Effects of a Renal Nordic Walking Program on *Quality of Life* and *Fitness* in renal patients at St. Paul's Hospital, Vancouver, BC, Canada

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Abstract

This study investigated the effects of a 3-month supervised Nordic walking (NW) program on the fitness and quality of life of renal outpatients. Thirty patients (transplant [n=10], pre-dialysis [n=14], hemodialysis [n=3], peritoneal dialysis [n=3], aged 45-84) were randomized to NW (n=15) or non-NW (n=15) groups. The NW group was offered 2 NW sessions per week; the non-NW group continued their own activities. Measurements at baseline and 3-month included weight, handgrip strength (HGS), 30-sec sit-to-stand test, 6-min walk test (6MWT), and Kidney Disease and Quality of Life questionnaire (KDQOL-36). Daily steps were recorded using Fitbit Flex2 tracker. The NW group appeared less healthy compared to the non-NW group at baseline. However, the NW group had greater improvements in KDQOL-36 (Effect of kidney disease; p=0.021), 6MWT distance (41.5m), and HGS (1.1kg) at 3-month indicating that a group-based supervised NW program may provide benefits to renal patients as part of their clinical care.

Introduction

Chronic kidney disease is a long-term progressive illness that affects functional ability and quality of life. Exercise has the ability to improve symptom burden, functional ability and mental health (1-7). Despite Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines for renal patients to undertake physical activity as part of a healthy lifestyle (8-10), many do not. The many barriers to exercise may be patient-related (e.g., physical, psychological, etc.) and/or structural (e.g., environmental, lack of support, etc.) (11).

A study by Clarke et al. (12) supports the development of hospital-affiliated group-based renalspecific exercise programs, that provide opportunities for peer support and supervision, potentially reducing fears and concerns and increasing exercise self-efficacy. Furthermore, a structured hospitalaffiliated program would most likely benefit patients with little exercise experience, few personal commitments, or who require a greater level of support (12). Additionally, group dynamic strategies such as group goal setting, interaction and friendly competition increases self-directed exercise, adherence, and reduces attrition rates (12).

Walking is widely recommended for general health and is usually the best-accepted form of exercise. Nordic walking (NW) is a form of exercise where natural walking is enhanced by the active use of a pair of specially designed NW poles (13), potentially augmenting confidence/balance in the elderly population. A systematic review that included 16 randomized-control trials and 11 observational studies, revealed with regard to short- and long-term effects on heart rate, oxygen consumption, quality of life and other measures, NW was superior to brisk walking without poles and in some endpoints to jogging (14). The reported health benefits of NW in other studies with respect to greater energy expenditure without the corresponding increase rating of perceived exertion (15-17), adherence/compliance to a program (16), upper body strength (18,19), and suitability for older adults (19-21), all indicate that NW would be a promising alternative to regular walking exercise.

With this in mind, a staff-volunteer supervised NW program for renal patients at SPH, the "Walk & Roll" was created in Spring 2016. To the best of our knowledge, no study on the effects of NW exercise on quality of life and fitness in renal patients has been reported, and since we only had informal data through verbal feedback and attendance with respect to benefits of the program to patients, we assessed the effects the "Walk & Roll" on *quality of life* and *fitness* in renal patients. We also considered the feasibility of such a program with respect to commitment from staff-volunteers and patients to twice a week supervised NW sessions, and reflected on recruitment and retention rates, as well as the ability of the renal clinics to support this type of program in terms of staffing, equipment, etc.

Methods

Thirty renal patients (renal transplant (n=10), CKD (n=14), HD (n=3), PD (n=3), 15 males, 15 females, median age 66, range 45-84 years) were recruited from SPH renal clinics into the study and allocated to either the NW intervention (n=15) or non-NW control (n=15) group using permuted-block randomization. Exclusion criteria included inability to wear Fitbit tracker, sync & record daily steps for 12 consecutive weeks, inability to attend 2 scheduled physiotherapist appointments for data collection, inability to attend any NW sessions during the 12-wk study period, high risk for falls, and inability to give informed consent. When recruitment began in March 2018, eligibility was limited to renal transplant patients. Since only 6 participants enrolled in 4 months (March 1 – June 30), the study inclusion criteria were amended in July to include non-dialysis (CKD) and dialysis (HD or PD) patients. Hence, inclusion criteria included > 19 years, renal patient (i.e., CKD, PD, HD, or > 12 weeks post-renal transplant unless has MD approval), able to walk safely and independently, has physician's approval for participation in physical activity, has a smartphone/tablet and is comfortable using Apps or similar. With the expanded inclusion criteria, 24 additional participants were enrolled in 2 months (July – Aug).

All participants underwent measurements at baseline and again after the 12-wk study period. Measurements included height, weight, handgrip strength (HGS), 30-sec sit-to-stand test (30-STS), 6min walk test (6MWT), and the Kidney Disease and Quality of Life questionnaire (KDQOL-36).

All participants were given a Fitbit Flex2 tracker and instructed to keep daily steps diaries for 12 consecutive weeks (from baseline) to assess physical activity levels. Participants in the NW group were offered 2 supervised NW sessions per week at SPH and attendance was recorded. Participants in the non-NW group continued with their own activities, and then invited to join the NW sessions after the 12-wk study period if they wished.

A research methodologist from CHEOS supported the study team in designing, undertaking and interpreting the data analysis. Kruskal–Wallis test for continuous non-normal variables (i.e. medians) was used for the bivariable analysis. Chi-squared or Fisher's exact test when necessary (expected counts < 5) was used for categorical variables (i.e. n). A non-parametric Brown-Mood median test was performed for the analysis of outcomes using the intention-to-treat principle (ITT). Post-hoc correlational analyses were completed as secondary outcomes to examine correlations between outcomes and average daily steps in both NW and non-NW groups, and between outcomes and number of NW sessions attended.

Results

Of the 30 participants recruited, 15/15 in the NW group and 13/15 non-NW controls completed the 12-wk study. Reasons for dropping out were due to medical reasons unrelated to the study. Baseline characteristics by group are shown in Table 1.

	Non-NW	NW	p.overall	Ν
	N = 15	N=15		
Age, y, median, [1Q;3Q]	65.0 [54.0;71.0]	66.0 [59.0;69.0]	0.693	30
Gender, n (%):			0.465	30
F	9~(60.0%)	6~(40.0%)		
M	6~(40.0%)	9~(60.0%)		
Modality, n (%):			1.000	30
CKD	7~(46.7%)	7~(46.7%)		
HD	2(13.3%)	1 (6.67%)		
PD	1 (6.67%)	2(13.3%)		
TX	5(33.3%)	5(33.3%)		
Diabetes, n (%):			1.000	30
Ν	9~(60.0%)	10~(66.7%)		
Y	6~(40.0%)	5(33.3%)		
GFR, mL/min/1.73 ² , median, [1Q;3Q]	28.0 [19.5;54.0]	43.0 [15.0; 58.0]	0.756	30
New Nordic walker, n (%):			1.000	30
Ν	2(13.3%)	1 (6.67%)		
Y	13~(86.7%)	14 (93.3%)		
BMI, kg/m^2 , median, [1Q;3Q]	24.4 [22.6; 30.2]	28.4 [25.2; 31.1]	0.198	30
6-min walk test, meters, median, [1Q;3Q]	$540 \ [460;589]$	485 [440;508]	0.093	30
30-sec sit to stand test, median, $[1Q;3Q]$	$11.0 \ [10.0; 16.0]$	$10.0 \ [9.00; 12.0]$	0.194	30
Overall handgrip strength, median, [1Q;3Q]	30.1 [24.9; 32.4]	31.5 [23.1;41.9]	0.604	30
Females Handgrip strength, median, [1Q;3Q]	26.6 [24.6; 30.1]	25.1 [23.0;27.7]	0.814	15
Males Handgrip strength, median, [1Q;3Q]	33.7 [31.9; 36.0]	33.2 [31.5; 42.0]	0.724	15
Symptom/problem list, median, [1Q;3Q]	$86.4 \ [82.2; 93.2]$	$81.8 \ [60.8; 85.2]$	0.022	30
Effect of kidney disease, median, [1Q;3Q]	87.5 [79.7; 96.7]	$75.0 \ [63.7;82.8]$	0.028	30
Burden of kidney disease, median, [1Q;3Q]	75.0 [59.4; 90.6]	56.2 [28.1;68.8]	0.114	30
SF-12 Physical composite, median, [1Q;3Q]	51.1 [38.6; 53.5]	39.2 [33.3;43.8]	0.036	29
SF-12 Mental composite, median, [1Q;3Q]	54.6 [41.8;57.3]	54.4 [42.2;57.9]	0.861	29
Number of days attended, median, $[1Q;3Q]$. [.;.]	14.5 [12.0;20.5]		14

Table 1. Baseline characteristics, quality of life, and fitness of study sample

With the exception of the lower prevalence of diabetes (n=11; 36.7%) in the study sample, the descriptive characteristics appear similar to the population we see in practice. The characteristics at baseline of the non-NW and NW groups are comparable for some measured variables (i.e., 30-STS, HGS) but the NW group appeared to have higher BMI, lower 6MWT, and considerably lower QoL with the exception of the SF-12 Mental composite domain.

The change values from baseline in each outcome is examined to take into account the fact that the non-NW and NW groups were dissimilar and had different starting points (i.e., baseline levels). The NW group had a median change in BMI of +0.2 from pre to post, compared to a -0.1 change in the non-NW group, hence the NW group had a median +0.30 increase in BMI change in comparison to non-NW group, with a 95% CI [-0.81, 1.34] and p= 0.4763.



Perhaps not surprising due to the specificity of exercise, the NW group improved a lot from pre to post compared to non-NW group. The NW group had a median 41.5 meter increase in 6MWT compared to a median 10 meter increase in non-NW group, which is a median difference in 6MWT change of +31.5 meters with a 95% CI [-3.0, 89.0] and p=0.1357 for NW group. The CI shows that our data is consistent with decreases in median 6MWT change of -3.0 meters, but it also skews positively up to 89.0 meters in favour of NW group compared to non-NW group.



t the data is inclusive at best. The NW group had a up from baseline (p=0.4471; 95% CI [-3, 1]).

in NW group relative to non-NW group, however ']).

ct and burden of kidney disease (Figures 3C-D), as to non-NW group. NW group had an on average domain with 95% CI [2.10, 23.96] and p=0.021





favour of NW group. Note differenced is not enough towreach Notat Montal significance of non-significant outcomes but the differenced of NW remains consistent. This actually provides more evidence that NW group is doing better because after removal of one patient who did not follow protocol/attend sessions, the NW group gets slightly even better in terms of outcomes.





Discussion

The lower prevalence of diabetes in our study sample may represent a selection bias. Since the renal team determines eligibility to participate, they may have perceptions that renal patients with diabetes are at risk for falls or unable to walk safely and independently. Future studies with 1:1 supervision instead of a group setting for renal patients with diabetes at risk for falls may be more appropriate.

We noted randomization did not yield comparable groups, as the NW group appeared to be doing worse than non-NW group with respect to higher BMI, lower 6MWT, and lower QoL scores. This imbalance may have occurred by chance due to the small sample size or a weakness of using a permuted-block randomization schedule. Since randomization assignments were in blocks of 4 for each renal modality (i.e., Tx, CKD, PD, HD), after the first 2 sealed envelopes were opened, it's theoretically possible to guess what the next 2 envelopes contain.

Although there is inconclusive evidence regarding the effect of NW on increases in BMI and 30-STS, a plausible explanation may be an increase in muscle mass. Again, although most of the effect of NW group is consistent with increases in hand grip but not conclusive, a study by Song et al. (18) demonstrated improved handgrip strength in Nordic walkers. While the data is mostly consistent with positive increases in 6MWT for NW group, there is still uncertainty with the current sample size. Nevertheless, this is still an important finding since most of the effect of NW group on 6MWT does appear to lead to improvements. We believe this 41.5 meter improvement is clinically meaningful above and beyond statistical significance. A systematic review (22) concluded that a change of 14.0 – 30.5 meters might be clinically important across multiple patient groups. In renal patients, Roshanravan et al. (11) reports <350 meter 6MWT is associated with a 2.82-fold increased risk for mortality or death in CKD. Torino et al. (23) showed 11% reduction in risk for mortality for every 20 meter improvement, our study showed NW results in ~40 meter improvement. Therefore, based on the literature, this 40 meter improvement is not only statistically significant but it's consistent with other studies which showed clinically meaningful improvement by lowering risk of death. Although we were unable to discern if a ~6 point improvement in KDQOL-36 effect of kidney disease domain is clinically meaningful from the literature, we can report that NW group had QoL improvements (p=0.021). Post study comments in Appendix 1 are consistent with participants' perception of improvements in QoL.

It is good to keep in mind that most of the time when patients are very sick at baseline, they improve at follow-up regardless of intervention (regression to the mean phenomenon), whether this was the case in our study with the NW group is unknown. Worth mentioning is that re-analysis of the data using per protocol (PP instead of ITT) to remove one participant from the NW group who did not attend

NW sessions, every outcome with the exception of the 30-STS, improves in favour of the NW group. Although the difference is not enough to reach statistical significance of non-significant outcomes, the direction of the effect of NW remains consistent. This actually provides further indication that NW group is doing better because after removal of one patient who did not follow protocol/attend sessions, the NW group gets slightly even better in terms of outcomes. Since no correlations in changes in QoL domains and average daily steps were observed, one could hypothesize that there seems to be some element of NW above and beyond just exercise that is leading to improvements in some domains of QoL. While the Fitbit Flex has been shown to have moderate validity for measuring physical activity relative to direct observation and the Actigraph (24), we witnessed a number of participants had problems with their Fitbit which required assistance from the study team. Hence, the validity and reliability of the average daily steps data should be interpreted with caution.

Missingness analysis shows that 93% of the required data is present and thus strengthens confidence in the findings. A reason for the low drop out rates may be due to incentivized behavioral change, as participants received a NW toolkit (Figure 4) and free parking. We also had a patient partner who provided our team with valuable feedback throughout the entire process from conception to T-shirt design.



Figure 4. NW Toolkit

Since randomization did not yield comparable groups at baseline, we are cautious with our interpretation. On average, we noted significant improvements in the effect and burden of kidney disease domains as well as the symptoms/problems domain of the KDQOL-36 for the NW group compared to non-NW group from baseline. Most of the NW group was also consistent with improvements in the physical and mental health domains, but the changes were somewhat imprecise for these domains. NW group was also consistent with increases in 6MWT distance and HGS from

baseline, however we are unable to conclusively say that there were significant increases but there is a definite movement in the direction of improvement with NW. A larger sample size may confirm these findings more confidently. There is inconclusive evidence regarding the effect of NW on BMI and 30-STS. We had a small sample size and may not have had enough data to detect some associations. Although one may argue that since investigators and participants were not blinded to the their treatment, this may have affected results. For example, those not happy with not being able to be part of NW group may try less. On the contrary, we observed some participants, who were randomized to the non-NW group to be somewhat relieved if not happy for various reasons (i.e., still employed and working, volunteering, studying, already active, attends gym regularly, etc.) We also witnessed many of the non-NW group participants had set personal goals to walk 10,000 steps daily without any input from the investigators. It is interesting that despite the NW group appeared to be doing worse than non-NW group at baseline, there was a definite hint towards better outcomes for the NW group. A paper by Kosmadakis et al. (6) emphasized that the most frail are probably those most in need of physical rehabilitation as part of their clinical care. Since frailty is prevalent in renal patients and is associated with an increased risk or mortality (25), our hospital-based supervised NW program may provide benefits to renal patients who require more support.

With respect to the feasibility of the "Walk and Roll" renal NW program, staff members (i.e., dietitians, physiotherapists, nurses, social workers, etc.) have been volunteering their time to supervise the walks because they believe in the program and benefits to patients. However, given increasing workloads that staff members have, there is limited and reduced incentive to run this program unless they are paid for the hour that it takes out of their lunch or day. To make this program more sustainable, we hope to apply for some funding through both the Enhanced Patient Care Grant and the BC Renal program so that the "Walk and Roll" can *hire* staff to lead the Tuesday and Thursday sessions consistently. For feasibility and growth, a funding source and formal operation and coordination structures in place are required.

Recommendations to the Research Challenge organizing committee

Aggie and Wilma were always supportive and accessible. The workshops to learn about literature searches, how to design the study question, methodology, data collection, time management, proposal writing, ethics application, etc. were all very helpful. In particular, the practical workshop in the computer lab to work on our ethics application was invaluable. On occasion, we felt Nesa and Alex contradicted each other with respect to our ethics application. We wish to thank the RC organizing committee for all their support; we really appreciated it and learned lots!

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Appendix 1. Post study comments from participants

1. Why did you decide to enroll in the study?	
 lose weight & improve heart health pain in my feet and not able to do other workouts improve walking improve health because I am weak reinforce my daily walking habit curious and interested in the testing wanted to help when asked to participate to be with people of similar mind improve from transplant surgery ASAP because have 3 kids and financial responsibilities to improve spirit and body because I was asked I've seen people walking with poles before; the Fitbit was a good incentive; I usually count my steps with my phone but the problem was that I don't always walk with my 	 to see if walking with poles reduced pain and increased endurance surprised patients on dialysis are encouraged to exercise; felt encouraged that it's not the end of world self improvement improve kidneys to help me exercise regularly to motivate self to be active; provide results to study group for future kidney studies motivation to exercise to get better & learn new skill for kidney health because of curiosity, wanted to assist in something that could make a difference for future patients, & if I'm being honest the free poles & Fitbit! to improve health, well-being, reduce stress, reduce anxiety & depression
2. What were you hoping to achieve?	
 to walk freely to help out by providing information to the Kidney Care Clinic improve kidney function improve health I want to be independent increase my daily step count learning how fit I am to help others increase exercise I wanted to know what NW is, & find out how many steps I actually walk a day 	 healthier and stronger weight loss and increase strength walk more without pain increase activity better physical fitness improve overall health and physical strength to be healthy & active walk more more active life style & inspiration getting well from the kidney transplant ASAP better health, posture, stronger muscle & endurance
3. What concerns or worries did you have about it, etc.,	
 less workout will not be helpful no worries about the study but worried about my energy & weakness didn't like walking indoors; balance issues and need poles for support; talked too much and concern about confidentiality time and location of the NW sessions pain and participation 	 none because walking is beneficial for me Nordic walking and coping with gait & posture limitations wearing the Fitbit daily and wifi access I would not be able to participate in too many of the NW sessions because of where I worked; turned out it wasn't a problem as I was in the control group

4. What did you like about it?	
• Fitbit	walking with friends
• NW poles	• free parking and supportive environment for individuals
• walk like a young person again	who walk at different paces
• walking and meeting friends: increased enjoyment	• socializing with people and walking with poles took mind
• motivates me	off foot pain
• walking with people and walking counter clockwise	• feedback from the Fitbit
(opposite direction of the group)	 location and purpose of the study; interacting with others
• Fitbit: encouraged walking as much as I can; it gave me	• enjoyed the setting and conditioning myself to do exercise
goals	• exercise encouragement
 walking with a group 	• weekly walks; routine helps
Fitbit helped increase self awareness wrt drinking more	• volunteers and group participants are inspiring; ratio of
and the sleep log was fascinating	staff /volunteers to participants was good and provided
 surprised how much I walk on days off 	compassionate care
• being in the control group	• walked 20,000 steps
• the Fitbit & the data it provided including for walking &	 improves health, fitness, more fun & social enjoyment
swimming	
5. What did you get out of it?	
• apart from the NW poles, enjoyed walking so much, I	• improved fitness; self awareness of step count on different
decided not to renew the car rental	days
• friend to walk with	• consistency with group walks throughout the week,
• lost weight; feel more energetic; eating less	helped with depression
• Fitbit shows my steps and health status	• improved fitness & health
• you helped me a lot	• motivation & stamina; I liked myself more
• consciousness of the need to get a warm up before	• learn to join group activity; I also feel my muscles &
walking	bones are not as tight as before
• feeling good	• healthier, more energetic, stronger, walk longer, less tired
• self awareness	• plan to continue to Nordic walk 5X/wk
• walking more, 30 mins daily	• more accurate step counting
• improved health; improved breathing	• learning how to walk & exercise 30-40 mins continuously
• improved confidence	
6. Did you notice any changes in your nearth, wendering, or quanty	
• arthritis pain in nips and legs resolved	• don t know yet
• warking definitely makes the enjoy the because I go out	• Improved QoL
• sleening less	• more energy more often
• feel improved	 miproved mental meanin model lifted because of the consistency of welling twice a
• ves I noticed I'm getting out more: walking 2.4 km and	week with the group
taking my friend, not doing that before	• assist to do things: increased flexibility: climmer woist
I seem to walk faster	circumference
• more aware of need to move	• improved health
ves, increased confidence	• improved sleep & breathing
• not as stiff	 less pain in thighs: sleeping better & less
 my well-being has been getting better all the time: this 	 encouraged to be active daily
study is a good reminder to continue walking & staving	• outside of the study. I was training for the Transplant
active!	games & I got stronger
 love being involved in studies 	• improves mood, reduces stress, better posture & balance
7. Anything you didn't like or found it to be a problem?	
the program is little bit too short	ongoing cramps in legs
• weather got in the way of attendance	• I just feel bad that not too many participants signed up
nothing particular	driving to SPH (location)
8. Any suggestions for improvement of the Nordic walking progra	m, etc.?
• more than 12 weeks!	• to help with dietary restrictions, participants should
• none	receive a menu for walking every week
everything was excellent	 time permitting, best to walk along English bay to enjoy
• walk longer than 45 mins	the breeze from the seashore
• walking longer, at least 4 laps	 increase frequency of NW sessions to 3X/wk
• maybe like the Transplant games, it needs more word of	• current patients walking around the unit talking to other
mouth, like from the nurses & doctors	patients

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