Physical and Psychological Health Conditions of Older Adults Classified as Gardeners or Nongardeners

Sin-Ae Park

Department of Horticulture, Forestry, & Recreation Resources, Kansas State University, 3738 Throckmorton Hall, Manhattan, KS 66506

Candice A. Shoemaker[1]

Department of Horticulture, Forestry, & Recreation Resources, Community Health Institute, and Center on Aging, Kansas State University, 2021 Throckmorton Hall, Manhattan, KS 66506

Mark D. Haub

Department of Human Nutrition and Center on Aging, Kansas State University, 127 Justin Hall, Manhattan, KS 66506

Abstract. The objective of this study was to compare the physical and psychological health conditions and leisure-time activities, particularly physical activities (PAs), of older gardeners and nongardeners. Fifty-three older adults were recruited from the community of Manhattan, KS. Three groups were classified based on results from the Community Healthy Activities Model Program for Seniors questionnaire: active gardeners (n = 11) classified as gardeners that met the Centers for Disease Control and Prevention's (CDC) PA recommendation through gardening; gardeners (n = 14) classified as gardeners that did not meet the CDC's PA recommendation through gardening; and nongardeners (n = 28). Overall physical and mental health conditions were determined with the Short-Form 36 Health Survey (SF-36), hand function (hand strength and pinch force) was determined by dynamometers, and bone mineral density (BMD) was determined by dual-energy x-ray absorptiometry. Active gardeners were significantly different from gardeners and nongardeners in physical health ($P \leq 0.05$) on SF-36. There were no differences in mental health among the three groups, but all groups had scores higher than the U.S. general population. Active gardeners + gardeners had greater hand strength and pinch force than nongardeners. There was no difference in BMD among the groups, but all subjects had higher scores than the standard BMD value for their age. The only significant difference of caloric expenditure in leisure-time PAs among the groups was gardening ($P < 0.001$). In conclusion, gardening can be a useful strategy to meet the CDC's PA recommendation. In addition to the health benefits linked to regular PA, this study showed that gardening promotes hand strength, pinch force, and overall physical health.

Regular physical activity (PA) contributes to the prevention and reduction of chronic diseases associated with aging and can help maintain independent living [American College of Sports Medicine (ACSM), 1998; Galloway and Jokl, 2000]. Health benefits from regular PA include reduction in the risk of coronary heart disease, hypertension, type 2 diabetes, osteoporosis, ischemic stroke, selected cancers, anxiety, and depression (ACSM, 1993, 2004; Hui and Rubenstein, 2006; Lee et al., 1991; Powell et al., 1987). Physical activity also increases fitness level, muscle strength, aerobic capacity, balance, and bone mineral density (BMD) (ACSM, 1998; DiPietro, 2001; U.S. Department of Health and Human Services, 1996). To maintain or improve health, the Centers for Disease Control and Prevention (CDC) and ACSM recommend at least 30 min of moderate-intensity PA on most days of the week (at least 150 min of moderate intensity PA per week) (Nelson et al., 2007; Pate et al., 1995).

Gardening is a popular leisure-time activity of people aged 65 years or older in the United States (Yusuf et al., 1996). In our previous research (Park et al., 2008), gardening was determined to offer moderate-intensity PA and thus has the possibility of offering the health benefits of PA for older adults. Gardening has been associated with improved physical and psychosocial health outcomes such as lower total cholesterol, lower blood pressure, lower mortality, psychological well-being, and social integration (Armstrong, 2000; Walsh et al., 2001). Turner et al. (2002) reported that gardening is an activity that is expected to influence whole body BMD because it includes weightbearing motions such as pushing a mower, digging holes, pulling weeds, carrying soil, and so on, and because it uses the whole body. Yard work and weight training were strong and positive predictors for BMD rather than other PAs such as jogging, swimming, calisthenics, bicycling, aerobic, walking, and dancing (Turner et al., 2002). Reynolds (1999) reported that gardening improved grip strength of participants after 6 months and cardiovascular fitness was expected because gardening activities elevated heart rate. In another study, Reynolds (2002) reported improved mental health and depression of participants through gardening after 3 months.

Although there is some evidence of the positive health benefits from gardening as a form of PA, there is limited research reported that has specifically studied gardening for health in older populations. Therefore, the purpose of this study was to investigate the physical and psychological health conditions (overall health conditions, hand function, and BMD) and the leisure-time activities, particularly PAs, of older gardeners and nongardeners for differences.

Materials and Methods

Subjects. Subjects were recruited from the community of Manhattan, KS. Recruitment was done in person at locations known to be frequented by older adults in Manhattan, KS, such as a senior center, coffee shops, restaurants, and churches. The researchers also recruited from garden clubs, a community garden group, exercise classes, a reading group, and an art group. In an orientation, the experimental procedures were explained, written informed consent was obtained, and a demographic information questionnaire was completed by the subjects. The demographic questionnaire was developed and included questions on age, gender, race, education, marital status, employment status, and annual income. A total of 53 subjects, aged 58 to 86 years old, participated in the study.

Health assessments. A trained specialist conducted the health assessments of the subjects in Oct. 2006. Height and weight were measured with a wall stadiometer (Seca 216 Stadiometers; Seca, Brooklyn, NY) and electronic balance (Ohaus ES200L; Ohaus, Pine Brook, NJ) without shoes. Body mass index [mass (kg)/height (m)^2] was calculated. Percent body fat was measured by dual-energy x-ray absorptiometry (Prodigy v6.8; GE Lunar, Milwaukee, WI).

To determine the physical and mental health conditions of the subjects, the Short-Form 36 Health Survey (SF-36) was used. The SF-36 is a 36-item self-rated survey that measures eight domains of health: physical

functioning, role limitations resulting from physical health, bodily pain, general health perceptions, vitality, social functioning, role limitations resulting from emotional problems, and mental health. It yields scale scores for each of these eight health domains and two summary measures of physical and mental health: the physical component summary and mental component summary. The reliability of the eight scales and two summary measures has been estimated using both internal consistency and test–retest methods. Published reliability statistics have exceeded the minimum standard of 0.70 recommended for measures used in group comparisons in more than 25 studies (Tsai et al., 1997); most have exceeded 0.80 (McHorney et al., 1994; Ware et al., 1993). Reliability estimates for physical and mental summary scores usually exceed 0.90 (Ware et al., 1994). Studies to date have reported content, concurrent, criterion, construct, and predictive evidence of validity (Ware, 2000).

Hand function (hand strength and pinch force) was determined by a hydraulic hand dynamometer and a pinch gauge (JAMAR Dynamometers 5030J1 and 7498-05; Sammons Preston, Chicago, IL). Subjects were tested three times on each hand and were asked to indicate their dominant hand.

To determine the bone density of the subjects, BMD ($g \cdot cm^{-2}$) of the spine and hip was measured by a certified technician using dual-energy x-ray absorptiometry (Prodigy v6.8; GE Lunar).

Leisure-time physical activities of older adults. The Community Healthy Activities Model Program for Seniors (CHAMPS) questionnaire for older adults was used to measure leisure-time PAs. The questionnaire lists many light- and moderate-intensity PAs. Subjects are asked to indicate their frequency and duration in doing these PAs during a typical week during the previous 4 weeks. Frequency and caloric expenditure for moderate-intensity activities [metabolic equivalent (MET) values above 3.0 and below 6.0 such as brisk walking, swimming, cycling, or dancing] and for all activities (i.e., light such as watering lawn or garden, fishing, or cooking and moderate intensity) were calculated (Harada et al., 2001; Stewart et al., 1997, 2001). The PAs in this questionnaire were classified as moderate-intensity PA and light-intensity PA (below 3.0 METs) based on the values reported by Ainsworth and colleagues (Ainsworth et al., 1993). Those not reported by Ainsworth et al. (1993) were classified by interpolating values of similar activities (e.g., water exercises' MET value was drawn from water aerobics and water calisthenics) (Stewart et al., 2001). This questionnaire has been shown to be reliable and valid in estimating frequency per week of all PAs and calories expended per week in all PAs (Stewart et al., 2001).

Exercise intensity and time spent gardening were calculated based on the CHAMPS questionnaire responses to questions on gardening. Subjects were then classified as active gardeners, gardeners, or nongardeners to

determine the health effects of gardening as a form of PA: active gardeners (n = 11) met or exceeded the CDC's PA recommendation by gardening at moderate intensity for more than 150 min per week; gardeners (n = 14) did not meet the CDC's PA recommendation by gardening but did garden for 120 to 150 min per week at both low and moderate intensity; and nongardeners did no gardening or little gardening at low intensity (n = 28). By separating gardeners that met the PA recommendation through gardening from gardeners that did not, we were able to determine the effects of gardening as a moderate-intensity PA.

Data analysis. Analysis of variance was performed by the Statistical Analysis System (SAS Version 9 for Windows; SAS Institute Inc., Cary, NC). Fisher's least significant difference test was used to compare means at $P = 0.05$ for health assessments and caloric expenditure and frequency of leisure-time PAs. PROC GLM and χ^2 tests were used to

compare the variables in the three groups for demographic information at $P = 0.05$.

SF-36 data were scored using SF-36 Scoring Software (Quality Metric, Lincoln, RI). This software also performs norm-based scoring through linear transformations of scores to a mean of 50 and SD of 10 in the general U.S. population. This transformation achieves the same mean and SD for all eight scales and for the physical and mental summary measures. With norm-based scoring, differences in scale scores is more clearly reflected (Ware, 2000).

In the BMD results, a T-score is given by comparing the ideal or peak BMD of a healthy 30-year-old adult with the subject's BMD. A score of 0 indicates the BMD is the same as the norm for a healthy young adult. A T-score of –2.5 or lower means the person has osteoporosis. A Z-score is given to compare the subject's BMD value with a typical individual whose age is matched to the subject's age (National Institutes of Health Osteoporosis

Table 1. Demographic information of 53 participants in a study to compare the physical and psychological health of active gardeners, gardeners, and nongardeners.

Variable	Active gardeners[z] (N = 11)	Gardeners[y] (N = 14)	Nongardeners[x] (N = 28)	P value[w]
	Mean (SD)			
Age	73 (7)	71 (6)	72 (9)	0.89 NS
Height (cm)	165.4 (7.2)	164.8 (7.0)	160.1 (8.4)	0.20 NS
Body weight (kg)	75 (15.6)	82.7 (12.4)	68.7 (13.2)	0.33 NS
Body mass index	27.0 (4.8)	29.4 (4.6)	26.5 (4.5)	0.17 NS
Percent body fat	35.1 (10)	42.9 (8.5)	38.7 (7.7)	0.08 NS
	Percentage (%)			
Gender				
Male	54.5	35.7	28.6	0.31 NS
Female	45.5	64.3	71.4	
Race				
White	90.9	100	75	0.14 NS
Asian	9.1	0	25	
Education[v]				
High school graduate	90.9	100	85.7	0.45 NS
2-year postsecondary education or less	18.2	35.7	28.6	0.63 NS
4-year postsecondary education or less	100	64.3	67.9	
No response	0	0	3.6	
Marital status				
Single[u]	36.4	26.8	35.7	0.88 NS
With partner[t]	63.6	71.4	64.3	
Employment status				
Retired	72.7	78.6	64.3	0.44 NS
Full-time	9.1	7.1	25	
Part-time	9.1	0	3.6	
Homemaker	0	14.3	3.6	
Disability	9.1	0	3.6	
Annual income				
Less than $40,000	18.2	50	32.1	0.22 NS
$40,000 to 59,999	27.3	7.1	25	
$60,000 to 80,000	9.1	14.3	21.4	
More than $80,000	45.5	14.3	7.1	
No answer	0	14.3	14.4	

[z]Active gardeners met or exceeded the Centers for Disease Control and Prevention's (CDC) physical activity (PA) recommendation by gardening at moderate intensity for more than 150 min per week.
[y]Gardeners did not meet the CDC's PA recommendation by gardening but did garden for 120 to 150 min per week at both low and moderate intensity.
[x]Nongardeners did no gardening or little gardening at low intensity.
[w]PROC GLM was used to compare means at $P = 0.05$ for age, height, body weight, body mass index, and percent body fat. Chi square was used to compare values at $P = 0.05$ for the remaining variables.
[v]The percentage sum for education in the active gardeners group is over 100% because subjects could mark "all that apply."
[u]Single = never married, divorced, separated, or widowed.
[t]With partner = married or having a partner.
NS = No significant difference by PROC GLM and χ^2 test at $P = 0.05$.

and Related Bone Disease, National Resource Center, 2006). In practice, an individual T-score is used for the diagnosis of osteoporosis, whereas a Z-score is useful in determining whether there may be an underlying disease or condition that is causing bone loss.

Results

Demographic information. There were no significant differences among the three groups across all demographic variables (Table 1).

Caloric expenditure and frequency of leisure-time physical activities. All subjects, regardless of gardening group, were very active, exceeding the PA recommendation considerably. This is evident in the weekly caloric expenditure and frequency of PA per week, which were not significantly different among the three groups (Table 2). Thus, activity level, when considering all activities, was the same for all three groups. When comparing energy expenditure for each of the activities in the CHAMPS questionnaire, gardening was the only activity that was significantly different

among the groups (Table 3). Therefore, any difference in health outcomes may be explained through the gardening activity.

Health assessments. Active gardeners reported higher physical function, bodily pain (higher score indicates lower pain), and physical summary scores (Table 4). There were no differences in mental health among the three groups (Table 4), but all groups had scores higher than the U.S. general population (mean ± SD, 50 ± 10).

There was no difference in BMD of spine and dual femur among the groups, but all participants had higher values than the standard value for their age (Table 5). Because hand function abilities are not influenced by exercise intensity, intensity of gardening was not used in classifying the subjects as was done previously. To analyze hand function abilities, subjects were classified as gardeners (gardening more than 120 min at both low and moderate intensity) or nongardeners (gardening less than 120 min at low intensity). Gardeners had significantly higher hand function abilities than nongardeners in their hand strength and pinch force ($P < 0.05$) (Table 6).

Discussion

Healthy active, older adults who participated in gardening enough to meet the PA recommendation of 30 min moderate-intensity PA on 5 or more days of the week had higher values in three of the physical domains of the SF-36 (physical function, bodily pain, and physical summary) and better hand function ability than those who were also active but did less gardening.

Physical function and bodily pain were positively associated with gardening in this

Table 2. Physical activity measures of active gardeners, gardeners, and nongardeners based on the CHAMPS[z] questionnaire to compare the physical and psychological health of active gardeners, gardeners, and nongardeners.

Measure	Active gardeners[y] (N = 11)	Gardeners[x] (N = 14)	Nongardeners[w] (N = 28)	P value
Moderate and greater intensity measures[v], mean (SE)				
Caloric expenditure per week in at least moderate-intensity physical activities (MET 3.0 or greater)	4,000 (795)	2,385 (705)	2,632 (498)	0.27 NS
Frequency per week in at least moderate-intensity physical activities (MET 3.0 or greater)	11 (3)	10 (2)	9 (2)	0.82 NS
All activities measures, mean (SE)				
Caloric expenditure per week in all listed physical activities	5,834 (1032)	4,152 (915)	4,441 (647)	0.43 NS
Frequency per week in all listed physical activities	22 (4)	26 (4)	22 (3)	0.70 NS

[z]Community Healthy Activities Model Program for Seniors.
[y]Active gardeners met or exceeded the Centers for Disease Control and Prevention's (CDC) physical activity (PA) recommendation by gardening at moderate intensity for more than 150 min per week.
[x]Gardeners did not meet the CDC's PA recommendation by gardening but did garden for 120 to 150 min per week at both low and moderate intensity.
[w]Nongardeners did no gardening or little gardening at low intensity.
[v]CHAMPS: Measuring caloric expenditure (Kcal/week) and frequency of leisure-time PAs in older adults. The PAs were classified as moderate-intensity PA [above 3.0 metabolic equivalents (METs) and below 6.0 METs] and light-intensity PA (below 3.0 METs) based on the values reported by Ainsworth et al. (1993).
NS = No significant difference by least significant difference test at $P = 0.05$.

Table 3. Kinds and energy expenditure (Kcal/week) of leisure-time physical activities in CHAMPS questionnaire performed by the subjects to compare the physical and psychological health of active gardeners, gardeners, and nongardeners.

Leisure-time physical activities	Active gardeners (N = 11)	Gardeners (N = 14)	Nongardeners (N = 28)	P value
Dance (such as square, folk, line, ballroom) (do not count aerobic dance here)	0	207.6	0	0.26 NS
Play golf, carrying or pulling your equipment (count walking time only)	83.8	21	22.4	0.34 NS
Play golf, riding a cart (count walking time only)	100.2	4	80.3	0.67 NS
Play tennis (single + double)	0	296.1	87.4	0.33 NS
Do work around the house (light + heavy)	1363	819.6	847.8	0.31 NS
Do gardening (light + heavy)	1,811.6 a	907.7 b	385.7 c	0.0001***
Work on your car, truck, lawnmower, or other machinery	55.9	154.8	102.9	0.75 NS
Jog or run	649.1	432.4	101.6	0.18 NS
Walk (uphill, hike uphill, fast, briskly for exercise)	750.7	650.1	598.1	0.90 NS
Walk (errands, leisurely) (count walking time only)	909.5	541.1	530.4	0.24 NS
Ride a bicycle or stationary cycle	145.6	146.7	184.8	0.96 NS
Do other aerobic machines such as rowing or step machines (do not count treadmill or stationary cycle)	276.5	11.9	81.5	0.11 NS
Do water exercises (do not count other swimming)	0	0	144.18	0.16 NS
Swim (moderately, fast, gently)	0	0	76.2	0.26 NS
Do stretching or flexibility exercises (do not count yoga or Tai-chi)	269.6	119.1	89.6	0.08 NS
Do yoga or Tai-chi	123.5	0	69.1	0.35 NS
Do aerobics or aerobic dancing	188.3	154.1	52.4	0.41 NS
Do moderate to heavy strength training (such as handheld weights of more than 5 lbs., weight machines, or pushups)	313.7	105.4	76.1	0.18 NS
Do light strength training (such as handheld weights of 5 lbs. or less or elastic bands)	72.3	67.1	116.5	0.64 NS
Do general conditioning exercises such as light calisthenics or chair exercises (do not count strength training)	48.4	26.6	61.9	0.69 NS

a, b, c = sharing at least one common letter are not significantly different by least significant difference test at $P = 0.05$.
***$P < 0.001$.
NS = No significantly difference by Least Significant Difference (LSD) test at $P = 0.05$.

Table 4. Health conditions of active gardeners, gardeners, and nongardeners based on the Short-Form 36 Health Survey.[z]

Component	Active gardeners[y] (N = 11)	Gardeners[x] (N = 14)	Nongardeners[w] (N = 28)	P value
Physical function	54.1[v] a	48.9 b	48.4 b	0.05*
Role limitations resulting from physical health	53.7	44.3	48.7	0.06 NS
Bodily pain	56.1 a	44.1 b	49.0 b	0.01**
General health	54.6	51	50.1	0.26 NS
Vitality	58.3	50.6	54.9	0.08 NS
Social function	55.7	53.3	53.8	0.69 NS
Role limitations resulting from emotional problems	50.6	48.6	52.0	0.50 NS
Mental health	57.3	52.6	53.3	0.16 NS
Physical summary	54.6 a	45.6 b	47.6 b	0.01**
Mental summary	55.2	53.2	55.3	0.65 NS

[z]SF-36 = The Short Form 36 Health Survey which consists of eight scales and two summary component measures (Ware et al., 1993).
[y]Active gardeners met or exceeded the Centers for Disease Control and Prevention's (CDC) physical activity (PA) recommendation by gardening at moderate intensity for more than 150 min per week.
[x]Gardeners did not meet the CDC's PA recommendation by gardening but did garden for 120 to 150 min per week at both low and moderate intensity.
[w]Nongardeners did no gardening or little gardening at low intensity.
[v]Norm-based scoring transformed to have a mean of 50 and a standard deviation of 10 from the 1998 U.S. general population. A scale score below 50 means below average (Ware, 2000).
a, b = sharing at least one common letter are not significantly different by least significant difference test at $\alpha = 0.05$.
*$P \leq 0.05$.
**$P \leq 0.01$.
NS = No significant difference by least significant difference test at $P = 0.05$.

Table 5. Comparisons of bone mineral density (BMD) of active gardeners, gardeners, and nongardeners.

	BMD	Active gardeners[z] (N = 11) Mean (SD)	Range	Gardeners[y] (N = 14) Mean (SD)	Range	Nongardeners[x] (N = 28) Mean (SD)	Range	P value
Hip	BMD (g·cm⁻²)	0.96 (0.2)	0.6–1.2	0.96 (0.1)	0.8–1.3	0.92 (0.1)	0.6–1.3	0.63 NS
	Young-adult T-score[w]	–0.71 (1.2)	–3.0–0.8	–0.56 (1.1)	–2.3–1.5	–0.84 (1.1)	–3.5–1.3	0.74 NS
	Age-adjusted Z-score[v]	0.41 (1.1)	–2.1–1.7	0.27 (1.0)	–1.2–2.5	0.42 (0.9)	–1.1–2.2	0.89 NS
Spine	BMD (g·cm⁻²)	1.11 (0.2)	0.7–1.4	1.24 (0.3)	0.9–1.9	1.13 (0.2)	0.7–1.7	0.23 NS
	Young-adult T-score	–0.80 (1.7)	–3.8–1.7	0.37 (2.1)	–2.5–5.3	–0.51 (1.6)	–3.6–3.8	0.21 NS
	Age-adjusted Z-score	0.21 (1.4)	–2.5–2.3	1.24 (2.1)	–1.4–5.9	0.78 (1.6)	–2.1–4.7	0.34 NS

[z]Active gardeners met or exceeded the Centers for Disease Control and Prevention's (CDC) physical activity (PA) recommendation by gardening at moderate intensity for more than 150 min per week.
[y]Gardeners did not meet the CDC's PA recommendation by gardening but did garden for 120 to 150 min per week at both low and moderate intensity.
[x]Nongardeners did no gardening or little gardening at low intensity.
[w]T-score is given by comparing the ideal or peak BMD of a healthy 30-year-old adult with the subjects' BMD. A score of 0 indicates the BMD is same to the norm for a healthy young adult. A T-score of –2.5 or lower means the person has osteoporosis.
[v]Z-score is given to compare the BMD value with a typical individual age, which is matched to specific age.
NS = No significant difference by least significant difference test at $P = 0.05$.

Table 6. Comparisons of hand function ability of active gardeners + gardeners and nongardeners.

Hand function	Hand	Active gardeners + gardeners[z] (N = 25)	Nongardeners[y] (N = 28)	P value
Strength	Dominant	30.1 a	25.1 b	0.04*
	Left	28.6 a	22.9 b	0.02*
	Right	30.2 a	24.9 b	0.03*
Pinch force	Dominant	6.2 a	4.7 b	0.00**
	Left	5.9 a	4.3 b	0.00**
	Right	6.2 a	4.6 b	0.01**

[z]Active gardeners and gardeners were combined. Because hand function abilities are not strongly influenced by exercise intensity, intensity of gardening was not used in classifying the subjects as was done previously. Active gardeners + gardeners did gardening more than 120 min at both low and moderate intensity.
[y]Nongardeners did gardening less than 120 min at low intensity.
a, b = sharing at least one common letter are not significantly different by least significant difference test at $\alpha = 0.05$.
*$P < 0.05$.
**$P \leq 0.01$.

Improved hand strength through gardening was also reported by Reynolds (1999). Gardening tasks can improve muscle coordination and train unused muscles in hands because many of the tasks require grasping, releasing, and flexion of the thumb and forefinger (Relf, 1973). Therefore, gardening may be used as a therapy activity for hand function ability.

All subjects had good physical and mental health based on the SF-36 results and when compared with the U.S. general population of their cohort (Ware, 2000) and were very physically active as indicated by the CHAMPS results. This supports the evidence that an active lifestyle provides physical and mental health benefits (Glass et al., 1999; Takano et al., 2002). Although all the subjects were healthy and active, the active gardeners had better physical health and hand strength and the only distinction for this group was they gardened.

This study did not show the distinct benefits of improved BMD through gardening as reported by Turner et al. (2002). The BMD values of all participants in this study were over standard values for their ages. A possible explanation is that all the subjects in

this study had healthy BMD because of their very physically active lifestyle as determined from the CHAMPS results (ACSM, 2004). Also, most of the older subjects showed high education attainment (Table 1) and education is assumed to be a contributor to bone health. A nutrition program, including a bone health curriculum, reduced the risk factors related to osteoporosis (Cheong et al., 2003). Cankurtaran et al. (2005) reported that low educational attainment is a risk factor for osteoporosis.

The results of this study support the need for continued research with a larger sample size. Additionally, research should determine various health benefits of gardening in older adults by treating gardening as an exercise intervention.

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