

# Effectiveness of Virtual Reality based-exercise to Increase Physical Activity on Older Adult with Sedentary Lifestyle during COVID-19 Pandemic: a Literature Review

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**Abstract**—The instrumental activities of daily living were affected during the COVID-19 outbreak. The older adults in COVID-19 pandemic are one of the vulnerable groups that are being affected by infections and other health problems. This also affects a decrease in physical activity and an increasingly sedentary lifestyle. This can contribute to worsening pre-existing chronic disease, accelerating weakness or locomotive syndromes, and increasing long-term morbidity among older adults. Virtual reality (VR) can provide viable alternative interventions for the older adults. This study aims to see the effectiveness of virtual reality-based exercise in increasing physical activity and sedentary lifestyle of the older adults. The literature was conducted by analyzing articles related to Virtual Reality, Sedentary lifestyle, COVID-19 pandemic, Older adults, and locate peer-reviewed studies published between 2015-2021. In total, 7 journal publications had analyzed, The VR techniques based on exercises has many positive effects to older adults in improving activity to avoid a sedentary lifestyle, such as, it can increase daily physical activity, improve the balance of performance, reducing the risks of falls, improve quality of life and also improve the social and emotional well-being of older adults. Furthermore, older adults perceived that VR techniques to be useful, easy to use, and enjoyable experience. This intervention based on the explores of this literature can resolve the sedentary lifestyle that occurred to older adults during the COVID-19 pandemic.

**Keywords**—COVID-19, Older Adults, Physical activity, Sedentary lifestyle, Virtual reality.

## I. INTRODUCTION

COVID-19 pandemic is a major threat to older adults [1]. According to WHO (2020), older adults are considered to be the group at risk of contracting COVID-19 due to vulnerability and death due to physiological fragility caused by the aging process. Older adults who engage in social constraints (eg, stay at home, isolation, or hospitalization) suffer a risk of sedentary behavior (SB), which is associated with unhealthy behavior and poor outcomes (eg physical inactivity (PI), diet, cardiovascular disease (CVD), illness) [2]. Early reports of COVID-19 also indicated that it was older adults comorbidities are more likely to develop severe complications following COVID-19 infection and have an increased risk death [3]. These observations indirectly show that low fitness, obesity, and an altered immune system can be dangerous for older adults during the Covid-19 Pandemic

[4]. And physical exercise in this situation is important for the efficiency of immune function during aging [5][6].

Physical activity during the aging process plays an important role in maintaining the immune system, including T and B lymphocytes [7]. Physical activity can support the immune system, due to the many protective effects caused by exercise, such as prevention of mild inflammation [8], with a strong association with type 2 diabetes and coronary artery disease. In theory, it helps the increase the production of endocrine hormones which can contribute to less accumulation of autoreactive immune cells, increases programmed cell death [9]. A decrease in the level of physical activity can cause a decrease in mechanical load, metabolic rate, and energy expenditure, resulting in a decrease in physical condition and excess energy in the body. All of these risk factors have been shown to have a high risk of causing serious health problems [10]

Due to the many risks and stresses experienced by older adults under the COVID-19 pandemic crisis, it is imperative to develop innovative and effective PA intervention programs that reduce stress and increase health and well-being promotion in older adults [9][10]. One of the innovative intervention strategies that can be developed and have opportunities in the field of health care is virtual reality (VR) based PA intervention [11]. As is well known, VR technology is currently used in various health fields and has been shown to be effective in improving balance and overall health and promoting weight control in older adults [12]. VR has also been shown to be effective in the promotion of exercise, which yields many health benefits, including reducing obesity and anxiety, too as an increase in cognition [13][12]. Application VR has been shown to have positive benefits on the physical and mental health of older adults.

## II. METHOD

The Method used in this paper is a literature review. The literature search uses searching methods from original research, databases in the form of ScienceDirect, Google Scholar, PubMed, Springer, and PloseOne that related to the virtual reality-based exercise in increasing physical activity to prevent sedentary lifestyle of the elderly. The Author used keywords "COVID-19", "Older Adults", "Physical Activity", "Sedentary Lifestyle", and "Virtual Reality". There are inclusion and exclusion criteria in the literature used.

The inclusion criteria used are: (1) Journals published in 2015-2020, (2) Journals using English and Indonesian, (3) Virtual Reality for older people. While the exclusion criteria used are (1) not focused on outcome of the intervention (2) literature review or systematic review.

### III. RESULT

There are 7 articles analyzed by the author. The research methods used from the 7 articles are varied, including experimental study, pilot study, quasi-experiment, and Randomized Control Trial (RCT) by directly intervening VR on older adults. The research sites of the 7 articles analyzed differed, among others, the first article was conducted in Taiwan, the second article in Turkey, the third article in the United States, the fourth article in Australia, the fifth article in Brazil, the sixth article in Iran, and the seventh

article in South Korea. The first article describes positive perceptions towards accepting and using VR to Support active aging in older adults, the second and sixth articles show the results that VR exercises can improve balance and reduce the risk of falling in the elderly, the third article proved that VR can increase physical activity in the elderly, the fourth article showed that VR increasing physical activity and reducing the risk of falling in the elderly, the fifth article showed that VR can increase short-term memory and mobilization in the elderly and the seventh article shows the results that VR can improve quality of life, physical activity, and this intervention also be used to improve self-management strategy.

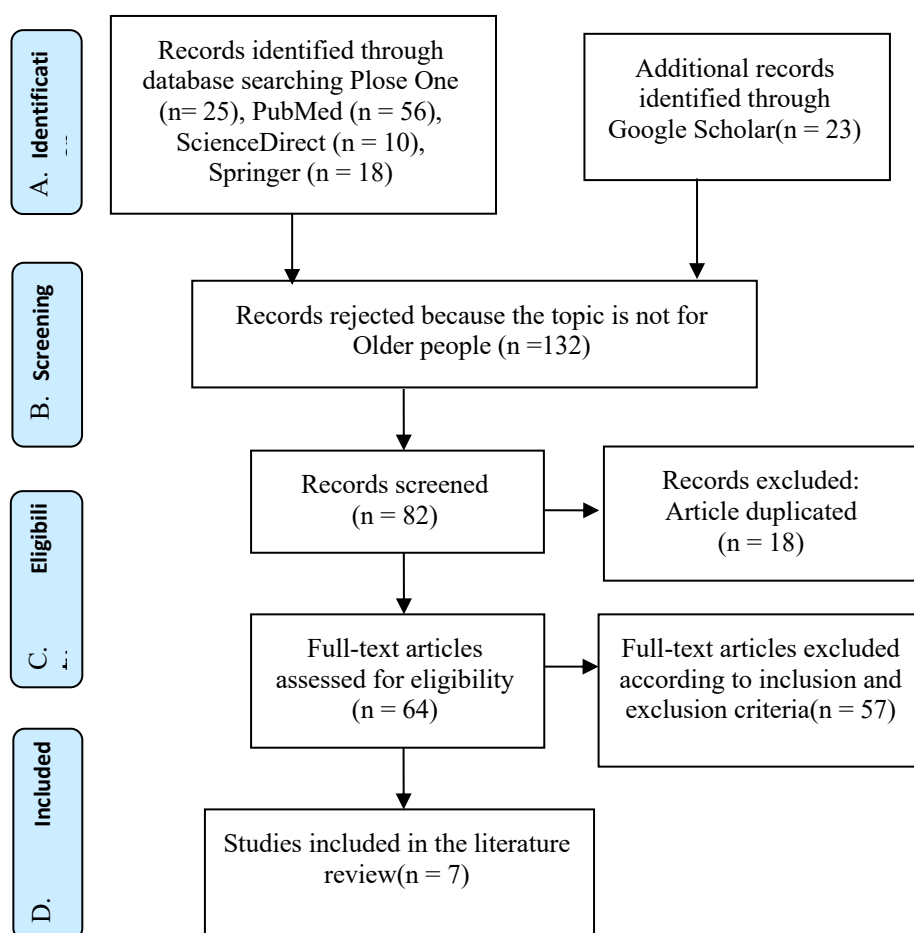


Figure 1. Prisma Diagram methods of this literature

A total of 7 articles were reviewed based on the following article search results:

Table 1. Literature Studies

| Author   | Year | Title   | Method   | Result   |
|--|------|---|--|--|
| Shabbir Syed, ShwetambaraMalwade, AldilasAchmadNursetyo, MishikaSood, Madhu Bhatia, Diana Barsella, Megan F.Liu, et, al. | 2019 | Virtual Reality among the Elderly: a Usefulness and Acceptance Study from Taiwan  | Pilot Study  | The results of this study showed that in total 30 older adults who participated in this study, they have positive perceptions towards accepting and using VR to support active aging. Participants perceived usefulness, perceived ease of use, social norms, and also perceived enjoyment were seen to had significant effects on the intervention using VR. Thus, VR was high accepted among the elderly population.   |
| SevgiSevi Y, MericcSenduran Yildirim, Murat Tomruk, ozgeErtekin, and Z. candanAlgun                                      | 2015 | Comparision of the Effects of Virtual Reality Based Balance Exercises and Conventional Exercises on Balance and Fall Risk in Older Adults Living in Nursing Homes in Turkey | Experimental Study                                   | There is 18 subject that participated in this study, which subject dived into 2 groups, 1st group given VR intervention and 2nd group given conventional exercises. In both groups, the Berg Balance Score (BBS), timed up, go duration, left leg stance, and tandem duration with eyes closed significantly improved with time. The VR exercises can improve the balance and fall risk of older adults who lived in the nursing home.   |
| Zan Gao, Jung Eun Lee, Daniel J, Calle Albers  | 2020 | Virtual Reality Exercise as a Coping Strategy for Health and Wellness Promotion in Older Adults during the COVID-19 Pandemic  | Quasi-Experimental Study                             | The results indicated that the application of VR exercise to facilitate improved physical outcomes like motor ability and this therapy can also reduce obesity in older adults. Furthermore, VR exercises can also improve cognition and psychological outcomes. The author also observed that VR can be an effective intervention strategy for fall prevention. VR programs can also promote some exercises that can be implemented during the COVID-19 pandemic to increase physical activity. |
| Steven Phu, Sara Vorgan, Ahmed Al Sedi, Gustavo Duque  | 2019 | Balance Training Using Virtual Reality Improves Balance and Physical Performance in Older Adults at Hight Risk of Falls   | Pre and Post Experimental Study                      | This studied was participated by 195 older adults with a median age of 78 who presented with risk and history of falls. The result of this study improves balancing and physical performing measures on older adults who get VR intervention.  |
| Renato Sobral Monteiro, Luiz F da S, Paulo de T Maciel, Erick Lohan Rodrigues Abud                                       | 2017 | Virtual Reality based Physical Exercise with Exergames (PhysEx) Improves Mental and Physical Health of Institutionalized Older Adults                                       | Randomized, Single-blind, and Controlled Pilot Study | The results of 29 older adults who participated in this study showed that VR-based physical exercise with exergames (PhysEx) improves the short-term memory and mobility of institutionalized older adults.  |
| Hamid Reza VatanKhah   | 2019 | Investigating the Effect of Virtual Reality Techniques on Balance of the Elderly  | Experimental Study                                   | The results of this study showed that in total 18 people aged between 70 to 90 years old accepted a significant effect of designed exercises on both the static and dynamic balance using VR of the elderly.   |
| Minyoung Lee, Jaebum Son, Jungjin Kim, Bum Chul Yoon   | 2015 | Individualized Feedback-Based Virtual Reality Exercise Improves Older Women's Self-Perceived Health   | Randomized Controlled Trial                          | <b>There are 54 participants enrolled in this study. The author studied that VR exercises are gaining attention as a cost-effective self-management strategy, the participants also increased on self-perceived health. From this study, the author proves that VR exercise can improve quality of life (QoL) in older women, improving physical fitness, and it also can be implemented to older women as an effective self-management strategy.</b>  |

#### IV. DISCUSSION

##### Risk of Sedentary Lifestyle to Older Adults's Health during COVID-19

In eliminating the COVID-19 pandemic, governments in each country are taking several protective steps to reduce the spread of the virus, such as implementing social distancing policies and restricting travel[14]. One of the conceivable impacts of social distancing policy on older adults is a reduction in physical activity. There's likely to be a decrease in both accidental physical action because of reduced participation in community activities such as socializing and reduction in formal work out such as attendance at exercise classes, gyms, bowls, golf, and other group activities [15]. Furthermore, older adults who did social distancing will affect their lifestyle, especially the sedentary lifestyle [16]. A sedentary lifestyle will harm the health of the elderly[14].

A sedentary lifestyle is a behavior of sitting, leaning back, and lying down which is done from waking up to before going to bed at night which is done continuously [17]. This habit is often carried out by the elderly because of the lack of knowledge and interest of the elderly who are in social institutions for physical activities. The long-term effect of sedentary lifestyle habits will affect the lifestyle and behavior of the elderly and harm mental health and physical activity patterns[18]. Recent studies suggest that a sedentary lifestyle is independently associated with cardiovascular disease risk factors and increased cardiovascular disease morbidity and global mortality, regardless of pulmonary artery (PA) Volume[17]. A sedentary lifestyle can inhibit the production of neurotrophins so that synapse transmission in the brain is disrupted[19]. When a person is accustomed to a sedentary lifestyle, the brain is not stimulated to produce a protein called brain-derived neurotrophic factor (BDNF). This protein functions to keep brain nerve cells healthy and is only produced when a person does physical activity [19].

### Physical Activity Needs of Older Adult

The World Health Organization (WHO) categorized physical inactivity as the fourth leading risk factor accounting for 6% of global mortality, following diabetes (6%), smoking (9%), and hypertension (13%)[20]. WHO recommends that the elderly accumulate at least 150 minutes of moderate to vigorous-intensity physical activity (MVPA) or 75 min of vigorous-intensity physical activity (VPA) throughout the week, cumulated in bouts lasting  $\geq 10$  min. This volume of physical activity (PA) is associated with a lower risk of cardiovascular disease mortality and morbidity and several other healthcare benefits[21]. Physical activity is been recognized as a central contributor to physical health and mental well-being generally in the elderly[22]. Older adults should be doing physical activity and exercises programs that reflect current evidence and are in line with current guidelines. Exercises on older adults should include a mix of balance, strength, balance, and aerobic exercises that can be done in bouts of 10 min [15].

Elderly sheltering in place needs an alternative option to increase social interaction and physical activity to promote health and well-being. COVID-19 pandemic offers an opportunity to give an intervention to older adults by utilizing the technology and informatics developments[22]. Given the older adult population's increased risk of health complications from COVID-19, and the potential of exercise to enhance immunological protection from viral respiratory disease, it is important to the health professional to facilitate the elderly's physical activity [22]. Innovative approaches using technology, such as virtual reality-based on exergames are nowadays had been recognized to contribute to improving physical activity in older adults[23]. Moreover, previous studies showed that VR based on exercise is an interactive intervention, feasible to apply by older adults, acceptable to all stakeholders, and it can improve functional capacities, including walking speed in older adults [24].

### VR- Based Exercises for Older Adult

There are several types of VR interventions used in research that are applied to participants with older adults in this literature, including:

#### a. *GPhysEx Physical (MAIN 5) (Exercise With Exergames)*

GPhysEx intervention performed 6 exergame exercises. Each training session, which lasts 30-45 minutes, is attended by individuals from each group. The participants were instructed to exercise comfortably by selecting the exercises they desired from GphysEx [25].

#### b. *The Otago Exercise Program (OEP)*

The Otago Exercise Program (OEP) is a home-based virtual program designed to increase physical activity in older adults who are at risk of falling. This intervention was carried out in groups, with older adults performing the exercise and cooling down before and after the exercise. The OEP intervention was carried out with 15 levels of difficulty with a duration adjusted to the development of older adults in the intervention [26].

#### c. *IFVR (Individualized feedback-based virtual reality)*

Individualized feedback-based virtual reality (IFVR) is a type of immersive interactive media that incorporates both visual and auditory feedback. IFVR displays individual movements on the screen and provides auditory feedback so

that each individual can adjust his posture and exercises independently; this exercise can also reduce the need for health professionals' supervision [27].

#### d. *VR SC-G06E Shinecon (Balance-Cardboard VR)*

Because of its connection to physical activity, balance skills, physical and visual coordination, and movement coordination, the VR Balance-Cardboard software is used. The intervention is carried out by directing the user to walk in the correct direction; participants must walk in the correct direction. If the participant takes a step back, the software will simulate a fall [28].

### Effect of VR-Based Exercises on Physical Activity in Older Adult

VR technology is one tool that can encourage the older adults to be more physically active [29][30]. Aside from the modern convenience and ease of use, older adults can use VR for mental relaxation[31]. In general, VR training has the potential to improve the motor skills of older adults by involving motor skill training, promoting motor sensory learning, and cortical plasticity [26]. Virtual reality training can also help with lower limb function, gait, balance, training activities, and cognition (primary education) [31]. VR is implemented by assigning tasks to perform specific activities [30]. The effectiveness of VR as a tool for reducing the risk of falls in the elderly population has also been studied and found to be effective [32][33]. This is supported by research [26], which states that VR is beneficial in improving balance and physical performance on par with traditional exercise, and is especially beneficial for those who have contraindications or are hesitant or non-adherent to conventional exercise programs.

### Practical Implication

VR is a new technology that has new opportunities for effective treatment in rehabilitation settings. By applying non-immersive VR with the use of a treadmill or applying the patient directly to a realistic environment, such as a city or park environment with head-mounted displays, physical and occupational therapy sessions can be enhanced [34]. Participants also found that exercising on a stationary bike with VR was more enjoyable than traditional cycling [35]. Since VR proved to be an attractive activity for older adults, this could be beneficial in increasing better adherence to the rehabilitation program and thus resulting in better health in patients. VR-based exercise interventions also include home-based interventions, such as VR-based Tai Chi and yoga programs [36]. The use of home-based exercise program techniques will lead to more effective rehabilitation, as older adults can engage in activities and improve health without the need to visit a health agency. This is especially important during the COVID-19 pandemic, so older adults may be advised to stay at home because they have a high risk of contracting the virus. So that a reduction in therapy or rehabilitation schedules for older adults can be replaced by doing VR-based activities as a substitute for increasing physical exercise for older adults during the COVID-19 pandemic [37].

### V. CONCLUSION

In a conclusion, this paper finds that the use of VR is an innovative and feasible technique to support and increase the functional autonomy of community-dwelling older adults. this study also provides the possibilities of virtual reality-based

exercise to improve balance and physical performance in the older adult during the COVID-19 Pandemic.

#### ACKNOWLEDGMENT

Thanks for support from the Faculty of Nursing, University of Jember, so that this literature review can be carried out successfully. We also extend our thanks to all the authors of the references used in this literature review.

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