

IJASC 22-3-22

Effect of Gardening as a physical activity on the improvement of Blood lipoprotein profile in an urban population in Republic of Korea: A pilot study

TaeSu Jang^{1§}, Ae-Kyung Lee^{2§}, EunJi Park³, and Jae Kyung Kim^{4*}

¹Professor, Department of Health Science, Dankook University College of Health & Welfare, Chungnam, South Korea

²Professor, Department of Horticulture Therapy and Rehabilitation, Dankook University College of Biotechnology & Bioengineering, Chungnam, South Korea

³Graduate student, Department of Medical Laser, Graduate School of Medicine, Dankook University, Chungnam, South Korea

⁴Professor, Department of Biomedical Laboratory Science, Dankook University College of Health & Welfare, Chungnam, South Korea

jangts@dankook.ac.kr, akleekr@dankook.ac.kr, name Eunji@naver.com, nerowolf@naver.com

Abstract

Purpose: Gardening has been reported to have positive emotional and physical effects in older adults. However, limited studies have assessed this relationship in Korea. Therefore, in this pilot study of densely populated urban dwellers, we aimed to investigate whether temporary but repeated experiences of the natural environment could positively change metabolism-related blood indicators.

Methods: This study used pre- and post-interventional designs to investigate the effects of 16 weeks of gardening on lipid profiles in an urban adult population and investigate their relationships. This study was conducted 30 times at the H Botanical Garden in Yongin City from August 16, 2021 to November 30, 2021 (16 weeks, twice a week, 3 hours each time). Before and after the gardening program, a clinical pathologist collected blood samples from the participants.

Results: High-density lipoprotein levels increased, low-density lipoprotein levels decreased, and total cholesterol levels decreased after the gardening activity.

Conclusions: Our findings suggest that gardening has potential for clinical application as it has good control over the lipid profile through physical activity. These findings can be used as basic data for studying the relationship between urban populations and their living environment and for various studies in the future as experiencing the natural environment provides many health benefits.

Key words: Cholesterol, Gardening, High-Density Lipoprotein, Horticulture, Low-Density Lipoprotein, Urban Populations.

1. INTRODUCTION

Studying the relationship between urban populations and their living environment owing to the increase in

urban populations is an important challenge in promoting urban public health and well-being. A large number and percentage of the world's population live in urban areas, and urban living is associated with many factors that adversely affect health, such as consumption of high-fat diet, social and psychological stress, and an increase in environmental pollutants [1,2]. Previous studies have reported that cities and nature can play an important role in creating a healthy society, and that experiencing the natural environment offers many health benefits [3].

Gardening involves horticultural activities in the form of cultivation of plants indoors and outdoors. This approach has therapeutic effects on individuals with an intellectual disability or mentally challenged individuals. Recently, this program has been widely applied to both patients with specific needs and the general public [4].

Gardening has positive psychological effects; it has been reported to reduce depression, increase happiness, change emotions, and increase life satisfaction. Moreover, keeping living plants is a medium of gaining confidence and a sense of accomplishment [5]. In older women, gardening reduces depressive symptoms and self-anxiety and improves life satisfaction [3].

According to Kang et al. [6], green activities increase sociality through the formation of communities both inside and outside the group. Such activities have significant positive emotional effects (achievement of self-confidence and self-respect) and physical effects (development and improvement of muscle function). Furthermore, green activities, such as gardening, increase a person's self-confidence, helps to recover cognitive ability through various stimuli, and provide opportunities for social and physical activities.

Cholesterol is a significant component of the cell membranes and is required to synthesize various hormones [7]. An increase in blood cholesterol levels is closely related to the risk of ischemic heart disease and arteriosclerosis, and a decrease in High-Density Lipoprotein-cholesterol (HDL-C) levels increases the risk of hyperlipidemia combined with heart disease, necessitating exercise therapy and dietary regulation [8,9]. Moreover, cholesterol is a crucial component of the neural membrane and plays a role in maintaining fluidity and being a signal modulator for the gene transcription involved in nutrient metabolism and inflammation [10].

In general, HDL levels during long-term physical activity increase in proportion to energy consumption, and activation of lipoprotein enzymes through exercise effectively improves the arteriosclerosis index by inducing an increase in HDL levels [8,11].

Lipoproteins are traditionally classified according to their size and density: chylomicrons, chylomicron remnants, and very Low-Density Lipoproteins are relatively large and light, whereas low-density lipoprotein (LDL) and HDL are sequentially smaller and heavier. In humans, LDL particles are the main carriers of cholesterol to peripheral tissues, wherein they are internalized through the LDL receptor, a crucial mediator of plasma LDL concentrations [12].

Numerous studies have shown that concentrations of various blood lipoproteins are risk factors for cardiovascular disease [13]. HDL-C levels can be used as an index to assess dyslipidemia as a health product [14]. High HDL-C levels contributes to the prevention of cardiovascular disease, whereas low HDL-C levels are associated with an increased risk of death due to coronary artery disease. Various factors cause an increase or decrease in HDL-C concentration in the blood, such as smoking, alcohol drinking, exercise, stress, obesity, and eating habits [15]. Furthermore, there are several studies on HDL and LDL as predictors for cardiovascular

disease [14].

Gardening has a positive effect on humans as an activity that involves nature; however, research related to the effects of gardening on metabolic diseases is conducted independently, and it is limited to understanding the effect of applying and collaborating with various programs. In Korea, few studies have assessed the relationship between blood cholesterol levels and metabolic syndrome development and compared the relationship before and after patients participated in gardening [16]. Nevertheless, it is difficult to directly apply foreign research results to the Korean setting, especially considering the vast differences in race, lifestyle, socioeconomic aspects, and cultural characteristics.

Therefore, in this pilot study of densely populated urban dwellers, we aimed to investigate whether temporary but repeated experiences of the natural environment could positively change metabolism-related blood indicators.

2. EXPERIMENTS

2.1. Research Design

In this pre-test and post-test study, we designed a before and after measurement experiment of the control population to investigate the effects of the gardening approach on HDL-C, LDL-C, and total cholesterol levels in adults (Table 1).

Table 1. Research design for this study

E	O1	X1	O2
---	----	----	----

E: Experiment group

O1: Pre-test, O2: Post-test

X1: Gardening program.

The age and sex distribution of the participants are shown in Table 2.

Table 2. Demographic data of the participants in this study

Item	Sub-item	Frequency	%
Sex	Male	2	10
	Female	17	90
	Total	19	100
Age	20-29	3	16
	40-49	2	10.5
	50-59	4	21
	60-69	8	42
	Over 70	2	10.5
	Total	19	100

2.2. Participants

In this study, participants were recruited through bulletin board notices, blogs, local communities, and various SNSs with the cooperation of the H Botanical Garden website and Yongin City Mental Health Promotion Center. Participants who voluntarily contacted the researchers were recruited in consideration of whether they could participate in the 30 activities during the research period and in the order of application. Of the 22 adult participants, 19 were selected, and the remaining three were excluded as they missed the post-examination. The participants were all Koreans and residents of the Seoul area. The researchers explained the study to the participants and their consent was obtained. The research was approved by the Research Ethics Review Committee (approval no. DKU 2021-06-035-001).

2.3. Research Process

This study was conducted 30 times at the H Botanical Garden in Yongin City from August 16, 2021 to November 30, 2021 (16 weeks, twice a week, 3 hours each time). Before and after the gardening program, a clinical pathologist collected 3 mL of blood at a time from the participants and sent the samples to the clinical trial support team in SCL (Seoul Medical Science Institute) for analysis. The purpose of the research, ethics-related information, program-related information, and so on were explained to the participants, and written consent to participate in the study was obtained.

2.4. Gardening Intervention

Gardening Program

The gardening program conducted among this study population involved activities to help them understand gardens and take care of 1-year-old plants. It involved creating two gardens and performing garden-related event activities. The program was structured to enable the participants to feel various functions of the garden based on their senses, sensibilities, cognition, behavior, and experience. There were 20 sessions of garden creation and garden activities (66.7%) and 10 sessions of garden-related event activities (33.3%). This program was revised and supplemented through consultation with one horticultural professor, one medical professor, and four professional gardeners.

In the introductory stage of the gardening activity, rather than starting with sudden garden activities, a light stretch was performed to loosen the body and gradually increase energy. To ensure complete attendance, badges of various shapes were awarded.

The full-scale gardening program involved creating gardens (daylily garden and vegetable garden), performing gardening activities, and participating in event activities.

Creating garden 1 (daylily garden creation) was planned by the participants, and it involved a wide range of activities from mixing the soil to planting saplings, creating facilities, creating a movement route, which led up to the opening ceremony. Roses and tulip bulbs were planted to see various types of plants, according to the change in seasons. In creating garden 2 (vegetable garden creation), vegetables were sowed and harvested, and what was needed for the plants was investigated. Moreover, the ecological relationship between nature and humans was evaluated by propagating plants in the garden, harvesting seeds, and sharing them with people around as well as making balls from effective microorganism soil that are beneficial to the garden.

Event activities included making flower hats with dried flowers, plant collages expressing happiness with emoticons using collected plants, and herbal postcards and calligraphy frames.

At the end of the gardening activity, the participants read articles related to gardening activities and took a walk with a gardener or alone. When taking a walk alone, a notebook was provided so that participants could organize their thoughts while walking around in nature. Participants were also asked to take one or two plants

along with them so that they could continue the feeling of being healed by the botanical garden after returning home.

2.5. Health Assessment

To investigate the effect of gardening on the participants' health, a professional clinical pathologist analyzed the blood samples collected from the study participants before and after the horticultural treatment program (3 mL of blood at a time). LDL, HDL, and total cholesterol concentrations were analyzed using Roche COBAS 8800 (Pleasanton, CA, USA).

2.6. Data Analysis

Data were analyzed using SPSS 26.0, and a single-population pre-test and post-test comparison was performed using the corresponding sample t-test.

3. RESULTS

Before-and-After Comparison of HDL-C Levels

When the blood HDL-C levels were compared before and after the gardening program, there was a 5% increase in the HDL-C concentration (from 55.6 ± 11.2 mg/dL [before] to 58.7 ± 12.8 mg/dL [after]) after participating in the 16-week program (twice a week, 30 times in total) (Figure 1(a)).

Before-and-After Comparison of LDL-C Levels

When the blood LDL-C levels were compared before and after the gardening program, there was a 10% decrease in the LDL-C concentration (from 116.9 ± 39.2 mg/dL [before] to 105.2 ± 24.5 mg/dL [after]) after participating in the gardening program (Figure 1(b)).

Before-and-After Comparison of Total Cholesterol Levels

When the blood total cholesterol levels were compared before and after the gardening program, there was a 5% decrease in the total cholesterol concentration (from 197.1 ± 44.6 mg/dL [before] to 187.7 ± 25.6 mg/dL [after]) after participating in the gardening program (Figure 1(c), Table 3).

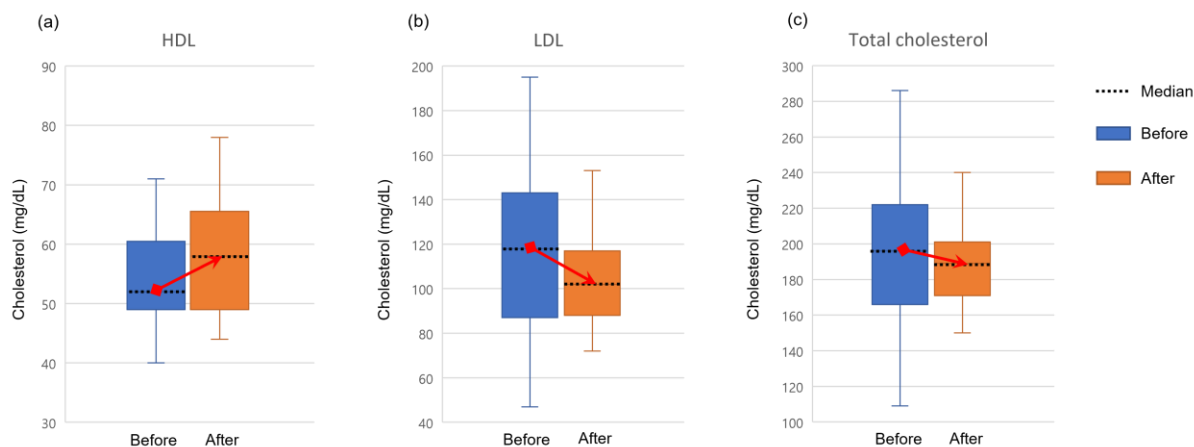


Figure 1. Effects of the horticultural treatment program on blood concentration of High-Density Lipoprotein(HDL), Low-Density Lipoprotein(LDL), and Total cholesterol

(a) Blood concentration of High-Density Lipoprotein(HDL), (b) Blood concentration of Low-Density Lipoprotein(LDL),

(c) Blood concentration of Total cholesterol.

The dotted line means the average value,

Left ; the blood levels of before the gardening program.

Right ; the blood levels of after the gardening program.

Table 3. Results of the lipid profile after the gardening program

Lipid profile	Before (n=19)	After (n=19)	t	P
HDL (mg/dL)	55.6±11.2 ^z	58.7±12.8	-0.78	0.220 ^{NS}
LDL (mg/dL)	116.9±39.2 ^z	105.2±24.5	1.11	0.139 ^{NS}
Total cholesterol (mg/dL)	197.1±44.6 ^z	187.7±25.6	0.79	0.218 ^{NS}

^z Mean ± standard deviation

LDL, Low-Density Lipoprotein; HDL, High-Density Lipoprotein; NS, Not significant

4. DISCUSSION

We conducted this study because only a few studies in Korea have assessed the before and after effects of gardening on the relationship between blood cholesterol concentration and metabolic syndrome development. Moreover, considering the vast differences in race, lifestyle, socioeconomic aspects, and cultural characteristics between Korea and other regions, it is critical to accumulate evidence in the Korean setting.

In this study, the 16-week gardening program contributed to a 5% increase in HDL levels, 10% decrease in LDL levels, and 5% reduction in total cholesterol levels, compared with the levels before receiving the treatment program.

Blood lipoproteins contain several components, including total cholesterol, HDL, and LDL [17]. High blood cholesterol level is closely related to the risk of ischemic heart disease and arteriosclerosis. Particularly, a decrease in HDL levels indicates that the risk of hyperlipidemia increases alongside the risk of heart disease. Therefore, the level of blood lipids is known to be a helpful indicator of vascular health [8].

According to previous studies [18,19], gardening is a form of physical activity and can be regarded as a moderate-to-high-intensity exercise of the whole body [20]. Gardening activities, which consist of moderate-intensity activities such as walking and strength training (e.g., weight lifting), can provide health benefits, such as increased aerobic capacity and muscle strength [13].

In general health-related perception, aerobic training is one of the most effective ways to reduce the risk of cardiovascular disease, and aerobic exercise is recommended as the easiest way to improve lipid and lipoprotein levels [21,22]. Studies conducted among obese and overweight women have shown that aerobic exercise improved the lipid profile and lipid-protein levels [23,24]. Furthermore, studies have shown that regular exercise contributes to a decrease in total cholesterol and LDL levels and an increase in HDL levels [25,26]. Additionally, studies have suggested that performing aerobic exercise thrice weekly reduces blood lipid levels in sedentary middle-aged men and is recommended to prevent cardiovascular disease in these men [21].

It is well known that high HDL levels help prevent cardiovascular and cerebrovascular diseases, whereas low HDL levels increase the risk of death due to coronary artery disease [15]. In addition, because high LDL levels are more likely to cause cardiovascular disease, therapeutic guidelines recommend maintaining LDL levels as low as possible among blood cholesterol components to prevent cardiovascular diseases [27].

Aerobic exercise improves body function, the immune system, and cholesterol levels, and gardening programs have similar effects. [8,12]. In our study, these levels were confirmed through blood lipoprotein analysis before and after participating in gardening, and the results suggested that participation in physical activity can help improve blood lipid levels.

Based on the results of this study, it can be inferred that gardening can help improve blood lipid levels. Although the blood analysis values were not significant in the t-test, the reliability of the average values after the program was increased by reducing the range of standard deviation of each item. In addition, some participants had LDL and total cholesterol levels below the normal standard; however, the improvement of blood lipid levels could be confirmed from a positive viewpoint, in that they were within the normal range after the program.

This study had some limitations that should be considered. For the experimental group, various variables such as the social characteristics (age, sex, etc.), health condition (underlying disease), lifestyle (eating habits, smoking status, etc.), hormonal changes (based on sex, age, etc.), and lipoprotein measurement method were not considered, limiting the analysis as the findings were not confirmed according to changes in complex and various factors. Furthermore, it is advisable to increase the target population and observe the results after the horticultural activity program; however, due to the process of gardening, many people could not be included. Therefore, it is necessary to design and conduct a comparative study with a large group of participants or those with various age groups and factors in the future.

In this study, we evaluated changes in blood cholesterol levels after gardening among adults in urban areas and attempted to investigate the relationship between these changes and the risk of cardiovascular disease.

5. CONCLUSION

Gardening was found to be useful in vascular health as it improved the blood lipid profile, which is an index for predicting the risk of cardiovascular disease. The significance of this study is that our findings suggest that gardening can reduce the risk of metabolic syndrome and cardiovascular disease by positively influencing the reduction of blood lipid levels and lipoprotein metabolism, and providing health promotion benefits. Through this pilot study of densely populated urban dwellers, we confirmed that temporary but repeated experiences of the natural environment could positively change metabolism-related blood indicators. In addition, these findings can be used as basic data for studying the relationship between urban populations and their living environment and for various studies in the future as experiencing the natural environment provides many health benefits. We findings suggest that gardening has potential for clinical application as it has good control over the lipid profile through physical activity and suggest that exposure to the natural environment alone may have a positive effect on lipid profile improvement.

DECLARATIONS

Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Funding statement

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Conflict of interest disclosure

The authors declare no competing interests.

Ethics approval statement

The research was approved by the Research Ethics Review Committee (approval no. DKU 2021-06-035-001).

Patient consent statement

The researchers explained the study to the participants and obtained their consent.

REFERENCES

- [1] M. Soga, K. J. Gaston, and Y. Yamaura, Gardening is beneficial for health: A meta-analysis, *Preventive Medicine Reports*, Vol. 5, pp. 92-99, March 2017.
- [2] Y. C. Shin. Job stress and depression, *Journal of Korean Neuropsychiatric Association*, Vol. 59, pp. 88-97, June 2020.
- [3] G. J. Lee, P. Sin-Ae and S. Ki-Cheol, Application of gardening program for improving life satisfaction of hospitalized elderly with stroke, *Journal of People Plants Environment*, Vol. 16, pp. 167-171, 2013.
- [4] S. A. Park, M.S. Jeong and M. Lee, An analysis of the healing effects of forest therapy and Gardening, *Journal of the Korean Institute of Landscape Architecture*, Vol. 43, No. 3, pp. 43-51, June 2015.
- [5] S. H. Park, S. J. Kim and J. W. Kim *et al*, The relationship between suicide attempts and serum lipids in patients admitted with depression, *Psychology Medicine*, Vol. 26, pp. 164-171, 2018.
- [6] H. K. Kang and S. J. Back, Effect of urban agriculture experience program on the mental health of the elderly, *Journal of Korea Society for Plants People and Environment*, Vol. 20, pp. 1-6, 2017.
- [7] T. Y. Lee and S. M. Choi, Convergence study for relationship between cholesterol level on serum and depression in Korean adults, *Journal of Digital Convergence*, Vol. 13, No. 5, pp. 269-276, 2015.
- [8] K. T. Kim and J. H. Cho, Effects of elastic band and aerobic exercise on fitness, blood lipids, and vascular inflammatory markers in elderly women, *The Asian Journal of Kinesiology*, Vol. 15, No. 2, pp. 129-138, April. 2013.
- [9] B. M. Park and H. S. Ryu, Relationship between metabolic syndrome and the triglyceride/high-density lipoprotein-cholesterol ratio in male office workers. *Journal of Korean Public Health Nursing*, 31.2, 376-388, 2017.
- [10] S. Y. Lim, E. J. Kim, and A. Kim *et al*, Nutritional Factors Affecting Mental Health, *Clinical Nutrition Research*, Vol. 5, No.3, 143-152, July 2016.
- [11] S. W. Y. M Thu, A. P. Zaw and P. P. Kyaw, Effect of exercise on non-HDL cholesterol level (non-HDL-C) in older women: a systematic review and meta-analysis of randomized controlled trials, *Journal of the University of Malaya Medical Centre*, Vol. 23, pp. 49-59, 2020.
- [12] P. M. Ridker, LDL cholesterol: controversies and future therapeutic directions, *Lancet*, Vol. 384, pp. 607-617, 2014.
- [13] S. A. Park, A. Y. Lee and H. G. Park *et al*, Gardening intervention as a low-to moderate-intensity physical activity for improving blood lipid profiles, blood pressure, inflammation, and oxidative stress in women over the age of 70: a pilot study, *HortScience*, Vol. 52, No. 1, pp. 200-205, 2017.
- [14] S. B. Hong and K. A. Shin, Significance of non HDL-cholesterol and triglyceride to HDL-cholesterol ratio as predictors for metabolic syndrome among Korean elderly, *Korean Journal of Clinical Laboratory Science*, Vol. 50, pp. 245-252, 2018.
- [15] S. L. Kim, S. Kam and M. G. Kim, The High-density lipoprotein (HDL) cholesterol and related factors in

- Korean middle-aged, *Journal of the Korea Academia-Industrial cooperation Society*, Vol. 19, No. 4, pp. 423-432, 2018
- [16] J. Kingsley, N. Hadgraft and N. Owen *et al*, Associations of vigorous gardening with cardiometabolic risk markers for middle-aged and older adults. *Journal of Aging and Physical Activity*, Vol. 30, No. 3, pp. 466-472, 2022
- [17] J. K. Do and K. Sang-Yeob, Effect of golf swing exercise on the vascular compliance and metabolic syndrome risk factors in elderly women, *Indian Journal of Science and Technology*, Vol. 8: No. 27, pp. 1-5, 2015.
- [18] S.A. Park, A. Lee and L. Young *et al*, A comparison of exercise intensity between two horticultural and four common physical activities among male adults in their 20s, *Horticultural Science & Technology*, Vol. 33, No. 1, pp. 133-142, Feb. 2015.
- [19] S. A. Park, A. Y. Lee and H. G. Park *et al*, Benefits of gardening activities for cognitive function according to measurement of brain nerve growth factor levels. *International Journal of Environmental Research and Public Health*, Vol. 16, No. 5, pp. 760, Aug.2019.
- [20] S. A. Park, A. Y. Lee and K. C. Son *et al*, Gardening intervention for physical and psychological health benefits in elderly women at community centers, *HortTechnology*, Vol. 26, No. 4, 474-483, 2016.
- [21] H. R. Mohammadi, E. Khoshnam and M. K. Jahromi *et al*, The effect of 12-week of aerobic training on homocysteine, lipoprotein A and lipid profile levels in sedentary middle-aged men. *International Journal of Preventive Medicine*, Vol. 5, No. 8, pp. 1060-1066, 2014.
- [22] M. Turgut, V. Çınar and T. Akbulut *et al*, Effect of acute exercise on lipid levels of woman, *European Journal of Physical Education and Sport Science*, Vol. 3, No. 12, pp. 413, 2017.
- [23] S. M. Marandi, N. G. B. Abadi and F. Esfarjani *et al*, Effects of intensity of aerobics on body composition and blood lipid profile in obese/overweight females. *International Journal of Preventive Medicine*, Vol. 4(Suppl 1), pp. S118-S125, April 2013
- [24] I. R. Lemes, B. C. Turi-Lynch and I. Cavero-Redondo *et al*, Aerobic training reduces blood pressure and waist circumference and increases HDL-c in metabolic syndrome: a systematic review and meta-analysis of randomized controlled trials, *Journal of the American Society of Hypertension*, Vol.12, No. 8, pp. 580-588, Aug. 2018.
- [25] Y. A. Choi, S. H. Park and M. K. Lee *et al*, Effects of 5-week combined exercise on blood lipid and health-related quality of life in obese military recruits, *Exercise Science*, Vol. 27, pp. 153-160, 2018.
- [26] W. Y. Lin, A large-scale observational study linking various kinds of physical exercise to lipoprotein-lipid profile, *International Society of Sports Nutrition*, Vol. 18, No. 1, pp. 35, 2021.
- [27] S. H. Lee, M. Park and D. H. Yoon *et al*, Gender difference in associations between serum cholesterol levels and depression symptoms in healthy general population, *Korean Journal of Psychosomatic Medicine*, Vol. 25, No. 1, pp. 27-32, June. 2017