Physical Activity in Older Adults

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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.

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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].

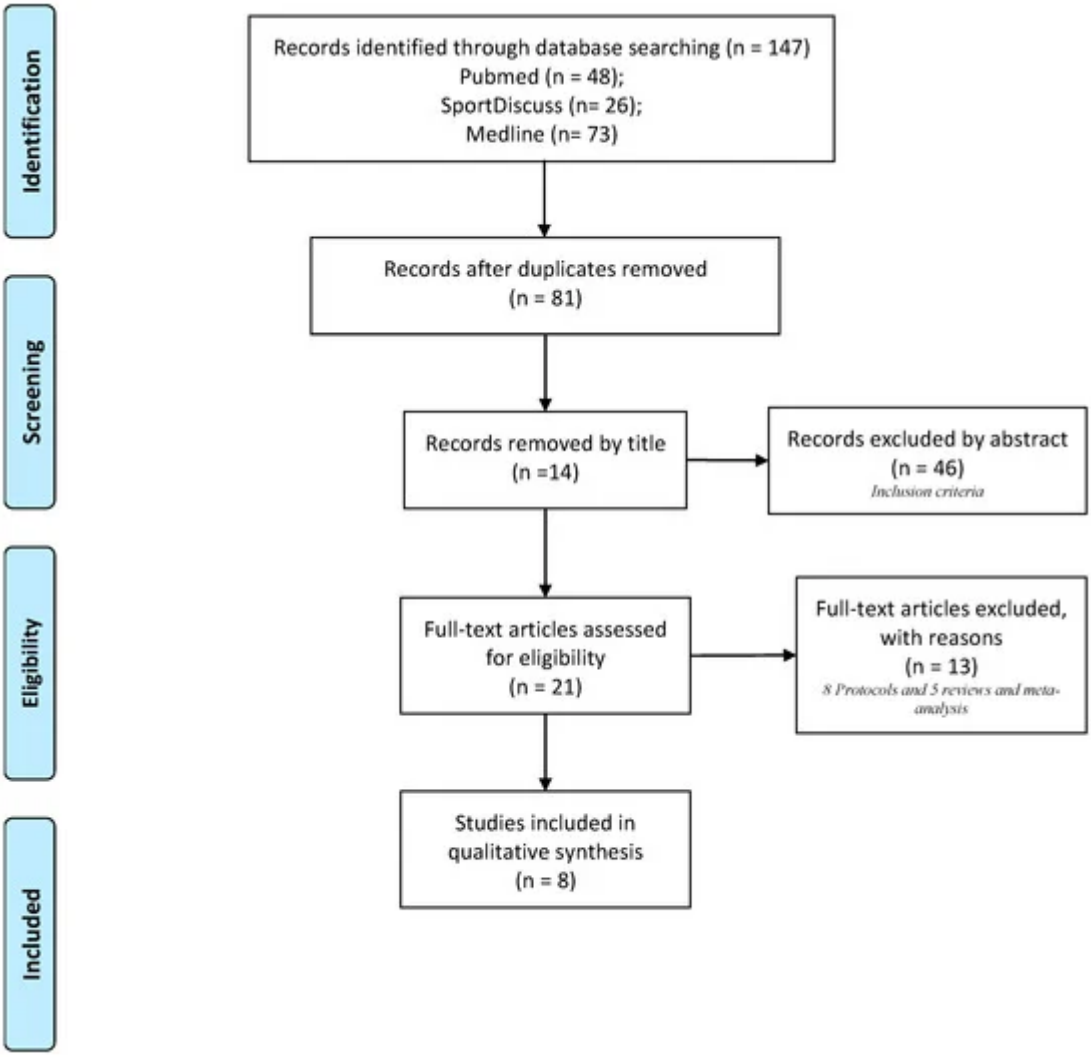

Figure 1. PRISMA flow-chart.

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,	x	x		

Reference	Transtheoretical Model Constructs			
	Stages of Change	Processes of Change	Decisional Balance	Self-Efficacy
C.J. (2017) [24]				
Guicciardi, M., et al. (2014) [25]	x			x
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.	- 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

Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
							have respiratory symptoms" (1.65 ± 0.97).
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.	- 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 ($p < 0.0001$). Significative correlations between exercise SE with PA time ($p < 0.0001$). The exercise SE was the only predicator 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.	- 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,

Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
							contemplation and preparation) for the older adults with disabilities.
Guicciardi, M., Lecis, R., Anziani, C., Corgiolu, L., Porru, A., Pusceddu, M. and Spanu, F. (2014) [40]	Health Psychology and Behavioral Medicine	Italy		*N*: 308 Age: 65.24 ± 8.31 years Gender: 172 male (56%) 136 female (44%) Pathology: Type II Diabetes	Descriptive cross-sectional study	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.	- 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.
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.	- 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

Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
							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). - DB: No significant differences between the DB score (p = 0.31) and perceived benefits (p = 0.92) with the SoC. - SE: No significant differences between

Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
							exercise SE and the SoC (p = 0.14).
Huang, H.Y., et al. (2015) [42]	Acta Cardiologica Sinica	Taiwan	2010–2011	*N*: 130 Age: 61.0 ± 12.2 years Gender: 92 male (70.8%) 38 female (29.2%) Pathology: Patients after Open Heart Surgery	Design: Prospective cohort study Duration: 6 months.	Aim: To assess exercise behavior and PA levels using TTM in patients undergoing open heart surgery.	- SoC: Significant differences between average of exercise min/week and SoC (p = 0.02). 6 months follow-up the inpatient cardiac rehabilitation programs, observed an increase in the percentage of patients in action (39.2%) and maintenance (37.7%) stages.
Yang, H.J., Chen, K.M., Chen, M.D., Wu, H.C., Chang, W.J., Wang, Y.C. and Huang, H.T. (2015) [43]	Journal of Advanced Nursing	Taiwan	2011	*N*: 169 Age: 71.28 ± 5.54 years Gender: 54 male (32%) 115 female (68%) Arms: Control (n = 85) Intervention (n = 84) Pathology: No specific	Design: Quasi-experimental design Duration: 6 months.	Aim: To test the effects of the group SEB exercises on the functional fitness of community older adults in the contemplation and preparation SoC	- SoC: SoC were used to identify and select participants for an elastic bands exercise program and to evaluate behavior change after 6 months. - Experimental group used strategies own of TTM to facilitate behavioral changes. Experimental group: 86.6% of the participants, switched from contemplation/preparation stages to action stage. Control group: 83.3% of the participants remained in the contemplation/preparation

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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

Reference	Journal	Country Territory	Study Periods	Study Population	Study Design	Aims	Important Findings
							stages after 6 months without training.
Harada, K., Shibata, A., Lee, E., Oka, K. and Nakamura, Y. (2014) [44]	Journal of Physical Activity and Health	Japan	2009	*N*: 1244 Age: 60–74 years Gender: 638 male (51.5%), 600 female (48.5%) Pathology: No specific.	Design: cross-sectional study	Aim: Examined the associations among the perceived health benefits of strength training, perceived barriers to strength straining, and SoC for strength-training behavior.	- SoC: Significant differences between SoC and perceived health benefits (referred to strength exercise recommendations) (p <0.0001) and lower perceived barriers (referred to strength exercise recommendations) (p < 0.0001). - 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 recommendations) (men: p < 0.001) and (women: p < 0.001) and in the perceived barriers (referred to strength exercise recommendations) (men p < 0.001) and (women: p < 0.001).

[24] [28] [23] [23][25] [23][25] [23] [25] [26] [22]

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TTM, Transtheoretical model of change; PA, Physical activity; SoC, Stages of change; PC, Processes of change; CR, Consciousness raising; DR, Dramatic relief; ER, Environmental re-evaluation; SR, Self-reevaluation; SL,

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