Likert scale (completely agree-completely disagree).

#### Intention

Three items which have previously shown good reliability and validity assessed intention to engage in more MVPA, e.g., “I am motivated to regularly engage in more MVPA.”<sup>[28-31]</sup>

#### Subjective norms

A composite measure combining three items, which assessed approval of and engagement in MVPA by important others and participants’ “motivation to comply” was used, e.g., “most of the people who are important to me engage in sufficient MVPA themselves.”<sup>[27]</sup>

#### Attitudes

Three items each with the stem “engaging in more MVPA each week would be ...” assessed instrumental (e.g., useless) and affective attitudes (e.g., enjoyable).<sup>[31-33]</sup>

### Perceived behavioral control

A single-item was used: “Whether or not I regularly engage in more MVPA is completely up to me (Jones *et al.*, 2004).”

#### Self-efficacy

A single-item was used: “If it were entirely up to me, I am confident I would be able to engage in more MVPA.”<sup>[34]</sup>

### Other measures

#### Knowledge of PA guidelines

An open-response textbox accompanied the question; “what are the PA guidelines?” to garner the unprompted knowledge.<sup>[35]</sup> Responses of 150 min a week of PA exactly were deemed to be correct as this reflects current PA guidelines. All other responses were deemed to be incorrect.

#### Analysis

ANCOVA analysis was performed using IBM SPSS version 20 [IBM Corp; Armonk, NY.] to identify group differences in intention to engage in more MVPA. Path analysis using Mplus software (Muthén and Muthén)<sup>[36]</sup> was then employed to evaluate whether TPB variables explained (i.e., mediated) the relationships among messages and intentions. First, a model was constructed examining the TPB variables as predictors of intentions. Then, a full indirect associations model was constructed, which included two binary categorical variables comparing the effects of the WalkT message and WalkNT message to the reference message (i.e., PhysT; see results section for the rationale for this approach), respectively. Potential mediation of these associations by the significant TPB variables was tested using the procedures outlined by Hayes and Preacher<sup>[37]</sup> for establishing mediation with categorical predictors and for calculating 95% bias-corrected bootstrap confidence intervals (CIs). Model fit for this full model was assessed using the confirmatory fit index (CFI), root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) to assess model fit.

Finally, potential moderation of the direct associations among message groups and TPB constructs by the PAMP variables was tested by constructing path models, which included the categorical message variables, a main effect of the respective PAMP variable on intentions, and a PAMP variable x message interaction term. The moderating influence of each PAMP variable on each message (relative to the reference message) was assessed in separate models.

## RESULTS

All subscales showed acceptable reliability (>0.70). From the 1861 adults who began the survey, 1412 (76%) provided complete datasets for analysis. The sample was 70% female, 43% under 45 and 93% white with 23% reporting meeting PA guidelines. Full descriptive statistics is provided in Table 1.

Preliminary analysis of demographic variables revealed that age and knowledge of PA guidelines significantly differed between message groups ( $P < 0.05$ ), thus these were included

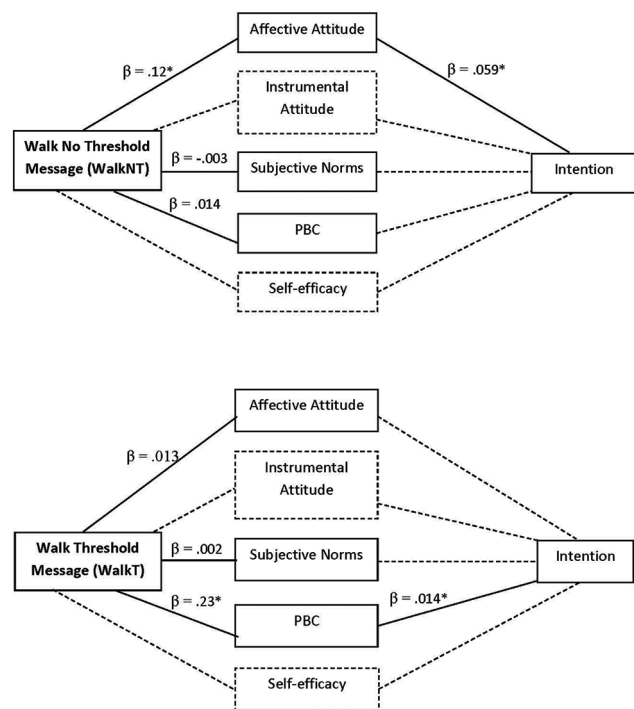
**Table 1: Descriptive statistics for demographic, TPB and PAPM variables stratified by group**

Variable	WalkT	PhysT	WalkNT
N	493	449	470
Demographics/other			
Age (% under 45)	54	58	63
Gender (% female)	74	68	67
Ethnicity (% white)	94	92	92
Education (% with a university degree)	90	86	88
Employment (% employed)	89	78	81
Marital status (% married)	57	54	47
Current health <sup>a</sup>	3.7±1	3.9±1	3.8±1
Days doing 30 min of PA	3.7±2.1	3.8±2.1	3.7±2.1
Manipulation check <sup>b</sup>	3.5±1	3.5±1	3.2±1
Environment <sup>c</sup>	5.3±1.5	5.2±1.4	5.2±1.4
TPB constructs			
Intention	5.3±0.1	4.5±0.1	5.3±0.1
Subjective norm	2.5±0.1	2.4±0.1	2.4±0.1
Affective attitude	5.4±0.1	5.2±0.1	5.3±0.1
Instrumental attitude	6.3	6.2±0.1	6.2±0.1
Perceived behavioral control	5.5±0.1	5.6±0.1	5.8±0.1
Self-efficacy	4.7±0.1	4.9±0.1	3.9±0.1
PAPM constructs			
Susceptibility	5.2±2	5±2.1	4.8±2
Severity	6.8±2.1	6.7±2.3	6.8±2.1
Awareness (% accurate)	64	70	65

Mean and SD reported unless stated otherwise. <sup>a</sup>Self-reported current health status, <sup>b</sup>Manipulation check was a composite score of five items which assessed the extent to which the message was trusted, interesting, informative, remembered and liked, <sup>c</sup>Composite of self-reported proximity to amenities, proximity of facilities for PA and perceived attractiveness of the local environment. WalkT=Walking used as an exemplar of MVPA and 150 min/week threshold included, PhysT=Physiological parameters used to describe MVPA and 150 min/week threshold included, WalkNT=Walking used as an exemplar of MVPA and no threshold used in message, SD=Standard deviation, TPB=Theory of planned behavior, PAPM=Precaution adoption process model, MVPA=Moderate-to-vigorous physical activity, PA=Physical activity

as covariates in the ANCOVA analysis. ANCOVA revealed a lower intention in group PhysT relative to the other two groups ( $P < 0.001$ ). Group PhysT was therefore selected as the reference group in the subsequent path analysis.

The path model exploring the pattern of relationships among TPB variables and intentions revealed significant PBC-intention ( $\beta = 0.06, P = 0.002$ ), affective attitude-intention ( $\beta = 0.48, P < 0.001$ ) and subjective norm-intention ( $\beta = 0.08, P < 0.001$ ) relationships. Instrumental attitudes ( $\beta = 0.02$ ) and self-efficacy ( $\beta = 0.04$ ) did not significantly predict intentions and so were removed from further analysis. A full model [Figure 1] was then examined testing the indirect associations of the two messages (i.e. WalkT and WalkNT compared to PhysT) on intentions via the three significant TPB constructs. This overall model demonstrated acceptable fit to the data: SRMR = 0.03; CFI = 0.91; RMSEA = 0.08 (CI = 0.06–0.10). Further, significant positive associations were observed between WalkT and PBC ( $\beta = 0.23, P = 0.005$ ), and WalkNT and affective attitude ( $\beta = 0.12, P = 0.027$ ), indicating that the participants receiving these messages



**Figure 1: Path analysis of the effect of two walking-based physical activity messages relative to a physiological threshold message on intention via theory of planned behaviour constructs, \* $P < 0.05$**

reported higher PBC and affective attitudes, respectively, compared with participants receiving the PhysT message. Subjective norms did not demonstrate any associations. In turn, all three TPB constructs were positively associated with intentions (PBC:  $\beta = 0.06, P = 0.005$ ; affective attitudes:  $\beta = 0.49, P < 0.001$ ; subjective norms:  $\beta = 0.09, P < 0.001$ ). Employing Hayes and Preacher’s procedures, a small but significant indirect relationship was identified between WalkT and intentions via PBC ( $\beta = 0.014, 95\% \text{ CI} = 0.004\text{--}0.028$ ), and between WalkNT and intentions via affective attitudes ( $\beta = 0.059, 95\% \text{ CI} = 0.006\text{--}0.113$ ).

A series of path models then tested whether PAPM variables moderated the direct effects of the two walking-based messages on intentions (relative to the PhysT comparison group). Severity did not moderate any of the associations; however, susceptibility and awareness were found to moderate the relationship between WalkNT (relative to PhysT) and intentions (susceptibility  $\times$  WalkNT:  $\beta = 0.16, P < 0.002$ ; awareness  $\times$  WalkNT:  $\beta = -0.11, P = 0.047$ ). Further inspection of the interaction terms revealed that the association between WalkNT (relative to PhysT) and intentions were greater for those with higher susceptibility and awareness.

## DISCUSSION

### Key findings

Present findings suggest that messages, which use walking to exemplify MVPA are associated with greater intentions to

do more MVPA when compared with messages, which use physiological parameters, such as heart rate or sweating. This finding supports the current prominence of walking exemplars in mass-media PA campaigns (e.g., healthy Hawaii initiative's step it up, Walk4Life [sub-campaign of Change4Life] and STEPember [sub-campaign of America on the Move]), as a useful tactic to increase engagement in MVPA.

On the other hand, the message which described MVPA most closely from MVPA guidelines (PhysT)<sup>[11]</sup> was associated with a lower intention to engage in more MVPA than the other two messages. This is in line with previous findings that a PA message which closely described UK guidelines was related to less positive perceptions of the health benefits associated with PA.<sup>[22]</sup> However, this previous study investigated communication of the duration aspect of PA guidelines, focusing on the use of the 150 min/week threshold. The present study extended this research by investigating both duration and intensity aspects of PA guidelines. In the present study, the 150 min/week threshold was only negatively associated with intentions to be more active when it was paired with a physiological description of MVPA.

The higher intention in the two groups receiving MVPA messages based around walking (groups WalkT and WalkNT) was mediated by PBC and affective attitudes. Affective attitudes mediated the relationship between group WalkNT and intentions. Effects were generally small which is normal for mediation effects associated with theoretical constructs. However, the direct effects identified were much larger. The "walk Missouri" PA campaign similarly found improvements in affective attitudes in response to walking messages.<sup>[38]</sup> "Walk Missouri" used generic messages such as "I do it for my health. Why do you walk?" Individuals probably like messages, which do not stipulate duration of MVPA because they allow ideas of smaller behavioral change to be entertained. However, while such messages may be motivational, they do not provide information on the duration of MVPA required for optimum health. As the knowledge of MVPA guidelines is low<sup>[39]</sup> it is preferable for messages to be both motivational and informative.

Group WalkT's higher intention relative to group PhysT was related to their greater PBC. Unlike the WalkNT message, the WalkT message provided accurate information on the duration of MVPA recommended for adults. According to goal theory; specific, measurable, attainable and time-framed goals can motivate increased PA.<sup>[40]</sup> The threshold of 150 min/week may fulfill some of these criteria. It has been suggested that this 150 min/week threshold may have negative impacts on motivation when used in campaign messages because it is not a realistic target for most of the adult population.<sup>[21]</sup> In the present study, the WalkT message incorporated the same 150 min/week threshold as Knox *et al.*,<sup>[21]</sup> but added the exemplar walking and motivations were not negatively affected. Indeed, it has previously been highlighted that to successfully encourage individuals to meet PA guidelines, messages must tell them how to achieve them, not only what they are.<sup>[41]</sup>

The present findings support this, providing evidence that positioning exemplars such as walking alongside duration thresholds may improve intention by increasing felt PBC over achieving 150 min/week of MVPA. Scott *et al.*,<sup>[31]</sup> found that adults considered MVPA to be under greater personal control than vigorous-intensity PA. Possibly, adults in group PhysT associated the physiological description of MVPA with more intense PA than the walking message group and subsequently perceived the message to be recommending vigorous-intensity PA, rather than MVPA. As one of the most popular activities in the UK,<sup>[42]</sup> walking may be an especially good exemplar as it is likely considered more accessible than other types of MVPA such as jogging, which could be deemed to be too intense.

Instrumental attitudes and subjective norms did not mediate the relationships between messages and intention to be more active. The MVPA messages in the present study did not target subjective norms, while instrumental attitudes appear to be more strongly related to intention to engage in more vigorous PA than MVPA.<sup>[31]</sup>

The PAPM suggests that individuals must move along a series of stages before they are likely to adopt a new behavior. The stages move through becoming engaged with a topic such as needing to increase PA, deciding to act and finally enacting the behavioral change. This theory can therefore add to our understanding around the variance in the relationship between predictors of intention and intention itself. One of the major constructs of PAPM which has been found to be related to intention to be active is awareness of PA behavior. Impaired awareness of PA behavior has been associated with reduced intentions to be active.<sup>[16-18]</sup> PAPM constructs of susceptibility to negative consequences and perceived severity of these consequences have received less attention in the literature. In the present study, awareness of current MVPA behavior and perceived susceptibility to health risks moderated the relationship between WalkNT and intentions. Adults receiving the WalkNT message who were accurately aware of the MVPA they engaged in and who felt susceptible to health problems had a greater intention to increase MVPA, compared with those who were not aware and did not feel susceptible. According to the PAPM, adults who overestimate their current PA level and the ensuing health effects will feel less susceptible to adverse health outcomes and will resultantly hold a lower intention to be more active. This was supported in the present study but only for adults receiving the WalkNT message. This is a possible weakness of the WalkNT message as individuals typically overestimate their PA level and these individuals may not find this message motivational.<sup>[16-18,25,43-45]</sup> The WalkNT message did not tell readers how much MVPA they should engage in, making it more difficult to rate their PA relative to MVPA guidelines. Messages containing a threshold may be more effective for adults who misperceive their current PA behavior, that is, the majority of inactive adults. As a result, campaigns using messages without thresholds, similar to the WalkNT message in the present study, may fail to persuade the very individuals they were conceived to target.

### Strengths, limitations and future directions

The present study is cross-sectional and so investigation of behavior change and of cause and effect is not possible. The TPB predicts change in behavior from intention and we, therefore, assume that the higher intention in the groups WalkT and WalkNT will translate to improved MVPA behavior.<sup>[46]</sup> However, a large amount of variance in behavior is not accounted for by intentions.<sup>[47]</sup> Further studies are therefore needed, which objectively measure change in MVPA behavior (e.g., using accelerometers). It is also not possible to remark on differences between adults completing the survey and those not due to data collection method employed. However, comparisons with freely available demographic data from the Health Survey for England 2011 suggest the adults in the present study are more educated than the general population but are otherwise representative. Despite these limitations, the provision of different PA mass-media campaign messages to a large sample is novel and has important applications for health promotion. Future studies should examine other exemplars of MVPA, such as cycling or gardening. This is especially important considering that walking is often performed at a below moderate intensity. Messages to promote PA guidelines should be further investigated in consideration of message design literature and different behavior change and health behavior theories. For instance Peetz *et al.*,<sup>[48]</sup> found messages with a 30 min/day threshold resulted in greater intention to be active than a 150 min/week threshold. The efficacy of using different duration thresholds could be further examined.

The present research investigated motivational implications of messages used to promote MVPA guidelines. An appropriate description of MVPA intensity, which avoids physiological descriptions, alongside the 150 min/week threshold is crucial to consider when developing messages targeting intentions to increase MVPA.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

## REFERENCES

- Department of Health Physical Activity Health Improvement and Protection. Start Active, Stay Active: A Report on Physical Activity for Health from the Four Home Countries' Chief Medical Officers. London: Department of Health; 2011.
- National Coalition for Promoting Physical Activity. National Physical Activity Plan for the United States; 2010.
- Latimer-Cheung AE, Rhodes RE, Kho ME, Tomasone JR, Gainforth HL, Kowalski K, *et al.* Evidence-informed recommendations for constructing and disseminating messages supplementing the new Canadian Physical Activity Guidelines. *BMC Public Health* 2013;13:419.
- National Health Services. Change 4 Life; 2013. Available from: <http://www.nhs.uk/Change4Life/Pages/exercise-activity-ideas.aspx>. [Last accessed on 2013 Jul 15].
- World Health Organization. Global Recommendations on Physical Activity for Health. Geneva, Switzerland: WHO Press; 2010.
- Blair SN, LaMonte MJ, Nichaman MZ. The evolution of physical activity recommendations: How much is enough? *Am J Clin Nutr* 2004;79:913S-20.
- Lovell GP, El Ansari W, Parker JK. Perceived exercise benefits and barriers of non-exercising female university students in the United Kingdom. *Int J Environ Res Public Health* 2010;7:784-98.
- Wimbush E. A moderate approach to promoting physical activity: The evidence and implications. *Health Educ J* 1994;53:322-36. Available from: <http://www.hej.sagepub.com/cgi/doi/10.1177/001789699405300310>. [Last cited on 2013 Jun 10].
- National Health Services. This Week's Top Tips from Change 4 Life! Change4Life Newsletter. Crown; 2012.
- Kelly P, Murphy M, Oja P, Murtagh EM, Foster C. Estimates of the number of people in England who attain or exceed vigorous intensity exercise by walking at 3 mph. *J Sports Sci* 2011;29:1629-34.
- Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process* 1991;50:179-211.
- Noar SM, Benac CN, Harris MS. Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychol Bull* 2007;133:673-93.
- Hagger MS, Chatzisarantis NL, Biddle SJ. A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: Predictive validity and the contribution of additional variables. *J Sport Exerc Psychol* 2002;24:3-32.
- Weinstein ND. The precaution adoption process. *Health Psychol* 1988;7:355-86.
- Ronda G, Van Assema P, Brug J. Stages of change, psychological factors and awareness of physical activity levels in The Netherlands. *Health Promot Int* 2001;16:305-14.
- van Sluijs EM, Griffin SJ, van Poppel MN. A cross-sectional study of awareness of physical activity: Associations with personal, behavioral and psychosocial factors. *Int J Behav Nutr Phys Act* 2007 8;4:53.
- van Stralen MM, de Vries H, Mudde AN, Bolman C, Lechner L. The long-term efficacy of two computer-tailored physical activity interventions for older adults: Main effects and mediators. *Health Psychol* 2011;30:442-52.
- Oja P, Vuori I, Paronen O. Daily walking and cycling to work: Their utility as health-enhancing physical activity. *Patient Educ Couns* 1998;33 1 Suppl: S87-94.
- Dawson J, Boller I, Foster C, Hillsdon M. Evaluation of changes to physical activity amongst people who attend the walking the way to health initiative (WHI). Oxford: The Countryside Agency; 2006.
- O'Dougherty M, Arikawa A, Kaufman BC, Kurzer MS, Schmitz KH. Purposeful exercise and lifestyle physical activity in the lives of young adult women: Findings from a diary study. *Women Health* 2009;49:642-61.
- Knox EC, Webb OJ, Esliger DW, Biddle SJ, Sherar LB. Using threshold messages to promote physical activity: Implications for public perceptions of health effects. *Eur J Public Health* 2014;24:195-9.
- Milton K, Bull FC, Bauman A. Reliability and validity testing of a single-item physical activity measure. *Br J Sports Med* 2011;45:203-8.
- Harris SS, Caspersen CJ, DeFries GH, Estes EH Jr. Physical activity counseling for healthy adults as a primary preventive intervention in the clinical setting. Report for the US Preventive Services Task Force. *JAMA* 1989;261:3588-98.
- Blue Cross and Blue Shield of Minnesota. Do-groove; 2007. Available from: <http://www.do-groove.com/tv-ads/commercials>. [Last accessed 2014 Oct 26].
- Lechner L, Bolman C, Van Dijke M. Factors related to misperception of physical activity in The Netherlands and implications for health promotion programmes. *Health Promot Int* 2006;21:104-12.
- Raats MM, Sparks P, Geekie MA, Shepherd R. The effects of providing personalized dietary feedback. A semi-computerized approach. *Patient Educ Couns* 1999;37:177-89.
- Ajzen I. Constructing a theory of planned behavior questionnaire. TPB Questionnaire Construction; 2011. p. 1-7. Available from:

- <http://www.people.umass.edu/aizen/pdf/tpb.measurement.pdf>. [Last accessed 2014 Jun 12].
28. Rhodes RE, Brown SG, McIntyre CA. Integrating the perceived neighborhood environment and the theory of planned behavior when predicting walking in a Canadian adult sample. *Am J Health Promot* 2006;21:110-8.
  29. Rhodes RE, Courneya KS, Blanchard CM, Plotnikoff RC. Prediction of leisure-time walking: An integration of social cognitive, perceived environmental, and personality factors. *Int J Behav Nutr Phys Act* 2007 31;4:51.
  30. Rhodes RE, Blanchard CM, Courneya KS, Plotnikoff RC. Identifying belief-based targets for the promotion of leisure-time walking. *Health Educ Behav* 2009;36:381-93.
  31. Scott F, Rhodes RE, Downs DS. Does physical activity intensity moderate social cognition and behavior relationships? *J Am Coll Health* 2009;58:213-22.
  32. Jones LW, Sinclair RC, Rhodes RE, Courneya KS. Promoting exercise behaviour: An integration of persuasion theories and the theory of planned behaviour. *Br J Health Psychol* 2004;9(Pt 4):505-21.
  33. Bellows-Riecken KH, Rhodes RE, Hoffert KM. Motives for lifestyle and exercise activities: A comparison using the theory of planned behaviour. *Eur J Sport Sci* 2008;8:305-13. Available from: <http://www.tandfonline.com/doi/abs/10.1080/17461390802195660>. [Last cited on 2012 Sep 06].
  34. Latimer AE, Rivers SE, Rensch TA, Katulak NA, Hicks A, Hodorowski JK, et al. A field experiment testing the utility of regulatory fit messages for promoting physical activity. *J Exp Soc Psychol* 2008;44:826-832.
  35. Green JH, Boyle FE. Lack of awareness of public health promotion messages among a group of adult New Zealanders who meet national guidelines for food intake and physical activity. *Asia Pac J Clin Nutr* 2001;10:17-20.
  36. Muthén LK, Muthén BO. *Mplus: Statistical Analysis with Latent Variables-User's Guide*. 6<sup>th</sup> ed. Los Angeles, CA: Muthén and Muthén; 2010.
  37. Hayes AF, Preacher KJ. Statistical mediation analysis with a multicategorical independent variable. *Br J Math Stat Psychol* 2014;67:451-70.
  38. Wray RJ, Jupka K, Ludwig-Bell C. A community-wide media campaign to promote walking in a Missouri town. *Prev Chronic Dis* 2005;2:A04.
  39. Knox EC, Eslinger DW, Biddle SJ, Sherar LB. Lack of knowledge of physical activity guidelines: Can physical activity promotion campaigns do better? *BMJ Open* 2013;3:e003633.
  40. Latham GP, Locke EA. Self-regulation through goal setting. *Organ Behav Hum Decis Process* 1991;50:212-47. Available from: <http://www.linkinghub.elsevier.com/retrieve/pii/074959789190021K>. [Last accessed 2014 Jul 09].
  41. Latimer AE, Brawley LR, Bassett RL. A systematic review of three approaches for constructing physical activity messages: What messages work and what improvements are needed? *Int J Behav Nutr Phys Act* 2010;7:36.
  42. The NHS Information Centre. *Health Survey for England 2008*. In: Craig R, Mindell J, Hirani V, editors. *Physical Activity and Fitness*. Vol. 1. Leeds: The Health and Social Care Information Centre; 2009.
  43. Bolman C, Lechner L, van Dijke M. Question order in the assessment of misperception of physical activity. *Int J Behav Nutr Phys Act* 2007;4:42.
  44. Watkinson C, van Sluijs EM, Sutton S, Hardeman W, Corder K, Griffin SJ. Overestimation of physical activity level is associated with lower BMI: A cross-sectional analysis. *Int J Behav Nutr Phys Act* 2010;7:68.
  45. Vandelanotte C, Mummery WK. Qualitative and quantitative research into the development and feasibility of a video-tailored physical activity intervention. *Int J Behav Nutr Phys Act* 2011;8:70.
  46. Webb TL, Sheeran P. Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychol Bull* 2006;132:249-68.
  47. Why YP, Huang RZ, Sandhu PK. Affective messages increase leisure walking only among conscientious individuals. *Pers Individ Dif* 2010;48:752-6. Available from: <http://www.linkinghub.elsevier.com/retrieve/pii/S0191886910000401>. [Last cited on 2012 Mar 14].
  48. Peetz J, Buehler R, Britten K. Only minutes a day: Reframing exercise duration affects exercise intentions and behavior. *Basic Appl Soc Psych* 2011;33:118-27. Available from: <http://www.tandfprod.literatumonline.com/doi/abs/10.1080/01973533.2011.568870>. [Last cited on 2012 Jun 06].