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Is There Something Beyond Stages of Change in the Transtheoretical Model? The State of Art for Physical Activity

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Over the past 30 years, there has been a growing interest in the application of the transtheoretical model (TTM) in the domain of physical activity (PA). Even though this model has been widely used to implement PA interventions, most of these interventions have not used all of the TTM's theoretical constructs. Indeed, several studies focused exclusively on the stages of change although this construct is only descriptive. Thus, in the present review, we wanted to encourage researchers to go beyond stages of change when they use the TTM. To do so, we aimed to provide an overview of the TTM, its constructs and to present on one hand, longitudinal studies examining the association between PA and TTM constructs and, on the other hand, summarising the efficacy of TTM-based interventions as to present future TTM challenges.

Public Significance Statement
Theory-based interventions, including those based on the transtheoretical model, showed their efficacy in physical activity promotion. However, although the transtheoretical model proposes key regulatory components (namely, processes of change, self-efficacy, decisional balance, and temptation) to implement interventions, most of research remains focused on the stages of change. It should be reiterated that stages of change are a construct, not a theory, and therefore should not be used to tailor physical activity interventions. The key regulatory components of the transtheoretical model should be used to individualize counseling to physical activity. Moreover, the specific role of the processes of change in health education towards a more physically active lifestyle represents a future area of research.

Keywords: physical activity, transtheoretical model, stages of change, processes of change, mediators of change

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As recently evidenced, the world actually faces an increasing prevalence of physical inactivity (Andersen, Mota, & Di Pietro, 2016), which partly explains the ever-rising worldwide prevalence of major noncommunicable diseases (Sallis et al., 2016). This physical inactivity epidemic constitutes an economic burden to the international health care systems of up to US$53.8 billion in 2013 (Ding et al., 2016). Thus, there is a pressing urgency to promote physical activity (PA) by implementing interventions that take into account the reasons favouring its adoption.

In this context, theory-based interventions constitute an interesting option, not only because they are assumed to be better than nontheoretical interventions but also because of the fact that they provide a framework that makes interventions easier to replicate and disseminate in real-life settings. A recent meta-analysis of randomized controlled trials (RCTs) concluded that theory-based interventions in PA promotion effectively increase PA and that none of the psychological theories included were found to be superior in PA promotion (Gourlan et al., 2016). This meta-analysis of 31 interventions (over the 82 included) using the transtheoretical model (TTM) also highlighted that this model is among the most used theories to promote PA

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(Prochaska & DiClemente, 1983). The TTM conceptualizes the process of intentional behaviour change by assuming that (a) a single theory cannot account for the complexity of human behaviour change, (b) behaviour change is a process that unfolds over time through several stages, (c) these stages are stable and open to change, and (d) specific processes should be used at specific stages to facilitate the efficacy of behaviour change (Prochaska, Redding, & Evers, 2008). It is interesting that the TTM speculates a nonlinear transition between the stages of change (SOC) with patterns of discontinuity (Lippke & Plotnikoff, 2006).

Even though the TTM is widely used, it remains poorly implemented in interventions seeking to improve PA behaviour (Romain, Bortolon, et al., 2016), and this can be explained by the fact that many researchers are probably unaware of all the TTM's constructs. In view of these observations, it was therefore necessary to explain how to use the TTM and its underlying mediators in research and intervention contexts. The objectives of the present narrative review were to (a) briefly provide an overview of the TTM and the mediators of change on which it is based, (b) discuss studies examining longitudinal associations between PA change and TTM mediators, (c) outline TTM-validated questionnaires, (d) examine the efficacy of TTM-based interventions for PA promotion, and (e) debate future TTM challenges.

The Transtheoretical Model and Its Mediators

The TTM identifies change as a progressive process through a series of five different SOC over time (Prochaska & DiClemente, 1983). Although the SOC are the most popular part of the TTM, notably because of their ease of use and scoring, they also constitute its most descriptive construct. The five SOC are precontemplation (not ready; not intending to change in the next six months), contemplation (getting ready; intention to change within the next six months), preparation (ready; intention to change within 30 days), action (new behaviour is initiated within the last six months), and maintenance (behaviour is sustained for more than six months). Thus, while going through the SOC, an individual starts by intending to adopt the behaviour criteria in the early preaction SOC (precontemplation, contemplation, and preparation) to later adopt and maintain this newly acquired behaviour throughout the action and maintenance stages (Prochaska & Velicer, 1997). If SOC represent the most descriptive part of the TTM, it is mainly because they explain "where" people are in terms of motivation but not "how" to motivate them or "why" they move across stages. Indeed, according to the TTM, the transition between the different SOC is influenced by its mediators of change (its theoretical constructs) that include decisional balance, temptation, self-efficacy, and processes of change (POC; Prochaska, DiClemente, & Norcross, 1992).

Decisional balance is defined as the perception of advantages (pros) and/or disadvantages (cons) related to the decision of undertaking or not a behaviour (Prochaska et al., 1994). *Temptation* is the urge to engage in a specific behaviour in the midst of difficult barriers (Hausenblas et al., 2001). *Self-efficacy*, a component of social–cognitive theory (Bandura, 1977), is defined as a person's judgment of his or her capabilities to organise and execute courses of action required to attain designated types of performance (Bandura, 1997). Finally, there are the *POC* that help clarify how behaviour changes take place, and SOC help pinpoint when those modifications occur. POC are comprised of a total of five experiential processes and five behavioural processes that need to be executed to ensure a certain progress through the SOC and achieve the desired behaviour change. *Experiential processes* are defined as processes in which individuals obtain information based on their own experiences, and *behavioural processes* regroup strategies used to modify the environment to help change the behaviour (Burkholder & Nigg, 2001; Romain, Chevance, Caudroit, & Bernard, 2016; see Table 1 for a definition of POC). In the TTM, the relationship between its mediators and the SOC has been tested extensively (Burkholder & Nigg, 2001; Marshall & Biddle, 2001), and was found to be consistent throughout different types of behaviour (e.g., smoking, diet). However, contrary to the assumptions formulated in tobacco cessation, the POC by SOC sequence was found to be different. Indeed, in smoking cessation, experiential and behavioural POC act sequentially, with experiential POC used in the early stages and behavioural POC in the later stages (action and maintenance). Inversely, in PA, this sequential order was not found with experiential and behavioural POC acting in tandem, with the use of both increasing across stages (Marshall & Biddle, 2001;

Table 1
Processes of Change and Their Definitions

Processes of change	Definition
Experiential processes of change	
Consciousness raising	Efforts to better understand the problematic behavior
Dramatic relief	Affective aspects of behavior change
Self-reevaluation	Cognitive or emotional appraisal of the impact of the behavior on the individual
Environmental reevaluation	Impact of negative or positive behavior on individual's social and physical environment
Social liberation	Recognition that actual social norms encourage individuals to reach/sustain their healthier lifestyle
Behavioral processes of change	
Self liberation	Committing to change and believing in this commitment
Helping relationships	Using the support of caring others to modify behaviour
Counterconditioning	Substituting unhealthy for healthy behaviour
Reinforcement management	Use of reinforcement and reward to support/sustain healthy behaviour
Stimulus control	Modifying the environment to encourage healthy behaviour

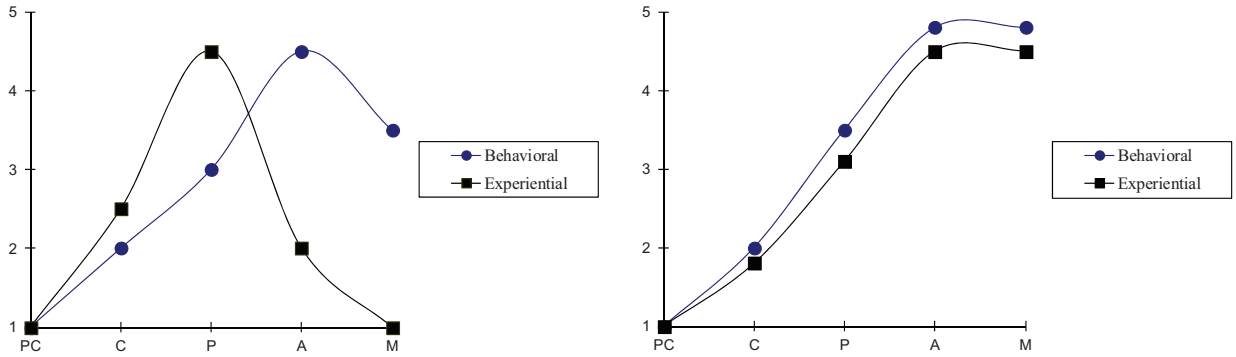

Figure 1. Schematic representation of the relationship between processes and stages of change in tobacco use (left figure; sequential association) and physical activity (right figure; tandem association). This figure has been adapted from Romain, Chevance et al. (2016) with their authorization. PC = precontemplation; C = contemplation; P = preparation; A = action; M = maintenance. See the online article for the color version of this figure.

Rosen, 2000; see Figure 1 for an illustration). This crucial point will be discussed further subsequently.

In the TTM, mediators explain "why" people modify their behaviour. In order to better understand how changes occur, it is essential to focus on longitudinal, interventional, or observational studies (Rhodes & Quinlan, 2015) rather than cross-sectional research designs.

What Do Longitudinal Observational Studies Using TTM Mediators Tell Us About the Transition Between SOC of Physical Activity?

Observational studies provide a primary insight to understand the complex associations between SOC and the mediators of the TTM. For this purpose, in this section, only observational studies having investigated the role of these mediators in the transition between SOC were included.

Plotnikoff, Hotz, Birkett, and Courneya (2001) assessed whether self-efficacy, decisional balance, and POC predicted the transition between exercise SOC within a 12-month period among 1,602 adults. Results showed that self-efficacy, decisional balance, and both experiential and behavioural POC were predictors of the transition between SOC. To be more precise, the transition out of the precontemplation and contemplation stages was predicted by higher levels of self-efficacy, perception of advantages (pros), and behavioural POC. Also, the transition out of the preparation stage was predicted by higher levels of self-efficacy and pros. Moreover, retention in postaction stages was predicted by higher levels of pros versus lower cons, and by the activation of both experiential and behavioural POC. Thus, Plotnikoff, Hotz, et al. (2001) study partially supports the validation of TTM in exercise.

A similar study testing the TTM's capacity for predicting PA transitions was performed among 1,674 adults with Type 1 or Type 2 diabetes over six months (Plotnikoff, Lippke, Johnson, & Courneya, 2010). Findings provided moderate support for the TTM constructs in predicting PA stage transitions, with very few differences between Type 1 and 2 diabetic groups. Indeed, the transition from precontemplation to contemplation was predicted by the pros and the experiential POC. The transition out of preparation was only predicted by higher self-efficacy. Transition out of the action stage was predicted by the pros and the behavioural POC, whereas remaining in the maintenance stage was predicted by higher levels of self-efficacy, pros, and experiential and behavioural POC. Analogous results were found in a prospective investigation in which TTM showed significant potential for motivating women with multiple sclerosis to increase their PA over a period of 12 months (Levy, Li, Cardinal, & Maddalozzo, 2009).

In addition, Dishman, Vandenberg, Motl, and Nigg (2010) assessed TTM constructs relating to the 2010 guidelines for regular moderate or vigorous PA, at 6-month intervals three or more times over 24 months, among a cohort of 497 multiethnic participants. The results provided great support for core TTM constructs by showing that people meeting, or partially meeting, PA guidelines had a decrease in temptation, an increase in self-efficacy, and also a higher use of both experiential and behavioural POC. Only decisional balance was not associated with PA guidelines. Nevertheless, the absence of results regarding decisional balance is not supported by one of the first longitudinal studies on TTM showing that pros, cons, and self-efficacy, but not POC, were associated with leisure exercise three years after initial assessment in adolescents (Nigg, 2001).

The aforementioned studies provide important information to consider, including the fact that all TTM constructs were predictors of the transition between the different SOC, but to different extents.

Thus, regarding PA, to progress through SOC, people need to find more reasons to exercise (the pros) than not to (the cons), and to feel more confident (self-efficacy) by increasing the use of both experiential and behavioural strategies (POC). These arguments are corroborated by findings from a previous meta-analysis of cross-sectional studies on TTM applications to PA (Marshall & Biddle, 2001).

The precited research supports the use of TTM interventions in the context of PA by demonstrating that all TTM constructs are necessary in order to adopt or sustain a physically active lifestyle. However, it should be noted that these observations were drawn from observational studies, so to confirm them it is necessary to analyse results from interventional studies.

Do Intervention Studies Tell the Same Story as Observational Research?

One of the interesting aspects of the TTM is that it enables researchers to create interventions that target specific constructs while ensuring a higher internal validity in the analysis of change over time (Rhodes & Quinlan, 2015). In other words, TTM findings inform the design of individualized stage matched expert system interventions that target variables most predictive of progress at each SOC (Marcus, Nigg, Riebe, & Forsyth, 2000; Redding et al., 1999).

Intervention Studies and Progression Through Stages of Change in the Context of Physical Activity

Several interventional studies support TTM constructs. For example, Lowther, Mutrie, and Scott (2007) performed a 12-month study among 312 healthy subjects separated into two PA groups (exercise consultation or fitness assessment) and found that behavioural POC were important to progress from contemplation to preparation, as well as to predict the regression from the maintenance stage of PA. Moreover, and similar to observational studies, both experiential and behavioural POC predicted the transition from preaction to postaction stages. Nevertheless, it should be noted that the other TTM constructs were not included.

Among 62 adults with obesity, Romain et al. (2014) performed a 1-week multidisciplinary intervention in which participants were contacted after one year. Their results showed that both experiential and behavioural POC were associated with the transition between SOC. Individuals becoming active increased their use of POC. Nevertheless, findings were limited by the fact that only POC were considered.

Interventional Studies and Physical Activity Level

In one of the first TTM-based studies, Marcus et al. (1998) conducted a 3-month motivationally tailored intervention. Their results underlined that individuals having progressed through SOC after the intervention increased their PA from 39 to 115 min per week. However, their conclusion was limited by the absence of data on the other TTM constructs. Thus, it is necessary to consider studies including these constructs in order to better understand how they regulate the efficacy of the intervention. Gallagher, Jakicic, Napolitano, and Marcus (2006) performed a 6-month behavioural weight loss intervention based on social–cognitive theory among 165 overweight women. Except for the temptation construct, all other TTM components were included and the intervention significantly modified self-efficacy and experiential and behavioural POC. However, when the amount of PA performed/executed was examined (150–199 min/week, 200–299 min/week, >300 min/week), results showed that the more women engaged in PA, the more they had advanced levels of self-efficacy and higher use of behavioural POC.

Regarding PA participation expressed in terms of PA guidelines (self-reported), a similar study was carried out over a 24-month period, with assessment each six months, among 144 overweight adults (Riebe et al., 2005). The results indicated that people maintaining PA recommendations had higher self-efficacy, lower cons, and also higher use of experiential and behavioural POC compared with the group that never met the PA recommendations.

In a well-designed TTM-based intervention in the form of consultation sessions among 70 inactive overweight adults with Type 2 diabetes, Kirk and colleagues (Kirk, Mutrie, MacIntyre, & Fisher, 2003, 2004) obtained a 28% increase in self-reported PA among the intervention group compared with a 12% decrease of PA in the control group. Moreover, this PA increase was associated with a higher use of both experiential and behavioural POC in the intervention group (Kirk et al., 2004).

Thus, intervention studies significantly support the use of the TTM in the domain of PA while also validating observational studies' findings. Indeed, contrary to the initial TTM assumptions applied to smoking cessation, it seems that people need to use all constructs to become active. This is particularly true when analysing the role of POC, seeing that participants used both experiential and behavioural POC to adopt or maintain PA, even over long periods of time (Riebe et al., 2005).

Can TTM Mediators Really Mediate Physical Activity Behaviour?

To better understand the efficacy and mechanisms of PA interventions, the analysis of TTM mediators is key (Rhodes & Pfaeffli, 2010), though few studies have addressed this issue. Consequently, there are still elements of the TTM that are poorly understood, particularly regarding PA. Nevertheless, some studies provide some insight on this missing piece of information.

Lewis et al. (2006) examined whether all TTM variables (except temptations) could be mediators of PA behaviour after a stage-matched intervention. They underlined that only self-efficacy and behavioural POC partially satisfied criteria of mediation. The failure to satisfy a complete mediation could be explained by the fact that their study was underpowered ($N = 110$). However, Lewis et al.'s study provided interesting preliminary support on mediating variables of PA.

Thus far, Napolitano et al. (2008) performed a similar 6-month intervention study on 239 inactive adults, revealing that only experiential and behavioural POC were mediators of the relationship between the intervention and the PA level. Nevertheless, in this context, although experiential POC were considered as mediators, they were significantly associated with lower PA levels. Also, and from a public health perspective, after controlling for several variables, it was reported that per one standard unit increase in behavioural POC, PA duration was enhanced by 84 min compared with the control group. When mediation was examined at 12 months (Papandonatos et al., 2012), all TTM variables were shown to be significant mediators of the relationship between the TTM intervention and PA level, even though, when a measure of exercise-induced feelings was introduced among mediators, only behavioural POC remained significant.

Moreover, in a physician-based intervention using the TTM framework, Pinto, Lynn, Marcus, DePue, and Goldstein (2001) found that the decisional balance index (e.g., cons minus pros score) and behavioural POC significantly mediated the relationship between the intervention effect and the self-reported PA level after six weeks in older adults. Experiential POC tended to have a statistically significant impact, though self-efficacy was not significant. However, at 8 months, none of the TTM variables were found to be significant mediators of PA behaviour (Hutchison, Breckon, & Johnston, 2009). Then, Baruth et al. (2010) showed

that after 24 months, behavioural POC were the only mediators of the relationship between the TTM intervention and PA/cardiorespiratory fitness relationship in sedentary adults. Thus, these two studies support the use of TTM, and more particularly behavioural POC in PA behaviour modulation.

Consequently, although the TTM provides information about its mediators, few studies have really addressed this relevant issue (Rhodes & Pfaeffli, 2010). Although some research failed to show any mediation effects, most studies showed that TTM mediators significantly modified PA level even though the sample size was too small to provide any robust conclusion (Fahrenwald, Atwood, Walker, Johnson, & Berg, 2004; Rabin, Pinto, & Frierson, 2006).

Among the most prominent TTM mediators, self-efficacy and behavioural POC were found to be of great importance in PA interventions, even though further explanations are necessary to understand the extent of their impact. The consistent association between these variables/mediators may be explained by the fact that they are often well correlated. Nevertheless, other assumption can be drawn from their significant relation. Loprinzi and Cardinal (2013) performed a study on the supposition that behavioural POC and self-efficacy are important in PA behaviour change and that the literature does not really provide any clear explanation. Thus, among breast cancer patients, they examined the mediation link between PA, behavioural POC, and self-efficacy, and highlighted that behavioural POC were related to PA and that this relationship was mediated by self-efficacy. This result was also confirmed by the Training Interventions and Genetics of Exercise Response study, in which self-efficacy and experiential and behavioural POC were correlated with PA at the baseline period of their trial, with only behavioural POC mediating the relationship between self-efficacy and adherence to exercise (defined as the number of exercise sessions attended compared with the possible number of exercise sessions offered; Dishman, Jackson, & Bray, 2014).

Consequently, even though these findings further solidify our understanding of the TTM when relating to PA change, they do not negate the role of experiential POC that can trigger the intention to exercise in different populations (Nigg, 2005).

Initial TTM Instruments Development for Physical Activity Behaviour Change

In the TTM, one of the undeniable limitations is that most assessment tools are presented in English, which restricts their use to English-speaking countries; in addition, not all studies used validated questionnaires in their surveys. Thus, to overcome this issue, in the following paragraphs, we present a systematic overview of the different worldwide validations that exist.

TTM research in the context of PA was initiated by Marcus, Rakowski, and Rossi (1992), who published three validation studies for assessing the four key TTM constructs with cross-sectional designs across work-site samples in Rhode Island. Except for the Temptation scale, these questionnaires have been extensively used, examined, and adapted.

As recommended by Reed, Velicer, Prochaska, Rossi, and Marcus (1997), the SOC measure was developed as an algorithm to categorise individuals in one of five SOC. This scale consists of one item with five statements representing each a stage, going from the "precontemplation" to the "maintenance" stage. Thus, a reliable SOC algorithm should include a clear definition of PA and its frequency and duration. PA defined as a 30 min session at least four times per week is generally recommended (Nigg et al., 2005; Romain et al., 2012), and the validity of this SOC algorithm has been shown with self-reported PA and anthropometrical measures in adults (Hellsten et al., 2008; Nigg et al., 2005).

Regarding POC, Marcus et al. (1992) adapted the initial scale developed for smoking cessation by Prochaska, Velicer, DiClemente, and Fava (1988) for the context of PA. The scale contained 39 items measuring both experiential and behavioural POC (α = .62–.88). Later, Nigg, Norman, Rossi, and Benisovich (1999) created a new and shorter measure of POC, which contains 30 items measuring the 10 POC for PA (α = .62–.85).

Regarding self-efficacy, Marcus et al. (1992) validated a five-item-measure scale assessing self-efficacy for PA (α = .82). In addition, Benisovich, Rossi, Norman, and Nigg (1998) developed the multidimensional self-efficacy questionnaire, which comprises 18 items measuring the individual's confidence in his ability to overcome PA-related barriers (e.g., excuse making, bad weather; α = .77–.85).

Finally, Marcus et al. (1992) validated a 16-item Decisional Balance scale for PA, with 10 items for the perceived benefits of PA (pros; α = .95) and six items for the perceived costs (cons; α = .79). Plotnikoff, Blanchard, Hotz, and Rhodes (2001) updated this scale by using 10 items (five pros, α = .79; five cons, α = .71) for PA.

The temptation measure was validated by Hausenblas et al. (2001). In their initial development and validation, two factors were reported: affect (five items; α = .81) and competing demands (five items; α = .86). Another seven-item version showed a similar structure (Geller, Nigg, Motl, Horwath, & Dishman, 2012).

Regarding the validation of TTM scales in PA, several studies have investigated the validity, adaptation, translation, and application of TTM constructs in different populations and languages (see Table 2 for summary and Supplementary File 1 of the online supplemental materials for the complete table).

TTM Questionnaires Available in 11 Different Languages

Among studies presented in the Table 2, several researchers have used the original TTM questionnaires validated in English (Blaney et al., 2012; Carnegie et al., 2002; Dishman, Jackson, et al., 2010; Geller et al., 2012; Kearney, de Graaf, Damkjaer, & Engstrom, 1999; Maddison & Prapavessis, 2006; Norman, Velicer, Fava, & Prochaska, 1998; Pickering & Plotnikoff, 2009; Rhodes, Berry, Naylor, & Wharf Higgins, 2004; Sallis, Pinski, Grossman, Patterson, & Nader, 1988; Skaal, 2013; Skaal & Pengpid, 2012; Vita & Owen, 1995). TTM scales were then translated into 11 different languages (see Table 2). Psychometric studies have validated TTM constructs from English to French (Bernard et al., 2014; Eeckhout, Francaux, Heeren, & Philippot, 2013; Eeckhout, Francaux, & Philippot, 2012a, 2012b; Romain, Bernard, Hokayem, Gernigon, & Avignon, 2016), Finnish (Cardinal, Tuominen, & Rintala, 2003, p. 200), Dutch (Ronda, Van Assema, & Brug, 2001), German (Bucksch, Finne, & Kolip, 2008; Fuchs & Schwarzer, 1994; Kanning, 2010; Tergerson & King, 2002), Greek (Bebetsos & Papaioannou, 2009; Korologou, Barkoukis, Lazuras, & Tsorbatzoudis, 2015), Persian (Farmanbar, Niknami, Lubans, & Hidarnia, 2013; Sanaeinasab, Saffari, Nazeri, Karimi Zarchi, & Cardinal, 2013), Korean (Y. Kim, Cardinal, & Lee, 2006; Y.-H. Kim, 2007), Chinese (Si et al., 2011;

Table 2
Systematic Summary of the Different Worldwide Studies Carried Out on TTM Constructs

Continent	Country	Authors	Language	Constructs
Europe	Belgium	Eeckhout et al. (2012a, 2012b); Eeckhout, Francaux, Heeren, & Philippot (2013)	French	POC, SE, DB
	France	Bernard et al. (2014); Romain, Bernard, Galvez, & Caudroit (2015)		POC, SOC
	Finland	Cardinal, Tuominen, & Rintala (2003)	Finnish	DB, POC, SE
	German	Bucksch, Finne, & Kolip (2008); Kanning (2010)	Dutch	POC,SOC, SE, DB
	Netherland	Ronda, Van Assema, & Brug (2001)	German	SOC
	Greece	Bebetsos & Papaioannou (2009); Korologou et al. (2015)	Greek	DB, POC, SE, SOC
Asia	Iran	Farmanbar, Niknami, Lubans, & Hidarnia (2012); Sanaeinasab et al. (2013)	Persian	DB, POC, SE, SOC
	Korea	Y.-H. Kim (2007); Y. Kim, Cardinal, & Lee (2006)	Korean	DB, POC, SE, SOC
	Taiwan	Tung, Gillett, & Pattillo (2005); Yang & Chen (2005)	Chinese	DB, POC, SE, SOC
	China	Si et al. (2011)		DB, POC, SE, SOC
	Malaysia	Phing (2014)	Malay	SOC
	Japan	Horiuchi, Tsuda, Kobayashi, Fallon, & Sakano (2016)	Japanese	SOC, DB, SE
America	USA	Blaney et al. (2012); Dishman, Jackson, & Bray (2010); Geller, Nigg, Motl, Horwath, & Dishman (2012)	English	DB, POC, SE, SOC
	Canada	Pickering et al. (2009); Rhodes, Berry, Naylor, & Wharf Higgins (2004)		POC, DB
	Mexico	Gonzalez & Jirovec et al. (2001)	Spanish	SOC
Oceania	New Zealand	Maddison et al. (2006)	English	DB, POC, SE, SOC
	Australia	Carnegie et al. (2008)		SOC
Africa	South Africa	Skaal et al. (2012, 2013)		SOC, POC

Note. More details about validation processes, psychometric information, and study participants are available in the online supplementary materials. TM = transtheoretical model; SOC = stage of change; POC = processes of change; SE = self-efficacy; DB = decisional balance.

Tung, Gillett, & Pattillo, 2005; Yang & Chen, 2005), Malaysian (Phing, 2014), Japanese (Horiuchi, Tsuda, Kobayashi, Fallon, & Sakano, 2017; Oka, 2000, 2003), Taiwanese (Sechrist, Walker, & Pender, 1987), and Spanish (Gonzalez & Jirovec, 2001). No psychometric investigation has, to our knowledge, interpreted or adapted the temptation scale in other languages.

Investigating Invariance of TTM Questionnaires

The different types of invariance (configural, metric, and scalar) of TTM questionnaires (see Table 2) have been investigated across various time sets and subgroup characteristics, with results showing that TTM constructs were invariant according to sex, student status, ethnicity, age, body mass index, employment, PA level, protocol adherence, level of education, and diabetes type (Bernard et al., 2014; Dishman, Jackson, & Bray, 2010; Geller et al., 2012; Paxton et al., 2008; Pickering & Plotnikoff, 2009). These analyses were performed with English and French versions of TTM questionnaires (Bernard et al., 2014; Geller et al., 2012).

Moreover, the longitudinal invariance of TTM constructs has also been provided across 3- and 6-month periods, with studies showing that any temporal differences or modifications identified can be interpreted as changes related to time or intervention mistakes, but not measurement errors (Dishman, Jackson, et al., 2010; Geller et al., 2012).

Are TTM-Based Interventions Effective in Promoting PA?

Over the last decade, interventional researchers in health psychology and behavioural medicine have gradually integrated the specific methodological requirements of evidence-based medicine (Keefe & Blumenthal, 2004). In this methodological paradigm, the RCT design is recognised as the highest level of investigative methodology to establish the efficacy or effectiveness of health behaviour change interventions (Davidson et al., 2003). In this context, several critics have questioned the worth of TTM interventions in promoting PA, arguing that SOC may not be applied to PA change because of the complexity of this behaviour, the lack of validated staging algorithms, and the possibility that the most reliable determinants of PA change are not included in the TTM (Adams & White, 2005; Armitage, 2009; Brug et al., 2005). However, two systematic reviews including only RCTs examined the efficacy of TTM interventions on PA promotion, with findings indicating that TTM-based interventions induce a small to medium effect size for PA behaviour change. The most recent review (Romain, Bortolon, et al., 2016) included 33 RCTs, with 4,950 and 5,400 participants in the interventional and control groups, respectively. Fourteen studies included exclusively adults with chronic illness (e.g., multiple sclerosis). The length of intervention ranged from 2 to 100 weeks, and PA level was an inclusion criterion but stage progression was not. In addition, all constructs related to PA were self-reported. This review obtained an overall effect size of $d = 0.33$ (95 % confidence interval [CI] [0.22, 0.43]) for PA behaviour change, which was consistent with Gourlan et al. (2016) ($d = 0.31$, 95 % CI [0.20, 0.42]). These effect sizes need to be interpreted in the context of public health (Prentice & Miller, 1992), seeing that even a slight PA increase may lead to a major health impact (Khan et al., 2012).

Evidence-Based Rather Than Evidence-Inspired TTM Interventions to Change Physical Activity Behaviour

In line with previous recommendations (Michie & Johnston, 2012), a thorough analysis of theoretical moderators of TTM-based interventions has been performed in the present narrative review. Romain, Bortolon et al. (2016) observed that TTM-based interventions implementing at least three constructs (e.g., self-efficacy, decisional balance, POC) obtained a 3-times larger effect size ($d = 0.49$, 95 % CI [0.29, 0.69]) versus applying two constructs or less ($d = 0.16$, 95 % CI [0.06, 0.25]) regarding PA promotion. Moreover, bivariate metaregressions showed that self-efficacy and POC were the most active and effective components

to modulate PA levels, whereas SOC were not. Hence, TTM-based interventions significantly improved PA whether they were stage-matched or non-stage-matched (22 of 33 RCTs), and whether participants were selected by stage or not selected by stage (13 of 33 RCTs) during the inclusion phase. This empirical finding was in line with experimental weaknesses mentioned in previous TTM published critics (Adams & White, 2003; Armitage, 2009; Rhodes & Nigg, 2011). For instance, Adams and White (2005) argued that although stage-matched intervention may induce stage progression, it is not always followed by actual behaviour change.

Nonetheless, although well-designed TTM studies had larger effect sizes, it is also known that other moderators can affect the efficacy of theory-based interventions. Therefore, the efficacy of TTM-based interventions could be overestimated because of methodological weaknesses. Indeed, factors such as the number of experimental patients, methodological quality score, and intervention duration (>14 weeks) were found to decrease the overall effect size of theory based-interventions on PA behaviour (Bernard et al., 2017). Even though this investigation did not focus exclusively on TTM-based interventions, these results could be also applied to TTM-based interventions.

Evidence Based Conclusions

Two meta-analyses including more than 30 RCTs concluded that TTM-based interventions were effective in promoting PA change in adults. Also, interventions tailored with all TTM constructs and lasting less than 14 weeks were more effective in altering PA behaviour. Thus, although the TTM has some weaknesses that should be acknowledged (e.g., classification of individuals into five distinct stages, lack of temporal sequence examination, social context not considered; Armitage, 2009), TTM-based interventions increase PA levels in inactive adults with or without chronic disease when implemented beyond stages (Armitage & Arden, 2010; Romain, Bortolon, et al., 2016) and when interventions are TTM-driven rather than TTM-inspired (Romain, Bortolon, et al., 2016).

Future Research Initiatives for TTM Research in the Context of Physical Activity

A Refined Physical-Activity-Specific Transtheoretical Model

From the first psychometric studies to the more recent prospective cohort studies (Plotnikoff, Hotz, et al., 2001; Plotnikoff et al., 2010) and meta-analyses (Gourlan et al., 2016; Marshall & Biddle, 2001; Romain, Bortolon, et al., 2016), a massive data set exists concerning TTM interventions in PA. Interestingly, researchers observed that several TTM assumptions specific to smoking cessation were inapplicable for PA research (Romain, Horwath, & Bernard, 2018), and consequently that there is a need to refine TTM application to the context of PA (Rhodes & Nigg, 2011). Indeed, as proposed by Noar and Head (2014), both general and behavioural-specific versions of a theory's application could coexist. Recent work suggests that a PA-specific TTM should be proposed, with new assumptions. Therefore, two seminal assumptions of the TTM should be modified when applied to PA behaviour: (a) the relative importance of SOC should be revised in favour of POC and self-efficacy, as these two constructs should be prioritized as targets to explain or modify PA behavior; and (b) the predominant role of experiential POC during precontemplation, contemplation, and preparation SOC should be replaced by a tandem use of both experiential and behavioural POC, which has been supported by cross-sectional (Bernard et al., 2014; Hwang & Kim, 2011; Marcus et al., 1992; Nigg & Courneya, 1998) and longitudinal (Dishman, Vandenberg, et al., 2010; Kirk et al., 2004; Lipschitz et al., 2015; Plotnikoff, Hotz, et al., 2001) studies. These studies consistently found that in later SOC (action and maintenance), experiential and behavioural processes were more triggered, whereas the contrary was also found in the earlier precontemplation stage (lower use of both, experiential and behavioral, POC). To illustrate this argument, Plotnikoff, Hotz, et al. (2001) showed that the transition out of the precontemplation stage (a preaction stage) was predicted by behavioural processes and not by experiential processes (contrary to the original TTM assumption). The same pattern was found for the transition out of the contemplation stage (another preaction stage). These findings are key because they highlight how TTM assumptions should be modified according to a PA context.

Future Research Questions on TTM Use for Physical Activity Behaviour Change

Is there an interaction hypothesis? Among the emerging hypotheses in PA research, there is the interaction hypothesis, based on the fact that during interventions, experiential and behavioural POC are used in tandem rather than sequentially (Marshall & Biddle, 2001; Rosen, 2000), and that this conjoint use could be explained by an interaction between them. This interaction hypothesis was tested in only one study, demonstrating that the interaction between experiential and behavioural POC predicted moderate PA among adults (Romain et al., 2018). Although of interest, with only one study examining this hypothesis, it is difficult to draw any final conclusions. A prospective investigation of POC and PA with monthly repeated measures analysed with latent-growth modelling with parallel change processes would be an interesting future study to test the interaction hypothesis.

Should research target the quality/type or the quantity/number of POC? The present review suggests that by using both experiential and behavioural POC, individuals can initiate or sustain their PA behaviour change. Considering the latter, we wonder if interventions should promote a specific type of POC (e.g., an online intervention targeting only POC with lower scores) or aim to activate a higher number of POC (e.g., intervention targeting all 10 POC). For example, Romain, Bernard, Galvez, and Caudroit (2015) showed that after a 3-month intervention, people with Type 2 diabetes that decreased their self-reported PA level were those that used fewer POC but also reduced their use of behavioural POC. Thus, this study suggests that the number and type of POC are involved in modifying PA behaviour. Nevertheless, more investigations are needed to provide a sound answer to this question

Can some POC have a suppressor effect on PA? Two longitudinal studies found a negative association between specific POC and PA level, demonstrating the suppressor effect of certain POC. Indeed, Napolitano et al. (2008) found that experiential POC suppressed PA, and in the Pinto and Dunsiger (2015) study, an increase in social support was found to decrease PA. Even though this suppressor effect

could be explained by some methodological considerations, all inhibitory impacts should be examined to avoid the POC that may negate PA progress. As an example of a possible negative effect, it has been shown that improvement in weight was negatively associated with experiential POC (Napolitano & Hayes, 2011). Further research is needed to determine an optimal implementation strategy for POC using an idiographic approach. For instance, n-of-1 RCT studies focusing on POC implementation could provide clear evidence-based results for the second and third questions (Craig et al., 2008).

Can POC modify environmental perception? Health behaviour change experts underlined that environmental characteristics (e.g., social, physical, organisational) are either barriers or facilitators of PA and an active lifestyle (Glanz & Bishop, 2010). Contrary to other theoretical models that only conceptualise the environment as a determinant of PA, the TTM framework helps individuals to modify their own environment to initiate or maintain PA. In fact, targeting three specific POC (stimulus control, helping relationships, and environmental reevaluation) could facilitate a favourable environment for PA (Romain et al., 2014).

Can the construct of temptation account for PA change? Temptation is the least examined TTM construct, and although it was found to have interest in other behaviours, such as fat reduction or smoking cessation (Plummer et al., 2001; Yusufov et al., 2016), there is no clear evidence of its role in TTM-based PA interventions. Future ecological momentary assessment studies could be useful in exploring modifications of environmental perceptions in participants soliciting these POC (Dunton, 2017). This method may also help to determine whether a consistent association exists between temptation and PA behavioural changes.

TTM Participating in the Cumulative Science of Behaviour Change

Concerning PA behaviour change, continued efforts are needed to systematically develop "all constructs" of TTM-based interventions in order to ensure a greater level of accuracy and efficacy in predicting PA transitions.

Providing details on behaviour change techniques ("active ingredients") related to TTM-based interventions focusing on PA could improve their understanding, replication, and implementation. Thus, scientist/interventionists should cite with precision all behaviour change techniques used in their interventions to facilitate research protocols and ensure comparability. Interestingly, a behaviour change technique taxonomy has been created to facilitate the reporting of behaviour change interventions (Michie et al., 2013). For instance, no information about behaviour change techniques were available in the most recent TTM-based interventions included in Romain, Bortolon, et al. (2016) review.

Efforts are needed to identify techniques better suited in adapting TTM key determinants, including POC and self-efficacy, regarding PA behaviour change. As such, experimental studies should be designed to determine optimal intervention technique(s) and timing while also testing theoretical mechanisms inducing beneficial change in PA behaviour (Peters, de Bruin, & Crutzen, 2015). Innovative study designs have been proposed for this purpose with n-of-1 RCT methodology offering a very good research basis for this purpose.

Conclusion

To date, even though there is no such thing as an ideal theory based on an exemplary framework capable of modifying PA behaviour, the TTM has revealed itself to be one of the most effective theoretical models in that context (Gourlan et al., 2016). Also, although the TTM is progressively entering the cumulative science of behavioural change, it is important to point out that the major weaknesses of its implementation are insufficient intervention content reporting and SOC overuse in interventions. As adequately written by Bridle et al. (2005), "the stage of change construct is a variable, not a theory, and it is unclear why some researchers would assume that a variable could facilitate consistent intervention effect" (p. 297).

Thus, other than to test new hypotheses or applications, cross-sectional investigations on PA behaviour should be ceased while multisite longitudinal investigations with repeated measures analysing the dynamic of behaviour change, and identifying associations between PA and TTM constructs, must be continued. As Rhodes and Nigg (2011) wrote, "Despite more than 100 studies using the TTM to understand PA, few advances that are PA specific have been documented since the original adaptation of the model from smoking behaviour" (p. 116). We are now in 2017, and even though there have been some changes regarding TTM's use in the field of PA, few advances have truly been made.

Concerning SOC, we should reiterate that (a) SOC are not the TTM, (b) SOC are organisational but not explanatory constructs, and (c) SOC are neither a model nor a theory, as they are often referred to as.

So, as an answer to our title, we can say that, yes, there are key PA regulatory elements beyond TTM stages, which are decisional balance, self-efficacy, POC, and, possibly, temptation.

Résumé

Au cours des 30 dernières années, on a pu observer un intérêt accru pour l'application du modèle transthéorique (MTT) dans le domaine de l'activité physique (AP). Bien que ce modèle ait largement été utilisé pour la mise en œuvre d'interventions en AP, la majorité de ces interventions n'ont pas utilisé tous les concepts théoriques du MTT. En effet, plusieurs études ont porté exclusivement sur les stades de changement alors que ce concept est uniquement descriptif. Ainsi, dans la présente étude, nous avons voulu encourager les chercheurs à aller au-delà des stades de changement lorsqu'ils utilisent le MTT. Pour ce faire, nous avions pour but de fournir un aperçu du MTT et de ses concepts tout en présentant, d'une part, des études longitudinales examinant la relation entre l'AP et les concepts du MTT et, d'autre part, en résumant l'efficacité des interventions basées sur le MTT et en abordant les défis de demain par rapport au MTT.

Mots-clés : activité physique, modèle transthéorique, stades de changement, processus de changement, médiateurs de changement.

References

Adams, J., & White, M. (2003). Are activity promotion interventions based on the transtheoretical model effective? A critical review. *British Journal of Sports Medicine, 37,* 106–114. http://dx.doi.org/10.1136/bjsm.37.2.106

Adams, J., & White, M. (2005). Why don't stage-based activity promotion interventions work? *Health Education Research, 20,* 237–243. http://dx.doi.org/10.1093/her/cyg105

Andersen, L. B., Mota, J., & Di Pietro, L. (2016). Update on the global pandemic of physical inactivity. *The Lancet, 388,* 1255–1256. http://dx.doi.org/10.1016/S0140-6736(16)30960-6

Armitage, C. J. (2009). Is there utility in the transtheoretical model? *British Journal of Health Psychology, 14,* 195–210. http://dx.doi.org/10.1348/135910708X368991

Armitage, C. J., & Arden, M. A. (2010). A volitional help sheet to increase physical activity in people with low socioeconomic status: A randomised exploratory trial. *Psychology & Health, 25,* 1129–1145. http://dx.doi.org/10.1080/08870440903121638

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191–215. http://dx.doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.

Baruth, M., Wilcox, S., Dunn, A. L., King, A. C., Marcus, B. H., Rejeski, W. J., . . . Blair, S. N. (2010). Psychosocial mediators of physical activity and fitness changes in the activity counseling trial. *Annals of Behavioral Medicine, 39,* 274–289. http://dx.doi.org/10.1007/s12160-010-9178-4

Bebetsos, E., & Papaioannou, A. (2009). *The use of model of stages of change towards exercise - physical activity, in Greek population*. Presented at the 12th world conference of sport psychology, Marrakesh, Morocco.

Benisovich, S. V., Rossi, J., Norman, G., & Nigg, C. (1998). Development of a multidimensional measure of exercise self-efficacy. *Annals of Behavioral Medicine, 20,* S190.

Bernard, P., Carayol, M., Gourlan, M., Boiché, J., Romain, A. J., Bortolon, C., . . . Ninot, G. (2017). Moderators of theory-based interventions to promote physical activity in 77 randomized controlled trials. *Health Education & Behavior, 44,* 227–235. http://dx.doi.org/10.1177/1090198116648667

Bernard, P., Romain, A.-J., Trouillet, R., Gernigon, C., Nigg, C., & Ninot, G. (2014). Validation of the TTM processes of change measure for physical activity in an adult French sample. *International Journal of Behavioral Medicine, 21,* 402–410. http://dx.doi.org/10.1007/s12529-013-9292-3

Blaney, C. L., Robbins, M. L., Paiva, A. L., Redding, C. A., Rossi, J. S., Blissmer, B., . . . Oatley, K. (2012). Validation of the measures of the transtheoretical model for exercise in an adult African-American sample. *American Journal of Health Promotion, 26,* 317–326. http://dx.doi.org/10.4278/ajhp.091214-QUAN-393

Bridle, C., Riemsma, R. P., Pattenden, J., Sowden, A. J., Mather, L., Watt, I. S., & Walker, A. (2005). Systematic review of the effectiveness of health behavior interventions based on the transtheoretical model. *Psychology & Health, 20,* 283–301. http://dx.doi.org/10.1080/08870440512331333997

Brug, J., Conner, M., Harré, N., Kremers, S., McKellar, S., & Whitelaw, S. (2005). The transtheoretical model and stages of change: A critique: Observations by five commentators on the paper by Adams, J. and White, M. (2004) why don't stage-based activity promotion interventions work? *Health Education Research, 20,* 244–258. http://dx.doi.org/10.1093/her/cyh005

Bucksch, J., Finne, E., & Kolip, P. (2008). The transtheoretical model in the context of physical activity in a school-based sample of German adolescents. *European Journal of Sport Science, 8,* 403–412. http://dx.doi.org/10.1080/17461390802438748

Burkholder, G. J., & Nigg, C. R. (2001). Overview of the transtheoretical model. In P. M. Burbank & D. Riebe (Eds.), *Promoting exercise and behavior change in older adults: Interventions with the transtheoretical model* (pp. 57–84). New York, NY: Springer.

Cardinal, B. J., Tuominen, K. J., & Rintala, P. (2003). Psychometric assessment of Finnish versions of exercise-related measures of transtheoretical model constructs. *International Journal of Behavioral Medicine, 10,* 31–43. http://dx.doi.org/10.1207/S15327558IJBM1001_03

Carnegie, M. A., Bauman, A., Marshall, A. L., Mohsin, M., Westley-Wise, V., & Booth, M. L. (2002). Perceptions of the physical environment, stage of change for physical activity, and walking among Australian adults. *Research Quarterly for Exercise and Sport, 73,* 146–155. http://dx.doi.org/10.1080/02701367.2002.10609003

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M., & Medical Research Council Guidance. (2008). Developing and evaluating complex interventions: The new Medical Research Council guidance. *British Medical Journal (Clinical Research Ed.), 337,* a1655. http://dx.doi.org/10.1136/bmj.a1655

Davidson, K. W., Goldstein, M., Kaplan, R. M., Kaufmann, P. G., Knatterud, G. L., Orleans, C. T., . . . Whitlock, E. P. (2003). Evidence-based behavioral medicine: what is it and how do we achieve it? *Annals of Behavioral Medicine, 26,* 161–171.

Ding, D., Lawson, K. D., Kolbe-Alexander, T. L., Finkelstein, E. A., Katzmarzyk, P. T., van Mechelen, W., . . . Lancet Physical Activity Series 2 Executive Committee. (2016). The economic burden of physical inactivity: A global analysis of major non-communicable diseases. *The Lancet, 388,* 1311–1324. http://dx.doi.org/10.1016/S0140-6736(16)30383-X

Dishman, R. K., Jackson, A. S., & Bray, M. S. (2010). Validity of processes of change in physical activity among college students in the TIGER study. *Annals of Behavioral Medicine, 40,* 164–175. http://dx.doi.org/10.1007/s12160-010-9208-2

Dishman, R. K., Jackson, A. S., & Bray, M. S. (2014). Self-regulation of exercise behavior in the TIGER study. *Annals of Behavioral Medicine, 48,* 80–91. http://dx.doi.org/10.1007/s12160-013-9573-8

Dishman, R. K., Vandenberg, R. J., Motl, R. W., & Nigg, C. R. (2010). Using constructs of the transtheoretical model to predict classes of change in regular physical activity: A multi-ethnic longitudinal cohort study. *Annals of Behavioral Medicine, 40,* 150–163. http://dx.doi.org/10.1007/s12160-010-9196-2

Dunton, G. F. (2017). Ecological momentary assessment in physical activity research. *Exercise and Sport Sciences Reviews, 45,* 48–54.

Eeckhout, C., Francaux, M., Heeren, A., & Philippot, P. (2013). Mesure de la balance décisionnelle en vue de pratiquer une activité physique régulière (BDAP): Adaptation et validation francophone de l'échelle Decisional Balance for Exercise [Assessment of decisional balance for regular physical exercise: Adaptation and validation of the decisional balance scale for exercise among a French Sample]. *European Review of Applied Psychology, 63,* 185–191. http://dx.doi.org/10.1016/j.erap.2013.01.001

Eeckhout, C., Francaux, M., & Philippot, P. (2012a). Auto-efficacité perçue pour la pratique d'une activité physique: Adaptation et validation francophone du Exercise Confidence Survey [Perceived self-efficacy for practicing physical activity: Adaptation and validation of the French Exercise Confidence Survey]. *Canadian Journal of Behavioural Science, 44,* 77–82. http://dx.doi.org/10.1037/a0025317

Eeckhout, C., Francaux, M., & Philippot, P. (2012b). Mesure des processus de changement vis-à-vis de la pratique d'une activité physique régulière (QPC): Adaptation et validation francophone du questionnaire Exercise processes of change [Exercise processes of change questionnaire: French validation]. *Science & Sports, 27,* 333–344. http://dx.doi.org/10.1016/j.scispo.2011.10.013

Fahrenwald, N. L., Atwood, J. R., Walker, S. N., Johnson, D. R., & Berg, K. (2004). A randomized pilot test of "Moms on the Move": A physical activity intervention for WIC mothers. *Annals of Behavioral Medicine, 27,* 82–90. http://dx.doi.org/10.1207/s15324796abm2702_2

Farmanbar, R., Niknami, S., Lubans, D. R., & Hidarnia, A. (2013). Predicting exercise behaviour in Iranian college students: Utility of an

integrated model of health behaviour based on the transtheoretical model and self-determination theory. *Health Education Journal, 72,* 56–69. http://dx.doi.org/10.1177/0017896911430549

Fuchs, R., & Schwarzer, R. (1994). [Self-efficacy towards physical exercise: reliability and validity of a new instrument]. *Zeitschrift für Differentielle und Diagnostische Psychologie, 15,* 141–154.

Gallagher, K. I., Jakicic, J. M., Napolitano, M. A., & Marcus, B. H. (2006). Psychosocial factors related to physical activity and weight loss in overweight women. *Medicine and Science in Sports and Exercise, 38,* 971–980. http://dx.doi.org/10.1249/01.mss.0000218137.25970.c6

Geller, K. S., Nigg, C. R., Motl, R. W., Horwath, C., & Dishman, R. K. (2012). Transtheoretical model constructs for physical activity behavior are invariant across time among ethnically diverse adults in Hawaii. *Psychology of Sport and Exercise, 13,* 606–613. http://dx.doi.org/10.1016/j.psychsport.2012.02.006

Glanz, K., & Bishop, D. B. (2010). The role of behavioral science theory in development and implementation of public health interventions. *Annual Review of Public Health, 31,* 399–418. http://dx.doi.org/10.1146/annurev.publhealth.012809.103604

Gonzalez, B. C. S., & Jirovec, M. M. (2001). Elderly Mexican women's perceptions of exercise and conflicting role responsibilities. *International Journal of Nursing Studies, 38,* 45–49.

Gourlan, M., Bernard, P., Bortolon, C., Romain, A. J., Lareyre, O., Carayol, M., . . . Boiché, J. (2016). Efficacy of theory-based interventions to promote physical activity. A meta-analysis of randomised controlled trials. *Health Psychology Review, 10,* 50–66. http://dx.doi.org/10.1080/17437199.2014.981777

Hausenblas, H. A., Nigg, C. R., Dannecker, E. A., Downs, D. S., Gardner, R. E., Fallon, E. A., . . . Loving, M. G. (2001). A missing piece of the transtheoretical model applied to exercise: Development and validation of the temptation to not exercise scale. *Psychology & Health, 16,* 381–390. http://dx.doi.org/10.1080/08870440108405514

Hellsten, L. A., Nigg, C., Norman, G., Burbank, P., Braun, L., Breger, R., . . . Wang, T. (2008). Accumulation of behavioral validation evidence for physical activity stage of change. *Health Psychology, 27,* S43–S53. http://dx.doi.org/10.1037/0278-6133.27.1(Suppl.).S43

Horiuchi, S., Tsuda, A., Kobayashi, H., Fallon, E. A., & Sakano, Y. (2017). Self-efficacy, pros, and cons as variables associated with adjacent stages of change for regular exercise in Japanese college students. *Journal of Health Psychology Journal of Health Psychology, 22,* 993–1003.

Hutchison, A. J., Breckon, J. D., & Johnston, L. H. (2009). Physical activity behavior change interventions based on the transtheoretical model: A systematic review. *Health Education & Behavior, 36,* 829–845. http://dx.doi.org/10.1177/1090198108318491

Hwang, J., & Kim, Y. H. (2011). Adolescents' physical activity and its related cognitive and behavioural processes. *Biology of Sport, 28,* 19–22. http://dx.doi.org/10.5604/935863

Kanning, M. (2010). Physically active patients with coronary artery disease: A longitudinal investigation of the processes of exercise behaviour change. *British Journal of Health Psychology, 15,* 583–597. http://dx.doi.org/10.1348/135910709X477476

Kearney, J. M., de Graaf, C., Damkjaer, S., & Engstrom, L. M. (1999). Stages of change towards physical activity in a nationally representative sample in the European Union. *Public Health Nutrition, 2,* 115–124. http://dx.doi.org/10.1017/S1368980099000166

Keefe, F. J., & Blumenthal, J. A. (2004). Health psychology: What will the future bring? *Health Psychology, 23,* 156–157. http://dx.doi.org/10.1037/0278-6133.23.2.156

Khan, K. M., Thompson, A. M., Blair, S. N., Sallis, J. F., Powell, K. E., Bull, F. C., & Bauman, A. E. (2012). Sport and exercise as contributors to the health of nations. *The Lancet, 380,* 59–64. http://dx.doi.org/10.1016/S0140-6736(12)60865-4

Kim, Y.-H. (2007). Application of the transtheoretical model to identify psychological constructs influencing exercise behavior: A questionnaire survey. *International Journal of Nursing Studies, 44,* 936–944. http://dx.doi.org/10.1016/j.ijnurstu.2006.03.008

Kim, Y., Cardinal, B. J., & Lee, J. (2006). Understanding exercise behavior among Korean adults: A test of the transtheoretical model. *International Journal of Behavioral Medicine, 13,* 295–303. http://dx.doi.org/10.1207/s15327558ijbm1304_4

Kirk, A., Mutrie, N., MacIntyre, P., & Fisher, M. (2003). Increasing physical activity in people with type 2 diabetes. *Diabetes Care, 26,* 1186–1192. http://dx.doi.org/10.2337/diacare.26.4.1186

Kirk, A. F., Mutrie, N., MacIntyre, P. D., & Fisher, M. B. (2004). Promoting and maintaining physical activity in people with type 2 diabetes. *American Journal of Preventive Medicine, 27,* 289–296. http://dx.doi.org/10.1016/j.amepre.2004.07.009

Korologou, S., Barkoukis, V., Lazuras, L., & Tsorbatzoudis, H. (2015). Application of the transtheoretical model to physical activity in deaf individuals. *Adapted Physical Activity Quarterly, 32,* 223–240. http://dx.doi.org/10.1123/APAQ.2013-0073

Levy, S. S., Li, K.-K., Cardinal, B. J., & Maddalozzo, G. F. (2009). Transitional shifts in exercise behavior among women with multiple sclerosis. *Disability and Health Journal, 2,* 216–223. http://dx.doi.org/10.1016/j.dhjo.2009.04.001

Lewis, B. A., Forsyth, L. H., Pinto, B., Bock, B. C., Roberts, M., & Marcus, B. H. (2006). Psychosocial mediators of physical activity in a randomized controlled intervention trial. *Journal of Sport & Exercise Psychology, 28,* 193–204. http://dx.doi.org/10.1123/jsep.28.2.193

Lippke, S., & Plotnikoff, R. C. (2006). Stages of change in physical exercise: A test of stage discrimination and nonlinearity. *American Journal of Health Behavior, 30,* 290–301. http://dx.doi.org/10.5993/AJHB.30.3.7

Lipschitz, J. M., Yusufov, M., Paiva, A., Redding, C. A., Rossi, J. S., Johnson, S., . . . Prochaska, J. O. (2015). Transtheoretical principles and processes for adopting physical activity: A longitudinal 24-month comparison of maintainers, relapsers, and nonchangers. *Journal of Sport & Exercise Psychology, 37,* 592–606. http://dx.doi.org/10.1123/jsep.2014-0329

Loprinzi, P. D., & Cardinal, B. J. (2013). Self-efficacy mediates the relationship between behavioral processes of change and physical activity in older breast cancer survivors. *Breast Cancer, 20,* 47–52. http://dx.doi.org/10.1007/s12282-011-0298-x

Lowther, M., Mutrie, N., & Scott, E. M. (2007). Identifying key processes of exercise behaviour change associated with movement through the stages of exercise behaviour change. *Journal of Health Psychology, 12,* 261–272. http://dx.doi.org/10.1177/1359105307074253

Maddison, R., & Prapavessis, H. (2006). Exercise behavior among New Zealand adolescents: A test of the transtheoretical model. *Pediatric Exercise Science, 18,* 351–363. http://dx.doi.org/10.1123/pes.18.3.351

Marcus, B. H., Emmons, K. M., Simkin-Silverman, L. R., Linnan, L. A., Taylor, E. R., Bock, B. C., . . . Abrams, D. B. (1998). Evaluation of motivationally tailored vs. standard self-help physical activity interventions at the workplace. *American Journal of Health Promotion, 12,* 246–253. http://dx.doi.org/10.4278/0890-1171-12.4.246

Marcus, B. H., Nigg, C. R., Riebe, D., & Forsyth, L. H. (2000). Interactive communication strategies: Implications for population-based physical-activity promotion. *American Journal of Preventive Medicine, 19,* 121–126. http://dx.doi.org/10.1016/S0749-3797(00)00186-0

Marcus, B. H., Rakowski, W., & Rossi, J. S. (1992). Assessing motivational readiness and decision making for exercise. *Health Psychology, 11,* 257–261. http://dx.doi.org/10.1037/0278-6133.11.4.257

Marcus, B. H., Rossi, J. S., Selby, V. C., Niaura, R. S., & Abrams, D. B. (1992). The stages and processes of exercise adoption and maintenance in a worksite sample. *Health Psychology, 11,* 386–395. http://dx.doi.org/10.1037/0278-6133.11.6.386

Marshall, S. J., & Biddle, S. J. (2001). The transtheoretical model of behavior change: A meta-analysis of applications to physical activity

and exercise. *Annals of Behavioral Medicine, 23,* 229–246. http://dx.doi.org/10.1207/S15324796ABM2304_2

Michie, S., & Johnston, M. (2012). Theories and techniques of behaviour change: Developing a cumulative science of behaviour change. *Health Psychology Review, 6,* 1–6. http://dx.doi.org/10.1080/17437199.2012.654964

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., . . . Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine, 46,* 81–95. http://dx.doi.org/10.1007/s12160-013-9486-6

Napolitano, M. A., & Hayes, S. (2011). Behavioral and psychological factors associated with 12-month weight change in a physical activity trial. *Journal of Obesity, 2011,* 515803. Advance online publication. http://dx.doi.org/10.1155/2011/515803

Napolitano, M. A., Papandonatos, G. D., Lewis, B. A., Whiteley, J. A., Williams, D. M., King, A. C., . . . Marcus, B. H. (2008). Mediators of physical activity behavior change: A multivariate approach. *Health Psychology, 27,* 409–418. http://dx.doi.org/10.1037/0278-6133.27.4.409

Nigg, C. R. (2001). Explaining adolescent exercise behavior change: A longitudinal application of the transtheoretical model. *Annals of Behavioral Medicine, 23,* 11–20. http://dx.doi.org/10.1207/S15324796ABM2301_3

Nigg, C. R. (2005). There is more to stages of exercise than just exercise. *Exercise and Sport Sciences Reviews, 33,* 32–35.

Nigg, C. R., & Courneya, K. S. (1998). Transtheoretical model: Examining adolescent exercise behavior. *Journal of Adolescent Health, 22,* 214–224. http://dx.doi.org/10.1016/S1054-139X(97)00141-9

Nigg, C., Hellsten, L., Norman, G., Braun, L., Breger, R., Burbank, P., . . . Williams, G. (2005). Physical activity staging distribution: Establishing a heuristic using multiple studies. *Annals of Behavioral Medicine, 29*(2, Suppl.), 35–45. http://dx.doi.org/10.1207/s15324796abm2902s_7

Nigg, C. R., Norman, G., Rossi, J. S., & Benisovich, S. V. (1999). Processes of exercise behavior change: Redeveloping the scale. *Annals of Behavioral Medicine, 21,* 79.

Noar, S. M., & Head, K. J. (2014). Mind the gap: Bringing our theories in line with the empirical data – a response to commentaries. *Health Psychology Review, 8,* 65–69. http://dx.doi.org/10.1080/17437199.2013.855593

Norman, G. J., Velicer, W. F., Fava, J. L., & Prochaska, J. O. (1998). Dynamic typology clustering within the stages of change for smoking cessation. *Addictive Behaviors, 23,* 139–153. http://dx.doi.org/10.1016/S0306-4603(97)00039-7

Oka, K. (2000). Recent trends of research on exercise adherence utilizing the transtheoretical model of behavior change [in Japanese]. *Research of Physical Education, 45,* 543–561.

Oka, K. (2003). [Stages of change for exercise behavior and self-efficacy for exercise among middle-aged adults]. *Japanese Journal of Public Health, 50,* 208–215.

Papandonatos, G. D., Williams, D. M., Jennings, E. G., Napolitano, M. A., Bock, B. C., Dunsiger, S., & Marcus, B. H. (2012). Mediators of physical activity behavior change: Findings from a 12-month randomized controlled trial. *Health Psychology, 31,* 512–520. http://dx.doi.org/10.1037/a0026667

Paxton, R. J., Nigg, C. R., Motl, R. W., McGee, K., McCurdy, D., Matthai, C. H., & Dishman, R. K. (2008). Are constructs of the transtheoretical model for physical activity measured equivalently between sexes, age groups, and ethnicities? *Annals of Behavioral Medicine, 35,* 308–318. http://dx.doi.org/10.1007/s12160-008-9035-x

Peters, G.-J. Y., de Bruin, M., & Crutzen, R. (2015). Everything should be as simple as possible, but no simpler: Towards a protocol for accumulating evidence regarding the active content of health behaviour change interventions. *Health Psychology Review, 9,* 1–14. http://dx.doi.org/10.1080/17437199.2013.848409

Pickering, M. A., & Plotnikoff, R. C. (2009). Factor structure and measurement invariance of a 10-item decisional balance scale: Longitudinal and subgroup examination within an adult diabetic sample. *Measurement in Physical Education and Exercise Science, 13,* 206–226. http://dx.doi.org/10.1080/10913670903260086

Pinto, B. M., & Dunsiger, S. I. (2015). Mediators of exercise maintenance after cardiac rehabilitation. *Journal of Cardiopulmonary Rehabilitation and Prevention, 35,* 13–20. http://dx.doi.org/10.1097/HCR.0000000000000065

Pinto, B. M., Lynn, H., Marcus, B. H., DePue, J., & Goldstein, M. G. (2001). Physician-based activity counseling: Intervention effects on mediators of motivational readiness for physical activity. *Annals of Behavioral Medicine, 23,* 2–10. http://dx.doi.org/10.1207/S15324796ABM2301_2

Phing, C. H., Saad, H. A., Yusof, B. N. M., & Taib, M. N. M. (2014). Stages of change for regular physical activity among government employees. *Journal of Physical Education and Sport, 14,* 609.

Plotnikoff, R. C., Blanchard, C., Hotz, S. B., & Rhodes, R. (2001). Validation of the decisional balance scales in the exercise domain from the transtheoretical model: A longitudinal test. *Measurement in Physical Education and Exercise Science, 5,* 191–206. http://dx.doi.org/10.1207/S15327841MPEE0504_01

Plotnikoff, R. C., Hotz, S. B., Birkett, N. J., & Courneya, K. S. (2001). Exercise and the transtheoretical model: A longitudinal test of a population sample. *Preventive Medicine: An International Journal Devoted to Practice and Theory, 33,* 441–452. http://dx.doi.org/10.1006/pmed.2001.0914

Plotnikoff, R. C., Lippke, S., Johnson, S. T., & Courneya, K. S. (2010). Physical activity and stages of change: A longitudinal test in types 1 and 2 diabetes samples. *Annals of Behavioral Medicine, 40,* 138–149. http://dx.doi.org/10.1007/s12160-010-9193-5

Plummer, B. A., Velicer, W. F., Redding, C. A., Prochaska, J. O., Rossi, J. S., Pallonen, U. E., & Meier, K. S. (2001). Stage of change, decisional balance, and temptations for smoking: Measurement and validation in a large, school-based population of adolescents. *Addictive Behaviors, 26,* 551–571. http://dx.doi.org/10.1016/S0306-4603(00)00144-1

Prentice, D. A., & Miller, D. T. (1992). When small effects are impressive. *Psychological Bulletin, 112,* 160–164. http://dx.doi.org/10.1037/0033-2909.112.1.160

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology, 51,* 390–395. http://dx.doi.org/10.1037/0022-006X.51.3.390

Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1992). In search of how people change. Applications to addictive behaviors. *American Psychologist, 47,* 1102–1114. http://dx.doi.org/10.1037/0003-066X.47.9.1102

Prochaska, J. O., Redding, C. A., & Evers, K. E. (2008). The transtheoretical model and stages of change. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education: Theory, research and practice* (4th ed., pp. 97–121). San Francisco: California.

Prochaska, J. O., & Velicer, W. F. (1997). The transtheoretical model of health behavior change. *American Journal of Health Promotion, 12,* 38–48. http://dx.doi.org/10.4278/0890-1171-12.1.38

Prochaska, J. O., Velicer, W. F., DiClemente, C. C., & Fava, J. (1988). Measuring processes of change: Applications to the cessation of smoking. *Journal of Consulting and Clinical Psychology, 56,* 520–528. http://dx.doi.org/10.1037/0022-006X.56.4.520

Prochaska, J. O., Velicer, W. F., Rossi, J. S., Goldstein, M. G., Marcus, B. H., Rakowski, W., . . . Rossi, S. R. (1994). Stages of change and decisional balance for 12 problem behaviors. *Health Psychology, 13,* 39–46. http://dx.doi.org/10.1037/0278-6133.13.1.39

Rabin, C., Pinto, B., & Frierson, G. (2006). Mediators of a randomized controlled physical activity intervention for breast cancer survivors. *Journal of Sport & Exercise Psychology, 28,* 269–284. http://dx.doi.org/10.1123/jsep.28.3.269

Redding, C. A., Prochaska, J. O., Pallonen, U. E., Rossi, J. S., Velicer, W. F., Rossi, S. R., . . . Maddock, J. E. (1999). Transtheoretical individualized multimedia expert systems targeting adolescents' health behaviors. *Cognitive and Behavioral Practice, 6,* 144–153. http://dx.doi.org/10.1016/S1077-7229(99)80025-X

Reed, G. R., Velicer, W. F., Prochaska, J. O., Rossi, J. S., & Marcus, B. H. (1997). What makes a good staging algorithm: Examples from regular exercise. *American Journal of Health Promotion, 12,* 57–66. http://dx.doi.org/10.4278/0890-1171-12.1.57

Rhodes, R. E., Berry, T., Naylor, P.-J., & Wharf Higgins, S. J. (2004). Three-step validation of exercise behavior processes of change in an adolescent sample. *Measurement in Physical Education and Exercise Science, 8,* 1–20. http://dx.doi.org/10.1207/s15327841mpee0801_1

Rhodes, R. E., & Nigg, C. R. (2011). Advancing physical activity theory: A review and future directions. *Exercise and Sport Sciences Reviews, 39,* 113–119. http://dx.doi.org/10.1097/JES.0b013e31821b94c8

Rhodes, R. E., & Pfaeffli, L. A. (2010). Mediators of physical activity behaviour change among adult non-clinical populations: A review update. *The International Journal of Behavioral Nutrition and Physical Activity, 7,* 37. http://dx.doi.org/10.1186/1479-5868-7-37

Rhodes, R. E., & Quinlan, A. (2015). Predictors of physical activity change among adults using observational designs. *Sports Medicine, 45,* 423–441. http://dx.doi.org/10.1007/s40279-014-0275-6

Riebe, D., Blissmer, B., Greene, G., Caldwell, M., Ruggiero, L., Stillwell, K. M., & Nigg, C. R. (2005). Long-term maintenance of exercise and healthy eating behaviors in overweight adults. *Preventive Medicine: An International Journal Devoted to Practice and Theory, 40,* 769–778. http://dx.doi.org/10.1016/j.ypmed.2004.09.023

Romain, A. J., Attalin, V., Sultan, A., Boegner, C., Gernigon, C., & Avignon, A. (2014). Experiential or behavioral processes: Which one is prominent in physical activity? Examining the processes of change 1 year after an intervention of therapeutic education among adults with obesity. *Patient Education and Counseling, 97,* 261–268. http://dx.doi.org/10.1016/j.pec.2014.08.004

Romain, A. J., Bernard, P., Attalin, V., Gernigon, C., Ninot, G., & Avignon, A. (2012). Health-related quality of life and stages of behavioural change for exercise in overweight/obese individuals. *Diabetes & Metabolism: Clinical and Experimental, 38,* 352–358. http://dx.doi.org/10.1016/j.diabet.2012.03.003

Romain, A. J., Bernard, P., Galvez, M., & Caudroit, J. (2015). Response to an exercise intervention for patients with Type 2 diabetes: A preliminary study of processes of change. *Journal of Applied Biobehavioral Research, 20,* 130–136. http://dx.doi.org/10.1111/jabr.12034

Romain, A. J., Bernard, P., Hokayem, M., Gernigon, C., & Avignon, A. (2016). Measuring the processes of change from the transtheoretical model for physical activity and exercise in overweight and obese adults. *American Journal of Health Promotion, 30,* 272–278. http://dx.doi.org/10.1177/0890117116633829

Romain, A. J., Bortolon, C., Gourlan, M., Carayol, M., Lareyre, O., Ninot, G., . . . Bernard, P. (2016). Matched or nonmatched interventions based on the transtheoretical model to promote physical activity. A meta-analysis of randomized controlled trials. *Journal of Sport and Health Science*. Advance online publication. http://dx.doi.org/10.1016/j.jshs.2016.10.007

Romain, A. J., Chevance, G., Caudroit, J., & Bernard, P. (2016). The transtheoretical model: description, interests and application in the motivation to physical activity among population with overweight and obesity. *Obésité, 11,* 47–55.

Romain, A. J., Horwath, C., & Bernard, P. (2018). Prediction of physical activity level using processes of change from the transtheoretical model. Experiential, behavioral, or an interaction effect? *American Journal of Health, 32,* 16–23. http://dx.doi.org/10.1177/0890117116686900

Ronda, G., Van Assema, P., & Brug, J. (2001). Stages of change, psychological factors and awareness of physical activity levels in the Netherlands. *Health Promotion International, 16,* 305–314. http://dx.doi.org/10.1093/heapro/16.4.305

Rosen, C. S. (2000). Is the sequencing of change processes by stage consistent across health problems? A meta-analysis. *Health Psychology, 19,* 593–604. http://dx.doi.org/10.1037/0278-6133.19.6.593

Sallis, J. F., Bull, F., Guthold, R., Heath, G. W., Inoue, S., Kelly, P., . . . Lancet Physical Activity Series 2 Executive Committee. (2016). Progress in physical activity over the Olympic quadrennium. *The Lancet, 388,* 1325–1336. http://dx.doi.org/10.1016/S0140-6736(16)30581-5

Sallis, J. F., Pinski, R. B., Grossman, R. M., Patterson, T. L., & Nader, P. R. (1988). The development of self-efficacy scales for healthrelated diet and exercise behaviors. *Health Education Research, 3,* 283–292. http://dx.doi.org/10.1093/her/3.3.283

Sanaeinasab, H., Saffari, M., Nazeri, M., Karimi Zarchi, A., & Cardinal, B. J. (2013). Descriptive analysis of Iranian adolescents' stages of change for physical activity behavior. *Nursing & Health Sciences, 15,* 280–285. http://dx.doi.org/10.1111/nhs.12020

Sechrist, K. R., Walker, S. N., & Pender, N. J. (1987). Development and psychometric evaluation of the exercise benefits/barriers scale. *Research in Nursing & Health, 10,* 357–365. http://dx.doi.org/10.1002/nur.4770100603

Si, Q., Yu, K., Loprinzi, P. D., Cardinal, B. J., Lee, H., Yan, Z., . . . Liu, H. (2011). Promoting exercise behavior among Chinese youth with hearing loss: A randomized controlled trial based on the transtheoretical model. *Psychological Reports, 109,* 896–906.

Skaal, L. (2013). Processes of change used by healthcare workers to participate in physical activity: What motivates healthcare workers to exercise? *African Journal for Physical, Health Education, Recreation and Dance, 19,* 843–853.

Skaal, L., & Pengpid, S. (2012). The predictive validity and effects of using the transtheoretical model to increase the physical activity of healthcare workers in a public hospital in South Africa. *Translational Behavioral Medicine, 2,* 384–391. http://dx.doi.org/10.1007/s13142-012-0136-5

Tergerson, J. L., & King, K. A. (2002). Do perceived cues, benefits, and barriers to physical activity differ between male and female adolescents? *The Journal of School Health, 72,* 374–380. http://dx.doi.org/10.1111/j.1746-1561.2002.tb03562.x

Tung, W.-C., Gillett, P. A., & Pattillo, R. E. (2005). Applying the transtheoretical model to physical activity in family caregivers in Taiwan. *Public Health Nursing, 22,* 299–310. http://dx.doi.org/10.1111/j.0737-1209.2005.220405.x

Vita, P., & Owen, N. (1995). A perspective on the behavioural epidemiology, the determinants, and the stages of exercise involvement. *Australian Psychologist, 30,* 135–140. http://dx.doi.org/10.1080/00050069508258918

Yang, P.-S., & Chen, C.-H. (2005). Exercise stage and processes of change in patients with chronic obstructive pulmonary disease. *The Journal of Nursing Research, 13,* 97–105. http://dx.doi.org/10.1097/01.JNR.0000387531.30266.75

Yusufov, M., Paiva, A. L., Redding, C. A., Lipschitz, J. M., Gokbayrak, N. S., Greene, G., . . . Prochaska, J. O. (2016). Fat reduction efforts: A 24-month longitudinal comparison of a large sample of maintainers, relapsers, and non-changers. *Health Promotion Practice, 17,* 116–126. http://dx.doi.org/10.1177/1524839915606423

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