+

Exploring the effects of walking backwards on Senior High School Students of De La Salle University

Maria Gabrielle R. Alvaran[1], Francesca Anne Denise C. Catolico[1], Jeroen M. Roxas[1], and Brendan James S. Saripe[1*]
[1]De La Salle University Integrated School
**corresponding author:brendan_james_saripe@dlsu.edu.ph*

Joan Kassey S. Acheampong[1] and Cedrick L. Torbeles[2]
[1 1]De La Salle University Integrated School

Abstract: The current pandemic has led to numerous health issues, including decreased public physical activity. To address this, it is vital to maintain and improve the physical condition of the general public. Backward walking is a simple exercise used in rehabilitation and various sports such as football, tennis, and basketball. This study examines the effects of a low-intensity but high-frequency intervention of backward walking on balance, strength, and ankle mobility. The data was collected from Grade 12 students at De La Salle University Laguna Campus and analyzed using various statistical techniques such as standard t-test, paired t-test, and descriptive statistics. Results indicate significant improvement in Modified Berg Balance Scale ($p = <0.001$, $t = 7.45$), Toe-to-wall Lunge in both left ($p = 0.001$, $t = 3.50$) and correct ($p = <0.001$, $t = 3.78$) ankles, and Stair Rise Power Test values based on a 0.61 increase in mean repetitions. Backward walking was more efficient for improvements in the Modified Berg Balance Scale than forward walking ($p = 0.001$, $t = 6.174$). Forward and backward walking demonstrated equal improvements in Chair Rise Test values ($p = 0.001$, $t = -0.13295$). These findings suggest that backward walking can be a beneficial exercise for improving balance, strength, and ankle mobility.

Keywords: ankle mobility; backward walking; balance; range of motion; strength

1. INTRODUCTION

Exercise is an essential part of human life. Currently, exercise has numerous benefits in a wide range of aspects. Recent studies suggest that exercise may enhance neurobiological processes that promote brain health in aging and disease (White & Castellano, 2008). Physical activity can decrease the risk and improve the prognosis of a limited number of cancers, such as colon, breast, and possibly endometrium (Febbraio, 2017). Evidence supports the pivotal role of physical activity and exercise in lowering stress, depression, and anxiety (de Abreu et al., 2022).

Walking backward is a simple exercise used as a rehabilitation component (Chang et al., 2021). Walking backwards shows more efficient muscle activation in the lower extremities than walking forwards (Cha et al., 2016). Backward walking is efficacious in improving gait and joint mobility since it interrupts the muscular activation pattern for walking forwards, expanding the lower body's range of motion (Chang et al., 2021). Backwards walking is more effective than other stability workouts in minimizing swaying in the human center of balance because it promotes neuromuscular function due to the lack of vision of the pathway (Wang et al., 2019).

An increasingly common sedentary lifestyle leads to various issues, including a measurable decline in vascular function and increased arterial wall stiffness (Lessiani et al., 2016). A similar study further supports this notion, finding a significant rise in metabolic risk associated with sedentary behavior (Hamburg, 2007, as cited in Tremblay, 2010). Additionally, the same study refers to several studies which all demonstrate a decrease in bone mineral density due to a sedentary lifestyle (Caillot-Augusseau, 1998; Morey-Holton & Globus, 1998; Zerwekh, 998; Kim, 2003; Smith, 2003; and Zwart, 2007 as cited in Tremblay, 2010). Consequently, the longer one remains inactive, the more their related musculature and physical abilities deteriorate.

Related musculature and physical abilities deteriorate the longer they are unused. Besides the physical aspect of a sedentary lifestyle, it also negatively affects one's mental capabilities (Sharma et al., 2006). Finally, a sedentary lifestyle inhibits a person's ability to partake in healthy recreational activities. Individuals, communities, and organizations must all work together to take a multifaceted approach to the problem of a sedentary lifestyle, especially in recovering from the recent COVID-19 pandemic.

The pandemic hosts numerous health problems and a probable decline in physical activity among the public. Fuelled by an increasing trend in the utilization of gadgets in innumerable aspects of life, coupled with the restrictions that came along with the pandemic, it was observed that there was a decrease in physical activity (Brand et al., 2020). Maintenance and improvement of the physical condition of the general public are desired. A study stating that the COVID-19 pandemic hurts the frequency of physical activity concluded that motivation is needed to do physical activities (Puccinelli et al., 2021). A solution to this declining physical condition would be doing exercises that mimic regular movement patterns such as walking, squats, push-ups, and pull-ups. An exercise with a reverse movement pattern from regular walking is backwards walking. It effectively activates the muscles on the lower extremities often neglected, such as the anterior tibialis and medial gastrocnemius (Balasukumaran et al., 2020).

A recent study reviewed multiple other studies regarding the effectiveness of backwards walking toward balance performance and found positive effects (Wang et al., 2019). Another related research did their study with a 4-week intervention (Whitley et al., 2011). A more recent paper uses a meta-analysis of previous studies to see how backwards walking training affects those with knee osteoarthritis (Wu et al., 2020). Another set of researchers did their study with a 4-week intervention on healthy adults to see how walking backward on a slope affects their gait and balance ability (Cha et al., 2016). All these studies may serve as the backbone of this paper. In addition, an extended intervention period, one spanning more than 4 weeks, is warranted to produce data that could be used to generalize the benefits of walking backwards. A related study shares this sentiment (Whitley and Dufek, 2011). Preserving and improving the current physical state are desired, and backward walking could solve this dilemma. The general public could benefit from this solution simply by doing it daily.

With these, the researchers aim to explore the benefits of walking backwards on balance, ankle range of motion, and lower extremity strength. In this endeavor, the following research objectives were set: (1) determine if walking backwards affects static and dynamic balance using the Berg Balance scale and a variety of step tests, (2) if walking backwards affects the strength of the lower extremity, (3) if walking backwards affects dorsiflexion and plantar flexion range of motion using a standard weight-bearing lunge setup, and (4) if walking backwards is more efficient than forward walking as a low-intensity and high-frequency exercise using forward walking data as a comparison.

The study gathered its data with its own experiment. By gathering volunteers from the senior high school students of DLSU Laguna, they were given an intervention of walking backward for a certain period. Their progress will be monitored with the use of reliable fitness tests to be described in the methodology. The results of this study will generally provide a simple and reliable exercise for the knee and ankle joints should it be fruitful. Additionally, this research's results will validate previous studies' findings on the effects of backward walking on non-healthy individuals.

2. METHODOLOGY

This study focuses on exploring the effects of walking backwards on healthy Senior High School students of the DLSU Laguna Campus. Specifically, the improvements in their static and dynamic balance, anterior and posterior flexibility, lower extremity strength, dorsiflexion and plantar flexion range of motion, and overall comparison of backwards and forwards walking. Static balance is defined as maintaining balance in a fixed position, while the dynamic balance is defined as maintaining balance while in movement (Orhan et al., 2021). Walking backwards has a positive effect on both static and dynamic balance and will most definitely allow the public to maintain proper balance easily. Increases in range of motion allow for an increase in freedom of movement, which can be beneficial, especially for less flexible individuals. According to new cross-sectional findings, hip range of motion and strength deficiencies are connected to lower physical function in older persons

(Coyle et al., 2021). Walking backwards benefits the body in general (Salyer, 2016). This physical activity may increase strength in bones, muscles, and even lesser-used leg muscles. It improves leg tolerance and aerobic capability. The strength of anterior muscles, such as the quadriceps muscle group and the anterior tibialis, will be emphasized in this study.

2.1 Research Design

The quantitative research will gather numerical data on participants' balance, strength, ankle range of motion, and walking efficiency before and after an intervention. The pre- and post-intervention checklists will include four tests: the modified Berg Balance Scale, 30-second Chair Rise Test, Stair Climb Power Test, and a distance-to-toe measurement using a tape measure in a weight-bearing lunge position. The study will involve 18 Grade 12 students of De La Salle University Laguna Campus with a healthy BMI range of 18.5 to 24.9 and will undergo criterion sampling. A t-test will be used to compare the findings of this research to the results of a previous study on forward walking versus backward walking.

2.2 Data Collection

The research activities in this study consisted of five main parts. The first part involved curating a set of tests that measured the participants' balance, strength, and ankle range of motion. These tests were used as a pre- and post-intervention checklist which includes a Modified Berg Balance Scale, a 30-second Chair Rise Test, a Stair Climb Power Test, and a distance-to-toe measurement using a tape measure. The second part of the study involved modifying the necessary instruments and forms to ensure participant safety. This included modifying the Physical Activity Readiness Questionnaire and the Berg Balance Scale to reduce the total number of activities and to create an even measurement of static and dynamic balance. The third part of the study involved procuring respondents through criterion sampling. A total of 18 respondents were selected based on their BMI being within the healthy range and their ability to meet the requirements set in the informed consent form and the modified Physical Activity Readiness questionnaire. The fourth part of the study involved the intervention itself, consisting of a warm-up, proper intervention, and a cool-down. The intervention proper was a 20-minute evenly paced backward walking routine, and the warm-up and cool-down routines focused on the main musculature used during the exercise. Finally, the fifth part of the study involved data analysis.

2.3 Data Analysis

The study will obtain quantitative data from Pre- and Post-Intervention checklists and compare it to normal values derived from forward walking. Relevant statistical analysis tools, such as paired t-tests, descriptive analysis, and standard t-tests, were used to compare the before and after values of the balance and ankle ROM parameters, to analyze the strength parameter, and to compare the effects of forward walking to the effects of backward walking.

The paired t-test will be used to analyze the significance of differences in balance and ankle ROM parameters before and after the intervention using the formula $t = \frac{\Delta x}{\frac{\Delta s}{\sqrt{n}}}$ To compute its test statistic. Descriptive analysis using measures of central tendency will be used to describe differences in strength. Lastly, the results of walking forward from another study will be compared to the results of walking backwards by the researchers (Parikh and Desai, 2022). The mean and standard deviation of the total of the Performance Oriented Mobility Assessment (POMA) and the 30-second chair rise test from the walking forward intervention done in another study would be compared to the mean and standard deviation of the Modified Berg Balance Test and 30-second chair rise test from the walking backward intervention by the researchers (Parikh and Desai, 2022). A standard t-test will be used utilizing the formula $t = \frac{(\underline{x_1} - \underline{x_2}) - (\mu_1 - \mu_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^1}{n_2}}}$ to obtain the test statistic.

An alternative hypothesis of after values greater than before values will be used, and a 0.05 significance level will be applied to all analyses.

3. RESULTS AND DISCUSSION

3.1. Paired T-Test

Table 1
Paired T-Test Values for Berg Balance Scale and Toe-to-Wall Lunge Measurement

		Test Statistic	P-value	Mean Difference	SE Difference
BBS Pre	BBS Post	7.45	<0.001	6.528	0.877
TW Left Pre	TW Left Post	3.50	0.001	0.778	0.222
TW Right Pre	TW Right Post	3.78	<0.001	1.083	0.287

The researchers found that the mean difference $\Delta \underline{x}$ between pre and post-intervention data is 6.528. A standard deviation of 3.27 was observed. Standard Error has been found to be 0.877. The test statistic has been found to be equal to 7.45. Comparing it to the p-value, we find that $t > p$. This means that we reject the null hypothesis and accept the alternative hypothesis that the post-intervention BBS score will be greater than the pre-intervention BBS score. This assumption is significant at a 0.05 significance level.

These results show a significant increase in balance ability when walking backwards is done as a low-intensity and high-frequency exercise. Showing that walking backwards has improvement in balance. This would also support a previous study showing emphasis on the positive effects to balance by walking backwards (Wang et al., 2019).

For the right ankle, a mean difference of 1.083 inches was found. For the left ankle, a mean difference of 0.778 inches was found. A standard deviation of 0.34 inches for the right ankle and 0.21 inches for the left ankle was observed. Standard Error has been found to be 0.287 inches in the right ankle and 0.222 inches in the left. The test statistic has been found to be equal to 3.78 for the right and 3.50 for the left. Comparing it to the p-value, we find that $t > p$. This means that we reject the null hypothesis and accept the alternative hypothesis that post-intervention ankle dorsiflexion is greater than pre-intervention ankle dorsiflexion for both ankles. This assumption is significant at a 0.05 significance level.

Significant improvement can be seen in both left and right ankles. Progress in the right ankle is slightly more than the left ankle. This could stem from the apparent footedness of the participants. This leaves room for further study regarding the difference in the degree of improvement, but significant progress was observed.

3.2. Descriptive Analysis

Table 2
Descriptive Statistics of Chair Rise Test, and Stair Climb Power Test

	Mean	SD	SE
CRT Pre	16.89	6.258	1.475
CRT Post	21.06	5.482	1.292
SCPT Pre	3.78	0.732	0.173
SCPT Post	4.39	0.698	0.164

Data related to muscular strength and endurance can be seen on Table 2. In the CRT, the participants initially tested for a mean score of 16.89 with a standard deviation of 6.258. After the 8-week intervention, the participants got a mean score of 21.06 and a standard deviation of 5.482. There is a significant increase in the mean score and a decrease in the standard deviation. This indicates overall improvement with all the participants as they achieved even higher repetitions in the test. The scores post-intervention have deviated slightly less compared to the pre-intervention. This means that the participants achieved more similar scores compared to the pre-test.

In the SCPT, the participants initially tested for a mean score of 3.78 with a standard deviation of 0.732. After the 8-week intervention, the participants got a mean score of 4.39 and a standard deviation of 0.698. There is a small increase in the mean score and a decrease in the standard deviation. This indicates overall improvement with all the participants as they achieved higher scores. The scores post-intervention deviated slightly less compared to the pre-intervention scores. This shows that the participants achieved scores that were more similar to one another than in the pre-test.

Consistent results in an increase in mean score and decrease in standard deviation indicate that backward walking improves muscular strength and endurance of lower extremity. A person may use backward walking as a strength exercise should their goal also align with balance and ankle mobility improvements. More efficient exercises are available if their goal is maximal strength improvements. The significance of this improvement in muscular strength and endurance should be subjected to further study.

3.3. Standard T-Test

The mean difference POMA score for forward walking has been found to be 0.13 while the mean difference BBS score for backward walking is equal to 6.53. A standard deviation of 3.91 was observed for forward walking values and for 3.27 backward walking values. The test statistic has been found to be equal to 6.174. Comparing it to the p-value, we find that $t > p$. This means that we reject the null hypothesis, and accept the alternative hypothesis that the backward walking values are greater than forward walking values. This assumption is significant at a 0.05 significance level.

The mean difference CRT score for forward walking has been found to be 4.3, while the mean difference CRT score for backward walking is equal to 4.17. A standard deviation of 2.14 was observed for forward walking values and for 5.87 backward walking values. The test statistic has been found to be equal to -0.13295. Comparing it to the p-value, we find that $t < p$. This means that we fail to reject the null hypothesis that both forward and backward walking elicit equal improvements in CRT scores.

When comparing forward versus backward walking, backward walking elicited more significant improvements in balance. This could stem from backward walking inhibiting sight as a main sensory ability. Furthermore, this greater improvement may be from its new stimulus as a reverse movement pattern to backward walking. On the other hand, improvement in muscular strength and endurance was similar in both forward and backward walking. No significant differences in their improvements were found. Both types of walking elicited improvements, but both do not put the main lower extremity musculature in its maximal range of motion.

The results of this study directly benefit the study's participants. Their physical capabilities were improved through the intervention and will continue to improve should they choose to do the intervention continuously. Adolescents and students, in general, also benefit from the results of this study as it gives insight into the effects of backwards walking on healthy students. They may be able to find similar applications to this type of research and personalize them for localized use. Additionally, researchers interested in the same topic could apply this topic in the context of the elderly, who potentially suffer from temperamental joints. Once this is achieved, the research may provide a plausible exercise for people of all ages.

Apart from being a basis for future research on the topic in the context of the general public, this research validates the findings of the previous studies on the effects of backwards walking on non-healthy individuals, applied to healthy individuals. Furthermore, this study could provide opportunities for science, technology, and engineering departments to enhance this exercise by utilizing their expertise in their specific fields.

4. CONCLUSION AND RECOMMENDATIONS

The results revealed that walking backwards significantly improves static and dynamic balance, lower extremity strength, and range of motion of the dorsiflexion and plantar flexion when compared to walking forwards.

The researchers found significant improvements in balance ability. The researchers also discovered significant improvements in lower extremity muscular strength and endurance. Improvements in both the left and right ankle range of motion was observed, with slightly greater improvement in the right ankle. Lastly, the researchers found that backward walking significantly improves balance ability as compared to forward walking. On the other hand, both forward and backward walking have similar improvements in muscular strength and endurance.

The researchers recommend further study on the significance of improvements in muscular strength and endurance, using the data collected and analyzed in this study as a springboard for future research. Additionally, the researchers recommend looking into footedness as a factor in the difference in the improvement of left and right ankle mobility in relation to backward walking. A larger sample size and longer intervention period, above 10 weeks, could prove to be beneficial.

5. ACKNOWLEDGMENTS

The researchers express their sincere gratitude to Ms. Joan Acheampong, their Research Adviser, for providing valuable advice, guidance, and assistance throughout the research process. Their expertise and support significantly contributed to the efficient implementation of the research objectives and the successful attainment and maintenance of data for this paper.

Furthermore, the researchers thank Sir Cedrick Torbeles, their Research Project Mentor and Secondary Adviser, for their invaluable help and guidance.

The researchers also extend their heartfelt appreciation to Sir Romwell Malicse, their Physical Education Teacher, for assisting with the necessary arrangements at the research venue, and facilitating the data collection process.

The researchers would also like to thank the participants who volunteered to participate in the study for their dedication throughout the intervention.

Lastly, the researchers would like to thank Sir Dale Anthony To, their General Biology 2 Teacher, for his thorough annotations and valuable suggestions for the paper. The researchers deeply value his time and effort in highlighting areas for improvement.

6. REFERENCES

Balasukumaran, Gottlieb, U., & Springer, S. (2020). Muscle activation patterns during backward walking in people with chronic ankle instability. BMC Musculoskeletal Disorders, 21(1), 489–489. https://doi.org/10.1186/s12891-020-03512-x

Brand, R., Timme, S., & Nosrat, S. (2020). When Pandemic Hits: Exercise Frequency and Subjective Well-Being During COVID-19 Pandemic. *Frontiers in Psychology*, *11*, 570567. https://doi.org/10.3389/fpsyg.2020.570567

Cha, H., Kim, T. Y., & Kim, M. (2016b). Therapeutic efficacy of walking backward and forward on a slope in normal adults. *Journal of Physical Therapy Science*, *28*(6), 1901–1903. https://doi.org/10.1589/jpts.28.1901

Chang, K., Lin, C., Yen, C., Yang, C., Tanaka, T., & Guo, L. (2021). The Effect of Walking Backward on a Treadmill on Balance, Speed of Walking and Cardiopulmonary Fitness for Patients with Chronic Stroke: A Pilot Study. *International Journal of Environmental Research and Public Health*, *18*(5), 2376. https://doi.org/10.3390/ijerph18052376

Coyle, P. C., Knox, P. J., Pohlig, R. T., Pugliese, J. M., Sions, J. M., & Hicks, G. E. (2021). Hip range of motion and strength predict 12‐Month physical function outcomes in older adults with chronic low back pain: The delaware spine studies. *ACR Open Rheumatology,* *3*(12), 850-859. https://doi.org/10.1002/acr2.11342

de Abreu, J. M., de Souza, R. A., Viana-Meireles, L. G., Landeira-Fernandez, J., & Filgueiras, A. (2022). Effects of physical activity and exercise on well-being in the context of the Covid-19 pandemic. *PLoS ONE*, *17*(1), e0260465. https://link.gale.com/apps/doc/A690547637/AONE?u=dlsu&sid=bookmark-AONE&xid=9d37ac2e

Febbraio, M. A. (2017). Exercise metabolism in 2016: Health benefits of exercise -- more than meets the eye! *Nature Reviews Endocrinology*, *13*(2), 72+. https://link.gale.com/apps/doc/A477323480/AONE?u=dlsu&sid=bookmark-AONE&xid=6a98e832

Lessiani, G., Santilli, F., Boccatonda, A., Iodice, P., Liani, R., Tripaldi, R., Saggini, R., & Davì, G. (2016). Arterial stiffness and sedentary lifestyle: Role of oxidative stress. *Vascular Pharmacology*, *79*, 1–5. https://doi.org/10.1016/j.vph.2015.05.017

Orhan, E., Altın, B., & Aksoy, S. (2021). Effect of Smartphone Use on Static and Dynamic Postural Balance in Healthy Young Adults. *American Journal of Audiology*, *30*(3), 703–708. https://doi.org/10.1044/2021_aja-20-00210

Parikh, P. R., & Desai, D. S. (2022, April 19). Effectiveness of Forward Walking Versus Retro Walking on Balance, Gait Speed and Lower Body Functional Strength among the Elderly Population - A Comparative Study. *International Journal of Health Sciences and Research, 12*(4), 283–291. https://doi.org/10.52403/ijhsr.20220433

Puccinelli, P. J., da Costa, T. S., Seffrin, A., de Lira, C. A. B., Vancini, R. L., Nikolaidis, P. T., Knechtle, B., Rosemann, T., Hill, L., & Andrade, M. S. (2021). Reduced level of physical activity during COVID-19 pandemic is associated with depression and anxiety levels: an internet-based survey. *BMC Public Health*, *21*(1). https://doi.org/10.1186/s12889-021-10470-z

Salyer, J. (2016, December 19). *Walking Backward: The Mind and Body Benefits*. Healthline. https://www.healthline.com/health/fitness-exercise/walking-backwards#Next-steps-

Sharma, A., Madaan, V., & Petty, F. (2006). Exercise for Mental Health. *Primary Care Companion to the Journal of Clinical Psychiatry*, *08*(02), 106. https://doi.org/10.4088/pcc.v08n0208a

Tremblay, M. S., Colley, R. C., Saunders, T. J., Healy, G. N., & Owen, N. (2010). Physiological and health implications of a sedentary lifestyle. *Applied Physiology, Nutrition, and Metabolism*, *35*(6), 725+. https://link.gale.com/apps/doc/A250578738/AONE?u=dlsu&sid=bookmark-AONE&xid=b6d767af

Wang, J., Xu, J., & An, R. (2019). Effectiveness of backward walking training on balance performance: A systematic review and meta-analysis. *Gait & Posture*, *68*, 466–475. https://doi.org/10.1016/j.gaitpost.2019.01.002

Whitley, C.R., & Dufek, J.S. (2011). Effects of Backward Walking on Hamstring Flexibility and Low Back Range of Motion. *International journal of exercise science, 4*, 4.

White, L. J., & Castellano, V. (2008). Exercise and Brain Health Implications for Multiple Sclerosis. Sports Medicine, 38(2), 91–100. https://doi.org/10.2165/00007256-200838020-00001

Wu, Y., Lei, C., Huangfu, Z., Sunzi, K., & Yang, C. (2020). Effect of backward walking training on knee osteoarthritis: protocol of a systematic review and meta-analysis. *BMJ Open*, *10*(10), e040726. https://doi.org/10.1136/bmjopen-2020-040726