

Physical Activity in Older Adults

Subjects: Nursing

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Healthy aging makes the practice of physical activity (PA) a necessity. However, PA guidelines achievement in older adults is scarce. The use of behavioral theories such as Transtheoretical Model (TTM), helps in older adults PA promotion. The aim of this review was to identify the use of TTM for PA in older adults (>60 years). PubMed, SPORTdiscus, and Medline databases were used to conduct the search. All steps of the process followed the recommendations of the PRISMA flow-diagram. We identified eight studies: Six were descriptive cross-sectional studies, one prospective-cohort study and one with a quasi-experimental design. Only two papers evaluated the four behavior change dimensions within the same study, three evaluated the processes of change and the decisional balance, four evaluated the exercise self-efficacy and all assessed the stages of change for PA behavior.

Keywords: Physical Activity in Older Adults

1. Introduction

Physical activity (PA) is considered as one of the most effective strategies to promote healthy aging^[1]. Regular PA practice in older adults is associated with improvements in functional fitness (maintains muscle strength and balance), chronic diseases risk prevention (coronary heart disease, diabetes, and stroke), improvement of mental capacity (self-esteem, maintenance of the cognitive function, reduce anxiety, and depression), and improvement in social response^{[2][3][4][5][6][7]}. PA is a good predictor of healthy aging and decreases the probability of disability in people over 65 years^[8].

Recommendations for adults and older adults state the need to achieve at least 150 min of PA at moderate intensity per week, together with muscle strength activities for an improvement in bone mass and activities to improve flexibility, at least 2–3 days per week^[9].

However, despite the important health benefits of PA, a little proportion of the population over 65 years meet World Health Organization (WHO) PA guidelines^[10]. In fact, this group is the least physically active out of all^[11]. According to WHO^[12], having a sedentary lifestyle is the fourth primary risk factor of non-communicable diseases. The good news are that those who practice regular PA can reduce their risk of pathologies at a rate between 20 and 30%^[1].

Older adults' exercise adherence is a multifactorial process, influenced by: Program characteristics (preference of exercise type), personal factors (demographic, health related, physical, and psychological factors)^{[13][14]}, social determinants, and environmental factors^[15]. It is important that interventions to promote physical exercise in older adults are based on theories that explain the behavior change, tailored to individual characteristics of the participants^[15]. Theory-based interventions to promote PA behavior seem to have a more successful effect than interventions without an established theoretical base^{[16][17]}. In addition, interventions based on a single theory reported greater impact on PA behavior than those interventions with a combination of theories^[17].

One of the models that better understands and predicts the behavioral–cognitive changes in the adoption of PA/exercise behavior, is the Transtheoretical Model of Change (TTM), proposed by Prochaska and Di Clemente^[18]. The TTM is a most comprehensive and integrated model of behavioral changes among health behavioral models^[19], this model began to be used in smoking cessation studies^[18], but over time its use has extended to the study of healthy lifestyle promotion, including PA, to become one of the most popular models to understand the PA behavior^[20]. This model is a cyclical model and explains the behavior change as a dynamic process, through a temporal dimension by describing them as a sequence of stages and processes by which the individual progress to adapt a regular behavior^[21].

2. Related Studies

Figure 1 details all the steps of the processes followed according to the recommendations of the PRISMA flowchart in the studies selection. We identified a total of eight studies published between 2014 and 2019 which were included in the systematic review from the original 147 papers identified by the literature search^{[22][23][24][25][26][27][28][29]}. The most

common reason for excluding studies was that they did not meet the inclusion criteria, mainly by the age.

The main characteristics, TTM dimensions, outcomes, and key findings for each of the 8 articles included in this review are listed in [Table 2](#) and [Table 3](#). Of these eight articles, six studies were descriptive-cross-sectional studies [\[22\]\[23\]\[24\]\[25\]\[26\]\[27\]\[28\]](#), one was a prospective cohort study [\[26\]](#) and one was a quasi-experimental design [\[28\]](#). Two of the studies originated from Ireland [\[22\]\[26\]](#), two more from Taiwan [\[27\]\[28\]](#) and individual studies from Iran [\[28\]](#), Korea [\[24\]](#), Japan [\[28\]](#), and Italy [\[25\]](#). According to the study population, the review gather a total of 2304 participants, included both men (51.65%) and women (48.35%). Only three of the studies (37.5%) worked with healthy older adults [\[23\]\[28\]\[29\]](#) and the rest with pathologies (62.5%) (bronchiectasis [\[22\]](#), non-cystic fibrosis bronchiectasis [\[26\]](#), physical disability or brain injury [\[24\]](#), type II diabetes [\[25\]](#), and patients after open heart surgery [\[27\]](#)). Regarding to TTM-interventions characteristics, we can find the following topics: Measuring PA levels [\[25\]\[27\]](#), to identified daily patterns of PA [\[26\]](#), to understand the levels of PA and sedentarism [\[22\]](#), to identify knowledge of muscle strength exercise recommendations [\[29\]](#) to create PA-interventions tailored to specific SoC [\[24\]](#) [\[28\]](#) and to corroborate the usefulness of this model in older adults [\[23\]](#).

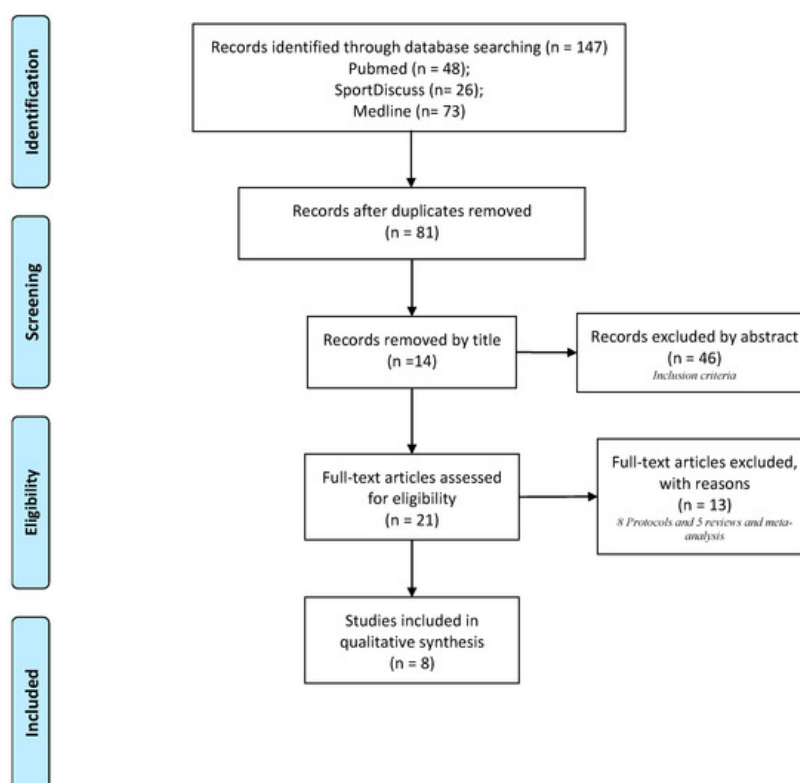


Figure 1. PRISMA flow-chart.

Table 2. TTM constructs.

Reference	Transtheoretical Model Constructs			
	Stages of Change	Processes of Change	Decisional Balance	Self-Efficacy
Bradley, J.M., et al. (2015) [22]	x	x	x	x
Abbaspour, S., et al. (2017) [23]	x		x	x
Koo, K.M., Park, C.H., and Kim, C.J. (2017) [24]	x	x		
Guicciardi, M., et al. (2014) [25]	x			x

Reference	Transtheoretical Model Constructs			
	Stages of Change	Processes of Change	Decisional Balance	Self-Efficacy
Wilson, J.J., et al. (2016) [26]	x	x	x	x
Huang, H. Y., et al. (2015)[27]	x			
Yang, H.J., et al. (2015) [28]	x			
Harada, K., et al. (2014) [29]	x			

TTM, Transtheoretical model of change.

Table 3. TTM in older adults.

Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
Bradley, J.M., et al. (2015) [37]	BMC Pulmonary Medicine	Ireland		N: 55 Age: 63 ± 10 Gender: 22 male (40%) 33 female (60%) Pathology: Bronchiectasis	Descriptive cross-sectional study	Aim: Explore the patterns and correlates of sedentary behavior and PA in bronchiectasis.	<ul style="list-style-type: none"> - PC: Cognitive and behavioral PC were used equally. - DB: Inverse correlation between the sedentary behavior time and DB 'pros' score ($p = 0.009$). - SE: Higher score "when on holiday" (3.35 ± 1.22) and lower score "when I have respiratory symptoms" (1.65 ± 0.97).

Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
Abbaspour, S., Farmanbar, R., Njafi, F., Ghiasvand, A.M., and Dehghankar, L. (2017) [38]	Electronic Physician	Iran	2013	N: 262 Age: 64.95 ± 5.03 Gender: 141 male (53.8%) 121 female (46.2%) Pathology: No specific.	Descriptive cross-sectional study	Aim: To identify the relationship between DB and SE in physical activities using the TTM in the members of a retirement center.	<ul style="list-style-type: none"> - DB: Significant differences between DB and SoC ($p < 0.001$), DB "benefits" and SoC ($p < 0.0001$) and DB "barriers" and SoC ($p < 0.0001$). Significant correlations between "benefits" and PA time ($p < 0.0001$) and significant and reverse association with the "barriers" ($p < 0.0001$). - SE: Significant differences between SE and SoC ($p < 0.0001$). Significant correlations between exercise SE with PA time ($p < 0.0001$). The exercise SE was the only predictor of PA behavior.
Koo, K.M., Park, C.H. and Kim, C.J. (2017) [39]	Journal of Exercise Rehabilitation	Korea	2014	N: 81 Age: >60 years Gender: 43 male (53%) 38 female (47%) Pathology: Physical disability or brain injury	Descriptive cross-sectional study	Aim: To develop strategies for promoting PA for the disabled older adults who were in the TTM of precontemplation, contemplation, and preparation stages about participating physical activities for promoting healthy life-styles.	<ul style="list-style-type: none"> - PC: Significant differences between PC of CR, DR, SR, SL, SeL, and SC with SoC ($p < 0.05$), but no significant differences between PC of ER, CC, HR and RM with the SoC. - PA promotion strategies based on PC were developed for each SoC (precontemplation, contemplation and preparation) for the older adults with disabilities.

Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
Guicciardi, M., Lecis, R., Anziani, C., Corgiolu, L., Porru, A., Pusceddu, M. and Spanu, F. (2014) [40]	Health Psychology and Behavioral Medicine	Italy		<p>N: 308</p> <p>Age: 65.24 ± 8.31 years</p> <p>Gender: 172 male (56%) 136 female (44%)</p> <p>Pathology: Type II Diabetes</p>	Descriptive cross-sectional study	<p>Aim: To investigate the relationships between self-reported PA and exercise SE and body satisfaction in a sample of older adults with Type 2 diabetes classified in different Soc.</p>	<ul style="list-style-type: none"> - SoC: Significant differences between PA minutes per week and SoC ($p < 0.001$). Significant correlations between SoC and minutes/week of PA ($p < 0.001$) and exercise SE ($p < 0.001$). - SE: Significant differences between exercise SE and SoC ($p < 0.001$). Linear trend for exercise SE across SoC ($p < 0.001$). Significant correlations between exercise SE and minutes/week of PA ($p < 0.001$). - Exercise SE ($p < 0.001$) and SoC ($p < 0.001$) were determinants of PA levels.

Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
Wilson, J.J., Kirk, A., Hayes, K., Bradbury, I., McDonough, S., Tully, M.A., et al. (2016) [41]	Respiratory Care	Ireland		N: 55 Age: 63 ± 10 Gender: 22 male (40%) 33 female (60%) Pathology: Non-cystic fibrosis bronchiectasis	Descriptive cross-sectional study	Aim: To examine patterns of (1) PA and (2) mediators of behavior change (SE, DB, and PC) across SoC in individuals with non-cystic fibrosis bronchiectasis.	<ul style="list-style-type: none"> - SoC: Significant differences between levels of PA with SoC. Significant differences between daily light-lifestyle PA time min/day ($p = 0.045$), daily total PA time ($p = 0.030$), daily total moderate to vigorous PA time ($p = 0.049$) and daily step counts ($p = 0.03$) with SoC. No significant differences in MVPA in 10-min bouts, activity energy expenditure and sedentary behavior time with SoC. - PC: Initial SoC (precontemplation and contemplation stages) used significantly fewer PC compared to advanced SoC (action and maintenance stages). Precontemplation and contemplation stages used significantly more cognitive PC ($p = 0.031$), preparation stage used equally cognitive and behavioral PC ($p = 0.92$) and action and maintenance stages used more behavioral PC ($p = 0.055$).

In the following sections, we “drill down” in the different constructs of TTM to examine what has been found regarding the influence TTM on PA.

2.1. Stages of Change (SoC)

The SoC have been considered as predictors of PA^[25]. Significant differences ($p < 0.05$) were found between the minutes of PA/week^{[25][26][27]}, daily total PA time, daily light-lifestyle PA time, daily total moderate to vigorous physical activity (MVPA) time and daily steps counts^[26] according to the different SoC. The average of bouts (10 min) MVPA and activity energy expenditure increased and the sedentary behavior time decreased regarding to SoC but not significantly^[26]. Moreover, there was an increase in PA levels and a decrease of sedentary behavior time as we moved through to more advanced SoC (action and maintenance stages)^{[25][26][27]}. Finally, advanced stages of behavior change corresponded to greater benefits and lower perceived barriers referred to the achievement of muscle strength exercise recommendations^[29].

2.2. Processes of Change (PC)

The PC are the techniques and strategies that people use to change or modify their behavior. PC were clearly identified in patients with bronchiectasis, showing a likewise use of cognitive and behavioral processes in their PA behavior^[22]. In patients with non-cystic fibrosis bronchiectasis, it was observed as initial SoC (precontemplation and contemplation stages) used significantly fewer PC compared to more advanced SoC (action and maintenance stages) ($p > 0.01$), on the other hand, precontemplation and contemplation stages tended to use cognitive PC ($p = 0.031$), preparation stage used behavioral and cognitive PC equally ($p = 0.92$) and action and maintenance stages tended to use of behavioral PC ($p = 0.055$). In patients with physical disability or brain injury, no significant differences were found among PC of ER, CC, HR, and RM across the SoC ($p > 0.05$), while, the patterns of use PC of CR, DR, SR, SL, SeL, and SC varied significantly across precontemplation, contemplation, and preparation stages ($p < 0.05$)^[24]. Finally, the use of PC to create and tailor interventions with the aim of promoting PA in the older adults, favored the progression of participants to more proactive SoC (action and maintenance) and therefore improved the acquisition of healthy habits^[28].

Reference	Journal	Country	Study Periods	Study Population	Study Design	Aims	Important Findings
2.3. Decisional Balance (DB)							
<p>There were a significant differences ($p < 0.001$) between the DB score among the different stages of the articles considered. Significant differences between DB can be divided in two dimensions: Benefits and barriers. According to benefits, there was a direct association ($p < 0.001$) between perceived benefits and PA levels^[23] and an inverse association ($p = 0.009$) with sedentary time^[24]. Significant differences were observed between SoC and perceived benefits ($p < 0.001$)^[23]. Regarding the barriers, we observed an inverse correlation ($p < 0.001$) between perceived barriers and levels of PA. In addition, there were significant differences between the inpatient cardiac rehabilitation programs, the DB score ($p = 0.31$) and the benefits perceived (39.2%) with the SoC. There were no significant differences between the percentage of patients in action (39.2%) and maintenance (37.7%) stages.</p>							
Huang, H.Y., et al. (2015)	Acta Cardiologica Sinica	Taiwan	2010–2011	Age: 61.0 ± 12.2 years Gender: 92 male (70.8%), 38 female (29.2%) Pathology: Patients after Open Heart Surgery	Prospective cohort study Duration: 6 months.	Aim: To assess exercise behavior and PA levels using TTM in patients undergoing open heart surgery.	SoC (37.7%) and maintenance (37.7%) stages.
2.4. Self-Efficacy (SE)							
<p>The SE refers to people's confidence in their ability to make a change in specific situations. Two SE as predictor of PA^{[23][25]}. Significant differences were found between the SE score and the SoC ($p < 0.01$)^{[23][25]}. In addition, a direct association between SE and PA levels was observed ($p < 0.01$)^[23]. Advanced SoC (action and maintenance stages) had higher SE scores^[23] with a linear trend ($p < 0.001$) in the result^[25]. On the other hand, studies with older adults with respiratory pathologies did not find any significant differences ($p = 0.14$) between SE score and SoC^[26] and they reported that their SE was reduced when they experienced situations related to symptoms of their disease^[22].</p>							
References							
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2. Warburton, D.E.; Charlesworth, S.; Ivey, A.; Nettleton, L.; Bredin, S.S. A systematic review of the evidence for Canada's Physical Activity Guidelines for Adults. Int. J. Behav. Nutr. Phys. Act. 2010, 7, 38. doi:10.1186/1479-5868-7-39[43]	World Health Organization	Canada	2010				Control group: 83.3% of the participants remained in the contemplation/preparation stages after 6 months without training.
3. Paterson, D.H.; Warburton, D.E. Physical activity and functional limitations in older adults: A systematic review related to Canada's Physical Activity Guidelines. Int. J. Behav. Nutr. Phys. Act. 2010, 7, 38. doi:10.1186/1479-5868-7-38.							
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7. Forte, G.; Favieri, F.; Casagrande, M. Heart Rate Variability and Cognitive Function: A Systematic Review. Front. Neurosci. 2019, 13, 710.							
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Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
15.	Stralen, M.; de Vries, H.; Mudde, A.; Bolman, C.; Lechner, I.					Determinants of initiation and maintenance of physical activity among older adults: A literature review. <i>Health Psychol. Rev.</i> 2009, 3, 147–207, doi:10.1080/17437190903229462.	- SoC: Significant differences between SoC and perceived health benefits (referred to strength exercise
16.	Chase, J.A.					Interventions to Increase Physical Activity Among Older Adults: A Meta-Analysis. <i>Gerontologist</i> 2015, 55, 706–718, doi:10.1093/geront/gnu090.	exercise
17.	Gourlan, M.; Bernard, P.; Bortolon, C.; Romain, A.J.; Lareyre, O.; Carayol, M.; Ninot, G.; Boiché, J.					Efficacy of theory-based interventions to promote physical activity. A meta-analysis of randomised controlled trials. <i>Health Psychol. Rev.</i> 2016, 10, 50–66, doi:10.1080/17437199.2014.981777.	perceived barriers
18.	Prochaska, J.O.; DiClemente, C.C.					Stages and processes of self-change of smoking: Toward an integrative model of change. <i>J. Consult. Clin. Psychol.</i> 1983, 51, 390–395, doi:10.1037//0022-006x.51.3.390.	(referred to strength exercise
19.	Spencer, L.; Adams, T.B.; Malone, S.; Roy, L.; Yost, E.					Applying the transtheoretical model to exercise: A systematic and comprehensive review of the literature. <i>Health Promot. Pract.</i> 2006, 7, 428–443, doi:10.1177/1524839905278900.	recommendations) ($p < 0.001$).
20.	Harada, K.; Shibata, A.; Lee, E.; Oka, K.; Nakamura, Y.	Japan	2009	Age: 60–74 years N: 1244 male (51.5%), 600 female (48.5%) Pathology: No Specific	Design: cross-sectional study	Aim: Examined the association among the perceived health benefits of strength training, perceived barriers to strength training, and SoC for strength-training behavior.	- The perceived benefits and barriers of this article do not correspond to the TTM. Significant differences were observed by gender in perceived benefits (referred to strength exercise
21.	Prochaska, J.O.; Redding, C.A.; Evers, K.E.					The transtheoretical model and stages of change. In <i>Health Behavior: Theory, Research, and Practice</i> ; Jossey-Bass: San Francisco, CA, USA, 2015.	recommendations) (men: $p < 0.001$) and (women: $p < 0.001$) and in the perceived barriers (referred to strength exercise
22.	Bradley, J.M.; Wilson, J.J.; Hayes, K.; Kent, L.; McDonough, S.; Tully, M.A.; Bradbury, I.; Kirk, A.; Cosgrove, D.; Convery, R.; et al.					Sedentary behaviour and physical activity in bronchiectasis: A cross-sectional study. <i>BMC Pulm. Med.</i> 2015, 15, 61, doi:10.1186/s12890-015-0046-7.	recommendations) (men: $p < 0.001$) and (women: $p < 0.001$) and in the perceived barriers (referred to strength exercise
23.	Abbaspour, S.; Farmanbar, R.; Njafi, F.; Ghiasvand, A.M.; Dehghankar, L.					Decisional balance and self-efficacy of physical activity among the elderly in Rasht in 2013 based on the transtheoretical model. <i>Electron. Phys.</i> 2017, 9, 4447–4453, doi:10.19082/4447.	perceived barriers (referred to strength exercise
24.	Koo, K.M.; Park, C.H.; Kim, C.J.					Development of strategies for changing in physical activity behaviors on older adults with disabilities. <i>J. Exerc. Rehabil.</i> 2017, 13, 676–683, doi:10.12965/jer.1735144.572.	recommendations) (men: $p < 0.001$) and (women: $p < 0.001$)
25.	Guicciardi, M.; Lecis, R.; Anziani, C.; Corgioli, L.; Porru, A.; Pusceddu, M.; Spanu, F.					Type 2 diabetes mellitus, physical activity, exercise self-efficacy, and body satisfaction. An application of the transtheoretical model in older adults. <i>Health Psychol. Behav. Med.</i> 2014, 2, 748–758, doi:10.1080/21642850.2014.924858.	perceived barriers (referred to strength exercise
26.	Wilson, J.J.; Kirk, A.; Hayes, K.; Bradbury, I.; McDonough, S.; Tully, M.A.; O'Neill, B.; Bradley, J.M.					Applying the Transtheoretical Model to Physical Activity Behavior in Individuals With Non-Cystic Fibrosis Bronchiectasis. <i>Respir. Care</i> 2016, 61, 68–77, doi:10.4187/respcare.04154.	
27.	Huang, Y.; Lin, Y.S.; Chou, Y.G.; Lin, P.A.; Chen, C.H.; Chen, P.C.; Tsai, H.Y.; Chang, F.H.; et al.					Application of the Transtheoretical Model to Exercise Behavior and Physical Activity in Patients After Coronary Artery Bypass Grafting. <i>Coron. Art. Dis.</i> 2015, 31, 202–208, doi:10.6515/acs.20150204a.	perceived barriers (referred to strength exercise
28.	Yang, H.J.; Chen, K.M.; Chen, M.D.; Wu, H.C.; Chang, W.C.; Wang, F.C.; Huang, Y.T.					Applying the transtheoretical model to promote functional fitness of community older adults participating in elastic band exercises. <i>J. Adv. Nurs.</i> 2015, 71, 2338–2349, doi:10.1111/jan.12705.	
29.	Harada, K.; Shibata, A.; Lee, E.; Oka, K.; Nakamura, Y.					Associations between perceived health benefits and barriers to strength training, and stages of change for strength-training behavior among older Japanese adults. <i>J. Phys. Act. Health</i> 2014, 11, 801–809, doi:10.1123/jpah.2012-0060.	