Exploring pole walking as a health enhancing physical activity for older adults

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BAppSc (Human Movement and Sport Science) (Hons)
BPhty

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ABSTRACT

The proportion of older adults in high income nations is increasing, and ageing is often associated with a decline in health. Although regular physical activity (PA) improves health in older adults, they typically have the lowest levels of PA of any population group. Pole walking (PW) is a form of walking with the addition of hand-held poles, used in opposition to lower limb locomotion, and has characteristics which may be suited to older adults. The aim of this thesis was to explore PW as a form of health enhancing PA for older adults through a series of three studies.

Study One (Chapters 2 and 3) was a systematic review of the effects of PW programs on physical and psycho-social health. A review of papers published to September, 2011 was described in Chapter 2. Fourteen papers describing randomised trials met the inclusion criteria. The results indicated that PW programs have beneficial effects on both physical and psycho-social health in adult populations, and the authors identified a need for future studies involving non-clinical populations of older adults. An update of the review, with 14 more papers published to October, 2014, was presented in Chapter 3. Three studies investigated PW exclusively in older adults. The beneficial effects of PW, compared with a variety of control programs, were confirmed for endurance, functional status, PA and muscle strength. Positive effects of PW, compared with non-exercise programs, were found for anthropometry (weight, body mass index and waist measurements) and oxygen uptake.

The aim of Study Two (Chapter 4), was to describe the characteristics of PW leaders, pole walkers, and PW programs in Australia; and participants’ perceptions of PW and reasons for participation. Self-administered surveys were distributed to PW leaders (n=31), and pole walkers (n=108). Data on sociodemographic and health information, program characteristics, and perceptions of PW were collected. The results showed that PW was being practiced largely by older females, who were born in Australia. The main finding was that a range of personal, social, and environmental characteristics positively affect older adults’ participation in PW, and are important in a health promotion context.

Study Three (Chapters 5 and 6) was a randomised trial which aimed to compare the effects of a PW and a walking program on physical and psycho-social wellbeing in older old adults. The study protocol is presented in Chapter 5, and the results are reported in Chapter 6. Participants were 42 men and women from assisted living communities with a
mean age of 82 (SD, 10) years (range, 60-99 years). They were randomised into a group-based PW or walking program, each consisting of three light intensity sessions of 20 minutes per week, for 12 weeks. Primary outcomes were selected measures of the Senior Fitness Test (chair stand, arm curl, 6 minute walk, and up-and-go) and hand grip strength. Secondary outcomes included measures of health, health behaviours, and wellbeing. The results showed a slight within-group deterioration in the up-and-go scores in the PW group, and a within-group decrease in sitting time in both groups, which was significant in the walking group. There was large inter-individual variation in the change scores for each test, and there were no significant differences between the PW group and the walking group in any of the outcome measures. When data from the two groups were combined, no sociodemographic, attendance or baseline performance scores were associated with improvement in any of the primary outcome measures.

Significance: Each study in this thesis contributes to our understanding of PW in older adult populations. Study One was the first systematic review of the physical and psycho-social health effects of PW with a quality rating of the reviewed papers. There were few investigations of PW in exclusively older adult populations. Study Two was the first rigorous and comprehensive survey of pole walkers and PW leaders in Australia. Study Three was one of the first intervention studies to compare the health effects of PW with walking in a group of older old adults.

Three key findings of this thesis were: 1) PW has beneficial health effects in several groups including older adults with and without clinical conditions; 2) PW is being practiced by older, health conscious adults in Australia; and 3) in a sample of frail elderly people in the United States, functional outcomes of a 12 week exercise program were similar for PW and walking.

Conclusions: PW has beneficial effects on physical and psycho-social health, which are relevant for older people. It is undertaken mostly by older adults in Australia, and has the potential to be used as a form of health enhancing PA in older people. Although PW was a feasible form of PA that was enjoyed by in a sample of frail elderly adults, there were no differences in the functional effects of short, low intensity PW and walking interventions.
DECLARATION BY AUTHOR

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in this work.

I have clearly stated the contribution of others to my thesis as a whole, including, survey design, statistical assistance, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

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PUBLICATIONS DURING CANDIDATURE

Peer-reviewed publications


Fritschi J, van Uffelen JGZ, Brown WJ. Pole walking down-under: Profile of leaders, walkers, and programs in Australia and factors relating to participation. Health Promotion Journal of Australia. Accepted November 2014. This paper forms Chapter 4 of the thesis.


Fritschi J, van Uffelen JGZ, Brown WJ. The effects of pole walking and regular walking on physical and psycho-social health in older adults: a randomised trial. Submitted for publication in Journal of Aging and Physical Activity. This paper forms Chapter 6 of the thesis.
PUBLICATIONS INCLUDED IN THIS THESIS

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CONTRIBUTIONS BY OTHERS TO THIS THESIS

Dr Jannique van Uffelen assisted with the original concept and design of the overall thesis. Professor Wendy Brown and Dr Jannique van Uffelen provided input into the development of the overall thesis objectives, support and guidance throughout collection, analyses and interpretation of data, and edited all written work contained in this thesis. Professor Brown, and Drs Enamul Kabir and Geeske Peeters provided advice concerning statistical analysis. Atria Senior Living, a United States based residential care facility provider, provided access to four residential aged care facilities in Louisville, Kentucky, staff training, walking group leaders, and logistical support for Study 3. The Exerstrider walk leader training program used in Study 3 was developed by Mr Tom Rutlin, who also provided input into the development of the pole walking programs used in Study 3.

STATEMENT OF PARTS OF THE THESIS SUBMITTED TO QUALIFY FOR THE AWARD OF ANOTHER DEGREE

None
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This thesis is the culmination of an unusual journey which I commenced several years ago, never dreaming that a PhD would be the result. It has been a unique experience and I have gained knowledge, skills and confidence, as well as many friends, along the way. As with any major life achievement, several individuals and groups have contributed to this work.

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_Then I will lead the blind along a way they never knew;_
_I will guide them along paths they have not known._
_I will make the darkness become light for them,_
_and the rough ground smooth._
_These are the things I will do;_
_I will not leave my people._

_Isaiah, 42:16_
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AUSTRALIAN AND NEW ZEALAND STANDARD RESEARCH CLASSIFICATIONS (ANZSRC)

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1106 Human Movement and Sports Science, 50%
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LIST OF ABBREVIATIONS USED IN THE THESIS

↑: Increase
↓: Decrease
<: Less than
≤: Less than or equal to
>: Greater than
≥: Greater than or equal to
6MWT: Six Minute Walking Test
AAS: Active Australia Survey
ABI: Ankle Brachial Index
ACR: American College of Rheumatology
AIP: Atherogenic Index of Plasma
ANCOVA: Analysis of Covariance
ASHT: American Society of Hand Therapists
AUD: Australian Dollars
BMI: Body Mass Index
BP: Blood Pressure
BRFSS: Behavioral Risk Factor Surveillance System
CI: Confidence Interval
cm: Centimetres
CONSORT: Consolidated Standards of Reporting Trials
COPD: Chronic Obstructive Pulmonary Disease
cpm: Counts per minute
CT: controlled Trial
CV: Cardiovascular
CYC: Cycling
DBP: Diastolic Blood Pressure
EOPW: Exercise Other Than Pole Walking
EQ-5D: European Quality of Life-5 Dimensions
F: Females
FIQ: Fibromyalgia Impact Questionnaire
FL: Flexibility
ft: Feet
HADS: Hospital Anxiety and Depression Scale
HBA1C: Glycated Haemoglobin
HDL: High Density Lipids
HE: Home Exercise
HOMA: Homeostasis Model Assessment of Insulin Resistance
HMW=high molecular weight adiponectin
HR: Heart Rate
HS-CRP: High Sensitivity C-reactive Protein
IC: Intermittent Claudication
IGT: Impaired Glucose Tolerance
ITT: Intention to Treat
ISEAL: Institute of Sport, Exercise and Active Living
JF: Juliette Fritschi
JvU: Dr Jannique van Uffelen
kg: Kilograms
l: Litres
LA: Lactic Acid
lb: Pounds
LBP: Low Back Pain
LBPRS: Low Back Pain Rating Scale
LDL: Low Density Lipids
LIW: Light Intensity Walking
LL: Lower Limb
LSVT-BIG: Lee Silverman Voice Therapy-BIG
LTPAI: Leisure Time Physical Activity Index
M: Males
m: Meters
Max: Maximum
MCS: Mental Component Score
MET: Metabolic Equivalent of Tasks
MFI-20: Multi-dimensional Fatigue Inventory
mmHg: Millimetres of Mercury
SF-36: 36 Item Short-Form Health Survey
SFT: Senior Fitness Test
SMA: Sports Medicine Australia
SPSS: Statistical Package for the Social Science
ST: Strength Training
SWED-QUAL: Swedish Health-related Quality of Life Questionnaire
T2DM: type 2 Diabetes Mellitus
TNF-α: Tumour Necrosis Finding Alpha
TUG: Timed Up and Go
UK: United Kingdom
UKK: Urho Kaleva Kekkonen Institute
UL: Upper Limb
US: Ultrasound
USA: United States of America
UPDRS: Unified Parkinson’s Disease Rating Scale
VAS: Visual Analogue Scale
VO\textsuperscript{2}: Oxygen Consumption
VT: Ventilatory threshold
W: Walking
WB: Professor Wendy Brown
yGT: Gamma Glutamyltransferase
1. CHAPTER ONE: Introduction

The post second world war baby boom has resulted in older adults being the fastest growing population group in Australia today. The proportion of adults over 65 years has been increasing steadily since the early 1970s, when they made up just 8.5% of the Australian population. By 2011, the proportion of Australia’s population aged 65 years and over increased to 14% and it is projected to further increase to between 18.3% and 19.4% by 2031 (1). The total number of people over 65 years is estimated to increase from approximately 3.2 million in 2012 to more than 5.7 million in 2031, and the number of those over 85 years is expected to double in the same period from 420,300 to 842,500 (2). These changes in population profile will bring challenges to Australian society. Along with other developed nations, Australia is now facing issues concerning the social and economic costs of care for an increasingly older and more frail population (3, 4). Maintaining and improving the health of older adults is a major challenge for our society now and into the future.

1.1 Ageing and health

According to the World Health Organization, health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (5). This involves a complex interaction of political, economic, social, cultural, environmental, behavioural and biological factors, which can all affect health positively or negatively (6). Disease and poor physical function are major factors which contribute to poor health.

Aging refers to a process or group of processes which, with the passage of time, lead to a loss of adaptability, functional impairment, and eventually death (7). Physiological changes which may accompany aging include losses in vision, hearing and strength, and these may be accelerated by disease or environmental factors (7). It is generally accepted that a person is classed as old from the age of 65. Old age can then be subcategorized into the young-old (ages 65-74), mid-old (ages 75-84) and old-old (ages 85+years) (8). As people move into older age categories, a loss in reserve capacity reduces the ability to adapt to cumulative physical and psychological stresses, causing an increased risk of disease and disability (9, 10).

The increasing prevalence of chronic diseases in adults over 65 years is cause for concern. In 2009, almost half of those aged 65-74 had five or more long-term health
conditions, and this increased to 70% in those aged 85 and over (11). The most common long-term health conditions in older adults include arthritis, hypertensive disease, diabetes, stroke, heart disease and vascular disease (11). In addition, in 2012, 1 in 5 older Australians had a severe or profound activity limitation, requiring assistance with daily activities such as self-care, or mobility (11). The challenge remains for health promotion professionals, health care practitioners and policy makers to facilitate the prevention of chronic disease and disease related disabilities in an ageing population.

1.2 Physical activity and health

Worldwide, physical inactivity causes about 3 million or 8% of all deaths per year from non-communicable diseases and it has been identified as one of the five priority interventions for non-communicable diseases (12). The five leading global risks for mortality worldwide in 2009 were high blood pressure, tobacco smoking, high blood glucose, physical inactivity, and overweight and obesity (13). These accounted for 39% of the total burden of disease (13). Not only is physical inactivity the fourth greatest cause of total burden of disease, it is also related to three of the other four largest factors, namely, high blood pressure, overweight and obesity, and high blood glucose. Chronic conditions related to these four risk factors, and which are prevalent in older adults, include ischemic heart disease, stroke, type 2 diabetes, arthritis, osteoporosis, colorectal cancer, dementia and depression (1).

Physical activity (PA) is defined as any bodily movement produced by skeletal muscles which results in energy expenditure (14). As such it includes all forms of activity, including exercise (planned, structured and repetitive, and done to maintain or improve one or more components of physical fitness) (15), other forms of leisure time activity, active transport, and occupational activity (14).

PA recommendations in Australia for adults over 65 suggest that people of this age do 150 minutes of moderate to vigorous PA, in bouts of 10 minutes or more, on most, preferably all, days of the week (16, 17). PA is usually categorised in terms of intensity, measured in metabolic equivalents or METs (multiples of resting metabolic rate). Categories include: light activity (less than 3 METs); moderate activity, (between 3 and 6 METs); and vigorous activity, (over 6 METs). Many health issues which cause poor function and disability in older adults can be improved or prevented by regular, moderate intensity PA. Longitudinal studies in several populations have established a reduction in
all-cause mortality with increasing levels of PA. Regular PA can lead to improvements in physical, mental and psycho-social health across the life span, even in people who may not be able to meet PA recommendations (18, 19).

1.2.1 Physical activity and physical health

Physical health consists of several domains, including physical function, physical fitness, general health, and energy levels (15). In older adults, physical function becomes increasingly important. A major issue facing older adults is a loss of independence due to deteriorations in physical function, which may in turn lead to decreases in functional abilities such as getting out of chairs, climbing stairs, and walking outdoors on rough or sloping ground (21). Physical function improves with gains in strength, balance, and flexibility (22), and is beneficial for maintenance or improvement of functional abilities. PA is a key factor in predicting non-disability before death in older adults (23). For example, in a study examining 7867 adults aged between 51 and 61 years, it was found that regular exercise significantly reduced the risk of health decline and development of new physical difficulties (24).

Along with declines in physical function, sensory and cognitive changes, and decreased limb joint flexibility may contribute to balance and mobility problems, and subsequently lead to increased falls risks in older adults. Approximately 30% of adults over 65 fall at least once per year, and the risk of falling increases with age (25). Along with potential physical injuries following a fall, an increased fear of further falls often leads to reduced activity, which in turn causes decreased physical ability and further risk of falls (26, 27). In addition, a large proportion of older adults, especially women, experience decreased bone density and osteoporosis, and subsequent increased risk of fractures (28). The consequences of falls in this age group are therefore more serious than in younger age groups. In Australia, falls were the most common cause of injury related death in 2004-2005, accounting for 29% of all community deaths by injury, and almost 90% of all deaths in this group occurred in people aged 70 years and over (29). Weight bearing PA, such as walking, prevents or delays bone strength deterioration (30). Therefore, walking-based activities can be important in preventing osteoporosis. This in turn decreases the risk of fractures and consequent disability following falls. In addition, PA such as walking, in combination with specific strength and balance training, may also assist in moderating declines in mobility, confidence and function, thus also contributing to decreased falls risk (31).
1.2.2 Physical activity and mental health

Along with physical health benefits, PA also has a role in improving and maintaining mental health. The mental sphere of health relates to thinking, perception, responding, behaviour, personality, intellect and emotion (32). A mental health condition usually refers to a clear range of signs and symptoms associated with a distinct deterioration in function (32). Depression and anxiety disorders are two of the most prevalent mental health conditions in Australia, affecting all age groups, including the elderly (33). Although cognitive impairments and dementia are not classed as mental illnesses, they are disorders of the brain which affect mental processes, and as such can be classed with other conditions which affect mental health (34). Additionally, adults with long term chronic diseases, many of whom are aged over 65, are two to three times more likely than the general population to experience mental health problems (35).

Regular PA results in prevention of and improvements in symptoms of depression and anxiety. Exercise has positive effects on depression, especially in the short term (36-38). PA and exercise are also associated with decreases in anxiety in adults (39-41). PA interventions have shown improvements in mental health in people with several chronic conditions, including diabetes, chronic obstructive pulmonary disease, and cancer (42-44), which further emphasizes its benefits for older people.

Dementia is an overall term which describes a wide range of symptoms associated with declines in memory or other thinking skills severe enough to reduce a person’s ability to perform everyday activities (45). As the proportion of older adults increases, cognitive impairment, which precedes dementia, is becoming more common, the prevalence of dementia in Australia is expected to more than double from 222,100 people in 2011, to 464,600 people in 2031 (46). Physical activity is associated with improvements in cognitive function in older adults with and without cognitive impairment (46-49), as well as with reduced risk of the development of dementia (51-53).

1.2.3 Physical activity and psycho-social health

Physical, mental and social factors all contribute to psycho-social health and wellbeing of older adults (54). In older adults, positive relationships have been found between PA and psycho-social measures such as quality of life, mental well-being, and physical self-esteem (42, 54-57).
The social aspects of PA are more important in older, than younger adults, and social activity may therefore contribute to improved psycho-social health (58). For example, group PA classes may reduce old-age social isolation, offering participants better perceived physical and mental function, and feelings of accomplishment and success (59, 60). These are especially important for those who live alone, as many in this age group do.

Environmental aspects of PA also have an effect on wellbeing. PA conducted outdoors is associated with improvements in psycho-social health of participants (61). This “green” exercise is associated with improved mood and self-esteem (61, 62).

1.3 Physical activity levels in older adults

Despite the benefits of regular PA, older adults are one of the least active population groups. Only 38% of adults between 65 and 74 years currently meet Australian PA guidelines, and in adults over 75 years, only one in four is currently meeting guidelines, compared with 43% of younger adults (63, 64). This is similar in other developed nations, including the United Kingdom and the US (65, 66).

The reasons for this lack of regular PA in the older population are complex, and can be described using a social ecological model (SEM) (67, 68). This model provides a framework for understanding the several interconnecting levels of influence, including individual, social, environmental and policy factors, which affect PA behaviour in individuals (67, 69). One of the advantages of the SEM is that it can be used to focus on different levels and influences as the outcomes of interest (67). Although all levels of the SEM are apparent in the projects which make up this thesis, only the first three, namely, individual, social, and physical environmental levels will be focussed on.
Factors which especially affect PA negatively in the elderly in the individual, or first level of the SEM, include low self-efficacy (70-72), lack of interest and enjoyment (73, 74), and poor health (75-77). At the social level, a lack of supportive social environments, and peers to exercise with, contribute to a lack of PA (77, 78). More recently, associations between the physical environment and PA have been investigated, and physical environmental factors associated with low PA in older adults include lack of interesting scenery (79, 80), poor weather (81), poor access to facilities (73), and lack of safe places to exercise (79, 80). Finding suitable, sustainable, and effective forms of PA which address these issues in the older population would help increase participation and improve health outcomes.

1.4 Walking and older adults

The types of physical activities which are most popular among older adults are of low to moderate intensity, and include walking, bowls, gardening, golf, and low impact aerobic activities (82, 83). Walking is one of the most prevalent forms of PA in older adults. In separate Australian and US surveys, nearly 50% of adults over 65 years reported that they walked for leisure (83, 84). One of the advantages of walking in the older population is that it is a functional PA, which is useful in activities of daily life, as well as for health and fitness benefits (85). Walking is also low cost, low impact, relatively risk-free, social, and sustainable (86).
1.5 Pole walking

Pole walking (PW) is an outdoor, non-competitive form of exercise which originated in Finland, and separately in the United States. It is a form of walking with the addition of hand-held poles, used in opposition to lower limb locomotion, and has similar low impact, moderate intensity characteristics to walking (87). Since the development of walking poles specific to the activity, forms of PW, such as Nordic walking and Exerstriding, have increased in popularity in Europe and are becoming more widespread in both the US and Australia (88). According to the International Nordic Walking Association, in 2010, Nordic walking was practiced in over 40 countries, with about 10 million walkers, predominantly in Europe, the US, Australia and New Zealand (88). PW has several unique characteristics which may make it an appropriate activity for older adults.

Table 1-1 Description of the main pole walking techniques

<table>
<thead>
<tr>
<th>Technique</th>
<th>Description</th>
<th>Countries practiced in</th>
<th>Pole type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nordic walking</td>
<td>Hand straps, long stride, extension of arms behind the body pushing backwards</td>
<td>UK, Europe, USA, Australia, New Zealand</td>
<td>Hand strap attaches hand to pole, non-moulded hand grip</td>
</tr>
<tr>
<td>Exerstriding</td>
<td>Normal gait, arms held in front of body pushes downwards against the handles</td>
<td>USA</td>
<td>No hand strap, moulded hand grip</td>
</tr>
<tr>
<td>Pacer poles</td>
<td>Normal gait, arm lever at side, pushes downwards and backwards against the handles</td>
<td>UK</td>
<td>No hand strap, angled and moulded handgrip</td>
</tr>
<tr>
<td>Urban poling</td>
<td>No hand straps, normal gait, arm lever at side or in front of the body, pushes downwards against the handles</td>
<td>Canada</td>
<td>As for Exerstriding poles</td>
</tr>
</tbody>
</table>
Cardiovascular effects of PW include an increased heart rate, oxygen capacity, and caloric consumption, while perceived exertion does not increase significantly compared with brisk walking (89, 90). Therefore, older adults with issues such as low self-efficacy, obesity, or poor fitness levels may find PW an easier alternative to other, more conventional forms of exercise.

Lower limb muscles and joints are also affected during PW. Compared with walking, PW results in increased upper limb and decreased lower limb muscle use (91). Some studies showed decreased medial knee joint loading in PW compared with walking (92, 93), although other studies found no differences (93). In addition, plantar pressure during PW is lower than walking (94). These effects may be of benefit to elderly people who have lower limb conditions which impair walking, such as painful arthritis, or joint replacements.

Another claim by proponents of PW is that the poles provide increased balance and stability during the activity. Although specific research concerning stability during PW has not been undertaken, biomechanical studies show that increasing the base of support using canes or crutches during walking results in increased stability (95). Therefore, the addition of poles may provide a similar effect.

In addition to the effects of regular PW on physical health, PW studies in people with chronic conditions that are prevalent in older adult populations, including Parkinson’s disease, low back pain, obesity, and peripheral vascular disease, have shown positive effects on their fitness, physical and psycho-social health (96-102). These findings will be discussed in more detail in Chapters 2 and 3 of this thesis.

1.6 Issues addressed in this thesis

Three major issues are addressed in this thesis. Firstly, the characteristics of PW, such as its low impact and the additional support of poles, suggest this may be a feasible option for increasing participation in PA in older adults. The number of published papers on PW programs is increasing, and there is a need for critical reviews of the physical and psycho-social health effects of PW programs, to confirm the suitability of PW for older adults.

Secondly, although there are several community led PW programs in Australia, there is little information about people who are currently leading PW groups and practicing PW, and their reasons for participation. Investigations into the characteristics of PW leaders,
pole walkers, and PW programs in Australia, would improve understanding of both the physical and psycho-social factors associated with participation in PW, and its applications in PA promotion.

Finally, although it is hypothesized that PW could be a suitable PA option for older adults, with additional benefits to walking, the physical and psycho-social effects of PW in comparison with walking in older adults are unclear. Therefore, investigations into the effects of PW compared with walking in this population group are indicated.

1.7 Thesis aim

The overarching aim of this thesis is to explore PW as a health enhancing physical activity for older adults.

1.8 Research questions

The research questions which will be addressed in this thesis are:

1. What are the effects of PW programs on physical and psycho-social health in adults?
2. What are characteristics of PW leaders, pole walkers, and PW programs in Australia, and participants' perceptions of PW, and reasons for participation?
3. Is there a difference in the physical and psycho-social effects of PW compared with regular walking (RW) in older adults?

These questions will be addressed using several research methodologies and the results will be described in the following chapters.
1.9 Thesis objectives

This thesis aims to achieve three objectives:

1. To critically examine the findings and the quality of studies that have examined the effects of PW programs on physical and psycho-social health in adults.

2. To describe the characteristics of PW leaders, pole walkers, and PW programs in Australia, and participants’ perceptions of PW and reasons for participation.

3. To compare the effects of a PW program with the effects of a RW program on physical function and psycho-social wellbeing in older old adults.

Table 1-2  Overview of thesis research questions

<table>
<thead>
<tr>
<th>Research question</th>
<th>Chapter</th>
<th>Methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research question #1</td>
<td>2, 3</td>
<td>Systematic literature review</td>
</tr>
<tr>
<td>Objective #1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research question #2</td>
<td>4</td>
<td>Survey</td>
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<tr>
<td>Objective #2</td>
<td></td>
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<tr>
<td>Research question #3</td>
<td>5, 6</td>
<td>Randomised trial</td>
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<tr>
<td>Objective #3</td>
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</table>

Research question #1: What are the effects of PW programs on physical and psycho-social health in adults?

Objective #1: To critically examine both the findings and the quality of studies that have examined the health effects of PW programs on physical and psycho-social health in adults.

Research question #2: What are characteristics of PW leaders, pole walkers, and PW programs in Australia, and participants’ perceptions of PW, and reasons for participation?

Objective #2: To describe the characteristics of pole walkers, leaders and programs in Australia, and participants’ perceptions of PW and reasons for participation.

Research question #3: Is there a difference in the physical and psycho-social effects of PW compared with RW in older adults?

Objective #3: To compare the effects of a PW program with the effects of a RW program on physical function and psycho-social wellbeing in older old adults.
1.10 References

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2. CHAPTER TWO: Systematic Review

This study has been published in the *Scandinavian Journal of Medicine and Science in Sports* (Impact Factor 3.174).

See Appendix three for the published version.
2.1 Abstract

The aim of this systematic review was to summarise the effects of pole walking (PW) programs on physical and psycho-social health. Randomised controlled and controlled trials were identified from literature searches in PubMed, Cochrane library, EMBASE, SPORTdiscuss, CINAHL and PEDRO. A total of 14 papers from 13 studies met the inclusion criteria. Eleven of the included studies had a quality score of 50% or higher. Most studies included mid to older aged men and women in clinical populations with various medical conditions. Only two studies included non-clinical populations. The majority of the PW programs consisted of supervised group sessions performed two to three times weekly for 8 weeks or longer. Most studies investigated the effects of PW on both physical and psycho-social health and the majority examined effects on four to five outcomes. The effects of PW on cardiorespiratory fitness were most extensively studied. The most frequently examined psycho-social measure was quality of life. All studies reported at least one beneficial effect of PW compared with the control group. The results of this systematic review indicate that PW programs have some beneficial effects on both physical and psycho-social health in adults with and without clinical conditions.

Key words: pole walking; randomised controlled trial; physical health; psycho-social health; quality of life
2.2 Introduction

Regular physical activity (PA) is associated with improved mental and physical health in adults regardless of age or health status (1). However, participation in PA and exercise in developed nations is low (2-4). Encouraging adults who are currently not achieving healthy levels of PA to increase their exercise through moderate intensity activities such as walking can be beneficial in terms of both individual and public health outcomes (5).

Walking is the most commonly reported form of physical activity in Western nations (6). Walking is self-regulated and, because of its low ground impact, has low risk of injury. It is often the preferred option for people who want to increase their physical activity, including aging adults and those affected by chronic conditions (7).

Pole walking (PW) is an outdoor, non-competitive form of exercise which originated in Finland, where it was developed as a summer conditioning exercise for cross country skiers. It is a form of walking with the addition of hand-held poles, used in opposition to lower limb locomotion, and has similar low impact, moderate intensity characteristics to walking (8). Since the development of walking poles in the 1980’s and 1990’s, PW has increased in popularity in Europe and is becoming more widespread in other Western nations (9). There are two main forms of PW: Nordic walking, which is common in Europe; and Exerstriding, which was developed and is almost exclusive to the United States. Key features of the Nordic walking technique are increased stride length, increased hip range of motion, and a grip/release hand grasp technique. Key features of the Exerstriding technique are a more normal gait, a higher arm position, and a continuous hand grip (9, 10).

Additional benefits of PW compared with regular brisk walking include higher oxygen uptake, increased heart rate and caloric expenditure without significantly increased perceived exertion (11), increased upper limb muscle activation (12), and possible reduction in vertical knee joint forces(13, 14).

PA levels in people who are overweight, elderly, or have chronic conditions such as heart disease are lower than in younger and healthier populations of adults (15), and the reporting of potential benefits of PW for these populations has led to an increase in the
number of PW programs offered by community and government organisations in various countries (16-18).

The health benefits of this type of exercise are however unclear because previous reviews did not include any assessment of the quality of the included studies (19, 20). The aim of this systematic review was therefore to critically examine both the findings and the quality of studies that have examined the effects of PW programs on physical and psycho-social health in adults.

2.3 Methods

2.3.1 Literature search

The bibliographic databases PubMed, Cochrane library, EMBASE, SPORTDiscus, CINAHL and PEDro were searched between February and October 2011. Trials of PW interventions were identified by searches for the following free terms in titles and abstracts: pole walking, polewalking, Nordic walking, walking with poles, walking poles, Exerstriding, pole striding, Nordic poles, power poles, and stick walking. An additional manual search of the reference lists of included papers was done to identify any further potentially relevant papers.

2.3.2 Inclusion criteria and selection process

Studies were included in the review if they met the following criteria: 1. Design: randomised controlled trial (RCT), or controlled trial (CT); 2. Population: adults over 18 years; 3. Intervention: program including a main component where participants walked with poles; 4. Control group: exercise program other than PW, non-exercise intervention, or non-intervention control group; 5. Outcome: subjective or objective measures of physical or psycho-social health. Only peer reviewed, full text papers were included. In addition, only papers written in English or other languages spoken by the research team (i.e. German, Dutch, French, Spanish, Finnish) were reviewed. Titles and abstracts of papers identified through the search were scanned by JF to exclude non-relevant papers. Following this, JF and JvU independently reviewed the full text of the remainder to ensure that inclusion criteria were met.
2.3.3 Data extraction

The following data were extracted: 1. Study design; population groups and numbers; age and gender; eligibility criteria; and recruitment setting and methods; 2. Details of PW interventions and control strategies; attendance, dropout, and numbers of participants for whom follow-up data were analysed; outcome measures; and the effect of PW on these outcomes. The outcome measures were categorized into physical, psycho-social or other outcomes with subcategories for the physical measures based on the outcomes assessed in the included studies.

Data on both between and within group differences were extracted and reported (Table 2-3), but only studies that reported between group differences were included in the description of the effects of PW on the examined health outcomes (Table 2-4). Thus, because one study only reported within group differences (21), 12 studies were included in the description of the effects and in Table 2-4.

2.3.4 Quality assessment

The methodological quality of the studies was assessed independently by JF and JvU using a list based on the Delphi list, developed by Verhagen et al. (1998). Two criteria i.e. blinding of trainers and blinding of participants, were not rated in this review because of the difficulty in blinding either of these in trials of specific exercise modalities such as PW (22). The quality rating list used in this review included the following seven items: randomisation; concealed treatment allocation; group similarity at baseline; specified eligibility criteria; blinded outcome assessor; point estimates and measures of variability for between group differences; intention to treat analysis.

The criteria were scored using a “yes” (1 point), “no” (0 points), or “unclear” (0 points) answer format. Authors were contacted for clarification if an item was scored as ‘unclear’. All criteria were equally weighted, and for this review a quality score was generated as a percentage of the maximum score for each included study analysed. High quality in this review was defined as having a quality score of over 50%.
Figure 2-1 Search process

Records identified through database searching=531

Duplicates removed=368

Records screened=368

Records excluded=345

Full-text papers assessed for eligibility=23

Papers identified as eligible=14

Additional records identified through reference lists of selected papers and screened, none eligible=7

14 papers included in qualitative synthesis describing 13 interventions

RCT=randomised controlled trial, CT=controlled trial
2.4 Results

Details of the search process are shown in Figure 2-1. Abstracts of 368 unique papers were initially reviewed. The full text of 23 papers was independently checked and nine were excluded. Thus 14 papers met the inclusion criteria (21, 23-35). One intervention was described in two papers, but with different outcome measures (33, 35). Both papers were therefore included and are considered as one intervention study in the results section.

2.4.1 Quality assessment

The results of the methodological quality assessment are presented in Table 2-1. Quality scores ranged from 29% to 86%. Eleven papers scored over 50% on the quality rating score. Authors were contacted for further information on blinding of the outcome assessor (six studies) and concealed treatment allocation (three studies).

Eight of the 11 randomised trials used concealed randomisation. Of all 13 included studies, intervention groups were similar at baseline in 11, eligibility criteria were specified in 12, outcome assessors were blinded in nine, intention to treat analysis occurred in five, and point estimates and measures of variability were reported in four.

2.4.2 Study population

Characteristics of the study participants are shown in Table 2-2. Participants in the studies were predominantly mid to older aged men and women from clinical populations (i.e. a diagnosed medical condition). Populations studied included type 2 diabetes, cardiovascular disease (28), peripheral artery disease (33, 35), musculo-skeletal conditions (27, 30), chronic obstructive pulmonary disease (24), Parkinson’s disease (25, 31), Sjogren’s syndrome (32) and breast cancer (21). There were only two studies in non-clinical populations. These were both populations of middle-aged women (23, 29). Although the study by Fritz et al. (2011) targeted adults with diabetes mellitus, they included normal glucose tolerant adults in one of their three intervention groups.

Sample sizes ranged from 12 to 212 participants, and most studies included around 60 participants. The average age of participants in each study ranged from 45 to 69 years. Five studies included only female participants (21, 23, 29, 30, 32), and one included only male participants (28).
Details of the PW and control programs are reported in Table 2-3. The duration of most of the PW programs was 8 weeks or longer (mean 14.2 weeks, range 3 to 24 weeks). The exception was the PW program in the study by Kocur et al. (2009), which had duration of three weeks. Session frequency of the programs varied from one to five exercise sessions per week, and duration of the PW sessions from 20 minutes to 70 minutes. Most of the programs required participants to exercise at moderate intensity, which was operationalised using both subjective and objective measures, including ratings of perceived exertion, heart rate and accelerometer data. In five programs, intensity was varied during the sessions (23, 30, 31, 33, 35). This was achieved in four programs by incorporating “speed plays” in order to increase the intensity during parts of the sessions (30, 33, 35, 36). Breyer et al. (2010) required participants to exercise at a high intensity of 75% of maximum heart rate throughout the session, and the program of Strombeck et al. (2007) increased from moderate to high intensity. Intensity was not reported in three PW programs (25, 26, 35), and Hartvigsen et al. (27) reported that their participants exercised at variable but unspecified intensities.

In most programs, the instructors were physiotherapists, exercise or Nordic walking instructors or medical staff trained in PW. The type of instructor was not specified in two studies (33, 35, 36). Two PW programs used a combination of supervised and unsupervised sessions (23, 32). Hartvigsen et al. (2010) compared a supervised with an unsupervised PW group, while the study by Fritz et al. (2011) included only unsupervised PW participants. In the study by Langbein et al. (2002), the program changed from unsupervised to supervised during the course of the intervention, because of poor adherence in the unsupervised program.

The used technique for PW was reported in six studies (21, 23, 24, 28, 31, 33, 35). Four studies used the Nordic walking technique advocated by the International Nordic Walking Association (23, 24, 28, 31) and two studies used the Exerstriding technique (21, 33, 35). Three studies did not provide a description of the terrain (24, 26, 32). Of the remainder, all programmes were performed outdoors except two which reported indoor sessions during inclement weather (21, 33, 35). Of the outdoor programmes, five described the terrain as parkland or forest paths (25, 27, 30, 31, 34). One study reported an asphalt walking surface (28) and the rest did not report type of surface.
Eight studies included control groups which consisted of an exercise program other than PW (21, 23, 25, 28-31, 34). Six of these compared PW with walking (21, 23, 28-31). Ebersbach et al. (25) compared PW with LSVT-BIG (Lee Silverman Voice Therapy, which is a therapy that focuses on high intensity exercise with high-amplitude movements) as well as home exercises, and Gram et al. (34) compared PW with a program of exercise on prescription, (a combination of strength training and aerobic exercise) and a non-exercise control. The control programs were of similar or lower intensity than the PW programs (Table 2-3).

Six studies included a non-exercise control group (24, 26, 27, 32-35). Nine studies compared PW with only one control group (21, 23, 24, 26, 27, 29, 30, 32, 33, 35). Four studies compared PW with two control groups (25, 28, 31, 34). Hartvigsen et al. (2010) compared supervised and non-supervised PW and included a third home exercise control group.

### 2.4.3 Cardiorespiratory measures

The effects of the interventions are summarised in Table 2-4. The most frequently examined physical outcomes were cardiorespiratory measures. Of these, six studies assessed endurance (24, 28, 30, 31, 33, 35, 36), five assessed oxygen uptake (23, 29, 32-35), and five assessed heart rate and blood pressure (23, 29-31, 34). Fewer assessed ratings of perceived exertion (24, 28, 29, 32) and ankle brachial index (33, 35).

Significant effects of PW compared with control groups were found for 16 out of 27 of the cardiorespiratory measures. Of these, the most frequent significant improvements of PW programs relative to controls were in endurance. Two studies that measured endurance found improvements relative to a non-exercise control (24, 33, 35), and two found improvements relative to a light intensity exercise (30, 31). Of the three studies measuring endurance which compared PW to a similar intensity exercise, two found an improvement in PW relative to a control group. One of these compared PW with a walking control (36). The other compared PW with cycle ergometer training (28).

Significant effects of PW on oxygen uptake (compared with a control group) were found in three studies (23, 32, 33, 35), of which one compared PW with similar intensity walking (36). Two studies that measured ratings of perceived exertion reported a significant effect in PW participants compared with a similar intensity control group and a non-exercise control group. Finally, in two studies, heart rate and blood pressure measures were
significantly improved compared with similar intensity walking (31) and light intensity walking (30). There was no effect of PW on ankle brachial index (33, 35).

2.4.4 Functional status
The effect of PW on functional status was examined in 5 studies, and measures included the timed up and go test (25, 28), the Unified Parkinson’s Disease Rating Scale (UPDRS) (25, 31), dynamic and static balance (29, 31), timed walk (25), Patient Specific Functional Scale (27), and the sit to stand test (28). Of the five studies which assessed functional status, two found a positive effect of PW relative to a control group (28, 31). In the study by Ebersbach et al. (2010), motor performance and timed up and go test improved in both LSVT-BIG and PW groups relative to baseline. However, there was a negative effect of PW on both measures compared with LSVT-BIG. The other two studies that measured functional status reported no significant effects of PW relative to the control group (27, 29).

2.4.5 Pain
The effect of PW on pain was also examined in five studies (27, 29-31, 35), of which three found significant improvements. Kukkonen-Harjula et al. (2007) examined the effect of PW on pain in five body areas in sedentary women, and found a significant decrease in sciatic back pain in the PW group compared with a walking control. Reuter et al. (2011) found a significant decrease in back, hand and leg pain in the PW group compared with a flexibility and relaxation control group in six body areas in adults with Parkinson’s disease. Langbein et al. (2002) found a significant decrease in claudication pain in the PW group compared with a non-exercise control group in adults with peripheral artery disease. No significant effects of PW were found on local pain score in a study of fibromyalgia patients, or on back pain in adults with low back pain (27, 30).

2.4.6 Other physical measures
Other physical outcomes assessed in less than five studies, included PA levels (24, 26, 28, 31), anthropometric measures (23, 26, 29, 34), muscle strength and flexibility (28, 29), fatigue (32), gait parameters (31), and blood glucose levels (34).

In the four studies that examined PA, there was an increase in PA in all PW groups relative to controls, except in Reuter et al. (2011), where there was no effect of PW on PA compared to a walking group. Of the four studies that included anthropometry, Fritz et
al. (2011) found a positive effect of PW on body mass index in adults with normal glucose tolerance compared with non-exercise controls, and Gram et al. (2010) found a positive effect of PW on fat tissue mass relative to a non-exercise control group. Kukkonen-Harjula et al. (2007) found no significant changes in waist circumference or weight relative to the control group. Figard-Fabre (23) found no significant differences between PW and walking groups in body mass, BMI, skinfold thickness or body fat percentage.

Of the two studies that examined the effect of PW on muscle strength, Kocur et al. (2009) found an improvement in arm curl strength in the PW group compared with both a control group and a walking group, and in the timed sit to stand test compared with the control group only. However, Kukkonen-Harjula et al. (2007) reported a decrease in one leg squat strength in participants with low fitness in the PW group compared with a walking control group. There was no effect of PW on flexibility in these two studies. In the only study that examined the effect of PW on fatigue, Strombeck et al. (2007) found a positive effect of PW on fatigue in Sjogren’s syndrome patients.

Reuter et al. (2011) examined the effects of PW on several gait parameters in adults with Parkinson’s disease, and found that stride time, stride length, and stride length variability all showed a significant improvement in the PW group compared with both the walking and flexibility and relaxation control group, and percentage of double stance improved in PW group compared with the flexibility and relaxation group only. Gram et al. (2010) found non-significant effects of PW compared with the control groups in blood glucose measures. Hartvigsen et al. (27) found no effects of PW compared with control groups on pharmacological treatment, time off work, other treatment and expectation to treatment.

2.4.7 Psycho-social measures

Four of the nine studies that examined the effects of PW on psycho-social measures assessed quality of life with the SF36 (24, 32-34). Other psycho-social measures included general and specific quality of life outcomes, fatigue as measured in a quality of life questionnaire, anxiety and depression (24-27, 30-32, 34, 35).

Six studies found significant psycho-social effects of PW relative to a control group. Breyer et al. (2010) found positive effects of PW on mood (Hospital Anxiety and Depression Scale-HADS) and generic quality of life (SF36) in patients with chronic obstructive pulmonary disease compared with a non-exercise control group. Fritz et al. (2011) found improvements in satisfaction with both physical functioning and physical
health in pole walkers compared with non-pole walkers with normal glucose tolerance and in quality of sleep, general health, and pain in pole walkers compared with non-pole walkers with diabetes. Langbein et al. (2002) found improvements in perceived ability to walk distance and walking speed in the PW group relative to the non-exercise control. Mannerkorpi et al. (2011) found that, in fibromyalgia patients, motivation and activity limitations significantly improved in the PW group compared with a light intensity walking group. In the study by Reuter et al. (2011), people with Parkinson’s disease had significantly improved concentration, memorization and recall of information in the PW group compared with those in a relaxation and flexibility group. Strombeck et al. (2007) found significantly reduced depressive symptoms in participants with Sjogren’s syndrome in the PW group compared with a low intensity exercise group.

2.4.8 Dropout and attendance

Dropout rate from the PW programs varied between 0% and 13% in twelve of the thirteen studies, and was 25% in the study by Sprod et al. (2005). Drop outs rates were similar in both the PW and control groups in all studies which recorded them. The most commonly reported reasons for drop-out reported in the studies were physical or psychological illness, or injury unrelated to the interventions and lack of time for participants (24, 25, 27, 29, 30, 33). Attendance at the PW sessions was reported in eight studies (23, 26, 29-35) and varied from 50% to 96%; only three studies reported session attendance of less 75% (26, 30, 34). Eight studies reported on reasons for non-attendance (24, 27-31, 33-35) and these same studies all reported adverse effects. In four studies, there were no adverse effects caused by the PW intervention (27, 28, 34, 35). Mannerkorpi et al. (2010) reported a case of acute trochanteritis, while Kukkonen-Harjula et al. (2007) reported three injuries; one ankle sprain, one overuse injury of the shoulder; and one heel injury. This was an injury rate of 1.4/1000 PW training hours, which was not statistically different from the injury rate in the non-exercise control group. In their study of Parkinson’s disease patients, Reuter et al. (2011) reported four falls, five cases of twisted ankles (of which four were minor), two cases of exercise induced hypotension, and two cases of shoulder pain. In two studies it was unclear as to whether one acute exacerbation of osteoarthritis and two cases of exacerbations of chronic obstructive pulmonary disease were caused by the PW training sessions (24, 33).
2.5 Discussion

The aim of this review was to describe and critically evaluate the effects of PW programs on physical and psycho-social health in adults. Fourteen papers from 13 randomised and controlled trials were identified in an extensive literature search. All 14 papers were published since 2002, with ten since 2010, suggesting that the area of PW research is in its infancy. The variety of study populations, control groups and outcome measures made comparisons between studies difficult. Nonetheless, all studies found at least one positive effect. PW particularly improved cardiorespiratory outcomes, functional status, physical activity, and quality of life. Effects on pain, anthropometry, muscle strength and flexibility, fatigue, gait parameters, and blood glucose levels were less clear.

The findings of this review are in line with the two previous reviews (19, 20) which showed improvements in cardiorespiratory outcomes, anthropometric data, pain levels and quality of life. The current review extends this evidence, by showing that adults with Parkinson's disease, obesity, low back pain, diabetic indicators and fibromyalgia can also benefit from PW. Of the studies that examined the effects of PW on cardiorespiratory outcomes, all those that included endurance measures found beneficial effects of PW compared with control groups. In several studies, improvements in endurance were found in groups who are limited in their ability to walk functional distances, such as adults with Parkinson's disease (25, 31), chronic obstructive pulmonary disease (COPD) (24), claudication pain (33, 35), and cardiovascular disease (28). However, the uniqueness of each population and their clinical characteristics makes generalisations about the benefits of PW for populations other than the ones described above difficult, and there is a need for caution when making claims about the fitness benefits of PW for people with other health conditions.

In systematic reviews of trials with clinical implications, quality rating is important, as it draws attention to potential bias and limitations. This can improve interpretation or study findings, and facilitate decision making about treatment effectiveness (37). Eleven of 13 studies scored 50% or above on the modified Delphi quality score, indicating the high quality of most of the studies. (23-31, 33, 34). The items on which studies did not score well included those which concerned blinding of outcome assessors, recording of point estimates and measures of variability, and intention to treat analysis. Blinding of participants, data collectors, outcome assessors, and data analysts, wherever possible, is
an important safeguard against potential bias, but these were not reported in five studies. Assessors who know if the participant is in the intervention or in the control group may, unconsciously, differentially assess outcomes, especially if they are subjective (38).

Blinding of participants was not considered realistic for most of the studies in this review.

Intention to treat analysis is defined as including all data from randomised participants in the analysis, retained in the group to which they were allocated regardless of whether they completed the intervention (39). Eight studies in this review did not include data from all randomised participants in the analysis (21, 24, 25, 27, 29, 32-35). Although it is often difficult to achieve high follow-up rates in studies that target clinical or frail populations, due to issues such as illness, injury or even death of participants, it is critical to make an effort to perform intention to treat analysis. Not using intention to treat protocols in the analysis can lead to a loss of power, due to reduced sample size, and, more importantly, the effects of an intervention could be overestimated if people not completing the study are excluded from the analysis. It is therefore recommended that either all subjects participate in all assessments, even if they may have dropped out from the intervention, or if possible, a last measure carried forward protocol or other form of imputation is used (40).

Finally, nine studies did not report point estimates, or measures of variability of between group differences. (21, 23, 26-28, 30-33, 35). This information is critical for comparing the effects of PW with control interventions, and provides information about the direction and the variability of the effects. Point estimates and measures of variability should therefore be included in future papers.

A description of PW technique was included in six of the reviewed studies (21, 23, 24, 28, 31, 33, 35). Although potential PW training effectiveness and benefits may differ depending on techniques and poles used, no studies have yet compared walking with different techniques and poles. It is difficult to draw conclusions about the qualitative or quantitative differences between Nordic walking and Exerstriding due to the small number of studies describing details of the used technique. Limited evidence in this review suggests that certain techniques may suit different populations. For example, Reuter et al., in their study of patients with Parkinson’s disease, found that the grip/release technique of Nordic walking was difficult for many of the patients (31). A recent study showed that in obese middle-aged women not familiar with the technique of PW, a learning period of PW technique was needed to enhance the difference in cardiovascular
demand between PW and walking (36). The provision of a clear description of the technique, training periods and poles used may therefore enable a better choice of technique and pole to suit specific clinical populations.

This review highlights a number of issues for further research. As the differences between the effects of PW and walking have not been extensively studied, and because walking is frequently the exercise of choice for those seeking to promote PA in clinical and inactive healthy populations, there is a need for more comparative studies of PW and walking. Only five of the reviewed intervention studies compared PW with walking at a comparable intensity (21, 23, 28, 29, 31); they found few additional benefits of PW over walking. The outcomes in these studies, however, were often general endurance measures, and not those which investigate specific differences between PW and walking. Walking with the addition of hand-held poles may be easier for some groups such as the elderly or those with balance problems. In order to examine the potential additional benefits of PW over walking, we suggest future studies also include population specific measures of outcomes such as measures of balance in older adults, upper limb muscle use and neck pain.

The lower limb effects of PW in clinical groups have not been investigated thoroughly. One characteristic of PW with clinical implications is that using poles could result in decreases in knee joint compressive forces (14, 41, 42). Populations such as those with knee joint osteoarthritis or total knee joint replacements, in which pain may be a limiting factor for exercise, may benefit from walking with poles. Of the three studies included in this review that investigated the effects of PW on lower limb pain (29, 31, 35), only one looked specifically at knee joint pain, and none studied the effects of PW in adults with knee conditions such as osteoarthritis. Hence, there is scope for further studies to test the effectiveness of PW as exercise for people with knee joint pathology.

Although evidence of the benefits of PW for many clinical groups is increasing, studies investigating the use of PW in generally healthy people without diagnosed conditions are underrepresented in the current review. In this review, all except three studies (which included sedentary, non-obese women, healthy obese women, and overweight individuals with normal glucose tolerance (23, 26, 29)) investigated PW in populations with clinical conditions. Populations such as the elderly, obese and sedentary individuals have some of the lowest physical activity levels in the general population, and often have difficulty maintaining recommended levels of PA (43). PW may provide an alternative
strategy for improving the physical and psycho-social health of these adults. We suggest that the effects of PW programs in healthy populations without clinical conditions, in terms of safety, PA maintenance, and health outcomes, are worth exploring in future studies.

Most of the studies were supervised. It is however difficult to draw conclusions about the role of supervision because of heterogeneity in program structure, walking techniques and learning processes. Langbein et al. (35) did however report much better adherence with their supervised than non-supervised group, to the extent that the non-supervised group was discontinued.

While there is a possibility that some studies were missed in the literature search, it is more likely that the small number of studies included in this review reflects the developing nature of this field of research. As PW is more prevalent in Europe, we included languages other than English in order to capture a more complete range of papers. As for all systematic reviews, the results of this review could have been affected by publication bias, i.e. studies with positive outcomes could have been more likely to be published and therefore included in this review.

2.6 Conclusions

The aim of this systematic review was therefore to critically examine both the findings and the quality of studies that have examined the effects of PW programs on physical and psycho-social health in adults.

Regarding effects of PW on physical health compared with controls, most improvements in cardiorespiratory function were found in endurance and oxygen uptake, and mixed effects were found in ratings of perceived exertion, and heart rate and blood pressure. About half the studied comparisons showed positive effects of PW on functional status and pain. Of the outcomes that were examined in fewer studies, there were positive effects of PW on the majority of PA and anthropometry measures. There were positive effects of PW compared with control interventions on psychosocial health. In this review, no effects of PW compared with controls were found on ankle brachial index, flexibility, and blood glucose.

Eleven papers showed acceptable quality as assessed by the modified Delphi list, having ratings over 50%. Three papers had quality ratings of less than 50.”
2.7 Perspective

The aim of this systematic review was therefore to critically examine both the findings and the quality of studies that have examined the effects of PW programs on physical and psycho-social health in adults.

Research into the effects of PW programs for adults is an emerging field, and this review highlights several new studies in adults with and without clinical conditions. There is evidence that PW has beneficial effects on many physical and psycho-social outcomes as well as being a well-tolerated and safe exercise for diverse populations.

2.8 Acknowledgements

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<td>Y</td>
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<td>N</td>
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<td>?</td>
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<td>Ebersbach et al. (2005)</td>
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<tr>
<td>Figard-Fabre et al. (2011)</td>
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<td>Y*</td>
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<td>Hartvigsen et al. (2010)</td>
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<td>NA</td>
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<td>Kocur et al. (2009)</td>
<td>N</td>
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<td>Mannerkorpi et al. (2010)</td>
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<td>Reuter et al. (2011)</td>
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<td>Sprod et al. (2005)</td>
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<td>Strombeck et al. (2007)</td>
<td>N</td>
<td>N</td>
<td>Y</td>
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<td>N*</td>
<td>29</td>
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</table>

#papers scoring a point /total papers

| 11/14 | 8/11 | 11/14 | 12/14 | 9/14 | 4/14 | 5/14 |

Y=present; N=not present

* Quality rated after obtaining additional information from the authors

** Same study but different papers and outcomes
<table>
<thead>
<tr>
<th>Study, date</th>
<th>Country</th>
<th>Population</th>
<th>Eligibility</th>
<th>Recruitment setting and methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breyer 2010</td>
<td>Austria</td>
<td>Chronic obstructive pulmonary disease - COPD patients</td>
<td>- self reported exacerbation &lt; twelve weeks - myocardial infarction ≤ six months - cardiac arrhythmias &gt; Lown IIIb - walking disturbances due to muscle or bone diseases</td>
<td>NR</td>
</tr>
<tr>
<td>Collins, 2005</td>
<td>USA</td>
<td>Peripheral artery disease - history of intermittent claudication</td>
<td>- vascular surgery or angioplasty within previous 6 months - other co-morbid conditions interfering with participation in an exercise program - currently taking vitamin E, warfarin sodium, or pentoxifylline - unable to render informed consent</td>
<td>Mid Western Department of Veterans Affairs Hospital - surrounding community</td>
</tr>
<tr>
<td>Ebersbach, 2010</td>
<td>Germany</td>
<td>Idiopathic Parkinson’s Disease - Fulfill diagnostic criteria for idiopathic PD Hoehn &amp; Yahr stages I-III - outpatient treatment - stable medication 4 weeks prior to inclusion</td>
<td>- dementia (MMSE &lt; 25) - severe depression - disabling dyskinesias - co-morbidity affecting mobility or ability to exercise</td>
<td>- referred from local outpatient clinics and office-based physicians</td>
</tr>
<tr>
<td>Figard-Fabre, 2011</td>
<td>Italy</td>
<td>Obese, middle aged women - BMI &gt;30 kg.m² - reporting exercising&lt;1 hour/week over previous 6 months</td>
<td>- taking medication known to influence the variables measured - having a medical condition that would limit exercise participation</td>
<td>NR</td>
</tr>
<tr>
<td>Fritz, 2011</td>
<td>Sweden</td>
<td>Overweight/obese individuals with normal glucose tolerance, impaired glucose tolerance, and type 2 diabetes mellitus - age 45–69 years - BMI &gt; 25 kg/m² - for people with Type 2 diabetes, HbA1c between 57 and 78 mmol/L</td>
<td>- physical impairment - symptoms of angina pectoris - atrial fibrillation determined by electrocardiogram - systolic or diastolic blood pressure &gt; 160 or &gt; 100 mmHg, respectively - insulin treatment</td>
<td>- newspaper advertisements - personal letters of invitation to 447 former participants in the Stockholm Diabetes Prevention Program</td>
</tr>
<tr>
<td>Gram, 2010</td>
<td>Denmark</td>
<td>Type 2 diabetes mellitus - type 2 diabetes &gt; 1 year - HbA1c in the range of 7% to 10 %</td>
<td>- symptomatic heart disease (NYHA 2-4) - ischemia in lower extremities</td>
<td>- diabetes outpatient clinic - newspaper advertisement</td>
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<tr>
<td>Country</td>
<td>Study</td>
<td>Inclusion Criteria</td>
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<tr>
<td>Sweden</td>
<td>Hartvigsen, 2010</td>
<td>Low back pain and/or leg pain of greater than eight weeks duration</td>
<td>- co-morbidity preventing patient from participating in the full intervention&lt;br&gt;- unable to sit on a stationary bike for at least 30 minutes in order to perform watt max bicycle test&lt;br&gt;- secondary sector specialized outpatient back pain clinic (referrals from primary care physicians and chiropractors when 4 weeks treatment in primary care by family physician, chiropractor, physiotherapist or combination has not resulted in satisfactory improvement)</td>
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<td>- LBP with or without leg pain &gt; 8 weeks</td>
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<td>- averaged pain &gt; 3 during the past two weeks on the 11 point numeric rating scale</td>
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<td>- completed four weeks of treatment in the primary sector by a family physician, chiropractor, physical therapist, or a combination</td>
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<td>- concluded all examinations, individual and group treatment at the back clinic with at least a 75% attendance rate</td>
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<td>- able to read and understand Danish</td>
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<td></td>
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<td>- attended group exercises twice a week for four weeks</td>
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<td>Poland</td>
<td>Kocur, 2009</td>
<td>Post-acute coronary syndrome</td>
<td>- previous episodes of cardiac arrest&lt;br&gt;- uncontrolled arrhythmias&lt;br&gt;- chronic or acute inflammation&lt;br&gt;- diabetes on insulin treatment&lt;br&gt;- liver or renal failure&lt;br&gt;- neoplastic disease</td>
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<td>- an acute coronary syndrome treated with primary percutaneous coronary intervention 2–3 weeks earlier</td>
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<td>- exercise tolerance &gt;6 metabolic equivalents in symptom-limited electrocardiography treadmill exercise test performed on admission to the cardiac rehabilitation centre</td>
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<td>- ejection fraction by echocardiography ≥40%</td>
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<td>Finland</td>
<td>Kukkonen-Harjula, 2007</td>
<td>Non-obese sedentary women</td>
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<td></td>
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<td>- 50–60 years of age</td>
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<td>- BMI 20–30 kg/m2</td>
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<td>- exercised no more often than twice weekly</td>
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<td>- no health problems preventing from training</td>
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<td>- used no drugs affecting HR</td>
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<td>USA</td>
<td>Langbein, 2002</td>
<td>Intermittent claudication pain</td>
<td>- severe leg pain at rest&lt;br&gt;- ischemic ulceration gangrene&lt;br&gt;- resting ABI of less than 40 mm Hg&lt;br&gt;- vascular surgery or angioplasty within the previous year&lt;br&gt;- current use of vitamin E, warfarin sodium, or pentoxifylline&lt;br&gt;- exercise capacity limited by factors other than PAD&lt;br&gt;- Department of Veterans Affairs Hospital’s Peripheral Vascular and Outpatient Clinics&lt;br&gt;- local physician groups&lt;br&gt;- participation in health fairs&lt;br&gt;- veteran publications</td>
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<td>- current diagnosis of PAD</td>
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<td>- a history of IC</td>
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<td>- ABI of less than 0.95 at rest or less - than 0.85 after exercise</td>
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<td>- pain from IC must have been the primary limiting factor to maximal exercise performance during a treadmill test</td>
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<td>- reported a diminished capacity to complete leisure-time and occupational activities because of claudication pain</td>
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<td>Sweden</td>
<td>Mannerkorpi, 2010</td>
<td>Fibromyalgia</td>
<td>- patients not speaking or reading Swedish&lt;br&gt;- other severe somatic or psychiatric disease&lt;br&gt;- ongoing or planned physical therapy, including exercise&lt;br&gt;- inability to accept times for planned exercise sessions&lt;br&gt;- newspaper advertisements&lt;br&gt;- health care centres in West Sweden&lt;br&gt;- participation in an earlier study</td>
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<td>- women aged 20-60 years with fibromyalgia, defined by the ACR 1990</td>
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<td>- a history of long-lasting generalized pain and pain in at least 11 of 18 tender points examined by manual palpation</td>
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<td>- able to manage a bicycle test at 50 watts or more</td>
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<td>- BMI &gt; 25 kg/m2</td>
<td>- myocardial infarction within the past 3 months&lt;br&gt;- severe lung disease&lt;br&gt;- exercise test performed on admission to the cardiac rehabilitation centre when 4 weeks treatment in primary care by family physician, chiropractor, physiotherapist or combination has not resulted in satisfactory improvement</td>
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<td>- aged 25 to 80 years</td>
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<td>- stable anti diabetic treatment &gt; 3 months before inclusion</td>
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<td>- 62+/-10, 59 +/-10, 61 +/- 10</td>
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<td>Study</td>
<td>Country</td>
<td>Disease</td>
<td>Sample Characteristics</td>
<td>Findings</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
<td>----------------------------------</td>
<td>-----------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Reuter 2011</td>
<td>Germany</td>
<td>Parkinson's disease</td>
<td>N=90; 62+/3.2, 62.1+/2.5, 63+/3.1; 45M, 45F; Hoehn &amp; Yahr stage II and III; severe concomitant diseases which limit physical performances; second neurological disease</td>
<td>-500 PD clients participating in sports from data base not specified</td>
</tr>
<tr>
<td>Sprod, 2010</td>
<td>USA</td>
<td>Breast cancer survivors</td>
<td>N=12; 50.33+/2.74, 59.17+/4.82; 12 F; undergone primary breast cancer treatment; - physical limitations that would inhibit participation in an exercise intervention that included walking poles</td>
<td>-breast cancer survivors who chose to participate in the Rocky Mountain Cancer Rehabilitation Institute’s exercise rehabilitation program</td>
</tr>
<tr>
<td>Strombeck, 2007</td>
<td>Sweden</td>
<td>Sjogren’s syndrome</td>
<td>N=21; 60 (41–65), 56.5 (42–63); 21 F; - female; - age ≤67 yrs; - primary Sjogren’s syndrome diagnosed according to the American European Consensus Criteria; - living in a specific area of southern Sweden</td>
<td>use of beta-blocker therapy; disease manifestations known to prevent or limit exercise performance; NR</td>
</tr>
</tbody>
</table>

PW=pole walking; COPD=chronic obstructive pulmonary disease; PAD=peripheral artery disease; PD=Parkinson disease; N=number; M=males; F=females; MMSE=mini-mental state examination; BMI=body mass index; LBP=low back pain; NR=not reported; ABI=Ankle-Brachial Index; HR=heart rate; IC=intermittent claudication; HBA1C=Glycated haemoglobin; NYHA=New York Heart Association classification; ACR=American College of Rheumatology
### Table 2-3 Program and control strategies, outcome measures and results from the 13 studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Program and control</th>
<th>Attendance</th>
<th>Outcome measures</th>
<th>Significant between group differences (p&lt;.05)</th>
<th>Significant within group differences (p&lt;.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breyer, 2010 Austria</td>
<td>-3M</td>
<td>-session attendance NR</td>
<td>Physical</td>
<td>-↑ PW vs NEC (3M,6M,9M)</td>
<td>-↑ +0.40m/s2+/ -0.1 4 (3M), +0.25+/ -0.09 (3M, 6M)</td>
</tr>
<tr>
<td></td>
<td>-3M/6M/9M</td>
<td>-8%</td>
<td></td>
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<tr>
<td></td>
<td>Program</td>
<td>R: PW,32, NEC,33</td>
<td>-↑ PW vs NEC (3M,6M,9M)</td>
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<tr>
<td></td>
<td>Program</td>
<td>A: PW,30, NEC,30</td>
<td>-↑ PW vs NEC (3M,6M,9M)</td>
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<tr>
<td></td>
<td>-3x weekly, 1 hr</td>
<td>-75%</td>
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<td></td>
<td>-75% of initial HR max</td>
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<tr>
<td></td>
<td>-group based, initial 2 hr instruction by PW instructor, then medical staff</td>
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<tr>
<td></td>
<td>NEC</td>
<td>-no intervention</td>
<td><strong>Physical</strong></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>-functional exercise capacity (6MWD)</td>
<td></td>
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<tr>
<td></td>
<td>-perceived dyspnoea after the 6MWD (modified Borg dyspnoea scale)</td>
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<tr>
<td></td>
<td>-endurance (time)</td>
<td>-8%</td>
<td></td>
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<tr>
<td></td>
<td>-BP (standard auscultation) systolic</td>
<td>-12%</td>
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<td></td>
<td>-HR (12-lead electrocardiograph)</td>
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<td></td>
<td>-o2 uptake</td>
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<td></td>
<td>-ratings of perceived leg pain (Borg)</td>
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<tr>
<td></td>
<td>-ABI</td>
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<tr>
<td>Collins, 2005 USA</td>
<td>-6M</td>
<td>-88 +/-23%</td>
<td>Physical</td>
<td>-↑ 15.1 +/- 4.5 mins vs baseline (10.3+/ -4.1mins)</td>
<td>-↑ 35+/ -38% decline in slope</td>
</tr>
<tr>
<td></td>
<td>-6M</td>
<td>-8%</td>
<td></td>
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<tr>
<td></td>
<td>Program</td>
<td>R: PW,27, NEC,25</td>
<td>-↑ PW vs NEC (3M,6M,9M)</td>
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<tr>
<td></td>
<td>Program</td>
<td>A: PW,25, NEC,24</td>
<td>-↑ PW vs NEC (3M,6M,9M)</td>
<td></td>
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<tr>
<td></td>
<td>-3x weekly, 30-60 min</td>
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<td></td>
<td>-68-73% of predicted HR max (incorporating 15-60 second “speed plays”) 80% of session</td>
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<td></td>
<td>-individual based, supervised but instructor NR</td>
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<tr>
<td></td>
<td>NEC</td>
<td>-ABI measurement 2x weekly</td>
<td><strong>Psycho-social</strong></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>-ABI</td>
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</tbody>
</table>

**Note**: For outcome measures, significant differences are indicated with an asterisk (*p<0.05*).
Psycho-social
- health-related QoL (SF36) physical
- health-related QoL (SF36) mental

Physical
- motor performance (UPDRS motor score)
- TUG
- timed walk 10 m

Psycho-social
- Qol (PDQ39)

Ebersbach, 2010 Germany
- PW 8W
- EOPW1: 4W
- EOPW2: 4W
- 16 W

Program
- 2x weekly, 1 hr
- NR
- group based sessions, physiotherapist trained as PW instructor

EOPW1
- LSVT-BIG therapy
- 4x weekly, 1 hr
- intensity NR
- one-to-one sessions by physiotherapist

EOPW2
- home exercises
- initial instruction by physiotherapist

Figard-Fabre, 2011 Italy
- 12W
- 6W, 12W

Program
- 3x weekly
- 10 mins warm-up, then interval training of 4 mins of moderate intensity exercise, followed by 1 min of more intense exercise, repeated 6 times, then 10 mins cool down
- group-based (1x weekly) and individual (2x weekly)
- group supervised by study investigators, individual non-supervised

EOPW walking
- 3x weekly
- interval training as above
- group-based (1x weekly) and individual (2x weekly)
- group supervised by study investigators

Psychosocial scores:
- ↑ PW vs NEC
- ↑ 5.1+/− 7.7 score
- ↓ PW vs NEC
- ↓ NS

Physical scores:
- ↑ PW vs EOPW1
- ↑ PW vs EOPW2 NS
- ↑ PW vs EOPW1
- ↑ PW vs EOPW2 NS
- ↑ PW vs EOPW1 & 2 NS
- ↑ 0.58+/− 3.17 score
- ↑ 0.58+/− 1.72 s
- ↑ 0.59+/− 1.34 s
- ↑ PW 84.6 (15.3) vs baseline 86.1 (15.2)
- ↑ PW 88.6 (18.7) vs baseline 95.7 (25.3)
- ↑ PW 40.6 (3.1) vs baseline 41.5 (3.9)
- ↑ PW 79 (8) vs baseline 86 (9)
- ↑ PW (6W, 12W)
- ↑ PW (6W, 12W)
- ↑ (6W, 12W)
Fritz, 2011
Sweden
- 4M
- 4M
Program
- 5 hrs weekly
- intensity NR
- individual based, non-supervised
NEC:
- habitual daily activity

- reporting >4hr/w PW
  NGT: 78%, IGT: 67%, T2: 50%
- median values of hrs/w
  PW NGT: 4.7, IGT: 4.6, T2: 3.8
- 5%
R: PW: 87, NEC: 125
A: PW: 87, NEC: 125

Physical
- BMI
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC
- PA (VAS)
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC

Psycho-social
(SWED-QUAL)
- quality of sleep
  ↑ T2 PW vs NEC
- physical functioning
  ↑ NGT PW vs NEC
- general health
  ↑ NGT PW vs NEC
- satisfaction with physical health
  ↑ T2 PW vs NEC
- pain
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC
- role limitation attributable to physical health
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC
- role limitation attributable to emotional health
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC
- positive effect
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC
- negative effect
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC
- cognitive functioning
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC
- family functioning
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC
- marital functioning
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC
- sexual functioning
  ↑ NGT PW vs NEC
  ↑ T2 PW vs NEC

Gram, 2010
Denmark
- 4M
- 4M/12M
Program
- 2x weekly for 2 M, then 1x weekly for 2 M, 30 min
- moderate intensity (>40% of VO2 max)
  (Borg)
- group based, physiotherapist
EOPW
- exercise on prescription
- 2x weekly for 2 M, then 1x weekly for 2 M, 30 min
- moderate intensity
- group based, physiotherapist
NEC
- no exercise

- PW >70% attendance rate: 54.5%
- overall mean attendance PW: 63.5%
- 1%
R: PW: 22, EOPW: 24, NEC: 22
A: PW: 21, EOPW: 24, NEC: 22 (4m)
A: PW: 21: EOPW: 24, C: 20 (12m)

Physical
- glucose metabolism
  (Hba1c)
- high density cholesterol/triglyceride
- body weight
- whole body fat tissue mass (dual X-ray densitometry)
- lean tissue mass
- BMI
- waist/hip circumference
- supine BP
- maximal oxygen uptake (VO2 max)

Psycho-social
- health-related quality of life (SF36)
- special questionnaires on

- ↑ PW vs NEC
- ↑ T2 PW vs NEC
- ↑ NGT 3.6 (3.6-14.3)
  ↑ T2 5.3 (3.5-16.1)
- ↑ NGT 3.2 (0-12.5)
  ↑ T2 0 (0-33.5)
- NS
- NS
- NS
- NS
- NS
- NS
- NS
- NS
- NS
- NS
- NS
- NS
- NS
Hartvigsen, 2010 Denmark
- 8W
- 11W/26W/52W

Program A
- 2x weekly, 45 min
- varied intensity, dose and frequency same
- group based, PW instructor

Program B
- one hr, initial PW instructor training, followed by non-supervised PW as much as they liked at home

NEC
- home
- no intervention

Kocur 2009 Poland
- 3W
- 3W

Program
- 5x weekly, 30 min
- 213.37 kcal (accelerometer), 255.67 kcal (HR monitor), 13 (Borg)
- group based, physiotherapist

EOPW 1 walking
- 5x weekly, 30 min
- 183.8 kcal (accelerometer), 278.23 kcal (HR monitor), 14 (Borg)
- group based, physiotherapist

EOPW 2 calisthenics only (without PW and W)
- 5x weekly, 30 min
- 183.8 kcal (accelerometer), 278.23 kcal (HR monitor), 14 (Borg)

Kukkonen-Harjula. 2007 Finland
- 13W
- 13W

Program
- familiarization period for 2 W, frequency NR, then 4x weekly, 40 min
- instruction to “walk briskly so that breathing is enhanced.”

hrs spent on physical activity and activities of daily living

Physical
- pain and disability (LBPRS) pain
- pain and disability (LBPRS)-function
- functional limitation (PSFS)

Psycho-social
- Health related QoL (EQ-5D)

Other
- medication use, other treatment, time off work
- expectation to treatment (Likert)

Physical exercise capacity (treadmill exercise test)
- 6MWT
- arm curl
- chair stand
- pull/reach
- back scratch
- up and go
- RPE
- energy expenditure (accelerometer)
- energy expenditure (HR monitor)

Physical cardiorespiratory performance
- RPE
- % HRR
- resting HR

maximal exertion

10.8 +/- 1.8 MET vs baseline (8.9 +/- 2.0)
663.0 +/- 77.0 m vs baseline (580.2 +/- 62.9)
25.9 +/- 4.8 reps vs baseline 22.3 +/- 4.6
21.2 +/- 4.1 reps vs baseline (17.4 +/- 3.9)
-0.2 +/- 10.3 cm vs baseline (-4.5 +/- 11.2)
6.4 +/- 10.8 cm vs baseline (-8.0 +/- 12.2)
4.4 +/- 0.6 s vs baseline (4.9 +/- 0.7)
6.4 +/- 10.8 cm vs baseline (-8.0 +/- 12.2)
4.4 +/- 0.6 s vs baseline (4.9 +/- 0.7)
4.4 +/- 0.6 s vs baseline (4.9 +/- 0.7)
6.4 +/- 10.8 cm vs baseline (-8.0 +/- 12.2)
4.4 +/- 0.6 s vs baseline (4.9 +/- 0.7)
4.4 +/- 0.6 s vs baseline (4.9 +/- 0.7)
6.4 +/- 10.8 cm vs baseline (-8.0 +/- 12.2)
4.4 +/- 0.6 s vs baseline (4.9 +/- 0.7)
-individually based, exercise instructors

**EOPW:**
- walking
- familiarization period for 2 weeks
- 4x weekly, 40 min
- instruction to “walk briskly so that breathing is enhanced.”
- individually based, exercise instructors

<table>
<thead>
<tr>
<th>Metric</th>
<th>PW</th>
<th>NEC</th>
<th>NS/NS</th>
</tr>
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<tbody>
<tr>
<td>Submaximal exertion</td>
<td>-NS</td>
<td>-NS</td>
<td>-NS</td>
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<tr>
<td>O2 pulse</td>
<td>-NS</td>
<td>-NS</td>
<td>-NS</td>
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<td>Ve</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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<td>HR</td>
<td>-NS</td>
<td>-NS</td>
<td>-NS</td>
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<td>LA max</td>
<td>-NS</td>
<td>-NS</td>
<td>-NS</td>
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<tr>
<td>Ratio of lactate to VO2</td>
<td>-NS</td>
<td>-NS</td>
<td>-NS</td>
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<tr>
<td>Weight</td>
<td>-NS</td>
<td>-NS</td>
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<td>Waist circumference</td>
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<td>Neuromuscular fitness</td>
<td>-NS</td>
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<tr>
<td>Leg strength (one leg squat) in low fitness participants</td>
<td>↓181% (6M)</td>
<td>↑ 23% (4W), ↑31% (8W), ↑40% (12W), ↑47% (16W), ↑51% (24W)</td>
<td>NR</td>
</tr>
<tr>
<td>Dynamic balance</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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<tr>
<td>One leg stance</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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<tr>
<td>Neck/shoulder mobility</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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<tr>
<td>Dynamic upper arm extension</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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<td>Musculo-skeletal pain</td>
<td>-NS</td>
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<tr>
<td>Neck</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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<tr>
<td>Elbow/forearm</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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<tr>
<td>Back (sciatic type)</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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<tr>
<td>Hip</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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<tr>
<td>Knee</td>
<td>-NS</td>
<td>-NS</td>
<td>-NR</td>
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</tbody>
</table>

**Langbein, 2002 USA**

Program
- 2-3x weekly, 30-45 min
- interval training, but intensity NR
- individually based, supervised but instructor NR

NEC:
- ABI measurements
- 2x weekly for the first 3 months, then monthly
- study staff

-24W
-4W/8W/12W/16W/24W

- Session attendance NR supervised, <50% non-supervised, so changed to completely supervised
- 12% R: PW:27, NEC:25 A: NR

**Physical**
- constant work-rate symptom-limited incremental treadmill exercise test
  - ↑ PW vs NEC (4W, 12W, 24W) 1181% (6M)
- peak O2:
  - ↑ PW vs NEC (16W, 24W)
  - 18.7 +/- 4.8 mL/kg/min (16W) vs baseline (16.7 +/- 4.0), 18.7 +/- 4.5 mL/kg/min vs baseline (24W)
  - ↑79% decrease mean slope (24W)
- rating of perceived leg pain
  - ↑ PW vs NEC (24W)
- ABI (doppler US scan)
  - NS

**Psycho-social**
- WIQ perceived ability to walk distance
  - ↑ PW vs NEC (12W,24W)
- WIQ perceived ability to walk faster
  - ↑ PW vs NEC (4W,12W,24W)
  - ↑ (12W,24W)
**Program**
- 15W
- 15W/6M
- low intensity walking
- 1x weekly, 40-45 min
- intensity as above
- organisation and instructor as above

**EOPW**
- 6M
- 6M/12M (telephone survey only)
- variable intensity
- group based sessions, physiotherapists trained as PW instructors

**EOPW 1:**
- walking
- frequency and duration as above
- variable Borg score
- group based sessions, same physios as PW

**EOPW 2:**
- flexibility and relaxation training in a gym
- frequency and duration as above
- variable Borg score
- group based, same physios as PW

**Physical**
- functional capacity
  - ↑ PW vs EOPW (15W)
  - ↑ 37.7 ±/−41.8 (16W), 20.9 ±/−52.5m (6M)
- exercise HR (ergometer test)
  - ↑ PW vs EOPW (15W)
  - ↑ −8.9 Beats/minute (15W) NS (6M)
- LTPA
  - NR
  - NS
- local pain score
  - NS
  - NS
- use of analgetics/antidepressants/sedatives
  - NR
  - NS

**Psycho-social**
- FIQ
  - ↑ FIQ total
  - ↓ −4.8 score (15W) NS (6M)
  - ↓ −7.9 score (15W) NS (6M)
- FIQ physical
  - ↑ PW vs EOPW (15W)
  - NS (16W, 6M)
- pain
  - ↓ PW vs EOPW (15W)
  - NS (16W, 6M)
- general fatigue
  - NS
  - NS (16W) ↑ −2.1 ±/−2.2 (6M)
- physical fatigue
  - NS
  - NS (16W) ↑ −1.9 ±/−2.5 (6M)
- reduced activity
  - NS
  - NS (16W, 6M)
- reduced motivation
  - ↑ PW vs EOPW (15W)
  - NS (16W, 6M)
- mental fatigue
  - NS
  - NS (16W, 6M)

**UPDRS**
- leg agility L
  - NR
  - NR
- leg agility R
  - NR
  - NR
- posture
  - ↑ PW vs EOPW (2)
  - ↑
- freezing
  - ↑ PW vs EOPW (2)
  - ↑
- alternating movements
  - ↑ PW vs EOPW (2)
  - ↑
- postural stability
  - ↑ PW vs EOPW (1 & 2)
  - ↑
- gait pattern
  - ↑ PW vs EOPW (1 & 2)
  - ↑
- exercise test (walking speed)
  - pain (VAS)
    - neck
      - NS
      - ↑
    - hip
      - NS
      - ↑
    - iliosacral
      - NS
      - ↑
- ↑ 4.7s
- ↑ 2.1 ±/−0.6s
- ↑ with increased walking speed (2.7 km/hr and 3.0 km/hr)
- ↑ motor score 6.4 ±/−4.1
- ↑ 4.1
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<tbody>
<tr>
<td>Program</td>
<td>2x weekly, 20 min</td>
<td>40% to 50% of heart rate reserve (Karvonen method)</td>
<td>- group based, cancer exercise rehabilitation specialist</td>
<td></td>
<td></td>
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<tr>
<td>EOPW:</td>
<td>-walking</td>
<td>-2x weekly, 20 min</td>
<td>-intensity as above</td>
<td>-organisation/ instructor as above</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Strombeck, 2007 Sweden</th>
<th>-12 W</th>
<th>-12 W</th>
<th>-97%</th>
<th>-9%</th>
<th>R: 11PW/10C</th>
<th>A: 9 PW/10C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>3 x weekly, 45 mins</td>
<td>-60–70% of age-predicted HR max for 8 weeks, then 70–80% of age-predicted HR max for 4 weeks,</td>
<td>-group (1x weekly) and individual (2x weekly) based, trained walker for group sessions, non-supervised for individual</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Psycho-social</th>
<th>PDQ39</th>
<th>↑ concentrate, memorize, recall information PW vs EOPW2</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Physical upper body muscular endurance</th>
<th>-bench press</th>
<th>-lateral pull down</th>
<th>-shoulder press</th>
<th>-shoulder ROM (goniometer measures)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-aerobic capacity VO2 max l/min</td>
<td>↑PW vs NEC</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>-aerobic capacity VO2 max ml/kg/min</td>
<td>↑</td>
<td>←NS</td>
<td>↑</td>
<td>↑</td>
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<td>↑</td>
<td>←NS</td>
<td>↑</td>
<td>↑</td>
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<tr>
<td>-fatigue VAS mm</td>
<td>↑</td>
<td>←NS</td>
<td>↑</td>
<td>↑</td>
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<tr>
<td>-ProF</td>
<td>↑</td>
<td>←NS</td>
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**Notes:**
- ↑ indicates increase compared to baseline or another group.
- ← indicates decrease compared to baseline or another group.
- NS indicates no significant change.

**References:**
- Sprod 2005
- Strombeck, 2007 Sweden
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<td>- 3x weekly</td>
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<td>- individual based, non-supervised</td>
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<td>SF-36</td>
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<td>- role, emotional</td>
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<td>- mental health</td>
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PW vs NEC: ↑ 2 (0–4) NS; ↑ 15 (0–45) NS; ↓ 4 (2–4) NS

PW=pole walking; EOPW=exercise other than Pole walking; NEC=non-exercise control; C=control; NGT=normal glucose tolerance; IGT=impaired glucose tolerance; T2=type two diabetes mellitus; NS=not significant; NR=not reported; M=months; W=weeks; LL=lower limb; UL=upper limb; VO2=maximal oxygen uptake; BP=blood pressure; HR=heart rate; ABI=ankle brachial index; RER=respiratory exchange ratio; RPE=ratings of perceived exertion; LA=lactate; MET=metabolic equivalent; VT=ventilator threshold; LBP=low back pain; EQ-5D=European Quality of Life-5 Dimensions; QoL=quality of life; MFI-20=Multi-dimensional fatigue inventory; 6MWT=6 minute walk test; TUG=timed up and go; WIQ=walking impairment questionnaire; LSVT-BIG=Lee Silverman Voice Therapy (exercise therapy for Parkinson's disease); UPDRS=unified Parkinson disease rating scale; PDQ39=Parkinson disease questionnaire; LBPRS=low back pain rating score; SF=Medical outcomes study short form; PSFS=patient specific function scale; FIQ=fibromyalgia impact questionnaire; VAS=visual analogue scale; ProF=profile of fatigue; WIQ=walking impact questionnaire; HADS=hospital anxiety and depression scale; MFI=multidimensional fatigue inventory; OR=odds ratio; CI=confidence interval.
Table 2-4  Outcome measures and results of 12 studies (13 papers) recording between group effects of pole walking on physical and psycho-social health (number of measures that showed significant change / total number of measures)*

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Physical outcomes

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<td>2/1†</td>
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<td>1/1†</td>
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Psycho-social outcomes

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<td>8/8†</td>
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<td>2/2†</td>
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EOPW=exercise other than PW (EOPW in bold face indicates similar intensity walking); NEC=non-exercise control; QoL=Quality of life; RPE=ratings of perceived exertion; HR=heart rate; BP=blood pressure; ABI=ankle brachial index; PA=physical activity

Dark coloured=significant improvement in at least one outcome measure of PW; Medium coloured=non-significant outcome measure; Light coloured=significant decrease in at least one outcome measure of PW; reference number in bold face indicates high quality, defined as over 50%

*The paper by Sprod et al. was not included in this table because only within group differences were reported. The total number of studies is therefore 13. The paper by Gram et al. recorded two control groups, but PW was only compared with the NEC. Therefore only one group was included in this table.

**Same study, but different papers and outcome measures.

†=objective measures; ‡=subjective measures
2.9 References


3. CHAPTER THREE: Systematic Review Update

3.1 Introduction

Since the publication of the systematic review included in Chapter 2 of this thesis, several new randomised controlled trials (RCTs) examining the effects of pole walking (PW) on physical and psycho-social health have been published. The first aim of this chapter is to critically examine the findings and quality of studies that have examined the effects of PW programs of physical and psycho-social health in adults, which were published after finalizing our earlier systematic review. The second aim was to examine whether the findings of the recently published papers are in line with the findings of the initial review.

3.2 Methods

3.2.1 Literature search

The systematic search was repeated to identify new papers published between November 2011 and September 2014 (Figure 3-1). The bibliographic databases searched included PubMed, Cochrane library, EMBASE, CINAHL and PEDro. The search terms are described in Chapter 2. In short, the following terms used in titles or abstracts were included in the search process: pole walking, polewalking, Nordic walking, walking with poles, walking poles, Exerstriding, pole striding, Nordic poles, power poles, and stick walking. Animal studies and papers not written in English were excluded from the search. Firstly, titles were scanned to exclude irrelevant papers. The abstracts of the papers were then reviewed and full texts of potentially relevant articles were obtained and reviewed for eligibility. In addition, the reference lists of included papers were checked to identify additional eligible intervention studies.
**Figure 3-1** Search process for the review update, with papers published between November, 2011 and October 2014

Records identified through database searching = 449

Record titles screened = 449

Record abstracts screened = 92

Full-text papers assessed for eligibility = 21

Papers identified as eligible = 14

Additional records identified through reference lists of selected papers and other sources = 1

15 papers included in qualitative synthesis describing 12 study interventions

Records excluded, irrelevant title, or duplication = 357

Records excluded, irrelevant abstract = 71

Full-text papers excluded, with reasons,
- not in English = 1
- no RCT or CT = 5
- control group other than NEC, EOPW = 1

Total = 7

RCT = randomised controlled trial; CT = controlled trial; NEC = non-exercise control group; EOPW = exercise other than pole walking
3.2.2 Inclusion and exclusion criteria
The same inclusion criteria as for the initial review were used. These were: (a) design: randomised controlled trial (RCT); (b) population: adults over 18 years; (c) intervention: program including a main component in which participants walked with poles; (d) control group: exercise program other than PW, non-exercise intervention, or non-intervention control group; and (e) outcome: subjective or objective measures of physical or psycho-social health.

3.2.3 Data extraction
The same data extraction protocol as for the initial review was used. Data were extracted about participant characteristics, recruitment strategies, program and control characteristics, attendance details, outcomes and results. For further details see the column headings of Tables 3-2 and 3-3.

3.2.4 Quality assessment
The methodological quality of the studies was assessed using a 7 item quality rating list based on the widely used Delphi list (Table 3-1) (1). The quality rating list used in both the initial review and this review update included the following seven items addressing internal validity, external validity, and statistical analysis: randomization, concealed treatment allocation, group similarity at baseline, specified eligibility criteria, blinded outcome assessor, point estimates and measures of variability for between-group differences, and intention-to-treat analysis. The criteria were scored using a “yes” (1 point), “no” (0 point), or “unclear” (0 point) answer format. Authors were contacted if an item could not be scored based on the information provided in the paper, and if no reply was received, the item in question was scored as “unclear”. All criteria were equally weighted, and a quality score was given as a percentage of the maximum score for each included study analysed. As in the full review, a paper was classed as high quality if the quality score was over 50%.

3.3 Results
Fifteen new papers which met the inclusion criteria were identified in the review update search (2-16). Five papers described four studies which were included in the initial review (2,4-5,7,16), but reported on different outcomes. Three papers described one new study, with different outcomes reported in each paper (13-15).
Thus, the 15 included papers reported on 12 intervention studies, of which four were included in the initial review and eight were new studies. The findings are described in terms of studies rather than papers. References for studies from the initial review are recorded in italics in the text.

### 3.3.1 Quality assessment

The results of the methodological quality assessment are presented in Table 3-1. Quality scores were generally higher than in the initial review, with scores ranging from 43% to 100%, versus 29-86% in the initial review. All papers except one were of high quality (score > 50%). The least reported and least included quality rating items were similar to those in the initial review. Items not well scored or reported in papers included in the review update were: blinded outcome assessors (nine studies); intention to treat analysis (eight studies); and concealed treatment allocation (six studies).

### 3.3.2 Study population

Participant characteristics and inclusion and exclusion criteria are shown in Table 3-2. A number of studies included in the review update examined the effects of PW in groups with clinical and subclinical conditions represented in the initial review. These included adults with fibromyalgia (2), peripheral artery disease (4, 5, 12), Parkinson’s disease (16), type 2 diabetes or impaired glucose regulation (7, 13-15), cardiovascular disease (3,8), and breast cancer (9). Of these, five papers described studies that were reported on in the initial review (2,4,5, 7, 16). Study populations in these studies included people with fibromyalgia (2), peripheral artery disease (4,5), Parkinson’s disease (16), and type 2 diabetes or impaired glucose regulation (7). Interestingly, four studies (3,6,10,11), examined the effects of PW in older adults, whereas there were no studies on the effect of PW in older people in the published review.

Similarly to the initial review, almost all studies included community dwelling participants. The exception was the study by Figuerido et al. (2013), which recruited inpatient and outpatient participants from two rehabilitation centres where patients’ planned time attending rehabilitation was more than 6 weeks. The average age of participants in the review update was 61 years (range 52-82 years), which was slightly higher than in the initial review (57 years, range 45-69). As in the initial
review, most studies in the review update had around 60 participants (range, 30-213). However, almost all studies in the review update included both men and women, whereas several studies in the initial review only included women (16-20). The proportion of women in the review update studies ranged from 7% to 100%.

Details of the PW and control programs are reported in Table 3-3. The mean duration of the PW programs (13.6 weeks, range, 6-24 weeks), number of weekly sessions (2-5 sessions per week), and session duration (15-70 minutes) were similar to those in the initial review. The exception in the review update was a novel study design by Ota et al. (2014), which involved older adults attending day care centres. In this study, participants were given poles to use for all walking activities when attending participating day care centres, rather than having specific exercise sessions. The mean walking time in this study was 9.7 minutes during the course of a day care session.

Exercise intensity was reported in ten studies and varied widely. Interestingly, only two programs from a single study reported different intensities in the same session (4,5), compared with four in the initial review (16, 18, 21-23). Intensity was assessed using subjective and objective measures, similar to those used in the initial review, such as ratings of perceived exertion and heart rate. PW sessions were supervised in the majority of studies in the review update (six studies) (2, 6, 8, 11, 13-16). However, two programs required participants to exercise individually and unsupervised (7, 12). Walk leaders included physiotherapists trained in the Nordic walking technique (6, 8), a Nordic walking trainer (11), and physical education instructors or personal trainers (2, 13-15).

All studies in the review update reported or described the technique used, compared with only six in the initial review (16, 19, 21-25). Nine studies used the Nordic walking technique (2,3, 6-9, 11-16). Of the other two, one study used the Exerstriding technique (4, 5), and one study used the PW technique (10). A description of the setting was provided by five studies: two studies required participants to exercise in a home environment (7, 12); one program was held indoors (10); and two were held at a local outdoor setting (except during inclement weather) (4, 5, 13-15). No studies reported the type of terrain or walking surface.
The control groups in this review update were similar to the control groups in the initial review. They were: exercise programs other than PW (2, 4-6, 8, 12-16), the majority of which compared PW with same intensity walking (2, 4-6, 8, 12); or non-exercise control groups (3, 7, 9-11, 13-15). Of the two studies which compared PW with two control groups, one new study compared PW with strength training and a non-exercise control (13-15), and one study, which was also reported on in the initial review, examined a home exercise program and Lee Silverman Voice Treatment-BIG (LSVT-BIG), a specialized exercise program for Parkinson’s disease (16).

The effects of PW on physical and psycho-social health are described in Tables 3-3 to 3-5. Both within and between group outcomes are shown in Table 3-3. Between group outcomes are shown in Table 3-4. The combined findings of the initial review and the review update are shown in Table 3-5.

Of the 9 studies reporting between group effects included in this review update, all reported the effect of PW on physical health. Endurance and oxygen uptake were the most frequently examined measures. Outcome measures which recorded the most positive physical effects of PW were cardiorespiratory endurance (8/17 measures), PA (3/4 measures), anthropometry (3/4 measures) and muscle strength (4/4 measures). There were no positive effects of PW relative to controls on heart rate and blood pressure, ankle brachial index, pain, gait parameters, lymphedema, blood glucose measures, metabolic measures, or atherogenic index of plasma (see Table 3-4).

Although the majority of physical outcome measures in the review update were similar to those in the initial review, four new measures were examined. These were: lymphedema (9); lipid, liver and regulatory markers (7, 13-15); atherogenic index of plasma, cytokines, and oxidative stress (13-15); and metabolic measures (13-15). The only physical outcome assessed in the initial review, but not in the review update, was fatigue (20).

3.3.3 Cardiorespiratory measures

Endurance effects of the interventions were again well represented in the review update, being reported in the majority of studies (six). Five studies, involving a variety of control groups, reported positive effects of PW on endurance (2, 7, 8, 12-15).
Oxygen uptake and energy expenditure were assessed in four studies in the review update (4, 5, 7, 8, 12), of which two found positive results (7, 12). Most positive effects on oxygen uptake were observed in studies which compared PW to non-exercise controls, whereas there were few positive effects of PW on oxygen uptake in studies which compared PW with walking. These findings are similar to those in the initial review.

Two studies in the review update which examined the effects of PW on heart rate and blood pressure found no effects of PW relative to strength training and non-exercise control groups (7, 13-15), compared with mixed results in the initial review (16-18, 23, 26). Perceived exertion was examined in only one study (12), which found a decrease in perceived exertion in PW compared with walking. This is in line with two out of four studies in the initial review (20, 25). There were no effects of PW on ankle brachial index in two studies in the review update which examined it (5, 12), which agreed with results of one study which examined ankle brachial index in the initial review (21, 22).

### 3.3.4 Other physical measures

Other physical outcome measures examined in the review update which were examined previously included strength, PA, anthropometric measures, functional measures, flexibility, gait parameters, pain, and blood glucose measures. New measures examined included lymphedema, lipids, liver and regulatory markers, metabolic measures and atherogenic index of plasma.

Four studies in the review update examined strength, making it one of the more frequently examined physical measures. All found increases in strength in PW relative to both walking and non-exercise control groups (7-9, 11). This strengthens findings in the initial review which reported positive effects in one of two studies (25), but not in the other (17).

Three studies examined PA in the review update, and all found increases in PW relative to controls (7, 8, 13-15). However, in addition to increases in structured and total leisure time PA levels, the study by Wasenius et al. (2014) found a decrease in non-structured leisure time PA in the PW group, relative to a non-exercise control, in men with impaired glucose regulation (15). Apart from this study, and one in the
initial review, which reported no effects of PA (23), all studies examining PA have found increases in the PW group relative to control groups.

Two studies in the review update which examined anthropometric effects confirmed previous findings of improvements in weight, body mass index and waist measurements in PW compared with non-walking controls (7, 13-15). However, the study by Keast et al., found no improvements in weight or waist measurements in PW compared with walking, in adults with heart failure (8).

Functional status was examined in only two studies in the review update (11, 16), which were fewer than the five which examined it in the initial review (17, 23, 25, 27, 28). Both found positive functional effects in PW compared with control groups. However, in one study, there were no effects on cued reaction time in Parkinson’s disease participants when PW was compared with LSVT-BIG therapy, although there was a positive effect when compared with a home exercise control group (16).

Only one new study examined flexibility, and found increases in PW relative to a non-exercise control group in older adults (11). Interestingly, this study used flexibility exercises as a component of their PW program, whereas two studies in the initial review, which reported no between group differences, did not (17, 25). The same study examined gait parameters, and found no benefits in the PW group (11).

Two studies in the review update found no effects of PW, compared with light intensity walking and regular walking, on pain, in people with fibromyalgia and claudication pain (2, 12). One study found no effects of PW, compared with a non-exercise control group, on arm lymphedema, in a breast cancer population (9).

Blood glucose measures were examined in three studies in the review update (2, 7, 13-15). No effects of PW relative to light intensity walking, strength training, and non-exercise control groups were found, which is in line with findings of the single study in the initial review which examined blood glucose measures (18). Lipids, liver and regulatory markers were examined in two studies, both of which found improvements in the PW group relative to a non-exercise control and strength training group (7, 13-15). One study found no effects of PW on either metabolic measures, or atherogenic index of plasma in people with impaired glucose regulation (13-15).
3.3.5 Psycho-social measures

Interestingly, only two studies in the review update examined psycho-social measures (4, 5, 8), compared with ten in the initial review (18, 20, 22-24, 26-29). Both examined PW relative to walking. Collins et al. found no effects of PW, compared with walking, on the SF36 Health Survey Physical Component Score or Walking Impairment Questionnaire in participants with peripheral vascular disease. Keast et al., when examining participants with heart failure, found improvements in PW, compared with walking, on depression, but not anxiety.

3.3.6 Dropout and attendance

Dropout rates were reported in all studies and were similar to those in the initial review (0-20%). There were no major differences in dropout rates between PW and control groups. The most commonly reported reason for dropout was non-program related medical reasons. Other reasons included lack of time or work constraints, non-attendance at follow-up testing, and motivational factors.

In the six studies which reported attendance rates, attendance varied from 61% to 100% (4, 5, 11-15). No studies reported adverse events, or reasons for non-attendance.

3.4 Discussion

An overview of the results of RCTs examining the effects of PW programs on physical and psycho-social health in adults published from November, 2011, to October, 2014, is provided in this chapter. The results confirm the findings of the initial review that PW confers some positive physical and psycho-social health benefits in various adult populations. The same numbers of studies were published in the last three years as in the previous 10 years, which indicates a maintained interest in the health effects of PW.

The quality of papers in the review update was slightly higher than in the initial review, with all papers except one rating as high quality. There are a number of reasons for this: five new papers reported on high quality studies included in the initial review; one new high quality study was represented in three papers; and all review update studies have been conducted in the past three years, with most
journals having a stronger focus on the use of CONSORT guidelines for reporting RCT results (31).

Blinding of outcome assessors, concealed treatment allocation and intention to treat analysis are still the main CONSORT items which are under-reported or not included in studies examining PW. There are often difficulties in concealing treatment allocation and blinding outcome assessors in PA trials (32), and it is important that readers have clarity on these issues in order to judge the validity of the trial (33). Intention to treat analysis is important to undertake in RCTs, as it overcomes any bias of differential drop out (33) and provides a better estimate of the effectiveness of an intervention.

This review update confirms evidence for positive effects of PW compared with a variety of control groups on endurance, functional status, PA, and muscle strength. It also strengthens evidence that, generally, there are positive effects of PW compared with non-exercise control groups, but no effects when compared with walking, in measures of anthropometry and oxygen uptake.

In addition to blood glucose measures, which were examined in the initial review, there were several new measures of metabolic markers were included in the review update, including lipid, liver and regulatory markers, metabolic measures, and atherogenic index of plasma. The majority of studies examining these measures indicated no effects of PW compared with non-exercise or other exercise controls on metabolic markers. Additionally, the findings of both reviews confirmed that there are no effects of PW on ankle brachial index.

Unfortunately, few new populations were represented in the review update. Several studies added additional measures, and three studies in the review update were conducted in populations which were previously studied. Clinical and non-clinical populations with balance or lower limb problems were still unrepresented in the review update.

In the initial review, further research investigating effects of PW on balance was indicated, as the use of poles has the potential to improve stability in users, similar to that of canes and crutches. This has implications for falls prevention (34). However, in the review update, only one study examined between group differences in balance (11), and none have examined dynamic balance during PW. In addition, it is unclear
whether improvements in balance might occur only while walking with poles. It is also unclear whether there would be a carry-over effect of improved balance when walking without poles, or in fact, whether there would be a deterioration in balance. The lack of investigations of the effects of PW on balance still highlights a future research direction.

Another condition which has not yet been examined is lower limb arthritis. Although Bechard et al. found no decrease in medial compartment loads in patients with varus gonarthrosis, there were large inter-participant variations (35). As well, only one measure of lower limb joint pain was included in the reviewed studies, and this showed a positive effect of PW on back, hand and leg pain in people with Parkinson’s disease (24). It is possible there may be clinical effects of PW in adults with hip or knee joint arthritis which are not yet clear, such as decreased in pain due to improved knee joint stabilisation. Further investigation of the effects of PW on lower limb joint pathology is therefore indicated.

Interestingly, the effects of PW in older adults was examined in four studies in the review update, whereas none of the studies in the published review studied this important population group (3, 6, 10, 11). Three studies included community dwelling older adults, and one investigated older adults undergoing rehabilitation. This indicates an interest in the potential benefits of walking with poles in the elderly. The study which examined between group outcome measures did so in a population of young old adults (mean age PW group, 62 years) (11). Two studies with populations of very old and frail adults investigated only within group differences (6, 10). Both studies included small numbers of participants, highlighting the difficulty of recruiting sufficient numbers for PA trials in the very old (36). These studies show that PW has the potential to be used as an adjunct to fitness, or as an assisted ambulatory device, in individuals at different stages of old age. It is therefore important to continue investigations of the effects of PW in old and low functioning populations.

3.5 Conclusions

In this review update, regarding effects of PW compared with controls on physical health, cardiorespiratory fitness was the most frequently studied outcome. Most improvements were observed for endurance. Fewer positive effects were found for oxygen uptake and ratings of perceived exertion. Other lesser studied physical
health outcomes, which were positive in the PW groups compared with controls, were functional measures, PA, anthropometry, and strength. Of two studies that examined the effects of PW on psycho-social health, one found positive outcomes for PW compared with walking. There were no positive effects of PW on compared with controls on ankle brachial index, heart rate and blood pressure, pain, flexibility, and blood glucose.

Taken together with the published review, this review update found evidence that confirmed the benefits of PW (compared with other types of exercise) on endurance, functional status, physical activity, and muscle strength. Few studies have investigated the effects of PW on lower limb joint arthritis and balance. There are still few studies of older adults (including the very old and low functioning) included in studies in this review update.

In conclusion, the findings of the literature review update are in line with the findings of the initial review and confirm that PW has beneficial effects on physical and psycho-social health in several population sub-groups.
<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>Chomiuk et al., (2013)</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>57</td>
</tr>
<tr>
<td>Collins et al.(A), (2012)**a†b</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y*</td>
<td>Y</td>
<td>Y</td>
<td>100</td>
</tr>
<tr>
<td>Collins et al.(B), (2012)**a†b</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y*</td>
<td>Y</td>
<td>Y</td>
<td>100</td>
</tr>
<tr>
<td>Ebersbach et al., (2013) †c</td>
<td>Y</td>
<td>?</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>71</td>
</tr>
<tr>
<td>Figueiredo et al., (2012)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>86</td>
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<tr>
<td>Fritz et al., (2013)†d</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>?</td>
<td>Y</td>
<td>Y</td>
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<td>Keast et al., (2013)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>86</td>
</tr>
<tr>
<td>Ota et al., (2013)</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y*</td>
<td>Y</td>
<td>N</td>
<td>57</td>
</tr>
<tr>
<td>Parkatti et al., (2012)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>86</td>
</tr>
<tr>
<td>Venojarvi et al.(A), (2013)**b</td>
<td>Y</td>
<td>Y*</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N* (except blood tests)</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Venojarvi et al.(B), (2013)**b</td>
<td>Y</td>
<td>Y*</td>
<td>Y</td>
<td>Y</td>
<td>Y*</td>
<td>Y</td>
<td>N</td>
<td>86</td>
</tr>
<tr>
<td>Wasenius et al., (2014)**b</td>
<td>Y</td>
<td>N*</td>
<td>Y</td>
<td>Y</td>
<td>N*</td>
<td>Y</td>
<td>N</td>
<td>71</td>
</tr>
</tbody>
</table>

# papers scoring a point /total papers: 14/15 9/15 12/15 14/15 6/15 15/15 7/15

Y=present; N=not present; ITT=intention to treat; #=number

* Quality rated after obtaining additional information from the authors

**a, **b Same study, but different papers and outcome measures

†a, †b, †c, †d Study reported in initial systematic review, but with different outcome measures
### Table 3-2 Participants, eligibility, and recruitment in the 12 studies (15 papers) reviewed

<table>
<thead>
<tr>
<th>Study, date</th>
<th>Population</th>
<th>Eligibility</th>
<th>Recruitment setting and methods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bjersing, 2012 (A)</strong></td>
<td>fibromyalgia</td>
<td>-women aged 20-60 years with fibromyalgia, defined by the ACR 1990</td>
<td>- NR</td>
</tr>
<tr>
<td>Sweden</td>
<td>N=49</td>
<td>-history of long-lasting generalized pain and pain in at least 11 of 18 tender points examined by manual palpation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>52 (interquartile range, 48-56)</td>
<td>-able to manage a bicycle test at 50 watts or more</td>
<td></td>
</tr>
<tr>
<td></td>
<td>49 F</td>
<td>-interest in exercising outdoors twice a week for 15 weeks</td>
<td></td>
</tr>
<tr>
<td><strong>Chomiuk, 2013 (A)</strong></td>
<td>elderly</td>
<td>-age over 65 years</td>
<td>-persons studying at the University of the Third Age in Warsaw</td>
</tr>
<tr>
<td>Poland</td>
<td>N=68</td>
<td>-efficient locomotor system enabling exercise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70.7, 69.9</td>
<td>-lack of serious disease limiting survival to 6 months</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M=8, F=60</td>
<td>-stable course of the heart disease: condition after a MI or cardiac and vascular surgery, over 6 months, no hazardous heart rhythm disorders, stable values of arterial pressure</td>
<td></td>
</tr>
<tr>
<td><strong>Collins, 2012 (A)</strong></td>
<td>peripheral artery disease</td>
<td>-peripheral artery disease</td>
<td>-radio and newspaper advertising</td>
</tr>
<tr>
<td>USA</td>
<td>N=85</td>
<td>-ankle-brachial index ≤0.90</td>
<td></td>
</tr>
<tr>
<td></td>
<td>69.4+/−9.1</td>
<td></td>
<td>-posted fliers</td>
</tr>
<tr>
<td></td>
<td>M=79, F=6</td>
<td></td>
<td>Letters of invitation sent to patients at the university and associated hospitals</td>
</tr>
<tr>
<td><strong>Collins, 2012 (B)</strong></td>
<td>peripheral artery disease</td>
<td>-ankle-brachial index in their most affected leg of 0.90 or greater or documented calcification of vessels</td>
<td>-NR</td>
</tr>
<tr>
<td>USA</td>
<td>N=103</td>
<td>-21 years or older</td>
<td></td>
</tr>
<tr>
<td></td>
<td>69.7+/−8.9</td>
<td>-positive response on the Edinburgh Claudication Questionnaire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M=96, F=7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

95
Ebersbach, 2013, Germany
- Parkinson Disease
- N=60
- 65.5+/9.0, 67.1+/-3.6, 69.3+/-8.4
- Men 36, Women 25
- Fulfill diagnostic criteria for idiopathic Parkinson's disease
- Hoehn & Yahr stages I–III
- Outpatient treatment
- Stable medication 4 weeks prior to inclusion
- Depression
- Dementia (MMSE < 25)
- Disabling dyskinesias, and co-morbidity affecting mobility or ability to exercise
- Referred from local outpatient clinics and office-based physicians

Figueiredo, 2012, Canada
- Elderly
- N=30
- 78 +/-7
- Men 13, Women 17
- ≥ 65 years old
- Undergoing rehabilitation in one of two participating centers
- Medically stable or in their usual state of health
- Severe cognitive impairments
- Unable to ambulate 15 m with or without aids
- Unrestricted mobility as represented by a gait speed >1.2 m/s
- Moderate to severe mobility limitation of upper extremity represented by a shoulder flexion ROM <90°, elbow flexion ROM <90°, and with a poor grip judged by the inability to release a can of 5 cm diameter
- Pathological conditions of the upper extremity
- Individuals whose planned time in rehabilitation was < 6 weeks
- Two rehabilitation centres from the Greater Montreal Area

Fritz, 2013, Sweden
- Overweight/obese individuals with normal glucose tolerance, impaired glucose tolerance, and type 2 diabetes mellitus
- N=213
- 60+/5.3, 95M 118F
- Age 45–69 years
- BMI > 25 kg/m²
- For people with Type 2 diabetes, HbA1c between 57 and 78 mmol/mol
- Physical impairment
- Symptoms of angina pectoris
- Atrial fibrillation determined by electrocardiogram
- Systolic or diastolic blood pressure > 160 or > 100 mmHg, respectively
- Insulin treatment
- Newspaper advertisements
- Personal letters of invitation to 447 former participants in the Stockholm Diabetes Prevention Program

Keast, 2013, Canada
- Moderate to severe heart failure
- N=54
- 62.4 +/- 11.4
- M=44, F=10
- Clinically stable heart failure
- Ejection fraction between 20% and 35%
- Ability to walk continuously for ≥ 10 minutes
- Inability to read and understand English
- Treatment for a serious psychiatric disorder in the past 10 years
- Unwillingness to return to the study centre for follow-up visits
- New referrals to the University of Ottawa Heart Institute’s cardiac rehabilitation program

Malicka, 2011, Poland
- Breast cancer
- N=38
- 62.8 +/- 8.1
- M=44, F=10
- Surgical treatment for breast cancer
- NR

Ota, 2013, Japan
- Day service centre users
- N=66
- 82.9 +/- 7.4, 82.6 +/- 5.9
- M=13, F=53
- Able to walk independently or under supervision
- To attend day service twice per week
- No severe cognitive impairment
- Inability to use the poles because of palsy of the hands and fingers
- Five day service centres facilities.
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Diagnosis</th>
<th>Sample Size</th>
<th>Gender</th>
<th>Age</th>
<th>Physical Activity</th>
<th>Other Conditions</th>
<th>Recruitment Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parkatti, 2012</td>
<td>Finland</td>
<td>older sedentary people</td>
<td>N=40</td>
<td>-</td>
<td>-5.2</td>
<td>male or female</td>
<td>-no disease</td>
<td>local newspaper</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>68.2± 3.8, 69.9±3.0</td>
<td></td>
<td></td>
<td>-no participation</td>
<td>-exercise</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>40 years or older</td>
<td>M=6, F=34</td>
<td></td>
<td></td>
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<tr>
<td>Spafford, 2014</td>
<td>UK</td>
<td>stable claudication</td>
<td>N=52</td>
<td></td>
<td>-45</td>
<td>male or female</td>
<td>-other conditions</td>
<td>referral from local vascular clinics over 12 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>65 (2), 62 (2)</td>
<td></td>
<td></td>
<td>-aged 65 years</td>
<td>-distance</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>M=35, F=17</td>
<td></td>
<td></td>
<td>-stable intermittent claudication</td>
<td>-walking distance</td>
<td></td>
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<tr>
<td>Venojarvi, 2013</td>
<td>Finland (A)</td>
<td>impaired glucose regulation</td>
<td>N=144</td>
<td></td>
<td>-55</td>
<td>fasting plasma</td>
<td>-previous detection of IGT</td>
<td>advertisements in newspapers and local occupational health care institutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>55 (6.2), 54 (6.1), 54 (7.2)</td>
<td></td>
<td></td>
<td>glucose 5.6-6.9 mmol/l and 2-h plasma glucose 7.8-11.0 mmol/l</td>
<td>-participation in regular and physically vigorous activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M=144</td>
<td></td>
<td></td>
<td>-BMI 25.1-34.9 kg/m2</td>
<td>-usage of any medication affecting glucose balance</td>
<td></td>
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<tr>
<td>Venojarvi, 2013</td>
<td>Finland (B)</td>
<td>impaired glucose regulation</td>
<td>N=144</td>
<td></td>
<td>-65</td>
<td>fasting plasma</td>
<td>-previous detection of IGT</td>
<td>advertisements in newspapers and local occupational health care institutes</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>54.5±6.5, 54 (6.1)</td>
<td></td>
<td></td>
<td>glucose 5.6-6.9 mmol/l and 2-h plasma glucose 7.8-11.0 mmol/l</td>
<td>-participation in regular and physically vigorous activities</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>M=144</td>
<td></td>
<td></td>
<td>-BMI 25.1-34.9 kg/m2</td>
<td>-usage of any medication affecting glucose balance</td>
<td></td>
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<tr>
<td>Wasenius, 2014</td>
<td>Poland</td>
<td>impaired glucose regulation</td>
<td>N=144</td>
<td></td>
<td>-65</td>
<td>fasting plasma</td>
<td>-previous detection of impaired glucose tolerance and engagement in any customized diet or exercise program</td>
<td>newspaper advertisements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PW 55.4 (6.2), EOPW 54.4 (6.1), NEC 53.6 (7.3)</td>
<td></td>
<td></td>
<td>glucose 5.6-6.9 mmol/l and 2-h plasma glucose 7.8-11.0 mmol/l</td>
<td>-engagement in regular and physically very vigorous activities</td>
<td>local occupational health care services</td>
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<td></td>
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<td>M=144</td>
<td></td>
<td></td>
<td>-BMI 25.1-34.9 kg/m2</td>
<td>-usage of any medication affecting glucose balance</td>
<td></td>
</tr>
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</table>

N=number; M=males; F=females; ACR=American College of Rheumatology; MMSE=mini-mental state examination; m=meters; m/s=meters per second; ROM=range of motion; cm=centimetres; kg=kilograms; l=litres; IGT=impaired glucose tolerance; mmol=millimoles; l=litres; BMI=body mass index; NR=not reported
<table>
<thead>
<tr>
<th>Study</th>
<th>Program and control strategies</th>
<th>Attendance</th>
<th>Outcome measures</th>
<th>Significant between group differences</th>
<th>Significant within group differences (p&lt;.05)</th>
</tr>
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<tr>
<td>Bjersing, 2012</td>
<td>Sweden</td>
<td>6 W</td>
<td>Physical</td>
<td>-NS</td>
<td>-1PW difference from baseline 36.5(15W), 29.3(30W)</td>
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<tr>
<td></td>
<td>15W/30W</td>
<td>session attendance NR</td>
<td>Physical</td>
<td>-NS</td>
<td>-1PW difference from baseline -0.7(30W)</td>
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<td></td>
<td>Program</td>
<td>-60-70%</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
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<td>-2x weekly, 40-45 min</td>
<td>moderate to high intensity</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
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<tr>
<td></td>
<td>-two physical education instructors per group</td>
<td></td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
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<tr>
<td></td>
<td>EOPW</td>
<td>low intensity walking</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
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<tr>
<td></td>
<td>-as for PW program</td>
<td>-session attendance NR</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
</tr>
<tr>
<td></td>
<td>Chomiuk, 2013</td>
<td>6 W</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
</tr>
<tr>
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<td>Poland</td>
<td>session attendance NR</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
</tr>
<tr>
<td></td>
<td>15W</td>
<td>-Pain threshold</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
</tr>
<tr>
<td></td>
<td>-6MWT</td>
<td>-Pain intensity</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
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<td>-IGF-1</td>
<td>-6MWT</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
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<tr>
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<td>-IGFB3</td>
<td>-SBP</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
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<td>-DBP</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
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<tr>
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<td>-no exercise program</td>
<td>-SBP</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
</tr>
<tr>
<td>Collins, 2012(A)</td>
<td>USA</td>
<td>12W</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
</tr>
<tr>
<td></td>
<td>session attendance NR</td>
<td>-initial claudication</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
</tr>
<tr>
<td></td>
<td>Program</td>
<td>12W/24W</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
<td>12W</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
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<tr>
<td></td>
<td>Follow-up assessments</td>
<td>12W</td>
<td>Physical</td>
<td>-NS</td>
<td>-NS</td>
</tr>
</tbody>
</table>
Program
- 3x weekly, 30 minutes building to 55 minutes
  - weeks 1-3: 20% light, 60% moderate, 20% hard, building to
    - week 10-12: 10% light, 45% moderate, 45% hard
  - supervision NR
EOPW
- walking
  - as for Program
Collins, 2012 (B)
USA
- 24W
  - PW 16W
    - Program
      - 3x weekly, 30-55 minutes
        - 30 minutes building to 60 minutes
          - weeks 1-3: 20% light, 60% moderate, 20% hard, building to
            - week 10-12: 10% light, 45% moderate, 45% hard
          - supervision NR
        - EOPW1: LSVT-BIG therapy
          - 4x weekly, 1 hr intensity NR
EOPW1: session attendance
  - NR
  - R: PW: 20/ EOPW1: 20
    - A: PW: 19/ EOPW1: 20/ EOPW2: 19

Physical
- % oxygenation
  - absolute walking time
    - R: PW: 45, W: 40
    - A: PW: 45, W: 40
  - time to nadir value
    - peak oxygen consumption
      - ABI
  - time to nadir value
    - peak oxygen consumption
      - ABI
  - as for Program
  - session attendance
    - NR
    - R: PW: 20/ EOPW1: 20
      - A: PW: 19/ EOPW1: 20/ EOPW2: 19
  - session attendance
    - NR
    - R: PW: 20/ EOPW1: 20
      - A: PW: 19/ EOPW1: 20/ EOPW2: 19

Ebersbach, 2013
Germany
- PW 16W
  - EOPW1 4W
    - Program
      - 2x weekly, 1 hr intensity NR
        - group based, supervised sessions
      - EOPW1: LSVT-BIG therapy
        - 4x weekly, 1 hr intensity NR
- PW 325+/-3.1 vs baseline 3.7+-/2.0 (16W)
- EOPW 16W
  - EOPW1 4W
    - Program
      - 2x weekly, 1 hr intensity NR
        - group based, supervised sessions
      - EOPW1: LSVT-BIG therapy
        - 4x weekly, 1 hr intensity NR
- PW 339+/-7.1 vs baseline 388+/-136 (8W)
- EOPW 16W
  - EOPW1 4W
    - Program
      - 2x weekly, 1 hr intensity NR
        - group based, supervised sessions
      - EOPW1: LSVT-BIG therapy
        - 4x weekly, 1 hr intensity NR
- PW 325+/-80 vs baseline 388+/-136 (16W)
EOPW 2: home exercises, initial instruction, supervised
-6W
-6W Program
-2x weekly, 20 minute intensity NR
-individual, physiotherapist who was also a certified PW instructor
EOPW: walking as for PW program

Figueiredo, 2012
Canada
-6W
-6W Program
-2x weekly, 20 minute intensity NR
-individual, physiotherapist who was also a certified PW instructor
EOPW: walking as for PW program

Session attendance
NR
-13%
R: PW:14/ EOPW:16
A: PW:13/EOPW:13

Fritz, 2013
Sweden
-16 W
-16 W Program
-5 hrs weekly intensity NR
-individual based, non-supervised
NEC: habitual daily activity

Session attendance
NR
-5%
R: 87PW/NEC:125
A: 87PW/NEC: 125

Keast, 2013
Canada
-12W
-12W Program
-2 x weekly, 15-30 minutes intensity NR
-60-70% heart rate reserve - group–based, supervised by

Session attendance
NR
-28.5%
R: EOPW:66.9%+-/ 29.8%
-20%
-20%
R: PW:27, EOPW:27
A: PW:27, EOPW:27

Sexual

Physical
-6MWT
-5-m walk test
-Berg balance scale
-Lower extremity function scale
-pain

-1PW difference from baseline 45(14,74)
-1PW difference from baseline 0.144 (0.8, 0.3)
-1PW 2(0.4, 8)
-NS
-NS

R:PW:14/ EOPW:16
A: PW:13/EOPW:13

NEC:
-habitual daily activity

-1PW (NGT)
-1PW (NGT)
-1PW (NGT, T2DM)
-1PW (NGT, IGT, T2DM)
-1PW (NGT, IGT, T2DM)
-1PW (NGT, IGT, T2DM)
-1PW (NGT, IGT, T2DM)
-1PW (NGT, IGT)
-1PW (NGT)
-1PW (NGT)
-1PW (T2DM)
-1PW (T2DM)
-1PW (T2DM)
-1PW (NGT)
-1PW (NGT)
-1PW vs EOPW
-1PW vs EOPW
-1PW vs EOPW
-1PW vs EOPW

-1PW (NGT)
-1PW (NGT, T2DM)
-1PW (NGT, IGT, T2DM)
-1PW (NGT, T2DM)
-1PW (NGT, IGT, T2DM)
-1PW (NGT, IGT, T2DM)
-1PW (NGT, IGT, T2DM)
-1PW (NGT, IGT)
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- ↑ PW vs NEC (velocity 36.67, 24.44, 12.22 cm/sec)
- ↑ PW vs baseline (velocity 36.67, 24.44, 12.22 cm/sec)
- ↑ PW vs baseline (velocity 36.67, 24.44, 12.22 cm/sec)
- ↑ PW vs baseline (velocity 36.67, 24.44, 12.22 cm/sec)
- ↑ PW vs baseline (velocity 24.44, 12.22 cm/sec)
- ↑ PW vs baseline (velocity 24.44, 12.22 cm/sec)
- ↑ PW vs baseline (velocity 12.22 cm/sec)
- ↑ PW vs baseline (velocity 24.44 cm/sec)
- ↑ PW vs baseline (velocity 36.67, 24.44, 12.22 cm/sec)
- ↑ PW vs baseline (velocity 12.22 cm/sec)
- ↑ PW vs baseline (velocity 24.44 cm/sec)
- ↑ PW vs baseline (velocity 36.67, 24.44, 12.22 cm/sec)
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<td>Ota, 2013</td>
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<td>Program -3M: 2 x weekly, average time/session 9.7 minutes -usual daily activity level -during usual walking activities, supervision NR</td>
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<td>Parkatti, 2012</td>
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<td>9W</td>
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<td>↑PW vs NEC</td>
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<td>Spafford, 2014</td>
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<td>-12W</td>
<td>Program -12W: 3 x weekly, 30 minutes -normal walking pace</td>
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<td>-4W/8W/12W</td>
<td>R: PW:28, EOPW: 24</td>
<td>-31%</td>
<td>↑PW (with poles) vs EOPW (0W, 12W)</td>
<td>↑0.04 (0.01-0.08)(0W), 0.07 (0.04, 0.10)(12W)</td>
<td>↑tested without poles 124 m, tested with poles 148 m (0W), tested without poles 199 m, tested with poles, 151 m (12W)</td>
<td>↑tested without poles 248, tested with poles 389 (0W), tested with poles 538, tested without poles 400(12W)</td>
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**103**
Wasenius N, 2014
Poland

-12W
-4W/8W/12W Program
-3 x weekly, 60 minutes
-55-75% heart rate reserve
-personal trainers, physiotherapy/exercise physiology students
EOPW
-power-type strength training
-as for PW program
NEC

-PW: 61%, EOPW: 67%, -20%
-R: PW: 48, EOPW: 49, NEC: 47
A: PW: 39, EOPW: 36, NEC: 40

-1PW vs EOPW (absolute and relative intensities) (W 1-4, W 5-8, W 9-12)
-1PW intensity (W 1-4, W 5-8, W 9-12)

-1PW vs NEC

-1PW vs EOPW (frequency and volume) (W 1-4, W 5-8, W 9-12)

-1PW vs NEC

-TPW vs EOPW (absolute and relative intensity) (W 1-4, W 5-8, W 9-12)
and NEC (relative intensity) (W 5-8, W 9-12)

PW=pole walking; EOPW=exercise other than Pole walking; NEC=non-exercise control; R=randomised; A=analysed; NS=not significant; NR=not reported; M=months; W=weeks; VO2=maximal oxygen uptake; BMI=body mass index; BP=blood pressure; HR=heart rate; ABI=ankle brachial index; RPE=ratings of perceived exertion; MET=metabolic equivalent; 6MWT=6 minute walk test; TUG=timed up and go; WIQ=Walking Impairment Questionnaire; SF=Medical Outcomes Study Short Form; NGT=normal glucose tolerance; IGT=impaired glucose tolerance; T2DM=type two diabetes mellitus; AIP=atherogenic index of plasma; HMW=high molecular weight adiponectin; OPN=Osteopontin; OPG=osteoprotegerin; SBP=systolic blood pressure; DBP=diastolic blood pressure; HbA1c=National Glycohemoglobin Standardization Program standard; HOMA=homeostasis model assessment of insulin resistance; HDL=high density lipoprotein; LDL=low density lipoprotein; TG=triglyceride; HADS=hospital anxiety and depression scale; hs-CRP=high sensitivity C-reactive protein; yGT=gamma glutamyltransferase; RBP4=retinol binding protein 4; TNF-α=tumour necrosis finding alpha; AIP=atherogenic index of plasma
Table 3-4: Outcome measures and results of 9 studies (12 papers) examining effects of pole walking on physical and psycho-social health (number of measures that showed significant change/ total number of measures)*

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N=number; NEC=non exercise control; EOPW=exercise other than pole walking; RPE=ratings of perceived exertion; HR=heart rate; BP=blood pressure; AIP=atherogeinic index of plasma

Dark coloured=significant improvement of PW compared to control in at least one outcome measure; Medium coloured=non-significant change in outcome measure; Light coloured=significant decrease in at least one outcome measure of PW; reference number in bold face indicates high quality study

*Papers by Figuerido et al., and Ota et al. were not included in this table because only within group differences were reported. The total number of studies is therefore 9

** Same study, but different papers and outcomes
Table 3-5  Updated summary of effects from 21 studies (25 papers), of pole walking groups versus control groups

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<td>W(2), LIW</td>
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</tr>
<tr>
<td>Heart rate/ blood pressure</td>
<td>W, LIW, FL W NEC(2)</td>
<td>W NEC, W NEC(2) ST</td>
<td>W(2) NEC(2) W(2)</td>
<td>(25), (13) (29)</td>
</tr>
<tr>
<td>Ankle brachial index</td>
<td>W(2), NEC, W NEC</td>
<td>NEC, HE NEC</td>
<td>LSVT LSVT</td>
<td>(23), (25), (10), (15), (27), (17), (28), (15), (28)</td>
</tr>
<tr>
<td>Functional status</td>
<td>NEC, W, FL NEC(2), W, FL</td>
<td>W NEC, W NEC, LIW</td>
<td>W NEC, LIW</td>
<td>(6), (29), (23), (25), (24), (29), (7), (14), (23), (14)</td>
</tr>
<tr>
<td>Pain</td>
<td>NEC(2), W, FL NEC</td>
<td>NEC, W, ST W</td>
<td>W NEC</td>
<td>(6), (26), (13), (7), (17), (16), (25), (6), (7), (8), (10), (17)</td>
</tr>
<tr>
<td>Physical activity</td>
<td>NEC(2) W, CYC NEC</td>
<td>NEC(2), ST W(2)</td>
<td>W W</td>
<td>(10), (17), (25)</td>
</tr>
<tr>
<td>Anthropometry</td>
<td>NEC(2) W, CYC NEC</td>
<td>NEC(2), ST W(2)</td>
<td>W NEC(2), CYC</td>
<td>(23), (10)</td>
</tr>
<tr>
<td>Muscle strength</td>
<td>W, CYC W NEC</td>
<td>NEC(2), W, ST W(2)</td>
<td>NEC(2) W</td>
<td>(8)</td>
</tr>
<tr>
<td>Lymphedema</td>
<td>W, FL NEC</td>
<td>NEC W(2), CYC</td>
<td>NEC NEC</td>
<td>(13), (6), (6), (13), (26), (2), (12)</td>
</tr>
<tr>
<td>Metabolic markers (blood glucose measures, lipid, liver, regulatory markers, other metabolic measures, AIP)</td>
<td>NEC(2), ST NEC</td>
<td>NEC NEC</td>
<td>NEC NEC</td>
<td>(13), (6), (6), (13), (26), (2), (12)</td>
</tr>
<tr>
<td>Gait parameters</td>
<td>W, FL NEC</td>
<td>W NEC(2), ST W(2)</td>
<td>NEC(2), LIW ST</td>
<td>(29), (23), (18), (7), (24), (21), (22), (20), (27), (23), (26), (28), (3)</td>
</tr>
<tr>
<td>Fatigue</td>
<td>NEC</td>
<td>NEC</td>
<td>NEC</td>
<td>(27)</td>
</tr>
<tr>
<td>Quality of Life/wellbeing</td>
<td>NEC(5), FL, LIW W</td>
<td>NEC(2), W, LSVT, HE W</td>
<td>NEC(2), ST</td>
<td>(29), (23), (18), (7), (24), (21), (22), (20), (27), (23), (26), (28), (3)</td>
</tr>
<tr>
<td>Other outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medication, other treatment, time off, expectation to treatment</td>
<td>NEC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NEC=non exercise control; EOPW=exercice other than pole walking; LIW=light intensity walking; W=walking; LSVT=Lee Silverman Voice Therapy (exercise therapy for Parkinson’s disease); HE=home exercises; ST=strength training; FL=flexibility and relaxation exercises; CYC=cycle ergometer; AIP=atherogenic index of plasma

References in green=positive effects of PW vs control groups; references in orange=no effects of PW vs control groups, references in red=negative effects of PW vs control groups; numbers in parenthesis=number of papers
3.6 References


4. CHAPTER FOUR: Survey

This study has been published in the *Health Promotion Journal of Australia* (Impact Factor 1.089).

See Appendix three for the published version.
4.1 Abstract

**Issue addressed:** Although pole walking (PW) has the potential to be a useful health-enhancing physical activity (PA), little is known about by whom or how it is being practised. The aims of this study were to describe (1) the characteristics of PW leaders, pole walkers and PW programs in Australia, and (2) participants’ perceptions of PW and their reasons for participation.

**Methods:** In 2012, PW leaders (n=31) and walkers (n=107) completed self-administered surveys that included questions about participants’ sociodemographic and health characteristics, PW programs and perceptions of PW. Data were analysed using SPSS.

**Results:** Leaders and walkers were generally born in Australia (leaders, 71%; walkers, 83%), older (leaders, 55 years [SD, 11.5]; walkers, 65 years [SD, 10.6]) and female (leaders, 77%; walkers, 79%). Most walkers (82%) walked regularly in groups, approximately once per week for about an hour, at light to moderate intensity. The program’s aims most strongly endorsed by PW leaders were to increase participant enjoyment (90%), increase PA levels (81%), provide a positive social experience (77%) and increase PA confidence (71%). The most strongly endorsed motivations for PW among walkers were to remain physically active (63%), improve fitness (62%) and personal and social enjoyment (60%).

**Conclusions:** In Australia, PW is being practised by a health conscious, older population. It is perceived as an enjoyable and health enhancing outdoor activity.

**So what?:** Health and exercise practitioners may find that PW is a beneficial form of PA for older Australians.
4.2 Introduction

The health benefits of regular physical activity (PA) are well known, and walking is an activity that is suitable for people of all ages, including those with chronic health conditions (1, 2). Walking with the addition of hand-held poles, or pole walking (PW), was developed in Europe and North America to maintain or improve fitness, and was recently introduced in Australia. PW is often taught and practiced under the guidance of trained PW leaders.

PW has similar low impact, moderate intensity characteristics to walking (3, 4). However, studies have found that cardiovascular responses are greater during PW than during regular walking at the same speed, while perceived exertion is similar (5, 6). A recent systematic review examining the effects of PW on health and wellbeing found beneficial effects of PW on cardiorespiratory function (fitness), body mass and waist circumference, pain levels, and quality of life, in both healthy adults and in those with chronic disease (7).

PW developed from the commonly practiced sport of cross country skiing, and, although widespread in Europe and Scandinavia, little is known about who participates in this activity in Australia (where skiing has a much lower profile), what type of programs exist for Australian pole walkers, or why they participate (8-10). Given the health benefits of PW, understanding the characteristics of PW programs in Australia, and of the people who regularly participate in them, would inform efforts to promote this activity in Australia.

The social ecological model (SEM) is widely used as a framework for understanding the factors which affect PA behaviour (11-13). It was used in this study to guide the development of questions about participation in PW, in order to improve understanding of the individual, social and environmental factors associated with participation in this activity.

The aims of this study were to describe (1) the characteristics of PW leaders, walkers, and programs in Australia, and (2) participants’ perceptions of PW and reasons for participation.

4.3 Methods

4.3.1 Design

This was a cross-sectional study. Data were collected in May-July, 2012.
Participants

PW leaders

Two of the three organisations in Australia involved in training PW leaders agreed to participate in the study (14-16). The leaders affiliated with these organisations were personally informed of the study by phone or email by the research team. Leaders who registered interest in participating were sent a leader survey, which they were asked to complete and return by reply paid mail. Up to two telephone reminders were made to leaders who did not return their survey.

Pole walkers

Participating PW leaders were asked to distribute surveys to pole walkers who were currently walking with their groups or individually, but not leading groups. Participating pole walkers were asked to complete the pole walker survey, and return it to the research team by reply paid mail.

Ethics and Informed Consent

The study was approved by University of Queensland Human Research Ethics Committee. Participation in the study was voluntary, written study information was provided, and informed consent of PW leaders and walkers was assumed by the return of the completed survey.

4.3.2 Measures

Standard questions were used to assess the sociodemographic characteristics of both leaders and walkers; these included age, sex, marital status, education, employment status, occupation, and country of birth. In addition, each questionnaire included specific questions for the leaders or walkers (details below).

Specific questions for PW leaders

The leaders’ survey consisted of 31 questions grouped into three sections: 1) sociodemographic information; 2) professional and PW program characteristics; and 3) program aims. In addition to the sociodemographic characteristics detailed above, PW leaders were asked a number of questions regarding their professional characteristics, including how long they had been PW leaders, exercise qualifications, and whether they worked for local health or community organisations. Questions about the PW program
characteristics included: number of groups; number of session attendees; session frequency, intensity (ranging from “as hard and fast as they can manage (vigorous)”, to “light intensity”, or “at variable intensities”), content and duration; and environment. Leaders were also asked about session and pole charges, and availability of options to buy or rent poles. Furthermore, they were asked whether they targeted particular age groups- for example, younger people (aged 18-45 years), middle-aged people (aged 45-65 years), older people (aged 65 years or over), or no specific age range- and people with specific health conditions, including chronic disease, obesity, chronic pain, balance problems, mental health issues, lower limb joint replacements, or other health conditions. Leaders were also asked to rate the importance of several statements concerning the program aims on a five point Likert scale, from 1 (“not at all important”) to 5 (“very important”). At the conclusion of the survey, leaders had the opportunity to add comments.

Specific questions for pole walkers
The pole walkers’ survey consisted of 43 questions grouped into four sections: 1) sociodemographic information; 2) health, health behaviours and PW history; 3) program and equipment characteristics; and 4) reasons for participation, perceptions of PW, and perceptions of differences between PW and walking. Questions about health included self-reported health, pain (location) (17), joint replacements (location), falls in the past 12 months, and health conditions (18). Self-reported weight and height were used to calculate body mass index (BMI) (kg/m²) (19).

Physical activity (PA) and sedentary behaviour (SB) were assessed using the Active Australia Survey (AAS) and the five domain sitting questionnaire respectively (20, 21). The AAS is used in Australian national surveys (22, 23). The questions assess frequency and time spent walking, and in moderate and vigorous leisure time activity in the past week. Any time greater than 840 minutes (14 hours) for a single activity type was recoded to 840 minutes as per the data management protocol (24). Time in each activity was then multiplied by a value of 3.33 METs (Metabolic Equivalents, or multiples of resting oxygen uptake) for walking and moderate activity, and 6.66 METs for vigorous activity. Total MET.minutes were categorized as daily PA of none (<33 MET.mins), some (33-499 MET.mins), or meeting guidelines (≥500 MET.mins) (24).
The five domain sitting questionnaire assesses the number of hours spent sitting at work, while travelling, watching television, using a computer when not at work, and during other recreation on a usual week day and weekend day (21). Average hours of sitting per day were calculated as: \( (5 \times \text{average weekday sitting in the 5 domains} + 2 \times \text{average weekend day sitting in the 5 domains})/7 \) (21).

Questions about PW history and programmes included how long participants had been walking with poles, whether they walked in a group or individually, and how often they walked. Questions about equipment included the cost of poles.

Finally, to address the second aim, pole walkers were asked to rate their agreement with a number of statements about reasons for participation in PW, perceptions of PW, and perceived differences between PW and regular walking, on a 5-point Likert scale, from 1 (“strongly disagree”) to 5 (“strongly agree”).

At the conclusion of the survey, walkers were given the opportunity to say what was easy or difficult about PW, and to add any other comments about their PW experiences.

### 4.3.3 Analysis

Data were analysed using descriptive statistics in SPSS version 20 (SPSS Inc., Chicago, IL). Written responses to the open ended questions in the PW leader and pole walker surveys were used to illustrate quantitative results.

### 4.4 Results

#### 4.4.1 Leaders

Thirty-one of the thirty-six contacted PW leaders returned the completed surveys (86%). Their sociodemographic characteristics are shown in Table 4-1. Ages ranged from 33 to 78 years, with a mean of 55 years (SD, 11.5). Most were female and born in Australia. Leaders’ professional characteristics are shown in Table 4-2. Most leaders had been leading groups for an average of 4.25 years (SD, 2.9), and had exercise or health qualifications. Most PW programs were organised within facilities such as Community Health Centres.

Program characteristics are shown in Table 4-2. The majority of leaders led one group of approximately eight regular participants per week. Most sessions were of light to
moderate intensity and included warm-up and cool down periods. Average PW time during the session was 43 minutes (SD, 10.5).

PW sessions were held in a variety of different environments, including sports grounds, public parks, urban areas, public facility grounds, bushland, and beaches (Table 4-2). The average session charge was AUD$3.70 (range AUD$0-$15). Free poles were supplied by more than half the leaders. The average cost of hiring poles was AUD$4.60 per session (range AUD$ 0-$15), and average cost to purchase poles was AUD$148 (range AUD$70-$200).

Most leaders reported that they did not target a certain age group. However, there were specific groups for people with chronic disease, chronic pain, lower limb joint replacements, balance problems, obesity, and mental health conditions.

PW leaders reported the most strongly endorsed program aims were: participant enjoyment, increasing PA levels, ensuring a positive social experience, and increasing PA confidence (See Figure 4-1). Participant enjoyment was endorsed as very important by 90% of leaders, supported by comments similar to the following by a female leader (age 49) that ‘it is great fun’. Increasing PA levels was classed as very important by 81% of leaders. This was reflected in the following comment by a 71 year old female leader “...We do only walk at a gentle pace but the distance we walk has increased substantially from 1 km to 3 km and occasionally further.” Ensuring a positive social experience was endorsed as very important by 77% of leaders. A female leader (59 years) said, “We include a social lunch once a month after the PW session- beneficial to my seniors’ mental health and a reward for attending programs”. Finally, 71% of leaders reported that increasing PA confidence was very important for their participants. A 78 year old male leader commented “We help to extend… or to at least sustain present activity levels.”

4.4.2 Pole walkers

Pole walkers’ surveys were distributed to 148 walkers, and 107 (72%) were completed and returned. The average age of pole walkers was 65 (SD, 10.6) years. Most were female, retired, and born in Australia (Table 4-1).

Responses to the questions about health, health behaviours and PW history are shown in Table 4-3. A total of 87% participants rated their health as either good, very good or excellent. However, the majority experienced bodily pain, 20% had experienced one or
more falls in the past year, and most reported various health conditions. Average BMI was 27 kg/m$^2$ (SD, 5.1). The majority met current PA guidelines, and sat for more than 6 hours per day.

Regarding PW history, program and equipment, pole walkers had participated in PW for between one month and 10 years, with an average of almost 3 years (SD 26.5 months). Most participants walked with a group once per week. However, 39% reported two to seven PW sessions per week. Most pole walkers purchased their own poles, at an average cost of AUD$112 (SD, 56.6), although the cost varied from $12 to $220. Pole walkers’ reasons for participation and perceptions of PW are shown in Figure 4-2.

Almost two thirds of walkers strongly agreed with the following reasons for PW: remaining physically active (63%), improving fitness (62%), personal enjoyment (60%), and social enjoyment (60%). Many responses to open ended questions related to the extra activity achieved, and especially the extra stability provided by the poles. For example, a 79-year-old male commented “I felt safe and secure knowing there is less chance of falling”. Several comments related to increased fitness gained by using poles. A 57-year-old male walker commented “I find that pushing really hard with poles in soft sand, or up hills (or both) can have me breathing nearly as hard as in my running days”. Although most walkers who commented on the social aspect of PW groups were not specific about PW, there were some unique social benefits to exercising with poles. For example, a 72-year-old male commented “Being on crutches or a walking stick has reduced my mobility. PW lets me exercise and enjoy the wonderful company of other people without standing out. Everybody uses poles.” More generally, several walkers specified positive elements of their environment as being part of the enjoyment of PW. For example, a 68-year-old female walker (aged 68) commented on the enjoyment in “…seeing the early morning sun rise or the kangaroos”.

Half the pole walkers strongly agreed that PW was easy to learn and maintain (49% and 52%, respectively), and 61% strongly agreed that they were confident that they would walk with poles in the next month, but only 25% strongly agreed that they found it easy to walk regularly when difficulties arose (Figure 4-2). Most walkers (87%) agreed that there was a difference between PW and regular walking. 51% strongly agreed they had stronger arms and 46% strongly agreed that PW used more energy than regular walking (see Figure 4-3).
| Table 4-1 Sociodemographic characteristics of the pole walking leaders and pole walkers |
|---------------------------------------------|----------------|----------------|
|                                             | Leaders N=31   | Walkers N=107  |
| Age (years)                                 | n  | %  | n  | %  |
| <55                                         | 15 | 50 | 16 | 15 |
| 55-69                                       | 13 | 43 | 54 | 52 |
| 70+                                         | 2  | 7  | 34 | 33 |
| Sex                                         |     |    |    |    |
| Male                                        | 7  | 23 | 23 | 21 |
| Female                                      | 24 | 77 | 84 | 79 |
| Marital status                              |     |    |    |    |
| Single (never married/previously married)   | 3  | 10 | 37 | 35 |
| Married/defacto                             | 27 | 90 | 70 | 65 |
| Education                                   |     |    |    |    |
| High school, leaving certificate or less    | 3  | 10 | 46 | 43 |
| Trade/apprenticeship/certificate/diploma    | 11 | 37 | 26 | 25 |
| University degree or higher degree          | 16 | 53 | 34 | 32 |
| Employment                                  |     |    |    |    |
| Full time                                   | 11 | 36 | 18 | 16 |
| Part time                                   | 13 | 41 | 20 | 19 |
| Not in paid employment                      | 7  | 23 | 69 | 65 |
| Occupation                                  |     |    |    |    |
| Professional                                | 18 | 60 | 25 | 23 |
| Skilled tradesperson/labourer               | 2  | 7  | 14 | 13 |
| Retired                                     | 9  | 30 | 66 | 62 |
| No paid job, student                        | 1  | 3  | 2  | 2  |
| Country of birth                            |     |    |    |    |
| Australia                                   | 22 | 74 | 90 | 87 |
| United Kingdom/Europe                       | 6  | 20 | 13 | 12 |
| Other (USA, Asia)                           | 2  | 6  | 1  | 1  |
Table 4-2  Professional characteristics of the leaders and characteristics of their pole walking programs (n=31)

<table>
<thead>
<tr>
<th>Professional characteristics</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration leading groups (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 4 years</td>
<td>11</td>
<td>35</td>
</tr>
<tr>
<td>4-6 years</td>
<td>12</td>
<td>39</td>
</tr>
<tr>
<td>Over 6 years</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td><strong>Exercise qualifications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise/fitness qualifications</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td>Health qualifications</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td><strong>Program characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average number of participants per session</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-6</td>
<td>14</td>
<td>45</td>
</tr>
<tr>
<td>7-12</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>≥ 12</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td><strong>Session intensity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vigorous</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Moderate</td>
<td>11</td>
<td>36</td>
</tr>
<tr>
<td>Light-moderate</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td>Variable</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td><strong>Environmental setting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sports ground</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>Public park</td>
<td>24</td>
<td>77</td>
</tr>
<tr>
<td>Urban area</td>
<td>12</td>
<td>39</td>
</tr>
<tr>
<td>Public facility grounds</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Bushland</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>Beach</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td><strong>Costs and charges</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per session (AUD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free</td>
<td>11</td>
<td>39</td>
</tr>
<tr>
<td>&lt; $5</td>
<td>12</td>
<td>43</td>
</tr>
<tr>
<td>$5-$15</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Cost of buying poles (AUD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; $150</td>
<td>23</td>
<td>77</td>
</tr>
<tr>
<td>≥ $150</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Duration of each session (min) mean (SD)</td>
<td>43</td>
<td>(11)</td>
</tr>
</tbody>
</table>

* Total may not add up to n=30 or 100%, as multiple answers were possible

PW=pole walking; min=minutes; SD=standard deviation; AUD=Australian dollars
Figure 4-1 Importance of pole walking program aims as rated by the pole walking leaders (% agreement) (N=31)*

<table>
<thead>
<tr>
<th>Aim</th>
<th>Very important</th>
<th>Somewhat important</th>
<th>Neutral</th>
<th>Not at all important/ not very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant enjoyment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increasing PA levels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ensuring a positive social experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increasing PA confidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving mental health</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular session attendance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving CV fitness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CV=cardiovascular; PA=physical activity

* In order of decreasing proportion indicating very important
Table 4-3  Health, health behaviours and pole walking history of pole walking participants (n=107)*

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self-rated health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Fair</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Good</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Very good</td>
<td>47</td>
<td>44</td>
</tr>
<tr>
<td>Excellent</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td><strong>Pain</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>Spinal pain</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Other pain</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td><strong>Joint replacement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>89</td>
<td>88</td>
</tr>
<tr>
<td>Knee</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Hip</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Shoulder</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2nd joint replacement (hip)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Falls in the past 12 months</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>84</td>
<td>80</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>&gt;1</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td><strong>Health conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>Arthritis</td>
<td>51</td>
<td>48</td>
</tr>
<tr>
<td>Depression, anxiety or stress</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>Bronchitis, asthma and other lung conditions</td>
<td>16</td>
<td>15</td>
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<tr>
<td>Angina, high blood pressure, high cholesterol and other heart conditions</td>
<td>14</td>
<td>13</td>
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<tr>
<td>Diabetes</td>
<td>9</td>
<td>8</td>
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<tr>
<td>Other</td>
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<tr>
<td><strong>Body Mass Index (kg/m²)</strong></td>
<td></td>
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</tr>
<tr>
<td>&lt; 25</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>25-30</td>
<td>42</td>
<td>40</td>
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<tr>
<td>≥30</td>
<td>21</td>
<td>20</td>
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<td><strong>Health behaviours</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Physical activity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None (&lt; 33 MET.min/week)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Some (33-499 MET.min/week)</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Meeting guidelines (≥ 500 MET.min/week)</td>
<td>82</td>
<td>81</td>
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<tr>
<td>Physical activity (min/week; median (IQR))</td>
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<tr>
<td><strong>Sitting time (min/day; mean +/-SD)</strong></td>
<td>385 +/-173</td>
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<tr>
<td><strong>History of participating in PW</strong></td>
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<td>26</td>
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<tr>
<td>≥ 60 months</td>
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<td>18</td>
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<tr>
<td><strong>Group/individual sessions</strong></td>
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<tr>
<td>Walk with a group</td>
<td>88</td>
<td>82</td>
</tr>
<tr>
<td>Walk with one other</td>
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<td>13</td>
</tr>
<tr>
<td>Walk alone</td>
<td>18</td>
<td>17</td>
</tr>
</tbody>
</table>

Kg=kilograms; m=meters; PA=physical activity; SD=standard deviation; MET=metabolic equivalent; min=minutes

*Totals may not add up to n=107 or 100% because of missing data or multiple answers.
Figure 4-2: Pole walkers’ reasons for participation, and perceptions of pole walking (% agreement) (N=107)

Figure 4-3: Pole walkers’ perceptions of differences between pole walking and walking (% agreement) (N=107)
4.5 Discussion

In contrast with countries such as Finland, where it has been well established for over 20 years (25), PW is relatively new to Australia. This study aimed to explore the characteristics of PW leaders, walkers, and programs in Australia, and to describe participants' perceptions of PW and reasons for participation. The results indicated that PW is predominantly instructed and practiced by older women who were born in Australia. Most participants walked regularly in groups about once per week, at light to moderate intensity, for about an hour, and had walked regularly for several years. This indicates that PW has the potential to contribute towards achieving the minimum PA levels of 150 mins/week recommended in public health PA guidelines (26).

In this study we used the social ecological model to understand better the broad range of factors associated with participation in PW (11, 12). The majority of participants identified fitness and health benefits as important reasons for participating in PW. Most pole walkers felt that, compared with walking, PW resulted in greater fitness, arm strength, and balance and less stiffness and pain. This is in line with previous studies which have identified the health benefits of PW in several adult populations, especially in relation to fitness benefits (7, 27). PW may provide an activity for those who wish to increase their health and fitness more than walking will allow, but who are unable to participate in high impact activities, such as older adults, or those undergoing rehabilitation.

Self-efficacy, or confidence about being able to perform a particular activity, is positively associated with PA participation in older adults (28). PW requires a measure of technical skill, and half the pole walkers in this study found the technique difficult initially. However, most reported high levels of confidence in maintaining the technique once learnt, and the technical achievement may be the reason many pole walkers were long time participants in the activity. Additionally, PW may be important for PA confidence in this age group when outdoors, as poles were perceived to be useful for balance on rough ground, sand and hills. PW may therefore be a valuable alternative to walking for those with balance issues.

Further factors identified by walkers were personal enjoyment of the activity (individual) and social support (social) provided by the groups. Both enjoyment (29-31) and social support (32-34) have been consistently identified as correlates of a wide variety of activities older people engage in. Interestingly, both leaders and walkers shared several
characteristics, such as age and sex, and thus leaders may contribute to peer as well as leader support (35).

Importantly, the SEM emphasises the dynamic interplay among diverse factors which underpin participation in PA. A clear example of this interplay was the participants' appreciation of outdoor environments (environmental factor) and how this improved their personal enjoyment (individual factor) of PW. The majority of the PW settings were parkland, sports grounds or bushland. PW is an accessible type of activity because it does not require specialised facilities and can be done in many locations. Furthermore, Australia’s relatively mild climate and amount of “green space” available for recreation are suited for outdoor activities. Australian studies reported that adults positively associate environmental aesthetics with PA (32, 33). Moreover, almost two thirds of participants (aged between 60 and 67 years) in a large Australian population based study indicated a preference for outdoor activities, with more than four fifths preferring low cost PA, and more than half preferring to do PA with people their own age (34). Context preferences such as types and locations of PA, and preferences for group or individual participation varied. However, PW may be a valuable option for those older adults who prefer outdoor activities that are inexpensive and can be done with their peers.

This is the first study to obtain information about the characteristics of PW leaders and walkers in Australia. Because both participating organisations have been established since 2000 (15, 16), most active leaders were able to be located. Non-participation of leaders and walkers from the third organisation could affect the results if these pole walkers differed from the participants of the other two. Additionally, if those with unfavourable PW experiences were less likely to participate, a selection bias could affect results with more positive attitudes towards PW being reported. However, response rates for both leaders and walkers were high.

A further limitation of this study is that the participants, both leaders and walkers, were self-selected volunteers and may not be totally representative of the total population of leaders and walkers. The results are therefore potentially not generalizable. This is a common limitation in survey research. However, as previously mentioned, all known PW organizations in Australia were contacted, and response rates were high (leaders, 86%, pole walkers, 72%).
4.6 Conclusion

In the sample of participants surveyed for this study, PW leaders and pole walkers are mostly older, health-conscious women, who walk in small groups outdoors at a light to moderate intensity level. Despite its predominance in Scandinavian countries, the study’s findings suggest that PW is also suitable for the Australian environment. Although the results are not generalizable, participant perceptions of enjoyment and health benefits, together with the added advantage that poles enhance stability and can reduce fear of falling, may make this activity a useful alternative to walking in health promotion programs for mid-aged and older adults.

4.7 Acknowledgements

The authors thank PoleAbout and Nordic Academy for providing access to PW leaders and all of the individuals who completed the surveys. JOF was supported by an Australian Post Graduate Research Scholarship and a National Health and Medical Research council program grant (#569940).
4.8 References


5. CHAPTER FIVE: Protocol for a Randomised Trial

This study has been published in the *BMC Public Health* (Impact Factor 2.321).

See Appendix three for the published version.
5.1 Abstract

**Background:** Physical activity is associated with better physical and mental health in older adults. Pole walking is a form of walking which may have additional health benefits in older adults, because of the addition of hand held poles, and consequent upper limb involvement. However, few studies have examined the potential additional effects of pole walking on physical and psycho-social health in older adults compared with walking. The aim of this study is to compare the effect of a pole walking program with the effects of a regular walking program, on physical function and psycho-social wellbeing, in older adults in assisted living facilities.

**Methods/design:** Sixty men and women from assisted living communities over 65 years will be recruited from senior retirement facilities and randomised into a group based, pole walking program, or walking program. The pole walking group will use the Exerstrider method of pole walking. Total duration of the programs is 12 weeks, with three sessions per week, building from 20 minute to 30 minute sessions. The primary outcome is physical function, as measured by items from the Seniors Fitness Test and hand grip strength. Secondary outcomes include physical activity levels, sedentary behavior, joint pain, and quality of life. All outcomes will be assessed before and after the programs, using valid and reliable measures.

**Discussion:** The study will add to the evidence base for the effects of pole walking, compared with walking, on physical and psycho-social health and physical function, in healthy older adults. This will improve understanding about the feasibility of pole walking programs and its specific benefits in this population.

**Trial registration:** Australian New Zealand Clinical Trials Registry ACTRN12612001127897.
5.2 Background

Being physically active is associated with better physical and mental health in adults, and it is well documented that there is no age limit to health benefits related to regular physical activity (PA) (1). Regular PA leads to improvements in cardiorespiratory fitness, muscle strength, endurance and flexibility (2). It is also associated with a decrease in the overall burden of disease, as well as improvements in psychological wellbeing, quality of life and cognitive functioning (2, 3). In older adults, there is now good evidence that regular PA increases average life expectancy and reduces disability (4, 5). PA which incorporates specific strength, flexibility and balance training, is also associated with a reduction in the risk of falls in this age group (6, 7).

Australian PA guidelines for older adults recommend accumulation of at least two and one half hours of moderate intensity PA on most, preferably all, days of the week for health benefits (8). US guidelines for older adults add that some PA is better than none, and that older adults who participate in any amount of PA will gain health benefits (5, 9). However, PA participation among older adults is low (10-12). For example, of Australians aged 65–74 years, only one in three met PA guidelines in 2007–8, and the proportion was just over one in five in those over 75 years (10). The proportion of adults aged over 65 years is expected to increase from 13% of the total Australian population in 2007 to between 23% and 25% in 2056 (13). Consequently, there will be a significant increase in the number of older adults who could potentially obtain health benefits from regular participation in PA. It is therefore important to find feasible ways for older adults to increase their PA levels.

Walking is one PA option for older adults, as it can be undertaken regardless of age, health status, and ability (14, 15). It is the most frequently reported form of PA in this population group (16, 17). For example, data from the USA Behavioural Risk Factor Surveillance System (BRFSS) show that 44% of men, and 45% of women, aged over 65 years, reported leisure time walking in 2000 (18). In addition, walking is the most frequently reported activity among older adults who meet the USA PA guidelines/recommendations (18). In Australia, walking for leisure is reported by 46% of adults over 65 years, and of those, 53% engage exclusively in walking (17). Walking at, or above, 3–4 km per hour is categorized as moderate intensity PA (19), and confers health benefits when recommended frequencies and durations are adhered to.
Pole walking (PW) is an outdoor, non-competitive activity. It is a form of walking, with the addition of hand-held poles, which utilizes upper body muscles (20). It has similar low impact, moderate intensity characteristics to walking (21). There are several additional effects of PW compared with moderate intensity walking. During PW, the average oxygen uptake, heart rate, and caloric expenditure are higher than for walking at the same speed (21-23). Importantly, these additional benefits are achieved without significantly increased perceived exertion (22, 24-26). Evidence of a reduction in knee joint loading when PW is ambiguous (27-29), although some studies have shown lower knee joint forces in participants who walk with poles than in those who don’t (30, 31). The use of poles may provide extra stability for walkers and reduce falls or fear of falls. However, to our knowledge, no studies have measured balance and stability during PW. Because of these characteristics, PW appears to be a suitable form of PA for older adult populations.

PW is used in PA programs by community and government organizations in several countries, and many participants in these programs are older adults (32-34). For example, 44% of older Polish sport and recreation session participants at Universities of the Third Age attended PW sessions (32). A recent systematic review of the effects of PW on health found a number of randomised controlled trials of the effects of PW in a range of both clinical and non-clinical populations (35). These include middle aged, non-obese women (36), adults with type 2 diabetes (37,38), cardiovascular disease (24), peripheral artery disease (39, 40), musculo-skeletal (41, 42) conditions, chronic obstructive pulmonary disease (43), Parkinson’s disease (44, 45), Sjogren’s syndrome (25) and breast cancer (46). Most of these intervention studies lasted between 8 and 24 weeks, were of moderate intensity, and conducted 2–3 times per week (35). This found that PW is simple, feasible, and effective, and has several beneficial physical and psycho-social effects in mid to older aged adults (35).

There are a number of different PW techniques. The Nordic walking technique, which emerged from the sport of cross country skiing, is practiced and taught throughout the world (47). In the United States, another style of PW, known now as the Exerstrider method, has developed separately from Nordic walking in Europe (48). The Nordic walking technique uses a longer stride length and greater hip range of motion than regular walking, and a grasp/release hand grip. The Exerstrider method uses a normal gait, a high forward arm position, and a continuous hand grip. There are indications that the Nordic walking technique is more difficult for older people than Exerstriding (45, 49).
For example, Figard-Fabre et al. found that, in obese mid-aged women, after four weeks of Nordic walking training, fewer than 50% of the participants were able to grasp three of the eight technical characteristics of the technique (49). In another study of adults with Parkinson’s disease, many participants had difficulties with the Nordic walking technique (45). These difficulties may also be experienced by older adults, who have shorter stride length, and smaller hip joint range of motion than younger adults (50).

Although PW seems to be a suitable form of PA for older adults, few studies have examined the effects of PW on physical and psycho-social health in exclusively older adult populations (35). To our knowledge, only one study has examined the effects of PW in healthy adults aged over 65 years (51). This study found significant improvements in functional capacity, but not in gait parameters, or walking speed, in older adults who walked twice weekly for nine weeks, compared with a non-exercise control. In addition, few studies have compared the effects of PW with regular walking (RW) in older adults (51, 52). Therefore, the aim of this trial is to compare the effects of PW with the effects of RW, on physical function, physical activity and sitting time, and wellbeing, in adults aged 65 years or over. The null hypothesis is that there is no difference in these outcomes between participants in the PW group and the RW group.

5.3 Methods/design

5.3.1 Design

An overview of the study design and timeframe is found in Figure 5-1. The study is a randomised trial with two arms: a PW program; and a RW program. The study protocol was approved by the Research Ethics Committee at The school of Human Movement Studies, The University of Queensland.

Study sample and recruitment

Participants will be recruited from four senior living facilities at different locations, but with similar environmental characteristics. The lead researcher will initially contact management staff in the senior living facilities by phone. This phone contact will be followed by a personal visit to the facility managers to introduce the study and the lead researcher. An “Active Aging” presentation will then be offered to the residents of the villages. The presentation will consist of information about the benefits of PA for older adults. The study will be explained in detail and an opportunity for attendees to ask
questions and register their interest in participating will be given at the end of the presentation. All attendees will be given an information brochure about the study and the eligibility criteria.

People interested in participating will be contacted personally by the lead researcher. She will then provide any additional information and explanations participants may require, and will screen potential participants for eligibility. Inclusion criteria are: aged 65 years or older. Exclusion criteria include: medically unfit to participate in a walking program; unable to speak or understand English; having a shoulder or elbow flexion range of motion (ROM) of less than 90 degrees; and having pathological conditions of the upper extremity.

In addition to specific verbal or written questions to check the eligibility criteria, the lead investigator will use the Sports Medicine Australia (SMA) pre-exercise screening tool to ascertain medical eligibility to participate in the moderate intensity PA programs (53). Written informed consent from the participants will be obtained prior to the start of the study.

5.3.2 Sample size

There are no previous data on the effects of PW compared with RW on physical function and psycho-social health. Sample size estimates were therefore based on the premise that the PW group would achieve changes at least 20% greater than those observed in the RW group, in selected measures of the Seniors Fitness Test (30-second chair-stand test, 30-second arm-curl test, timed up and go test, and a 6-minute walk test) (54). This difference is thought to be a clinically relevant difference in functional status (52). Of those subtests, the largest number of participants needed for a statistically significant 20% difference was for the arm curl test. Based on a 20% difference in normative data for women aged 65–69 years for the arm curl test (mean, 17, SD, 4.1), a power of 0.80 and significance of 0.05, and using the formula \( n = 2 \left( \frac{z^2 \times s^2}{\Delta^2} \right) \), we estimate that 23 participants per group would be needed to detect a between group difference of 20% (i.e. mean, 3, SD, 4.1) in the change score (52).
Figure 5-1  Overview of study design and timeframe

Initial population of older adults from 4 retirement village sites

Telephone screening interview

Site 1  Site 2  Site 3  Site 4

Baseline assessment
Senior Fitness Test and Grip strength test, Accelerometry, Active Australia Survey, Sedentary Behaviour Questionnaire, SF-12, Vitality Plus Scale, Numerical Rating Scale

Randomisation
Site 1  (n=15)
Randomisation  Site 2  (n=15)
Randomisation  Site 3  (n=15)
Randomisation  Site 4  (n=15)

PW  RW  PW  RW  PW  PW  PW  RW

12 week intervention period

Follow up assessments

PW=pole walking; RW=regular walking; n=number; SF-12=12 Item Short-Form Health Survey
5.3.3 Randomization

After baseline assessment of eligible participants at one site, the lead researcher will notify an external researcher of the participant identification numbers. The external researcher will randomly assign 50% of the participants to the PW intervention and 50% to the RW intervention using a random number generator in SPSS and inform the lead researcher of group allocation. This process will be repeated for each site separately. Thus, the total number will be approximately 30 participants in the PW group and 30 in the RW group, with one PW group, and one RW group, with seven to eight participants in each group, at each of four sites.

5.3.4 Blinding

Outcome measures will be assessed by trained assessors who will be blinded for group allocation before and after the programs. However, participants and exercise instructors will not be blinded because of the difficulty in blinding either of these in trials of specific PA/exercise modalities such as PW (55).

5.3.5 Outcome measures

Outcome measures will be assessed before commencing the program and at a follow-up testing session one week after the end of the program. The primary outcome measures are selected physical function items of the Seniors Fitness Test (30 second chair stand, 30 second arm curl, timed up and go test, and 6 minute walk test) and grip strength (54). Secondary outcome measures are behaviour (PA levels and sitting time), and wellbeing (joint pain, quality of life, vitality).

Primary outcome measures

**Senior fitness test**

The Senior Fitness Test is used to assess physical function, according to standard protocols (54). This is a widely used test battery for evaluating the effect of exercise interventions in older adults, with 6 subtests which measure the physical abilities needed to perform activities of daily living. However, two of the subtests, for upper and lower limb flexibility, will not be used, as flexibility is not an outcome of interest in this study. Therefore, the tests used in this trial will be: 30-second chair-stand test (the number of times in 30 seconds a participant can stand fully from a seated position without using their arms); 30-second arm-curl test (the number of times a 2.27 kg (5 lb) weight can be
curled fully on the dominant side); 2.44 m (8 ft) timed up and go test (the time in which participants can stand from a chair, walk 2.44 m, then return and sit down); and the 6-minute walk test (the maximum distance a participant can in six minutes) (56). All tests will be measured once, except the timed up and go test, which will consist of a practice, then two trials. The Seniors Fitness Test has acceptable test-retest reliability (R=0.81-0.98), construct validity against a range of indicators, such as age and exercise status, and criterion validity (r=0.71-0.82) (54).

Although upper limb tests are usually not included when evaluating walking-based activities, it was decided to include them in this trial. This decision was based on the findings of previous reviews and surveys that indicated that there may be effects of PW on upper limb outcomes, and on the fact that upper limb strength is relevant to activities of daily living in older people (24, 51, 57-59).

**Hand grip strength test**

Hand grip strength is associated with functional limitations, premature mortality, and the development of disability in older adults (60). Hand grip strength will be measured by the amount of static force that the participant’s dominant hand can squeeze around a dynamometer. A Jamar dynamometer will be used as it is accurate, and shows good inter-rater and test-retest reliability and validity in the older adult population (61, 62). Hand grip strength will be measured in the seated position as per the standard testing protocol approved by the American Society of Hand Therapists (ASHT) (63). Three trials of grip strength for each hand, with a 60 second rest period between trials, and each with a three second maximum grip, will be conducted and the maximum value recorded (64).

**Secondary outcome measures**

**Behaviour**

*Objectively measured physical activity and sitting time*

A tri-axial accelerometer (ActiGraph GT3X+) will be used to assess levels of physical activity and sedentary behaviour in all participants in both the PW and the RW groups before, during (week 6), and at the end of the program (week 12). Participants will be shown by the lead researcher how to position the ActiGraph accelerometer, which will be worn on an elastic clip-on belt, above the left iliac crest. Participants will be asked to put it on when they first get up in the morning and wear it until going to bed at night. In addition, participants will be asked to complete an activity diary to verify the time that the
accelerometer was worn. Valid wear time will be defined as a minimum wear time of 10 hours per day for 4 days (65, 66). Sedentary behaviour will be defined as <200 cpm, light intensity activity as 200–2689 cpm, moderate intensity activity as 2690–6166 cpm, and vigorous intensity activity as >6167 cpm (67, 68).

**Self reported physical activity**

The Active Australia Survey is a self-administered survey which is widely used to assess PA in Australian national and state surveys, and intervention studies (69). Items have acceptable measurement properties for ambulatory older adults (70). It consists of a set of questions which assess frequency and total time spent walking, and in moderate and vigorous leisure time activity in the past week. Time in each activity is multiplied by a generic metabolic equivalent value of 3.33 METs for walking and moderate activity, and 6.66 METs for vigorous activity, and the sum of all MET.minutes per week is categorized as no PA, (<33), some PA (33–499), or meeting PA guidelines (≥500-999), or high PA (≥1000).

**Self-reported sitting time**

Sitting time will be assessed by a five domain sitting questionnaire (71). The questionnaire assesses the number of hours spent sitting at work, while travelling, watching television, and using a computer when not at work, and during other recreation. These domain specific questions have acceptable reliability and validity (71).

**Wellbeing**

**Pain**

Pain levels in the neck, lower back, hip, knee and shoulder joint will be assessed using the Numerical Rating Scale (NRS), consisting of an 11 point interval scale labelled from 0 to 10, with 0 being no pain, and 10 being the worst pain possible (72). This scale was chosen because it is easy for older adults to understand, and is sensitive to change, valid and reliable (72).

**Quality of life**

The SF-12 (12 Item Short-Form Health Survey) is a self-administered questionnaire used to assess quality of life, and it is frequently used as a succinct overall assessment of health (73). The SF-12 has good internal consistency and test–retest reliability in older
adults (74). Two summary scales will be derived, the physical and mental summary scales. They will be scored using norm based methods (73).

**Vitality**

The vitality plus scale is used to assess the perceived benefits of exercise by older adults (75). It is a self-administered 10 item, multi-dimensional scale, which assesses sleep, energy, aches and pains, restlessness, stiffness, cheerfulness, constipation and appetite. Constructs of vitality relevant to exercise are therefore captured in a concise, reliable, and valid instrument, which is also easy for older adults to use (75).

5.3.6 Intervention

**Program duration, frequency and intensity**

The exercise sessions will take place at outdoor areas adjacent to the facilities which are convenient to the participants. Program duration is 12 weeks, with a session frequency of 3 times per week. Session durations for the PW and the RW groups will be 20 minutes at the start of the program, increasing to 30 minutes by week 6. Participants will be advised not to change other lifestyle habits, including PA, during participation in the program. The PW and RW sessions will be at different times and/or days so that the groups are separate throughout the program. The exercise sessions will consist of a 5 minute warm up, followed by 20 mins of RW or PW at the first session, and a cool down/ stretching period of 5 mins. After six weeks, the RW/PW component will increase to 30 minutes. Participants will be asked to walk at a comfortable intensity. The reason for this is that many of the participants are expected to be frail and non-exercisers. Therefore, to reach a moderate intensity may be unrealistic for them.

**Pole walking technique to be used**

The Exerstrider technique and poles will be used in the PW group. As this PW technique requires a natural gait, continuous hand grip and no arm extension, it has fewer technical requirements for older adults to learn and perform consistently, than the Nordic walking technique (49). The first exercise session will be used to teach the Exerstrider technique to the PW group, and as an instruction session in the RW group.

**Group structure and supervision**

The intervention programs will consist of supervised group sessions, as there is a positive association between PA maintenance and social support from instructors and group
members in older adults (76). Sessions will be supervised by qualified recreational therapists who are known to the participants and experienced in leading exercise groups. Both the PW and RW group instructors will receive the same instruction and information concerning the PW and RW session procedures. PW and RW group routes will be the same at each site. In addition, the PW group instructors will be trained in The Exerstrider method. The training package is a standard one developed for use in retirement facilities by the developer of Exerstriding and master trainer of the method (personal communication). Participants in the PW group will receive a free set of Exerstrider poles and training at the beginning of the program. The RW participants will be advised at the beginning of the program that they will be given the opportunity to receive poles and training in their use at the end of the program.

The trial will be monitored by the study leader, who will visit each of the PW and RW groups once weekly to ensure compliance with study protocols. In the case of adverse events, instructors will contact facility medical staff who will arrange for onsite first aid or other intervention as appropriate. The medical staff will inform the study leader within 12 hours. The study leader will register adverse events with the University of Queensland ethics committee within 48 hours.

**Attendance and dropout**

Attendance will be registered at each session by the session supervisor. Participants who do not attend a session will be contacted following the session by the group exercise instructor, and the reasons for their absence will be recorded. If participants indicate that they intend to discontinue the program, the reasons for this will also be recorded, and they will be encouraged to attend the post intervention assessments. If this does not occur, a last measure carried forward protocol will be used.

**5.3.7 Data analysis**

To ensure that randomization resulted in equal distribution of sample characteristics in both intervention groups, baseline characteristics in the intervention and control groups will be compared using t-tests for normally distributed continuous data, appropriate non-parametric tests for non-normally distributed continuous data and chi square tests for categorical variables. Between group differences in study outcomes will be examined using repeated measures of covariance (ANCOVA), adjusted for variables that are associated with both the explanatory and outcome measures; based on previous
publications, these may include factors such as age, sex and number of medical conditions.

Both intention to treat analysis, including all participants who were enrolled in the study, and provided both baseline and follow up data, and per protocol analyses, including only participants who completed the program, will be analyzed. The level of significance will be set at 0.05. All analyses will be conducted using SPSS version 20 (SPSS Inc., Chicago, IL).

5.4 Discussion

This paper describes the protocol for a randomised trial comparing the effects of PW and RW on physical function, physical activity and sitting time, and wellbeing, in older adults. Although effects of PW on fitness have been well-researched (22, 23, 77, 78), no studies have compared the effects of PW with RW on physical function in healthy older adults.

Several different versions of PW exist, and studies have found that different techniques and poles can lead to different outcomes in effectiveness and safety (49). The choice of the Exerstrider method is a unique feature of this study as it is a simple technique designed for PA, rather than fitness, and thus suited to the older adult population.

In older populations, considerations other than cardiovascular fitness are important for physical and mental health. Maintaining strength to perform activities of daily living, maintain PA levels, and prevent falls, are critical to maintaining independence in older adults (4). If independence is reduced in this population, quality of life is also reduced and there is an increased risk of institutionalization (79). Falls in older adults are often a factor in reduced activity levels, leading to poorer physical function (80). An activity such as PW, which potentially provides increased stability during exercise compared with RW, may improve overall PA levels and associated health benefits. Thus, PW has the potential to be a safe, effective and easily maintained activity option for older adults. This study will enable better understanding of the potential of PW for increasing PA levels and promoting physical and mental health in healthy older adult populations.
5.5 Abbreviations

PA, Physical activity; PW, Pole walking; RW, Regular walking; ROM, Range of motion; BRFSS, Behavioral risk factor surveillance system; ANCOVA, Repeated measures of covariance.

5.6 Competing interests

The author(s) declare that they have no competing interests.

5.7 Authors’ contributions

JF developed the original design of the study. JF, JvU and WB were involved in further developing the design and the protocol for carrying out the study. JF wrote the first draft of the manuscript. All authors read, edited draft versions and approved the final manuscript.

5.8 Acknowledgements

This study will be supported by an NHMRC program grant (#569940) at the University of Queensland School of Human movement Studies.
5.9 References


6. CHAPTER SIX: Randomised Trial

A manuscript describing the results of this study has been submitted to the Journal of Physical Activity and Aging as follows:


There are slight differences in the aims, outcome measures, and methods described in the study protocol paper published in BMC Public Health (Chapter 5), and those described in this Chapter, as the actual trial differed in setting and population sample from the original concept.
6.1 Abstract

Pole walking (PW) is a form of walking with the use of hand held poles. Because of increased stability, it may be a more suitable form of Physical activity (PA) than walking for older adults. The effects of a PW program and a regular walking (RW) program in frail older adults (N=42) were compared. Participants were randomised into a 12 week PW or RW program with three, 20 minute, light intensity sessions weekly. Physical function and indicators of health and wellbeing were assessed. There was a slight deterioration in the up-and-go test time in the PW group (0.7 seconds, (0.01, 1.34)), and a decrease in sitting time in the RW group (73 minutes, (-137.35, -9.84)). There were no significant between group differences. The effects of a 12 week light intensity PW program in frail older adults were comparable to the effects of a 12 week RW program.

Key words: walking, walking poles, frail elderly, exercise, physical activity, aging
6.2 Introduction

Physical ability decreases as adults' age, and may eventually lead to difficulties in physical function, loss of independence, and poor quality of life in older adults (1). Regular physical activity (PA), such as walking, can improve function in older adults, by moderating chronic disease development, restoring functional capacity and increasing muscle strength (2, 3). In addition, regular physical activity is associated with significant decreases in risk of clinical depression and anxiety, and improvements in quality of life, and overall psychological well-being in older adults (4, 5).

Pole walking (PW) is a form of walking with hand held poles. Studies of PW have shown that the use of poles increases upper arm and postural muscle use (6, 7), and lowers perceived exercise intensity (8, 9) compared with walking. The provision of poles also provides extra stability during walking, due to an increased base of support (10). These qualities give PW a possible advantage over walking in older adults, especially in the older old age group, in whom safe walking for functional activities is important.

In the few studies which examined the effects of PW on function in older adults, results were mixed (11-13). Figueiredo et al.(2012) examined the effects of a six week PW program on walking distance in people in a rehabilitation program (mean age, 78 years, range 65-92) (11). They found that walking distance improved by 45 meters in the 6 minute walking test (11). Another study found no difference in the timed up and go test after a three months PW program in older attendees of community centre programs (mean age, 82.9 years, SD, 7.4) (12). The only intervention study which included a non-exercise control group found improvements in functional fitness as measured by the Senior Fitness Test (SFT) in younger old adults (mean age, 68.2, SD, 6.8) (13). None of the studies reported adverse events and PW therefore seems to be a suitable activity for improving functional fitness in older adults. The effects of PW relative to walking, especially in older old adults are still unclear.

The aim of this study was to compare the effects of a PW program with the effects of a regular walking (RW) program on physical function and indicators of health and wellbeing in older old adults.
6.3 Methods

6.3.1 Study Design

The study was a 12 week randomised intervention trial in which participants were randomly allocated to a PW program or a RW program (14). The study protocol was approved by the Research Ethics Committee at The School of Human Movement Studies, The University of Queensland.

6.3.2 Participant recruitment and randomisation

An overview of participant flow is provided in Figure 6-1. Participants were recruited from residential care facilities operated by Atria Senior Living, which provides residential facilities for older adults in the United States. Following introductions from a North American PW promoter, and email requests from the research team, ATRIA agreed to provide access to residents from four assisted living facilities (two with attached memory care units), walk leaders and logistical staff support for the study.

Atria Senior Living management selected four facilities, and introduced the facility managers to the lead researcher, who explained study details and participant requirements to managers and walk leaders at each facility. To introduce the study, a presentation about the benefits of PA for health was provided to facility residents and interested community members. Following an overview of the study, interested residents and community members were invited to participate. Potential participants were verbally screened for exclusion criteria, which included: medically unfit to participate in a walking program; unable to speak or understand English; having a shoulder or elbow flexion range of motion of less than 90 degrees; or having pathological conditions of the upper extremity. Written informed consent from the participants was obtained prior to the start of the study.

Six eligible participants were unable to give informed consent due to cognitive impairment, as assessed by facility nursing staff, and surrogate consent was obtained from a relative.

Eligible participants were enrolled for the study. Following baseline assessments participants were randomly assigned either to a PW or a RW group at each of the four facilities. Computerised randomisation was carried out using SPSS version 20 (SPSS Inc, Chicago, IL).
Figure 6-1 Flow of participants through trial

Initial population of older adults from 4 assisted living facilities

Screening interview – assessed for eligibility (N=45)

- Ineligible (n=3)
  - Medically unfit to participate (n=2)
  - Unable to understand English (n=1)

Randomized (N=42)

Pole walking group (n=22)

- Dropouts (n=6)
  - Program related condition (back pain) (n=1)
  - Non-program related condition (painful feet, vertigo, trigeminal neuralgia) (n=3)
  - Not interested (n=1)
  - Withdrawn by staff (n=1)

- Data included in analysis (n=22)

Regular walking group (n=20)

- Dropouts (n=3)
  - Program related condition (fall) (n=1)
  - Not interested (n=1)
  - Moved (n=1)

- Data included in analysis (n=20)

N=total number; n=number
6.3.3 Intervention

The 12 week intervention consisted of three PW or RW group sessions per week, of approximately 20 minutes each. Participants in both the PW and RW groups walked at a light intensity (between 10 and 12 on the Borg Rating of Perceived Exertion (RPE) Scale), which was described to participants as exercising “at a comfortable intensity” (15). PW and RW sessions were held either at separate times, or on separate days, at all participating facilities. Sessions were held in or adjacent to the grounds of the facilities, or a combination of both. Most sessions were conducted outdoors, with indoor sessions held in facility corridors if the weather was deemed too wet or hot by the walk leaders (between four and eight sessions out of 36 for each facility). Walk leaders recorded session attendance.

Pole Walking Program

Exerstrider poles and technique were used in the PW program. PW group sessions were led by walk leaders trained in the Exerstrider technique. This technique was chosen because it has few technical requirements and is therefore easier for older adults to learn than other PW techniques (9, 16). The first session for the PW group was an orientation session, in which participants learned the Exerstrider technique and familiarised themselves with the walking routes.

Walking Program

RW group sessions were led by the same walk leaders who led the PW groups in two facilities. In the other two, the RW sessions were led by other leaders. Walking routes were the same as the PW routes, and the first RW session consisted of route familiarization. At the conclusion of the study, the RW group participants were offered a set of poles and instruction in their use.

6.3.4 Outcome measures

Outcome measures were assessed by trained research staff before and after the 12 week programs. Baseline measures were taken in May and June, 2013, and follow-up measures in August and September, 2013. Research staff were blinded to group allocation for baseline data collection, but not for follow-up data collection, as research staff were present at some of the PW and RW sessions.
Primary Outcome Measures

**Senior Fitness Test**

The SFT is a battery of test items which assesses the functional fitness of older adults. It has acceptable test-retest reliability (R=0.81-0.98), construct validity against a range of indicators, and criterion validity (r=0.71-0.82) (17, 18).

The SFT measures selected for this study were: the chair-stand test (the number of times in 30 seconds a participant can stand fully from a seated position without using their arms); arm-curl test (the number of times in 30 seconds a weight [5 lb (2.27 kg) for women; 8 lb (3.63 kg) for men] can be curled on the dominant side); 6-minute walk test (the distance a participant can walk in six minutes); and timed up-and-go test (the time taken to stand from a chair, walk 8 ft (2.44 m), then return and sit down) (18). As per the SFT protocol, participants were allowed to practice the timed up-and-go test before the test was scored. All the other tests were scored at the first trial (18).

**Hand Grip Strength Test**

Hand grip strength was measured with a Jamar dynamometer, and defined as the amount of static force that the seated participant could squeeze using the dominant hand, with the elbow unsupported at 90 degrees (19, 20). Participants had three trials of a three second maximum grip for each hand, with a 60 second rest period between trials. The maximum value was recorded, as per the standard testing protocol approved by the American Society of Hand Therapists (ASHT) (19-21).

**Secondary outcome measures**

**Health measures**

Health measures included blood pressure, waist circumference, and body mass index. Blood pressure was taken with an Omron digital automatic blood pressure monitor. Two blood pressure readings were taken, with a one minute interval between them, from the left arm, with the participant seated in a relaxed position and the arm supported. The average of the two measurements was recorded (22). Waist circumference was taken with the participant standing. A non-elastic tape measure was used over light clothing, midway between the inferior margin of the last rib and crest of the ilium in a horizontal plane. The circumference was measured once at the end of expiration (23). Weight and
standing height were measured and used to calculate participant’s body mass index, using the formula: weight/(height)$^2$.

**Behaviour**

*Physical activity*

The Active Australia Survey was used to assess self-reported physical activity (24). This survey has acceptable validity for use in older adults (25). Frequency and total time spent in walking, moderate and vigorous leisure time activity in the past week were recorded. Time in each activity was multiplied by a generic metabolic equivalent value of 3.33 METs (metabolic equivalent of tasks) for walking and moderate activity, and 6.66 METs for vigorous activity (26). A weekly PA score was calculated from the sum of all MET.minutes.

*Sitting time*

Sitting time was assessed with a five domain sitting questionnaire, which has acceptable measurement properties (27). The questionnaire assesses the number of hours spent sitting while travelling, while watching television, during non-work computer use, and during other recreation on a typical week and weekend day (27). Participants were not asked to report time spent sitting at work, as all were retired. Average daily sitting time was calculated using the formula: $(5\times[\text{average weekday sitting in four domains}]+2\times[\text{average weekend day sitting in the four domains}])/7$ (27).

**Wellbeing**

*Pain*

Self-assessed pain levels in the neck, lower back, hip, knee and shoulder joint were reported with the numerical rating scale (28). Participants were asked to give a number on an 11 point interval scale which best described their pain in the last week. The scale ranged from 0 to 10, with 0 described as no pain, and 10, the worst pain possible (28).

*Quality of life*

The SF-12 (12 Item Short-Form Health Survey) was used to assess Quality of Life (29). It is a shorter, validated version of the SF-36, and includes 12 questions with a yes/no, or a Likert-type response, about physical, mental, and emotional and social functioning, bodily pain, and general health (30). Physical and mental summary scale scores were derived
from the responses, and scored using norm based methods (31). Higher scores indicated higher Quality of Life.

6.3.5 Sample size

Sample size estimates were based on the premise that the PW group would achieve changes at least 20% greater than those observed in the RW group in the arm curl test of the SFT (14). The number of participants required was estimated for all subtests of the SFT used in the study and results are reported for the arm curl test, because it required the largest number of participants in the power calculation. It was estimated that 23 participants per group would be needed to have sufficient power to detect a 20% between group difference, power of 0.80 (p-value=0.05). We increased this number to 30 per group, to allow for a dropout of 25% (11).

6.3.6 Statistical analysis

Data were analysed using SPSS version 20 (SPSS Inc., Chicago, IL). Analyses were based on intention-to-treat, with the last observation carried forward in cases where follow-up data were missing. The level of significance was set at 0.05.

Baseline characteristics of the PW and RW groups were compared with t-tests for normally distributed data and chi square tests for categorical data. Within group differences were analysed with dependent t tests for normally distributed data, and Wilcoxon signed rank tests for non-parametric data. Mean change in outcome measures was calculated and between group differences in mean change were analysed with independent t-tests for normally distributed data and Mann-Whitney tests for non-parametric data.

Using a meaningful clinical change of 20% of the published norms for 80-85 year olds for each test (18), those who improved by 20% of more were categorized as “improvers”, those who deteriorated by 20% or more were categorized as “deteriorators”, and those remaining were categorized as “no change” for each of the primary measures (chair stand, arm curl, 6 minute walk, up-and-go, and grip strength). Logistic regression was used to determine if sex (male, female), age (<80, ≥80 years old), medical conditions (<3, ≥3), pain (none, some), attendance (≥75%, <75%), and baseline scores for each outcome (>50th, ≤50th percentile) were significantly associated with improvement, compared with deterioration, in the primary outcome measures. Odds ratios and 95% confidence
intervals are reported for univariate regressions, as it was not possible to examine the associations in multivariable analyses, because of relatively low participant numbers.

6.4 Results

6.4.1 Participant flow, drop out and program attendance
Of the 45 participants screened and assessed for eligibility, 42 were randomised; 22 in the PW group and 20 in the RW group (see Figure 6-1). Nine participants dropped out during the program. Reasons for drop out included program related injuries/conditions (low back pain, fall; n=2), non-program related injuries/conditions (painful feet, vertigo, trigeminal neuralgia; n=3), lack of interest (n=2), withdrawn by staff (n=1), and moved away (n=1). All except two participants who dropped out did so in the first two weeks of the program. There were no significant differences between those who dropped out and those who completed the program on any of the baseline variables. All dropouts were either reassessed at the end of the 12 week program (n=7), or a last measure carried forward was used in the analysis (n=2). Almost half the participants (45%) attended more than 75% of the sessions.

6.4.2 Technique
Five of the 22 pole walkers did not fully achieve the main technical requirement of opposite arm to leg technique by week four of the program. Of these, two dropped out in the first week of the program, and all were moderately cognitively impaired.

6.4.3 Baseline characteristics
There were no group differences in sociodemographic, baseline measures of health, or attendance (See Table 1). The average age of participants was 82 (range, 60-99), the majority were female (64%), and half had more than 3 chronic conditions. Four participants were community dwelling, five were from memory care units, and the rest were from assisted living facilities. Ten were classed as moderately or severely cognitively impaired by facility nursing staff.

All SFT mean baseline scores, except for the arm curl test, were lower than norm scores for 80-89 year olds. Mean scores (SD) for the total group were: chair stand, 10.9 (1.3) compared with the norm score of 11.9 (3.6); 6 minute walk, 346.2 yards (113.2) compared with the norm score of 550.1 (86.7); and up-and-go 10.0 seconds (3.0)
compared with the norm score of 7.1, (SD 2.0) (18). The mean arm curl score was 16.7 (3.4), which was similar to the norm score of 16.5, (4.1).

6.4.4 Intervention results
Means and standard deviations for each of the pre- and post-intervention measures are shown in Table 6-2. In the primary measures, using intention-to-treat analysis, the only significant within group change was in up-and-go time, which increased slightly in both groups, but was significant only within the PW group (0.7 seconds (CI, 0.01, 1.34)) (See Table 6-2). Change scores for the PW and the RW group, and between group differences in these change scores, are also presented in Table 6-2. There were no significant between group differences in change scores for any of the measures. Regarding the secondary measures, although there was a similar (73 minutes) within group decrease in sitting time for both groups, this was only significant in the RW group.

6.4.5 Combined groups
As there were no significant between group differences, the data from the two groups were combined and the participants were categorized as improvers (those above a meaningful change score), or deteriorators (those below) (Table 6-3). When the data for the completers (n=33) were analysed, the results did not change, therefore, the data for the combined groups are presented as per protocol results. The distributions of the change scores are shown in Figures 6-2a to 6-2e. For the primary outcome measures, improvers outnumbered deteriorators in the arm curl, 6 minute walk and grip strength tests; deteriorators outnumbered improvers in the up-and-go test; and there were no differences in numbers of improvers and deteriorators in the chair stand test. There were no clear differences in distribution of change scores between pole walkers and regular walkers. However, there was large variation in change scores for the different outcome measures across all participants (See Figure 6-2).

The results of the univariate logistic regression analyses to examine variables associated with improvers (versus deteriorators) are shown in Table 6-4. None of the examined participant characteristics were associated with improvement of the primary outcome measures.
Table 6-1  Baseline characteristics of the participants by intervention group (N=42)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pole walkers (n=22)</th>
<th>Walkers (n=20)</th>
<th>p-value for difference*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sociodemographic characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years) mean (SD)</td>
<td>82 (10.0)</td>
<td>82 (10.2)</td>
<td>0.91</td>
</tr>
<tr>
<td>Range</td>
<td>65-99</td>
<td>60-93</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>0.23</td>
</tr>
<tr>
<td>Male</td>
<td>6 (27)</td>
<td>9 (45)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>16 (73)</td>
<td>11 (55)</td>
<td></td>
</tr>
<tr>
<td><strong>Education level</strong></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>High school or less</td>
<td>11 (55)</td>
<td>11 (55)</td>
<td></td>
</tr>
<tr>
<td>More than high school</td>
<td>9 (45)</td>
<td>9 (45)</td>
<td></td>
</tr>
<tr>
<td>Income management</td>
<td></td>
<td></td>
<td>0.30</td>
</tr>
<tr>
<td>Easy/ easy all the time</td>
<td>21 (100)</td>
<td>19 (95)</td>
<td></td>
</tr>
<tr>
<td>Not too bad/ difficult all the time</td>
<td>0 (0)</td>
<td>1 (5)</td>
<td></td>
</tr>
<tr>
<td><strong>Country of birth</strong></td>
<td></td>
<td></td>
<td>0.17</td>
</tr>
<tr>
<td>North America</td>
<td>20 (90)</td>
<td>20 (100)</td>
<td></td>
</tr>
<tr>
<td>Other (South Korea, Germany)</td>
<td>2 (10)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td>0.99</td>
</tr>
<tr>
<td>Married</td>
<td>6 (27)</td>
<td>5 (25)</td>
<td></td>
</tr>
<tr>
<td>Widowed/ divorced</td>
<td>15 (68)</td>
<td>13 (70)</td>
<td></td>
</tr>
<tr>
<td>Never married</td>
<td>1 (5)</td>
<td>1 (5)</td>
<td></td>
</tr>
<tr>
<td><strong>Health characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of chronic conditions**</td>
<td>0.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>2 (10)</td>
<td>1 (8)</td>
<td></td>
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<tr>
<td>1</td>
<td>6 (29)</td>
<td>5 (42)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3 (13)</td>
<td>2 (17)</td>
<td></td>
</tr>
<tr>
<td>3 or more</td>
<td>10 (48)</td>
<td>4 (33)</td>
<td></td>
</tr>
<tr>
<td><strong>Self-rated health</strong></td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>4 (18)</td>
<td>4 (20)</td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>8 (36)</td>
<td>4 (20)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>6 (27)</td>
<td>10 (50)</td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>4 (18)</td>
<td>2 (10)</td>
<td></td>
</tr>
<tr>
<td><strong>Pain</strong></td>
<td>0.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some pain</td>
<td>7 (33)</td>
<td>10 (53)</td>
<td></td>
</tr>
<tr>
<td>No pain</td>
<td>14 (67)</td>
<td>9 (47)</td>
<td></td>
</tr>
<tr>
<td><strong>Number of painful joints</strong></td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>14 (67)</td>
<td>9 (47)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5 (23)</td>
<td>4 (21)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2 (10)</td>
<td>6 (32)</td>
<td></td>
</tr>
<tr>
<td><strong>Session attendance</strong></td>
<td>0.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of sessions attended</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;75%</td>
<td>11 (50)</td>
<td>6 (60)</td>
<td></td>
</tr>
<tr>
<td>≥75%</td>
<td>11 (50)</td>
<td>8 (40)</td>
<td></td>
</tr>
</tbody>
</table>

SD=standard deviation; CI=confidence interval; MET=metabolic equivalent; min=minutes

*p value for pole walking/regular walking group difference by independent t-test for age, chi square test for all other variables  **numbers vary slightly due to missing data
### Table 6-2  Within and between group comparisons in functional fitness, health measures, wellbeing, and lifestyle behaviours during a 12 week intervention in older adults (intention to treat analysis, N=42)

<table>
<thead>
<tr>
<th></th>
<th>Pole walkers (n=22)</th>
<th>Walkers (n=20)</th>
<th>Between group differences in change scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Post</td>
<td>Change (95% CI)</td>
<td>Pre</td>
</tr>
<tr>
<td><strong>Mean (SD)</strong></td>
<td></td>
<td></td>
<td>Mean (SD)</td>
</tr>
<tr>
<td><strong>Functional fitness</strong></td>
<td></td>
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<tr>
<td>Senior fitness test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chair stand (number in 30 sec)</td>
<td>10.3 (2.73)</td>
<td>10.4 (2.94)</td>
<td>0.1 (-0.46, 0.74)</td>
</tr>
<tr>
<td>Arm curl (number in 30 sec)</td>
<td>16.0 (3.46)</td>
<td>16.2 (3.41)</td>
<td>0.2 (-1.23, 1.63)</td>
</tr>
<tr>
<td>6 minute walk (yards)</td>
<td>347.8 (117.05)</td>
<td>352.9 (122.74)</td>
<td>5.1 (-19.46, 29.57)</td>
</tr>
<tr>
<td>Up-and-go (sec)</td>
<td>9.7 (2.93)</td>
<td>10.3 (2.90)</td>
<td><strong>0.7 (0.01, 1.34)</strong></td>
</tr>
<tr>
<td><strong>Grip (lb)</strong></td>
<td>45.1 (16.36)</td>
<td>44.3 (15.75)</td>
<td><strong>-0.8 (-4.18, 2.64)</strong></td>
</tr>
<tr>
<td><strong>Other health measures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>132.0 (21.47)</td>
<td>131.2 (19.71)</td>
<td>-0.7 (-8.66, 7.20)</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>72.7 (10.12)</td>
<td>72.2 (11.85)</td>
<td>-0.5 (-6.73, 5.73)</td>
</tr>
<tr>
<td>Waist (inches)</td>
<td>35.5 (6.69)</td>
<td>35.6 (7.09)</td>
<td>-0.1 (-1.16, 1.38)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.8 (7.02)</td>
<td>25.9 (6.96)</td>
<td>0.1 (-0.19, 0.41)</td>
</tr>
<tr>
<td><strong>Wellbeing</strong></td>
<td></td>
<td></td>
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<tr>
<td>SF-12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCS</td>
<td>46.2 (10.08)</td>
<td>47.7 (10.54)</td>
<td>1.5 (-0.60, 3.60)</td>
</tr>
<tr>
<td>MCS</td>
<td>55.0 (5.66)</td>
<td>56.7 (6.09)</td>
<td>1.8 (-0.84, 4.35)</td>
</tr>
<tr>
<td>Vitality (score)</td>
<td>43.7 (6.19)</td>
<td>43.4 (5.79)</td>
<td>-0.3 (-1.81, 1.21)</td>
</tr>
<tr>
<td><strong>Lifestyle behaviours</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting (min/day)</td>
<td>320.5 (175.90)</td>
<td>247.4 (139.36)</td>
<td>-73.1 (-169.40, 23.22)</td>
</tr>
<tr>
<td>Physical activity (min/week)</td>
<td>120 (80.0-180.0)</td>
<td>113 (46.3-217.5)</td>
<td>16.8 (-110.05, 143.74)</td>
</tr>
</tbody>
</table>

Significant results in bold type.

SD=standard deviation; CI=confidence interval; sec=seconds; lb=pounds; mmHg=millimetres mercury; BMI=body mass index; kg=kilograms; m=meters; SF-12=12 Item Short-Form Health Survey; PCS=physical component score; MCS=mental component score; MET=metabolic equivalent; min=minutes
Table 6-3  Minimum and maximum change scores for the primary outcome measures, meaningful upper and lower change score margins*, and number of participants above and below margins (program completers, N=33)

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>Change scores</th>
<th>Meaningful change score margins*</th>
<th>n above upper change score margin ‘responders’/ N</th>
<th>n below lower change score margin ‘non responders’/ N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
<td>Upper</td>
<td>Lower</td>
</tr>
<tr>
<td>Chair stand (number in 30 seconds)</td>
<td>-4</td>
<td>4</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Arm curl (number in 30 seconds)</td>
<td>-5</td>
<td>6</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>6 minute walk (yards)</td>
<td>-101.71</td>
<td>100.61</td>
<td>20 yards</td>
<td>20 yards</td>
</tr>
<tr>
<td>Up-and-go (seconds)</td>
<td>-3.90</td>
<td>4.30</td>
<td>-1 second</td>
<td>1 second</td>
</tr>
<tr>
<td>Grip (pounds)</td>
<td>-8.6</td>
<td>14.2</td>
<td>3 lbs</td>
<td>-3 lbs</td>
</tr>
</tbody>
</table>

N=total number, n=subset number

*Changes derived from approximately 20 % above and below mean based on norms for 80-85 year olds (18).
Table 6-4  Results of logistic regression analysis for combined groups, showing odds ratios for improvement on primary outcome measures (program completers, N=33)*

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Chair stand (improved by ≥ 2)</th>
<th>Arm curl (improved by ≥ 2)</th>
<th>6 minute walk (improved by ≥ 20 yards)</th>
<th>Up-and-go (improved by 1 seconds)</th>
<th>Grip (improved by ≥ 3 pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N  n+  n-  OR (95%CI)</td>
<td>N  n+  n-  OR (95%CI)</td>
<td>N  n+  n-  OR (95%CI)</td>
<td>N  n+  n-  OR (95%CI)</td>
<td>N  n+  n-  OR (95%CI)</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>19  2  2</td>
<td>19  7  6</td>
<td>18  7  3</td>
<td>19  4  9</td>
<td>19  6  3</td>
</tr>
<tr>
<td>Male</td>
<td>14  5  2</td>
<td>14  8  2</td>
<td>14  6  3</td>
<td>14  4  5</td>
<td>14  5  6</td>
</tr>
<tr>
<td></td>
<td>(0.20, 2.19)</td>
<td>(0.50, 26.40)</td>
<td>(0.12, 5.94)</td>
<td>(0.31, 10.52)</td>
<td>(0.07, 2.58)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;80</td>
<td>11  4  0</td>
<td>11  5  0</td>
<td>11  4  2</td>
<td>11  4  2</td>
<td>11  5  3</td>
</tr>
<tr>
<td>≥80</td>
<td>22  3  4</td>
<td>22  8  6</td>
<td>22  4  12</td>
<td>22  6  3</td>
<td>22  6  3</td>
</tr>
<tr>
<td></td>
<td>(0.02, 1.91)</td>
<td>(0.02, 1.28)</td>
<td>(0.02, 1.28)</td>
<td>(0.10, 3.72)</td>
<td>(0.10, 3.72)</td>
</tr>
<tr>
<td><strong>Medical conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;3</td>
<td>16  1  3</td>
<td>16  5  2</td>
<td>16  5  2</td>
<td>16  4  5</td>
<td>16  5  3</td>
</tr>
<tr>
<td>≥3</td>
<td>13  2  2</td>
<td>13  6  4</td>
<td>12  8  2</td>
<td>13  3  7</td>
<td>13  5  4</td>
</tr>
<tr>
<td></td>
<td>(0.02, 6.65)</td>
<td>(0.46, 24.44)</td>
<td>(0.17, 15.27)</td>
<td>(0.08, 3.53)</td>
<td>(0.11, 5.24)</td>
</tr>
<tr>
<td><strong>Pain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>19  3  3</td>
<td>19  7  6</td>
<td>18  6  3</td>
<td>19  6  8</td>
<td>19  7  4</td>
</tr>
<tr>
<td>Yes</td>
<td>13  1  3</td>
<td>13  6  3</td>
<td>13  7  3</td>
<td>13  2  6</td>
<td>13  4  4</td>
</tr>
<tr>
<td></td>
<td>(0.19, 47.96)</td>
<td>(0.31, 12.84)</td>
<td>(0.17, 8.09)</td>
<td>(0.65, 3.03)</td>
<td>(0.09, 3.64)</td>
</tr>
<tr>
<td><strong>Attendance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥75%</td>
<td>19  4  1</td>
<td>19  7  4</td>
<td>19  6  2</td>
<td>19  4  7</td>
<td>19  8  4</td>
</tr>
<tr>
<td>&lt;75%</td>
<td>14  3  1</td>
<td>14  7  5</td>
<td>13  7  4</td>
<td>14  4  7</td>
<td>14  3  5</td>
</tr>
<tr>
<td></td>
<td>(0.02, 3.77)</td>
<td>(0.08, 4.39)</td>
<td>(0.08, 4.39)</td>
<td>(0.18, 5.68)</td>
<td>(0.05, 1.94)</td>
</tr>
<tr>
<td><strong>Baseline score for each test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥50%</td>
<td>19  4  3</td>
<td>20  9  6</td>
<td>16  5  2</td>
<td>17  2  5</td>
<td>17  5  7</td>
</tr>
<tr>
<td>&lt;50%</td>
<td>13  3  1</td>
<td>13  5  3</td>
<td>16  8  4</td>
<td>16  6  9</td>
<td>16  6  2</td>
</tr>
<tr>
<td></td>
<td>(0.15, 33.93)</td>
<td>(0.14, 6.28)</td>
<td>(0.11, 6.10)</td>
<td>(0.24, 11.58)</td>
<td>(0.59, 30.10)</td>
</tr>
</tbody>
</table>

N=total number; n+=number of improvers; n-=number of deteriorators; OR=odds ratio; CI=confidence interval; ref(reference category)

* Numbers vary slightly due to missing data

** Unable to calculate due to one category having no data
Figure 6-2 Individual change scores for each primary outcome measure (N=33) *

- **a** Chair stand
- **b** Arm curl
- **c** Up-and-go
- **d** 6 minute walk
- **e** Grip strength

Dark bars = pole walking participants; pale bars = regular walking group participants; x-axis from left to right indicates poorest to best individual change scores; horizontal lines indicate upper and lower clinical significance value. 

* Numbers vary slightly due to missing data.
6.5 Discussion

This study found no differences in the effects of light intensity PW and RW on physical function and health and wellbeing in a volunteer sample of frail older adults. It also found no association between selected participant characteristics and improvement in outcome measures in the combined group. However, up-and-go time increased slightly in the PW group, and sitting time decreased, which was significant only in the walking group. There were large variations between individuals in change scores for all outcomes.

The lack of significant between group differences in this study may reflect the low numbers of participants who were able to be recruited and poor attendance rates. Although we calculated that we would require 30 participants per group to examine group differences, there were only 22 and 20 in the PW and RW groups respectively. Of these, only 16 in the PW, and 17 in the RW group completed the program. Ideally, variability in sample characteristics of the two groups should be taken into account in multivariable analysis, but we were unable to do this because of low numbers. Moreover, fewer than 45% of participants attended at least three quarters of the sessions, and the overall intervention dose may have been too low to elicit any improvements. Another reason for the lack of findings in both groups may be that the training duration of 12 weeks was not sufficient to illicit improvements in this very old volunteer sample (39, 45).

The majority of participants in this study could be categorised as pre-frail or frail. Frailty is an increased state of vulnerability to stressors, which affects health negatively in older adults (33). Estimates of the prevalence of frailty range from 7% to 43% of older adults, and the proportion increases with age (34, 35). In this study, more than one third of participants were cognitively impaired, and almost all the baseline SFT scores were considerably lower than the norms for 80 to 89 year olds, which is indicative of frailty (36, 37). For example, the mean 6 minute walk test was below the 25th percentile for norm scores for 80-89 year olds (18). As frail older adults improve more slowly than their less frail counterparts, frailty may partially explain the lack of significant findings in this study (38).

There were slight increases in the up-and-go times in both groups. In a study with a similar population, deterioration was found in similar tests in the intervention group who performed functional exercises, but this was less than in a non-exercise control group.
As our study did not include a control group, we were unable to investigate the possibility that the observed declines in performance were less than may have occurred without any intervention. The up-and-go test results in the PW group may also indicate that poles do not improve balance when participants’ balance is assessed without them. However, poles may increase stability or balance confidence while being used. Only one fall occurred in the RW group during the program, indicating that that both RW and PW are relatively safe in frail elderly people.

Self-reported sitting time decreased in both groups. Little is known about the validity and reliability of self-reported sitting measures in older adults, although in other adult populations, multi-domain, self-reported sitting measures are as reliable as self-reported PA measures. The decrease in perceived sitting time of 73 minutes per day was, however, greater than the time spent participating in the program, so it is possible that the participants made other efforts to be physically active during the program.

There is a possibility that the within group results may be a result of chance. This is because there were 14 outcome measures, and three analyses were done on each measure (within group for the PW and RW group, and between group analyses). With a p-value of 0.05, two of 42 results could be significant based on chance. However, as the sitting results were the same for each group (a decrease of 73 minutes for both), this was less likely to be a chance finding.

Although the age and physical ability of participants in this study may have reduced the effects of the interventions, PA is not only important for improving functional ability in the older old, but also for preventing or slowing rates of decline. In a longitudinal study of older women, aged 70 to 75 years at first assessment, the threshold for functional disability was reached about 14 years earlier in the least active than in the most active women. PA levels in the older old are very low, and it is a challenge to encourage appropriate functional PA, especially in those who have not been physically active previously. Moving into a more supportive environment may be an opportunity to increase PA participation, delay physical deterioration, and thus delay the onset of disability in these vulnerable older adults.

Many assisted living facilities offer chair or resistance based exercise classes. However, walking programmes, including PW, may help older people to maintain their independent mobility. In a study of frail elderly people, using poles for walking activities in day care
centres was found not to improve functional measures, but there were deteriorations in the control group (12). Interestingly, the mean time of pole use in that study was only 9.7 minutes per day. Introducing poles to assist with short bouts of walking might therefore be helpful in maintaining functional walking activities, such as to and from dining rooms for meals; and so further examination of the use of poles in this context is warranted.

A strength of this study is that it was conducted in with people who were older than those in many other “older adult” PA studies. The average age of our participants was 82, but 45% were over 85 years, which is classed as “older old” (43). Although a measure of frailty was not undertaken, all but 4 participants were in residential aged care, indicating that the majority were unable to function independently in the general community. This study therefore adds knowledge and understanding of the type of PA programs which are feasible in older old, frail, and institutionalized people.

There were two main limitations of this study. Firstly, the old age, poor health, and lack of interest in PA in this volunteer sample made recruitment challenging, and therefore, numbers were low. The dropout rate was, however, comparable with other, similar studies (44), indicating that the programs were acceptable to the majority of participants. Secondly, because this study was done in a residential care setting, all residents were invited to participate, rather than a specific subgroup. The sample was therefore quite heterogeneous, and included men and women with a wide range of ages (60-99 years), physical and cognitive abilities. However, with hindsight, this heterogeneity meant that a larger sample size would have been required to detect group differences, had they occurred.

6.6 Conclusions

This study found no differences between short-term, low intensity PW or RW programs in older old adults in physical function or indicators of health and well-being. It highlights the difficulties of recruiting, and conducting walking based activities in older, mainly institutionalized adults.
6.7 References


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7. CHAPTER SEVEN: Discussion

The overarching aim of the research presented in this thesis was to explore pole walking (PW) as a health enhancing PA for older adults. Three studies were conducted, including a systematic review of the literature, a survey, and a randomized trial (RT). Addressing these aims will provide knowledge about the feasibility of PW in older adults.

The aim of the Study 1 (described in Chapters 2 and 3) was to critically examine the findings and quality of studies that have examined the effects of PW programs on physical and psycho-social health in adults. The systematic review in Study 1 found 25 papers representing 18 studies, which examined a range of study samples, including people from different population groups, with and without health conditions, and different age groups. Studies in older adult population samples have only been conducted in the previous three years, indicating increased interest in the effects of PW on health in this population group. The systematic review found evidence for positive effects of PW, compared with a variety of control groups, on endurance, functional status, PA, and muscle strength. There were also positive effects of PW, compared with non-exercise control groups, on measures of anthropometry and oxygen uptake. There were no studies of the effects of PW in people with lower limb joint replacements, or in people with balance issues. However, as these issues are prevalent in older adults, future research could specifically examine the feasibility and effects of PW in people with these conditions.

The aim of the second study was to describe the characteristics of pole walkers, leaders and programs in Australia, and participants’ perceptions of PW and reasons for participation. The survey of Australian PW leaders and pole walkers (described in Chapter 4), found that the activity is being led and practiced by mostly mid-aged to older women. In addition, PW was generally practiced in groups. PW leaders and pole walkers identified several intrapersonal, social, and environmental characteristics as important to their participation in the activity. The survey found that PW was predominantly being practiced by health conscious, older people, who perceived it as an enjoyable and health enhancing outdoor PA, and noted that it was therefore an activity with qualities which may make it suitable for PA promotion for older adults in Australia.
The aim of the third study was to compare the effects of a PW program with the effects of a regular walking (RW) program on physical function and psycho-social wellbeing in older old adults (3). A RT (described in Chapters 5 and 6), was used to compare changes in physical function, health behaviours, wellbeing, and Quality of Life in older adults who participated in a group based PW or RW program for 12 weeks.

Overall, there were no differences between the effects of PW and RW in any of the outcome measures, and changes within both groups were small. There was a slight decline in dynamic balance in the PW group, and sitting time decreased in the RW group. Although there were people who improved in both the PW and the RW group, in depth analysis did not find any specific participant characteristics that were associated with improved outcomes. Most participants had low functional status, and there were large individual variations in the change scores of most of the primary outcome measures. More studies of PA generally in the older old as a unique population group, and also of PW specifically, are warranted.

One issue facing those investigating the effects of specific PA modalities in older adults is the wide variation in age and ability within the category typically referred to as “old”. This includes many in the younger old age group of 65-75, who are generally quite fit and able, those throughout the older age group (aged 65 onwards) who are more likely to have health issues which cause functional decline, and those who are in the older old category (aged over 85) who have more age-related physiological changes, such as muscle weakness and cardiovascular limitations (4). The studies in this thesis investigated two age groups with different physical, mental and psycho-social characteristics, and related differences in technical use and effects of PW. In Study 2 the average age of pole walkers was 65 years (range 36-90). Participants in the third study were mostly older old, with an average age of 82 years (range 60-99), and frail (having cognitive or physical impairments considerably over and above age related norms).

In Australia, pole walkers are mostly younger old. They perceive PW as a health enhancing PA, and are interested in its fitness and health benefits, as well as social benefits. Most studies reported on in Study 1 had age ranges which included participants in the younger old age group. Benefits associated with PW, which can therefore be attributed to the younger old, include improved cardiovascular fitness, PA levels, muscle strength, functional ability, BMI and waist circumference. Although younger old adults are...
usually still healthy and functioning independently in the community, maintaining health becomes increasingly important as they age (5, 6). PW in Australia is often practiced under the guidance of health or fitness professionals, within health organizations, and among population groups who have health issues (2). The placing of PW in a health context may therefore appeal to younger old people, who are interested in maintaining good, and minimizing poor, health.

Two other aspects of PW programs which suit younger old pole walkers are the outdoor environment, and the social nature of the activity. PW is practiced outdoors, and Australian pole walkers perceive the outdoor environment as part of the attraction of PW. Much of Australia is rural, and cities are large in area, with often poor public transport links, which makes travel to appropriate environments difficult without private transport. Adults in the younger old age group are mostly still able to drive, and the ability to travel to an environmentally appropriate area for PW is therefore easier for younger, than for older old adults.

Adults in their 60s and 70s are often more socially active, and have wider social networks, than older old adults (7). Social connectedness is important for older adults, and one of the key determinants of healthy ageing (8). PW is therefore not only a suitable activity to maintain or improve health and fitness, but the group based aspects allow people to be part of a social network. The novel nature of PW may make be part of the appeal to younger old adults, and reinforce the social aspect of participation (9).

The PW programs possible in the mainly older old sample in Study 3 were in contrast to PW programs carried out for mainly younger old participants in Study 2. Results from this thesis indicated that most younger old adults walked with their poles at a moderate pace for an hour at a time. In contrast, the older old participants who participated in the intervention study were only able to exercise for 20 minutes, at a light intensity. The use of poles in older old adults may therefore have a different purpose than in younger old adults, who perceive them as being used to increase fitness, through upper limb involvement. In older old adults, poles are more likely to be used as stability devices, similar to the use of a walking stick. Interestingly, although there are claims that PW results in improved balance and stability, the results of Study 3 showed that there was limited evidence to support improvement in balance as a result of using poles in older old adults. However, PW was well tolerated and safe for participants during the activity,
which was also found in other studies examining PW in older people and those with chronic health conditions (10-13), as described in Study 1.

PW requires coordination of upper and lower limbs, in addition to various other technical requirements which need to be mastered, in order to perform the activity correctly. Even in younger old adults surveyed in Study 2 (Chapters 5 and 6), the technical requirements of PW were perceived as challenging. As a result of this finding, we chose the less complex technique of Exerstriding for the RCT. Even so, half of those assessed as being cognitively impaired were not able to master the “opposite arm to leg” technique, although all those without cognitive impairment were able to achieve it. The use of poles is therefore not recommended for cognitively impaired older adults.

In all but very frail people, PA has positive effects (14-16). Some studies have indicated that PA in frail elderly people may prevent or slow rates of functional decline (17, 18). The type of exercise most suitable for improving strength, balance, endurance, and function is, however, still unclear, and multicomponent exercise programs are recommended (15, 19, 20). PW is unique because it is a weight bearing, functional exercise with an upper limb component, which may provide a sense of stability for those practicing it. It is therefore an appropriate activity for inclusion in multicomponent exercise programs in frail or older old adults.

7.1 Methodological considerations

In this thesis, wherever possible, measurement instruments with demonstrated validity and reliability were used. Validity is a measure of the extent to which a test measures the construct it purports to measure, and reliability is the precision of a test when replicated under different conditions (21, 22). The measures of PA, sitting, Quality of Life, vitality, and pain levels used in the studies in this thesis all have acceptable measurement properties. However, to our knowledge, no specific questionnaires have been developed for pole walkers or leaders, so questions in Chapter 4 were developed specifically for this survey. Because these questions assess PW program characteristics and history, they have clear face validity. Examining other types of validity for these questions is probably less useful. However, it may be useful to examine the reliability of the questions.

When developing the protocol for Study 3, it was anticipated that the target group would be independent living residents of Australian retirement villages. The measures used in
the RT were therefore chosen with this target group in mind. However, when recruitment difficulties occurred in Australia, and the opportunity arose to work with residents of assisted living facilities in the USA, it was necessary to make changes to the outcome measures for the RT. For example, we originally had a measure of social support in the assessment. When it was clear that the majority of participants had social support provided within the residential facilities, this was no longer deemed relevant for the study.

Ideally, people with cognitive impairment should have been excluded from the trial, especially as it relied heavily on self-reported PA and sitting measures. However, as this study was done in a residential care setting, all residents were invited regardless of cognitive status. Alternatively if including those with cognitive decline, it may have been more appropriate to use simple, four point scales when using Likert type questions with this group (25). Future studies could also consider using objective measures of PA and sedentary behavior.

Originally, we had intended to examine accelerometer data from the RT participants in order to compare objective and subjective measures of PA in this sample, as well as to avoid recall issues associated with subjective measures (26). However, many participants declined to wear the accelerometer, or could not comply with the protocol. The accelerometers were attached with elastic clip on belts, and participants were asked to take them off at night, and put them on again in the morning. About a third of the participants were cognitively impaired, and others had memory problems. As a result, many forgot to wear their accelerometer. A number of participants found the accelerometers were uncomfortable, or did not stay in place. Two participants were unable to unclip and remove them due to severe arthritis of the fingers. As a result, there were insufficient data for meaningful analysis.

The physical measurements used in the RT were also originally chosen for a younger and fitter population. The older old participants generally tolerated the tests well. However, two participants were unable to finish the 6-minute walk test due to fatigue, and most were in the lower functioning range of the endurance, balance, and lower limb strength scores. On reflection, in order to make the tests more acceptable for this population group, functional tests such as a two minute or 20 meter walk test (27), and a five sit to stand test (28) might have been more appropriate. As these tests measure
similar outcomes in older population groups, it is unlikely that there would have been different within or between group results if they had been used.

Overall, PW was well tolerated by most participants, as evidenced by mostly positive comments in the follow-up testing. Also, there were no falls in the PW group, in spite of the poor baseline balance test results, outdoor walking routes, and lack of recent walking group experience in most participants prior to the program. Results of Study 2 indicate that poles provide balance confidence in the younger old, and the suggestion that poles might boost confidence during walking activities in older old people is one that warrants further investigation.

7.1.1 Statistical issues

The setting from which our RT sample was recruited was a group of assisted living facilities for people who could no longer live independently. Many residents were either ineligible for the study, or unwilling to participate in a walking program. It was therefore very challenging to recruit sufficient participants for the RT. As a result, the study was underpowered for the measures used, and this may have contributed to the lack of significant between group differences. Similar difficulties have been reported in other studies of older and frail people, highlighting the difficulties of promoting PA in this age group (19, 29).

The small sample size also created problems for the secondary analyses in this study, in which we examined the association between participants’ characteristics and the odds of improvement in functional status. Ideally, when using logistic regression analysis to identify explanatory variables that may be associated with the outcome of interest, variability in sample characteristics of the two groups being compared should be taken into account. This is usually done in multivariable analysis, where all explanatory variables are adjusted for each other (30). However, the low numbers precluded this, and we were therefore only able to assess the explanatory variables separately (31).

7.1.2 Other methodological issues

Among frail elderly adults, exercise program attendance is often poor (17, 32). In Study 3, only 45% of participants attended 75% or more sessions. This may have been due to the fact that in these residential aged care facilities, many different activities are provided for the residents. Those residents who volunteered for the study may have also have been
participants in other activities offered by the facilities, and so were unable to comply well with the regular exercise sessions. Also, in addition to a number of illnesses of short duration causing sessional absences, five participants became unexpectedly and seriously ill for more than three weeks (nine sessions), and one was unable to recover for the final assessment. Widely fluctuating health states, often caused by relatively minor stressor events, are characteristic of frailty (33), and this presents a challenge to researchers and clinicians working with frail older adults in PA interventions. However, although it can be challenging, benefits are associated with regular PA in frail older people and more research into suitable activities for this growing population group is required. Based on the finding of this thesis, PW could be one of these activities.

7.2 Strengths

A strength of this thesis was the inclusion of a wide variety of methodologies. The systematic literature review (Study 1) required the researcher to undertake search strategies, extract information from the papers selected, and rate the quality of the included papers. The series of studies built on each other to the final randomised trial of study 3. The comprehensiveness of the systematic literature review enabled detailed information about the effects of PW on physical function and psycho-social wellbeing in RCTs to be examined. The third study employed a parallel group, RT methodology. It was a multi-centre, international trial, involving the coordination of facility staff, and liaison with company executives.

A particular strength of Study 3 was the population sample of older old adults. This is a priority group for intervention studies, as those over 85 years have unique problems of increasing physical and cognitive disabilities, frailty, and poor health, and are under-represented in the PA literature (34, 35). Consequently, this thesis contributed to evidence on the effects of PA, and strategies to improve PA levels, and maintain or improve functional status, in older old adults.

The lack of a true control group, and inability to blind either participants, or assessors, was a measure of the real world conditions in which Study 3 was carried out. The exercise programs used in the study were planned to be close to what could be achieved in usual, non-experimental conditions. As such, we were able to identify issues relating to
the exercise programs which were undertaken during the trial, as well as those which may arise in PA programs in non-trial situations.

The studies in this thesis involved a range of data analyses. In Study 1, a Quality Rating was undertaken of RCTs. Data extraction and reporting techniques were also employed. In Study 2, descriptive data analyses were undertaken, using an SPSS statistical package. A particular strength of this study was the qualitative data collection and analyses, through open-ended questions included in the questionnaires. As the study was the first comprehensive survey of PW leaders and pole walkers, this qualitative data enabled more detailed and exploratory information to be gathered than from closed questions alone. An example of the effectiveness of this strategy was that information was obtained concerning environmental aspects of PW which was not captured in the closed questions included in the survey. Study 3 required complex primary and secondary analyses, using SPSS. These included descriptive analysis, within and between group comparisons, and logistical regression analysis.

Three papers have been published from the results of the research presented in this thesis, and a fourth has been submitted for publication. The papers published have all been accepted by peer reviewed journals with impact factors ranging from 1.089 to 3.174. These papers involved the acquisition of skills of scientific writing and collaboration with co-authors.

7.3 Limitations

There are some limitations to the data analysis in the studies in this thesis. In the published review, two criteria i.e. blinding of trainers and blinding of participants, were not rated in because of the difficulty in blinding either of these in trials of specific exercise modalities such as PW. However, this yielded relatively high overall quality scores. In the published review, 11 out of the 14 studies were rated as high quality. If the two blinding items had been rated, only eight would have scored as high quality. Similarly, in the review update, 10 out of 15 studies would have been scored as high quality, compared with all of them when blinding items are not taken into account. A limitation of this review was that it included a quality rating list that focused on the quality of the included studies alone, rather than using a method which combines quantity and quality of the assessed
studies—which may provide better information about the overall strength of evidence (low/medium/high) (36)

In Study 3, the low numbers and wide variations in age and health status of the volunteer sample made the analyses challenging, and yielded mostly wide non-significant confidence intervals."

Several compromises had to be made to the original study protocol of the intervention study because the target group was a more physically and cognitively impaired group than originally envisaged. The amended methods and the measurement difficulties that occurred as a result of the inclusion of an older and frailer sample than intended may have weakened the study design. It is likely that this contributed to the observed minor changes in the outcome measures.

One such change was the dropping of the planned objective assessment of PA using accelerometers. Accelerometer measurements would have improved the accuracy of measuring PA. Furthermore, using alternative objective PA measures such as inclinometers (e.g. ActivPals) would have been more appropriate for this sample, as this type of inclinometer/accelerometer is simply taped to the body for 5-7 days and does not need to be removed at night.

As well, we encountered response difficulties to questionnaires due to cognitive impairments of participants, and problems with conducting some planned physical measurements due to physical impairments.

**7.4 Future directions**

The studies in this thesis have contributed to understanding the role of PW as a health enhancing PA for older adults. Several future directions are possible for research on this subject. These include directions for the synthesis of available evidence, obtaining more knowledge about who participates, and future directions for RCTs and potential target groups and health outcomes.

The amount of research into PW is increasing, as can be seen in Chapters 2 and 3. Further and more detailed reviews of RCTs, including meta-analyses, or ranked
systematic reviews could be explored to quantify the health effects of PW, so that research can be targeted more effectively.

It also became clear after doing extensive literature reviews that, despite the fact that PW seems to be a popular form of PA in mid-aged and older adults, the number of studies in older people is low. Studies examining the effects of PW on conditions prevalent in this age group are warranted. These could include research into the effects of PW on balance and lower limb pain. In addition, more RCTs are needed in this age group to compare PW with other interventions, with more sophisticated statistical techniques to analyse between group differences.

The international nature of, and interest in, PW, has not been explored in detail. Different applications and technical aspects of the activity may suit populations in different countries. This could reflect differences in culture, climate or terrain. In addition, very little scientific evidence about who participates in the activity exists in countries other than Australia. Refining, establishing the reliability of, and applying the survey developed for Chapter 4 of this thesis would improve our understanding of PW in an international context.

A larger sample size for future RCTs would extend the findings of this research. Larger sample sizes allow for the use of more elaborate statistical techniques because of increased power. More elaborate analyses such as multivariable models would possibly lead to more definite conclusions. Additionally, larger samples of older adults would mean that more homogenous groups could be examined, and possibly lead to more conclusive results. More tightly defined groups could include older adults with or without cognitive impairments, specific age groups (e.g. 65 to 75, 75-85, or 85+ years) or groups with comparable functional status.

Future RCTs in older adults could also consider using objective measures of PA and sedentary behaviour appropriate to this population sample. These could involve the use of instruments which do not require the wearer to put on or remove the device, such as the ActivPal accelerometer/inclinometer.

With very old subjects, effectiveness of a PW program may take longer. A future PW trial could benefit from a longer intervention period, so that the first three months could be used as a lead-in period, where relative intensity can be gradually increased to a moderate level, followed by three to six months of the intervention.
In Chapter 4 of this thesis, PW was examined as a health promoting activity. Translational research concerning the implementation of PW in specific under-active populations is a challenge. However, the potential population health benefits make this area worthy of future exploration.

7.5 Conclusions

In summary, the research presented in this thesis provides an overall view of PW as a health enhancing PA for older adults. In younger old populations, there are clear indications of its effectiveness for both physical and psycho-social health. It is also a safe form of PA for people with various chronic health conditions. As it is well accepted by PW leaders and pole walkers alike, it shows promise as a health enhancing exercise which may increase PA options and levels in the younger old population.

In older old adults, the effects of PW are less clear. In the RCT, there appeared to be no advantages of PW over walking in terms of physical function, or psycho-social well-being. Nonetheless, this study showed that these mostly frail older adults were able to master the pole-walking technique, and that the use of poles was acceptable to them. Future studies with a more intensive intervention might demonstrate improvements in physical function, and could further investigate the properties, uses and effectiveness of PW as a functional form of PA in this population.
7.6 References


A 1.1 Conference abstract: The effects of pole walking on health in adults: a systematic review.

A 1.1.1 Abstract

Introduction. The aim of this systematic review was to summarise the effects of pole walking (PW) programs on physical and psycho-social health.

Methods. Randomised controlled and controlled trials were identified from an extensive literature search. Fourteen papers from 13 studies met the inclusion criteria. Eleven of the included studies had a quality score of 50% or higher.

Results. Most studies included mid to older aged men and women in clinical populations with various medical conditions. Only two studies included exclusively non-clinical populations. The majority of the PW programs consisted of supervised group sessions performed two to three times weekly for eight weeks or longer. Most studies investigated the effects of PW on both physical and psycho-social health and the majority examined effects on four to five outcomes. The effects of PW on cardiorespiratory fitness were most extensively studied. The most frequently examined psycho-social measure was quality of life. All studies reported at least one beneficial effect of PW compared with the control group.

Discussion. The results of this systematic review indicate that PW programs have some beneficial effects on both physical and psycho-social health in adults with and without clinical conditions.

A 1.2.1 Abstract

Introduction The aim was to critically evaluate and summarise the effects of pole walking (PW) programs on physical and psycho-social health.

Methods Systematic review of randomised controlled and controlled trials, identified from literature searches in PubMed, Cochrane library, EMBASE, SPORTdiscuss, CINAHL and PEDRO from January to October 2011. Two reviewers independently screened the papers for eligibility and rated their methodological quality using a standard quality rating list.

Results 14 papers from 13 studies met the inclusion criteria. Eleven studies had a quality score of 50% or higher. Most studies included mid to older aged men and women in clinical populations with various medical conditions, including type 2 diabetes, cardiovascular disease, peripheral artery disease, musculo-skeletal conditions, chronic obstructive pulmonary disease, Parkinson’s disease, Sjogren’s syndrome and breast cancer. Only two of the studies were conducted in exclusively non-clinical populations of middle aged women. The majority of the PW programs consisted of supervised group sessions performed two to three times weekly for eight weeks or longer. Most studies investigated the effects of PW on both physical and psycho-social health and the majority examined effects on four to five health outcomes. The effects of PW on cardiorespiratory fitness were most extensively studied (eight studies), and significant effects of PW compared with control groups were found for 16 out of 26 of the cardiorespiratory measures. Other physical outcomes included functional status, pain, physical activity levels, anthropometric characteristics, muscle strength and flexibility, fatigue, gait parameters and blood glucose levels. The most frequently examined psycho-social outcome was general quality of life (predominantly assessed with the SF36). Other psycho-social outcomes included disease specific quality of life, fatigue, anxiety and depression. Seven of the eleven studies examining quality of life reported at least one positive effect of PW. All studies reported at least one beneficial effect of PW on health compared with the control group.

Discussion This systematic review highlights that PW for health and fitness benefits is an emerging area of research, particularly in adults with clinical conditions, although there is less research in adults in non-clinical conditions.
A Conference Abstract: Pole walking downunder: A profile of pole walkers in Australia and factors relating to participation.

A 1.3.1 Abstract

Introduction. The aims of this study were to describe the characteristics of pole walking (PW) programs in Australia, and of those who lead and participate in these programs.

Methods. Two self-administered surveys were sent to PW leaders and walkers in 2012. Sociodemographic and health information, PW program characteristics, and perceptions of PW were collected. Data were analysed using SPSS. Open ended comments were thematically analysed. Response rate to the surveys was 86% (n=31) for leaders and 72% (n=107) for walkers.

Results. Walkers and leaders were generally Australian born, older and female. Most walked regularly in groups, about once per week for about an hour, at a light to moderate intensity. The most strongly endorsed reasons for instructing or participating in PW for both leaders and walkers were social and personal enjoyment, health, fitness and physical activity (PA) benefits, support of poles, and being in the outdoor environment.

Discussion. In conclusion, in Australia, PW is being practiced by a health conscious population, who are mostly over 65 years. It is perceived as an enjoyable and health enhancing outdoor PA. Health and exercise practitioners may find that PW is a potentially useful PA for older Australians.
A 1.4 Conference Abstract: A randomised controlled trial into the effects of pole walking and regular walking on physical and psycho-social health in older adults: assistance on a slippery slope?

Fritschi J, van Uffelen JGZ, Brown WJ. A randomised controlled trial into the effects of pole walking and regular walking on physical and psycho-social health in older adults: assistance on a slippery slope? Programme and abstracts; U21 Graduate Research Conference-Celebrating Aging Research, Auckland, New Zealand, July 1-4, 2014
A 1.4.1 Abstract

Introduction: Study aims were to 1) compare the effects of a pole walking (PW) program with the effects of a regular walking (RW) program on physical function and psycho-social wellbeing in older adults in assisted living facilities; and 2) identify the characteristics of people whose physical and psycho-social wellbeing improved.

Methods: 42 men and women aged 65+ years from assisted living communities were randomised into a PW program or a RW program, which consisted of three group sessions of 20 minutes per week, for 12 weeks. Primary outcomes were physical function and hand grip strength. Secondary outcomes included measures of health, health behaviours, and wellbeing. Pre and post outcome measures were assessed. Between group differences in study outcomes were examined using independent t-tests and chi square tests. Logistic regression was used to determine if independent variables were associated with improvement on outcome measures.

Results: Mean age (SD) of the participants was 82 (10.0) years and 36% were male. In the 33 participants (79%) who completed the program, there were non-significant, between group differences with greater improvement in the PW group than in the RW group on walking distance (4.6 m [95% CI; -24.69, 34.29]) and blood pressure (systolic blood pressure=-4.5 [-17.58, 8.49]; diastolic blood pressure =-4.2 [-12.83, 4.34]). No participant characteristics were significantly associated with improvement in outcome measures.

Discussion: The effects of a 12 week light intensity PW program for assisted living residents were comparable to the effects of a 12 week RW program.
A 1.5 Conference Abstract: The effects of pole walking and regular walking on physical and psycho-social health in older adults: a randomised controlled trial.

A 1.5.1 Abstract

Introduction: Regular walking (RW) is associated with better health in older adults. Pole walking (PW), a form of walking with hand held poles, is suitable for older people due to increased stability and may have additional health benefits to walking because of associated upper limb involvement and lower perceived intensity. The aim of this study was to 1) compare the effects of a PW program with the effects of a RW program on physical function and psycho-social wellbeing in older adults in assisted living facilities; and 2) identify the characteristics of people whose physical and psycho-social wellbeing improved.

Methods: 42 men and women aged 65+ years were recruited from assisted living communities and randomised into a PW program or a RW program. Both group based programs consisted of three sessions of 20 minutes per week, for 12 weeks. The primary outcome was physical function, measured by items from the Seniors Fitness Test and hand grip strength. Secondary outcomes included blood pressure, BMI, waist measurement, physical activity (PA) levels, sedentary behaviour, joint pain, and quality of life. All outcomes were assessed before and after the programs. Between group differences in study outcomes were examined using independent t-tests and chi square tests. Logistic regression was used to determine if sex, age, number of medical conditions, session attendance, and pain were associated with improvement on outcome measures (no improvement versus improvement).

Results: Mean age (SD) of the participants was 82 (10.0) years and 36% were male. Almost 50% of participants rated their health as good/excellent, and 34% met recommended PA guidelines. Session attendance did not differ between groups. In the intention to treat analysis (n=42), there were no significant between group differences. However, in the 33 participants (79%) who completed the program, there were some small, non-significant, between group differences with greater improvement in the PW group than in the RW group on walking distance (4.6 m [95% CI; -24.69, 34.29]) and blood pressure (systolic blood pressure=-4.5 [-17.58, 8.49]; diastolic blood pressure =-4.2 [-12.83, 4.34]). None of the participant characteristics were significantly associated with improvement in outcome measures.
**Discussion:** The effects of a 12 week light intensity PW program for assisted living residents were comparable to the effects of a 12 week RW program. Both programs were feasible in frail older adults.

**A 1.6 Invited presentations**


APPENDIX TWO: Study Materials

A 2.1 Ethics approval: Walking with Poles study

May 2, 2012

Ms Juliette Fritschi
School of Human Movement Studies,
Connel Building
The University of Queensland
St Lucia QLD 4072

Dear Ms Fritschi,

Re: ethical review of the following project:

An examination of the demographic, health and functional characteristics of Pole walkers, and factors relating to participation in pole walking in Australia.

Thank you for the opportunity to review your proposal. I am pleased to let you know that your project has been cleared in accordance with the ethical review guidelines at The University of Queensland. Your approval number is: HMS12/0502.

Please note that:

(i) Amendments to any part of the approved protocol (however minor) should be submitted to me for consideration.

(ii) Signed statements of informed consent should be kept secure in case we need to access them in the future.

I wish you well with your research.

Yours sincerely,

Timothy J. Carroll
School of Human Movement Studies Ethics Committee
A 2.2 Participant information sheet: Walking with Poles leader survey

Walking With Poles

Group leader/instructor Information

A research project from the School of Human Movement Studies, The University of Queensland

Juliette Fritschi, Professor Wendy Brown, Dr Jannique van Uffelen

We are researchers at the School of Human Movement Studies, the University of Queensland, and we are conducting the first survey about walking with poles (Nordic walking) in Australia. Your responses will help us understand who is taking up this activity in Australia, and their experiences. The survey involves surveying two groups,

1. Nordic/pole walking group leaders and instructors
2. Nordic/pole walkers

What does participation involve?

You will receive a paper based survey which will take about 30 minutes to complete. It includes questions about you, your experiences of walking with poles, and the characteristics of your walking groups.

There will be an opportunity for you to share more detailed information about your experiences in a phone interview, if you wish to participate further. This interview will take up to 30 minutes.

We will also ask you to distribute another survey for your group participants to fill out.
How do you benefit from participating?

Your responses are important for us to learn more about people who walk with poles in Australia. To thank-you for your participation, you will receive a summary of the results of the survey and all group leaders who participate in the survey will go into a draw to receive a custom designed t-shirt featuring the “walking with poles” image above.

So how can you participate?

All you have to do is to register your interest by contacting Juliette Fritschi at The School of Human Movement Studies, The University of Queensland, St Lucia, QLD 4072 by:

1. email walkingwithpoles@uq.edu.au
2. phone 0400 490 008

Further Information

Project title: An examination of the demographic, health and functional characteristics of pole walkers, and factors relating to participation in pole walking in Australia.

Participation in this study is voluntary and you are not obliged to fill out the survey.

All information will be confidential and only anonymous summary data will be reported. If the data collected are published you will not be identified in any way.

This study has been cleared in accordance with the ethical review guidelines and processes of the University of Queensland. These guidelines are endorsed by the University’s principal human ethics committee, the Human Experimentation Ethical Review Committee, and registered with the Australian Health Ethics Committee as complying with the National Statement. You are free to discuss your participation in this study with project staff (contactable on 0400 490 008.). If you would like to speak to an officer of the University not involved in the study, you may contact the School of Human Movement Studies Ethics Officer on 3365 6380.

We look forward to hearing from you soon
A research project from the School of Human Movement Studies, The University of Queensland

Juliette Fritschi, Professor Wendy Brown, Dr Jannique van Uffelen

We are researchers at the School of Human Movement Studies, the University of Queensland, and we are conducting the first survey about walking with poles (Nordic walking) in Australia. Your responses will help us understand who is taking up this activity in Australia, and their experiences.

What does participation involve?

You will receive a paper based survey from your pole (Nordic) walking group leader which will take about 30 minutes to complete. It includes questions about you and your experiences of walking with poles.

There will be an opportunity for you to share more detailed information about your experiences in a phone interview, if you wish to participate further. This interview will take up to 30 minutes.
How do you benefit from participating?

Your responses are important for us to learn more about people who walk with poles in Australia. To thank-you for your participation, you will receive a summary of the results of the survey and all participants will go into a draw to receive a custom designed t-shirt featuring the “walking with poles” image above.

So how can you participate?

All you have to do is to fill out the survey given to you by your pole (Nordic) walking group leader and return it in the reply paid envelope provided. If you have any questions, you may contact Juliette Fritschi at The School of Human Movement Studies, The University of Queensland, St Lucia, QLD 4072 by:

   email walkingwithpoles@uq.edu.au
   or
   phone 0400 490 008

Participation in this study is voluntary and you are not obliged to fill out the survey.

All information will be confidential and only anonymous summary data will be reported. If the data collected is published you will not be identified in any way.

This study has been cleared in accordance with the ethical review guidelines and processes of the University of Queensland. These guidelines are endorsed by the University's principal human ethics committee, the Human Experimentation Ethical Review Committee, and registered with the Australian Health Ethics Committee as complying with the National Statement. You are free to discuss your participation in this study with project staff (contactable on 0400 490 008.). If you would like to speak to an officer of the University not involved in the study, you may contact the School of Human Movement Studies Ethics Officer on 3365 6380.

We look forward to hearing from you soon
A 2.4 Survey items: Walking with Poles leader survey

Walking With Poles

Leader survey ID_________ Staff_________
Thank you for completing this survey

Your answers are completely confidential. Only the Walking with Poles staff will see this material, and your information will be kept confidential and anonymous.

This survey is about you, your training, pole walking groups, and thoughts about walking with poles (Nordic walking)

Please read each question carefully and answer all as accurately as you can.

If you are unsure about a question, please choose the answer closest to your thoughts.

There are no right or wrong answers; we would like to know about your experiences and opinions.

In this survey, pole walking, or walking with poles refers to any type of walking with the aid of two poles, each placed on the ground in opposition to the foot. Other names for this may include Nordic walking, Exerstriding, or pole striding. Walkers refer to people who walk with poles in your group/s.

Most questions can be answered by circling a number, for example:

How important are the following goals for the pole walking group to you? (circle one)

<table>
<thead>
<tr>
<th>Not at all important</th>
<th>Not very important</th>
<th>Neutral</th>
<th>Somewhat important</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant enjoyment of the activity</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Some questions ask you to write your response, for example:

How many times per month do you run pole walking sessions?

_____ & _____ times per month
### Questions about you

1. **What is your age?**
   
   ________________ years

2. **Are you male or female?** *(circle one)*
   
   - male 1
   - female 2

3. **What is the highest qualification you have completed?** *(circle one)*
   
   - No formal education or school certificate 1
   - High school or leaving certificate 2
   - Trade/apprenticeship/certificate/diploma (e.g. Child Care, Technician) 3
   - University degree or higher degree 4

4. **Which of the following best describes your main current employment situation?** *(circle one)*
   
   - Full time employment 1
   - Part time employment 2
   - Not in paid employment (e.g. home duties, unable to work) 3
### 5 What is your main occupation?

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional (e.g. registered nurse, allied health professional, teacher, artist)</td>
<td>1</td>
</tr>
<tr>
<td>Skilled tradesperson or related worker (e.g. plumber, dressmaker, hairdresser)</td>
<td>2</td>
</tr>
<tr>
<td>Labourer or related worker (cleaner, factory worker, kitchen hand)</td>
<td>3</td>
</tr>
<tr>
<td>No paid job/student</td>
<td>4</td>
</tr>
<tr>
<td>Retired</td>
<td>5</td>
</tr>
<tr>
<td>Don’t know</td>
<td>6</td>
</tr>
</tbody>
</table>

### 6 Where were you born? *(circle one)*

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1</td>
</tr>
<tr>
<td>USA/ Canada</td>
<td>2</td>
</tr>
<tr>
<td>UK</td>
<td>3</td>
</tr>
<tr>
<td>Finland, Denmark, Norway or Sweden</td>
<td>4</td>
</tr>
<tr>
<td>Another European country</td>
<td>5</td>
</tr>
<tr>
<td>An Asian country</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
</tr>
</tbody>
</table>

Which country? ____________________________

213
What is your present marital status? (circle one)

- Never married 1
- Widowed, divorced or separated 2
- Married/defacto 3

Questions about your training

8. How long ago did you first lead a pole walking group?

______________ years _____________ months

9. What health or exercise qualifications do you have? (circle all that apply)

- Degree course in exercise/sport science (e.g. exercise physiology) 1
  Which one? __________________________________________________________

- Non-degree higher education course in exercise/fitness leadership (e.g. certificate in fitness leadership) 2
  Which one? __________________________________________________________

- Degree course in health care (e.g. physiotherapy) 3
  Which one? __________________________________________________________

- Non-degree course in health care (e.g. enrolled nursing) 4
  Which one? __________________________________________________________

- First aid course or equivalent 5

- No specific training 6

- Other 7
  Which? ____________________________________________________________
10. **What training in pole walking have you undertaken? (circle all that apply)**

<table>
<thead>
<tr>
<th>Training Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coaching course with a pole walking organisation (qualification to train other pole walking leaders)</td>
<td>1</td>
</tr>
<tr>
<td>Leaders’ course with a pole walking organisation (qualification to lead groups)</td>
<td>2</td>
</tr>
<tr>
<td>Onsite training with a pole walking leader/coach</td>
<td>3</td>
</tr>
<tr>
<td>No specific training to lead pole walking groups</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
</tr>
</tbody>
</table>

Which? ____________________________

11. **Where did you train? (circle one)**

<table>
<thead>
<tr>
<th>Location</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Australia</td>
<td>1</td>
</tr>
<tr>
<td>Overseas</td>
<td>2</td>
</tr>
</tbody>
</table>

Where? ____________________________
Questions about your participants, groups and sessions

12 In which state does your group walk? *(circle one)*

<table>
<thead>
<tr>
<th>State</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales</td>
<td>1</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>2</td>
</tr>
<tr>
<td>South Australia</td>
<td>3</td>
</tr>
<tr>
<td>Tasmania</td>
<td>4</td>
</tr>
<tr>
<td>Victoria</td>
<td>5</td>
</tr>
<tr>
<td>Western Australia</td>
<td>6</td>
</tr>
</tbody>
</table>

13 Do you lead groups as part of an organisation (e.g. St Luke’s Hospital)? *(circle one)*

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
</tr>
</tbody>
</table>

14 How many separate pole walking groups do you usually lead each week?

_________ groups

15 How many sessions do you run for each group? *(please respond for each group)*

<table>
<thead>
<tr>
<th>Group</th>
<th>Sessions per week of mins</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>_____sessions per week of _____mins</td>
</tr>
<tr>
<td>2</td>
<td>_____sessions per week of _____mins</td>
</tr>
<tr>
<td>3</td>
<td>_____sessions per week of _____mins</td>
</tr>
<tr>
<td>4</td>
<td>_____sessions per week of _____mins</td>
</tr>
<tr>
<td>5</td>
<td>_____sessions per week of _____mins</td>
</tr>
<tr>
<td>6</td>
<td>_____sessions per week of _____mins</td>
</tr>
</tbody>
</table>
16 What is the cost per session to walkers in your group?

__________________________

17 Do you target a specific age range for your group? *(circle one)*

<table>
<thead>
<tr>
<th>Option</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, younger people (aged 18-45)</td>
<td>1</td>
</tr>
<tr>
<td>Yes, middle-aged (aged 45-65)</td>
<td>2</td>
</tr>
<tr>
<td>Yes, older people (aged 65 or over)</td>
<td>3</td>
</tr>
<tr>
<td>No, I do not target any specific age range</td>
<td>4</td>
</tr>
</tbody>
</table>

18 How do you recruit walkers? *(circle all that apply)*

<table>
<thead>
<tr>
<th>Option</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper based advertising (e.g. local newspaper)</td>
<td>1</td>
</tr>
<tr>
<td>Radio-based advertising</td>
<td>2</td>
</tr>
<tr>
<td>Internet advertising (e.g. web page)</td>
<td>3</td>
</tr>
<tr>
<td>Through a fitness based facility (e.g. a gym)</td>
<td>4</td>
</tr>
<tr>
<td>Through health professional referrals (e.g. physiotherapist)</td>
<td>5</td>
</tr>
<tr>
<td>Advertising through a community facility (e.g. senior citizens centre)</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
</tr>
</tbody>
</table>
19  What technique of pole walking do you teach? *(circle all that apply)*

<table>
<thead>
<tr>
<th>Technique</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nordic walking</td>
<td>1</td>
</tr>
<tr>
<td>Exerstriding</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
</tbody>
</table>

*Which?*

____________________________________________________________________________________

20  Do you provide poles for your walkers? *(circle all that apply)*

<table>
<thead>
<tr>
<th>Option</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>I provide free poles</td>
<td>1</td>
</tr>
<tr>
<td>My walkers hire poles from me/my organisation</td>
<td>2</td>
</tr>
<tr>
<td>Please give details</td>
<td></td>
</tr>
<tr>
<td>My walkers buy poles from me/my organisation</td>
<td>3</td>
</tr>
</tbody>
</table>

*What is the cost per set of poles? ________________________*

<table>
<thead>
<tr>
<th>Option</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>4</td>
</tr>
<tr>
<td>Please give details</td>
<td></td>
</tr>
</tbody>
</table>
21 How important are the following goals to you for your walkers? *(circle one in each category)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Not at all important</th>
<th>Not very important</th>
<th>Neutral</th>
<th>Somewhat important</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Participant enjoyment of the activity</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>b</td>
<td>Regular session attendance</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>c</td>
<td>Improving cardiovascular fitness levels</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>d</td>
<td>Increasing overall physical activity levels</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>e</td>
<td>Increasing confidence in physical activity ability</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>f</td>
<td>Improving participants’ mental health</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>g</td>
<td>Ensuring a positive (social) group experience</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>-----</td>
<td>----</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Chronic disease (eg diabetes, arthritis)</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>Obesity</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>Chronic pain</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Balance problems</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>Mental health issues (eg anxiety, depression)</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>Lower limb joint replacements</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g</td>
<td>Other health conditions</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which? ____________________________________________
### 23. At what intensity level do you usually encourage your walkers to exercise (excluding warm up and cool down periods)? *(circle one)*

- As hard and fast as they can manage (vigorous intensity)  
- Just beyond a comfortable intensity (moderate intensity)  
- At a comfortable intensity (moderate-light intensity)  
- At a very gentle pace (light intensity)  
- At variable intensities (eg moderate-vigorous ‘speed plays’)  
- Other ____________________________________________________________

### 24. Why do your walkers attend your sessions? *(circle all that apply)*

- Just to learn the technique and then practice independently  
- To regularly walk with the group on an ongoing basis  
- To attend a set course of sessions (eg a 10 week course)  
- Other ____________________________________________________________
25. Which of the following do you include in your sessions apart from your regular walk? (circle all that apply)

<table>
<thead>
<tr>
<th>Option</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-up (slower pace at the start of a session)</td>
<td>1</td>
</tr>
<tr>
<td>Cool down (slower pace at the end of a session)</td>
<td>2</td>
</tr>
<tr>
<td>Stretches</td>
<td>3</td>
</tr>
<tr>
<td>Other exercises</td>
<td>4</td>
</tr>
</tbody>
</table>

Which? _______________________________________________________

26. Approximately how long does your main walk last in a usual session (not including warm-up/cool downs etc)?

___________________ minutes

27. How many walkers attend a usual session?

____________________________________

28. Do you have a minimum and maximum required number of walkers in a session? (circle one)

<table>
<thead>
<tr>
<th>Answer</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>Yes</td>
<td>2</td>
</tr>
</tbody>
</table>

If yes, Minimum   

Maximum   


29  **Where does your group walk?** *(circle all that apply)*

<table>
<thead>
<tr>
<th>Option</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>A public sports ground (eg a football oval)</td>
<td>1</td>
</tr>
<tr>
<td>A public park</td>
<td>2</td>
</tr>
<tr>
<td>A public urban area (eg a neighbourhood footpath)</td>
<td>3</td>
</tr>
<tr>
<td>The grounds of a public facility (eg hospital grounds)</td>
<td>4</td>
</tr>
<tr>
<td>Bushland/forest</td>
<td>5</td>
</tr>
<tr>
<td>Beach</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
</tr>
</tbody>
</table>

Where? _____________________________________________________________

30  **What type of surface does your group walk on?** *(circle all that apply)*

<table>
<thead>
<tr>
<th>Surface</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paved track</td>
<td>1</td>
</tr>
<tr>
<td>Unpaved track (e.g. gravel, sand)</td>
<td>2</td>
</tr>
<tr>
<td>Grass</td>
<td>3</td>
</tr>
</tbody>
</table>
### 31 What type of terrain does your group walk on? *(circle all that apply)*

<table>
<thead>
<tr>
<th>Terrain</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hilly terrain</td>
<td>1</td>
</tr>
<tr>
<td>Flat terrain</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
</tbody>
</table>

Is there anything else you would like to tell us about your experiences as a pole walking leader or your groups?

______________________________________________________________________________________

______________________________________________________________________________________

______________________________________________________________________________________

______________________________________________________________________________________

______________________________________________________________________________________

Thank you for the time and effort that you have put into completing this survey.

Please enclose the survey in the reply paid envelope provided (no stamp necessary) and post it back to us.
We are interested in knowing more about the experiences of leading pole walking groups. Would you be happy to have someone contact you further about your answers to this survey? If so, please tick the box and leave your contact details in the space provided.

Yes, I would be happy to provide further information about my answers in this survey ☐

My name ________________________________________________________________

My phone number ________________________________________________________

Best time/day to contact __________________________________________________

No, I don’t wish to be contacted further ☐

Do you have any questions or concerns about this survey?

If you have any questions about the survey or would like additional information, please contact the “walking with poles” research team by email (walkingwithpoles@uq.edu.au) or phone 0400 490 008
Walking With Poles
Walker survey

staff__________

ID____________
Thank you for completing this survey

Your answers are completely confidential. Only the Walking with Poles staff will see this material, and your information will be kept confidential and anonymous.

This survey is about you, your activities, health, and thoughts about walking with poles (Nordic walking)

Please read each question carefully and answer all as accurately as you can.
If you are unsure about a question, please choose the answer closest to what you think.
There are no right or wrong answers; we would like to know about your experiences and opinions.

In this survey, pole walking, or walking with poles refers to any type of walking with the aid of two poles placed on the ground one at a time opposite to the foot (like marching). Other names for this may include Nordic walking, Exerstriding, or pole striding.

Most questions can be answered by circling a number, for example:

<table>
<thead>
<tr>
<th>At what intensity level do you usually walk with poles? (circle one)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigorous (makes you breathe harder or puff and pant)</td>
</tr>
<tr>
<td>Moderate (brisk walking pace, breathing harder, but still able to hold a conversation/talk)</td>
</tr>
<tr>
<td>Mild to moderate (normal walking pace)</td>
</tr>
<tr>
<td>Mild (slow walking pace)</td>
</tr>
</tbody>
</table>

Some questions will ask you to write your response, for example:

In the last week, how many times did you do other more moderate activities that you have not already mentioned? Eg gentle swimming, social tennis, golf?

3 times
Questions about you

1. **What is your age?**

   ____________ years

2. **Are you male or female? (circle one)**

   Male 1 Female 2

3. **What is the highest qualification you have completed? (circle one)**

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>No formal education or school certificate</td>
<td>1</td>
</tr>
<tr>
<td>High school or leaving certificate</td>
<td>2</td>
</tr>
<tr>
<td>Trade/apprenticeship /certificate/diploma (e.g. Child Care, Technician)</td>
<td>3</td>
</tr>
<tr>
<td>University degree or higher degree</td>
<td>4</td>
</tr>
</tbody>
</table>

4. **Which of the following best describes your main current employment situation? (circle one)**

<table>
<thead>
<tr>
<th>Employment Situation</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full time employment</td>
<td>1</td>
</tr>
<tr>
<td>Part time employment</td>
<td>2</td>
</tr>
<tr>
<td>Not in paid employment (e.g. home duties, unable to work)</td>
<td>3</td>
</tr>
</tbody>
</table>
5 What is your main occupation?

- Professional (e.g. registered nurse, allied health professional, teacher) 1
- Skilled tradesperson or related worker (e.g. plumber, dressmaker, hairdresser) 2
- Labourer or related worker (cleaner, factory worker, kitchen hand) 3
- No paid job/student 4
- Retired 5
- Don’t know 6

6 Where were you born? (circle one)

- Australia 1
- USA/ Canada 2
- UK 3
- Finland, Denmark, Norway or Sweden 4
- Another European country 5
- An Asian country 6
- Other 7

Which country? _____________________________________________
### What is your present marital status? *(circle one)*

<table>
<thead>
<tr>
<th>Option</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never married</td>
<td>1</td>
</tr>
<tr>
<td>Widowed/divorced or separated</td>
<td>2</td>
</tr>
<tr>
<td>Married/defacto</td>
<td>3</td>
</tr>
</tbody>
</table>

### Questions about your health and your activities

#### 8 In general would you say your health is? *(circle one)*

<table>
<thead>
<tr>
<th>Health Rating</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>1</td>
</tr>
<tr>
<td>Very good</td>
<td>2</td>
</tr>
<tr>
<td>Good</td>
<td>3</td>
</tr>
<tr>
<td>Fair</td>
<td>4</td>
</tr>
<tr>
<td>Poor</td>
<td>5</td>
</tr>
</tbody>
</table>

#### 9 The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much? *(circle one in each category)*

- **a** Moderate activities, such as moving a table, pushing a vacuum cleaner, bowing or playing golf
  - Yes, limited a lot: 1
  - Yes, limited a little: 2
  - No, not limited at all: 3

- **b** Climbing several flights of stairs
  - 1
  - 2
  - 3

#### 10 During the past 4 weeks have you had any of the following problems with your work or other regular activities as a result of your physical health? *(circle one in each category)*

- **a** Accomplished less than you would like
  - Yes: 1
  - No: 2

- **b** Were limited in the kind of work or other activities
  - Yes: 1
  - No: 2
11   During the past 4 weeks, have you had any of the following problems with your work or other regular activities as a result of any emotional problems (such as feeling depressed or anxious)? *(circle one in each category)*

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12   During the past 4 weeks, how much did pain interfere with your normal work (including both outside the home and housework)? *(circle one)*

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

13   These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. *(circle one in each category)*

How much of the time during the past month:

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
14 During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)? (circle one)

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

15 In the last week, how many times have you walked continuously for at least ten minutes, for recreation, exercise, or to get to and from places?

__________ times

16 What do you estimate was the total time you spent walking in this way in the last week?

__________ hours and _______ minutes

17 In the last week, how many times did you do any vigorous gardening, or heavy work around the yard, which make you breathe harder or puff and pant?

__________ times

18 What do you estimate was the total time that you spent doing vigorous gardening or heavy work around the yard in the last week?

__________ hours and ____________ minutes

The next questions exclude household chores, gardening, or yard work

19 In the last week, how many times did you do any vigorous physical activity, which made you breathe harder or puff and pant? Eg jogging, cycling, aerobics, competitive tennis

__________ times

20 What was the total time you spent doing this vigorous physical activity in the last week?

__________ hours and ____________ minutes
21 In the last week, how many times did you do other more moderate activities that you have not already mentioned? Eg gentle swimming, social tennis, golf

_______ times

22 What do you estimate was the total time that you spent doing these activities in the last week?

_______ hours and _________ minutes

23 Please estimate how many hours and minutes you spend sitting each day in the following situations: *(please write your answer)*

<table>
<thead>
<tr>
<th>On a week day</th>
<th>On a week-end day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours</td>
<td>Minutes</td>
</tr>
<tr>
<td>While travelling to and from places</td>
<td></td>
</tr>
<tr>
<td>While at work</td>
<td></td>
</tr>
<tr>
<td>While watching television</td>
<td></td>
</tr>
<tr>
<td>While using a computer at home</td>
<td></td>
</tr>
</tbody>
</table>

In your leisure time, NOT including television (e.g., visiting friends, movies, dining out, etc.)

24 Do you have any of the following? *(circle all that apply)*

<table>
<thead>
<tr>
<th>Pain</th>
<th>Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinal pain</td>
<td>1</td>
</tr>
<tr>
<td>Pain other than spinal</td>
<td>2</td>
</tr>
<tr>
<td>A Joint replacement</td>
<td>3</td>
</tr>
</tbody>
</table>

Which joint/s_________________________________________
25 Have you fallen in the past 12 months? (circle one)

Yes 1  No 2

If yes, how many times? _______

26 Have you ever had or been told by your doctor that you have any of the following? (circle all that apply)

Diabetes 1

Arthritis or musculo-skeletal conditions (osteoarthritis, rheumatoid arthritis, osteoporosis) 2

Lung disease (eg asthma, bronchitis/ emphysema) 3

Depression, anxiety or stress 4
Which? ____________________________

Other major medical condition 5
Which? ____________________________

27 How tall are you without shoes?

_________ cms  or  _________ ft ________ in

28 How much do you weigh without clothes or shoes?

________ kg  or  _______ stones ______ pounds

Questions about walking with poles

29 How long ago did you first walk with poles in a group?

_________ years ________ months
### 30 How did you hear about walking with poles? *(circle one)*

<table>
<thead>
<tr>
<th>Option</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended by health professional</td>
<td>1</td>
</tr>
<tr>
<td>Which one? (eg physio, GP) __________________________________________</td>
<td></td>
</tr>
<tr>
<td>Recommended by fitness professional</td>
<td>2</td>
</tr>
<tr>
<td>Friend</td>
<td>3</td>
</tr>
<tr>
<td>Family</td>
<td>4</td>
</tr>
<tr>
<td>Advertised</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
</tr>
<tr>
<td>From who, or how? __________________________________________________</td>
<td></td>
</tr>
</tbody>
</table>

### 31 On a usual pole walk, who do you walk with? *(circle one)*

<table>
<thead>
<tr>
<th>Option</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A group (more than one other person)</td>
<td>1</td>
</tr>
<tr>
<td>One other person</td>
<td>2</td>
</tr>
<tr>
<td>On your own</td>
<td>3</td>
</tr>
</tbody>
</table>

### 32 These questions are about the poles you use *(circle one)*

<table>
<thead>
<tr>
<th>Option</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>I own my own poles</td>
<td>1</td>
</tr>
<tr>
<td>What was the purchasing cost?</td>
<td></td>
</tr>
<tr>
<td>I hire my poles</td>
<td>2</td>
</tr>
<tr>
<td>What is the cost? _____________ per week</td>
<td></td>
</tr>
<tr>
<td>I borrow my poles</td>
<td>3</td>
</tr>
</tbody>
</table>
### 33 What type of poles do you use? (*circle one*)

- My poles are especially made for pole walking 1
- My poles are made for hiking 2
- I am not sure whether my poles are made for pole walking or hiking 3

### 34 What is the cost per session to you of walking with poles?

_________________________

### 35 How many times did you walk with poles?

Last week  ____________ times  Last month  ____________ times

### 36 How long would you spend pole walking in a usual session?

____________________ minutes

### 37 On a usual pole walk, at what intensity level do you walk? (*circle one*)

- As hard and fast as I can manage (vigorous intensity) 1
- Just beyond a comfortable intensity (moderate intensity) 2
- At a comfortable intensity (moderate-light intensity) 3
- At a very gentle pace (light intensity) 4
- At variable intensities (eg moderate-vigorous ‘speed plays’) 5
**38 What technique do you use when walking with poles? (circle one)**

- Nordic walking: 1
- Exerstriding: 2
- Other: 3

Which one? ____________________________________________

- I Don’t know: 4

**39 How far do you travel to attend your session of walking with poles? (circle one)**

- Walking distance: 1
  - I drive: 2
    - How long does this take you? ____________________mins
  - I take public transport: 3
    - How long does this take you? ____________________mins
- Other: 4
  - Which? _______________________________________
  - How long does this take you? ____________________mins
### Questions about why you walk with poles

40. What best describes your opinion of the following statements? *(circle one in each category)*

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>I walk with poles in order to improve my fitness</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>I walk with poles in order to keep moving as I age</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c</td>
<td>I walk with poles because I enjoy walking in my pole walking group</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d</td>
<td>I walk with poles because the activity is enjoyable generally</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>e</td>
<td>I find the technique of walking with poles easy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>f</td>
<td>I found the technique of walking with poles easy to learn</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>g</td>
<td>I find it very easy to regularly walk when difficulties arise (e.g. bad weather, family issues, mood etc)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>h</td>
<td>I am confident that I can keep up with regular pole walking in the next month</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
The next questions ask about the differences between pole walking and walking. Circle the answer which best describes your opinion. *(circle one in each category)*

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Walking with poles is the same as walking without them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>Walking with poles strengthens my arms more than walking without them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c</td>
<td>I use more energy when I walk with poles than when I walk without them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d</td>
<td>I can walk further with poles than I can without them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>e</td>
<td>I have less pain when I walk with poles than when I walk without them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>f</td>
<td>I have less stiffness when I walk with poles than when I walk without them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>g</td>
<td>I feel that I am less likely to fall when I walk with poles than when I walk without them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>h</td>
<td>I breathe easier when I walk with poles than when I walk without them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
42 What are some things that make it difficult to walk with poles?

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

43 What are some things that make it easy to walk with poles?

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Would you like to make any other comments about your experiences of walking with poles?
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Thank you for the time and effort that you have put into completing this survey.

Please enclose the survey in the reply paid envelope provided (no stamp necessary) and post it back to us.
Would you be happy to have someone from the walking with poles research team contact you further about your answers to this survey in the next two months? If so, please tick the box and leave your contact details in the space provided.

Yes, I would be happy to provide further information about my answers in this survey ☐

My name ________________________________________________________________

My phone number ________________________________________________________

The best time/day to contact me is __________________________________________

No, I do not wish to be contacted further ☐

If you have any questions about the survey or would like additional information, please contact the “walking with poles” research team by email (walkingwithpoles@uq.edu.au) or phone 0400 490 008
A 2.6 Participant feedback distributed in the Walking with Poles leader survey

Walking with Poles – the results

Well, the results of the Walking with Poles survey have now been analysed. Thank-you all very much for your participation. There were two surveys – one for leaders/instructors, and one for the walkers themselves. The response rate was fantastic, with 31 out of 36 leaders returning surveys, and 107 out of 148 walkers returning theirs. Here are the main results: I have written them in two separate parts, so that you can distribute them to your walkers if you like.

Juliette Fritschi, February, 2013

Leader/instructor results

The average age of leaders was 54 years and 77% of leaders were female. The leaders came (in order of frequency) from Victoria, South Australia, New South Wales, Western Australia, and Queensland. The average time a leader had been leading groups/individuals was 4 years and 3 months. 49% of the leaders held exercise or fitness qualifications, 29% had health qualifications and 23% had other qualifications. With regards to training in pole walking, 84% had undertaken a training course, and almost all were Nordic walkers. The majority of leaders (71%) held sessions as part of an organisation such as a hospital, or Community Health Centre.

The average time for a session was 56 minutes, but if leaders took a second session, the sessions were on average, about 20 minutes longer. The average cost of a session was $3.70, but there was a wide spread of charges for sessions, ranging between being free and costing $15.00. 52% of leaders provided poles free of charge, 52% hired poles, and 71% sold poles. The average cost of hire poles was $4.60. 74% of leaders who sold poles charged under $150.00 per set and the cost varied from $70-$200.

The average size of a group was 8 people, and the size of groups ranged from 1 to 20 people. Almost all leaders’ participants attended sessions to walk regularly. Most leaders had a period of warm-up and cool down, and a stretching session. The majority of walks ranged from light to moderate intensity (81%).

Specific health conditions targeted by leaders included chronic disease (45%), chronic pain (36%), hip or knee joint replacements (39%), balance problems (36%), obesity (29%), and mental health conditions (23%).
Leaders were asked about the importance to them of the following items, and the table below shows the results.

**Figure 1: Motivation for leading PW programs for leaders (% agreement)**

- **Participant enjoyment**
- **Improving CV fitness**
- **Increasing overall PA levels**
- **Ensuring a positive social group experience**
- **Increasing confidence in PA ability**
- **Regular session attendance**
- **Improving participants mental health**

CV=cardiovascular; PA =physical activity

**Some comments from leaders about pole walking...**

**About the ages of walkers:**

“We provide walking groups across ages and encourage all to walk with someone.”

“Our walkers are mostly 60 years plus, but we do not target this age group specifically.”

**Some of the ways leaders use walking with poles:**

“We have mainly utilized the poles in a clinical setting. One on one training and demonstration is given according to the needs of the client.”

“I use Nordic walking as a way to introduce brain health and reducing dementia risk. It incorporates a physical and mental work out with socialising.”

“Since I have started the group the fitness level has increased. We do only walk at a gentle pace but the distance we walk has increased substantially.”

“Pole walking gives confidence to people with poor balance.”

**About the social aspects of PW groups:**

“It is very difficult to get the group to maintain exercise intensity (despite taking heart rates) - talking and socialising always wins.”

“We include a social lunch once a month after PW session- beneficial to my seniors’ mental health and a reward for attending programs.”
A 2.7 Participant feedback distributed in the Walking with Poles walker survey

Walking with poles survey – Walker results

The average age of walkers was 65 years. And 65% were aged over 60 years, and the majority (79%) were female.

Health was rated as excellent, very good or good by 87% of walkers. However, 72% of walkers experienced either spinal or some other form of pain, and 11% of walkers had joint replacements. Falls in the past 12 months had been experienced by 20% of walkers. Health conditions reported by walkers included (in order of frequency) arthritis, depression, anxiety or stress, lung conditions, CV related conditions, diabetes, and cancer. Most walkers were quite active, and 77% achieved or exceeded PA guidelines of over 150 minutes of moderate intensity physical activity (or equivalent) per week. However, the average sitting time was an unhealthy 6 hours per day.

The average length of time walkers had been walking was 2 years and 7 months. The majority of walkers (82%) walked with a group. Most walkers owned their own poles (74%) and the average cost of poles was $112. 90% of walkers had poles specially made for walking, rather than hiking. The average number of sessions walked was 2 per week for around about an hour.

Some comments from the walkers about walking with poles (from the most frequent comments for a topic to the least frequent)...

The good things...

Individual and Social enjoyment:

"I like the pole walking because we meet and walk with happy people and we have fun and go out for lunch sometimes- it is very social and gives me something to do."

"I feel the most enjoyable thing about walking with poles is the social interaction I have with my group of friends. We solve the problems of our life while walking."

"It’s second nature to me now-it's just easy because I love it."

Balance:

"I felt safe and secure knowing there is less chance of falling."

Endurance and fitness:

"When I use them I feel like I have had a real good workout."
Difficult surfaces:
“"I can walk places I couldn’t walk before. e.g. the bush."

“They help in getting up steep slopes. They help you brace going down steep slopes.”

“Walking on the sand dunes, one gets more leverage.”

Outdoor environment:
“Seeing the early morning sun rise or the kangaroos.”

“Fresh air (all weathers).”

Health:
“Walking with poles has been a huge help to my recovery from an accident…”

“My specialist tells me to keep it up.”

Upper body workout:
“It is much more exercise for the arms and shoulders than just ordinary walking.”

And the leaders…
“The commitment of the volunteer leader is exceptional.”

“Encouragement from our leader.”

And the not so good…
Difficult surfaces (again!):
“Uneven paving in my neighbourhood (footpaths).”

“I don’t like walking on a hard surface, like the road on footpaths. Much prefer grass or sand.”

Discomfort/pain:
“Hand grip rubs on hands- now I wear gloves.”

“Arms get tired going up a 3 km hill.”

Difficulties with the technique:
“I found it unbelievably hard to learn the technique and not to walk with the same arm and leg forward. It took me much longer than anyone else in the group... Now I have perfected it, it is easy.”

“Establishing a walking rhythm.”
Walkers were asked a number of questions about their motivations for walking with poles. The following figures show their responses. The first figure shows responses to questions about why they walked with poles. The second figure shows the responses to questions about the differences between walking with poles and walking without them.

**Figure 1a (upper panel): Motivating factors for pole walkers**

**Figure 1b (lower panel): PW compared with W for pole walkers**

### 1a
- Confident that I can continue exercising
- Technique easy to learn
- Technique easy once learnt
- Socially enjoyable
- Activity is enjoyable
- Easy to do in spite of other difficulties
- Fitness motivation
- PA motivation

### 1b
- No difference
- Less pain
- Easier to breathe
- Less stiffness
- Able to walk increased distances
- Better balance
- More energy
- Stronger arms
A 2.8 Ethics approval: On Your Feet study
A research project from The School of Human Movement Studies at the University of Queensland

PARTICIPANT INFORMATION

The investigators on this project are:

Juliette Fritschi and Professor Wendy Brown, from the School of Human Movement Studies at The University of Queensland

Dr Jannique van Uffelen, Senior Research Fellow in Active Aging at the Institute of Sport, Exercise and Active Living (ISEAL) at Victoria University, Melbourne

What is this study about?

Thank-you for your interest in this study. The purpose of this study is to compare the effects of walking with specially designed poles with the effects of normal walking on physical function and quality of life in adults over the age of 65.

Who can participate in this study?

You can participate in the study if:

You are aged over 65 years

- You have no medical or upper limb problems that would limit your ability to participate in a walking programme with or without poles
- You are able to understand English and follow instructions

Please inform us if any aspects of the study cause you concern because of your cultural, religious or traditional customs or beliefs.
What does participation involve?

You will be randomly assigned to one of the following two supervised walking programmes.

- A pole walking program in which participants will walk at a moderate intensity with poles, similar to cross country ski poles
- A walking program in which participants will walk without poles at a moderate intensity.

Each program consists of three sessions of up to 30 minutes per session, for 12 weeks. The sessions will be at an outdoor location in your local area. You will be asked to complete an assessment session at the start and end of the program to help us examine the effects of the walking programs. These sessions will include:

- A questionnaire about your health and physical function
- Measurements of general health, including blood pressure, height, weight, and waist measurements,
- Measurements of physical function which will include a chair-stand test, an arm strength test, a 3 meter up from a chair test, and a 6-minute walking distance test.
- A score sheet to record any joint pain you may have

You will also wear a small device (about the size of a watch face) for five days to measure your physical activity levels. In addition to wearing it before and after the program, you will wear it in week 6 of the program.

How do you benefit from participating?

This study provides you with the opportunity to participate at no cost in an easy, enjoyable and healthy exercise program in your local area. The walking programmes do not require you to attend a gym or wear any special clothes, and will provide an opportunity to socialise with other people in your area. Both the pole walking and the regular walking programmes will be supervised by trained exercise leaders who are keen to help people become healthier through moderate intensity physical activity.

Walking with or without poles are easy activities which do not require anything more than the special poles. If you wish, you can continue walking with others after the study has finished. Everyone who participates in the study, including people in the regular walking program, will receive a free set of poles valued at $90 after completion of the program and the assessments. At the end of the project, there will also be an opportunity for those in the regular walking program to learn how to walk with poles.
Walking is a low impact activity suitable for individuals of all ages and physical abilities. There are minimal risks of falls, injuries, fatigue, muscle soreness, and cardiovascular events. The sessions will be forty minutes in duration when you commence. This will include a 5 minute warm up and 5 min cool down/stretch session. The sessions will gradually increase to 30 minutes in total over the course of the programme. The intensity will remain at a moderate level throughout the programme. All walking and pole walking group instructors will have mobile phones with emergency numbers in case of medical incidents.

At the end of the study, you will receive a summary of the study findings. You will also receive feedback about your own assessment, so you will be able to see if your physical abilities have changed during the study.

So how can you participate?

All you have to do is to register your interest by contacting Juliette Fritschi at The School of Human Movement Studies, The University of Queensland, St Lucia, QLD 4072 by:

email juliette.fritschi@uqconnect.edu.au
or
phone 502-271-9495

Further Information

Project title: A comparison of pole walking and walking in older adults.

Your participation is totally voluntary and if you do not wish to be part of the study any longer, you may stop at any time without penalty, simply by informing Juliette Fritschi (contact details above). You do not have to give reasons for withdrawing. We will keep all information collected from you confidential and stored in a locked cabinet at the University of Queensland. Findings will be reported at group levels, this means that we will not identify individuals in any reports or publications arising from this study.

This study has been cleared in accordance with the ethical review guidelines and processes of the University of Queensland. These guidelines are endorsed by the University's principal human ethics committee, the Human Experimentation Ethical Review Committee, and registered with the Australian Health Ethics Committee as complying with the National Statement. You are free to discuss your participation in this study with project staff (contactable on 0400 490 008.). If you would like to speak to an officer of the University not involved in the study, you may contact the School of Human Movement Studies Ethics Officer on 3365 6380.
Participant Consent Form

Name ___________________________ D.O.B __________________

Address ______________________________________________________

______________________________________________________________

Email ___________________________ Phone ________________________

This study has been explained to my satisfaction. I understand that the project will be carried out by Juliette Fritschi, Dr Jannique van Uffelen, and Professor Wendy Brown as described in the information sheet. I understand that my participation is completely voluntary, I can ask questions about the study at any point, and I can withdraw at any time simply by informing the researcher. I understand that the collected information will be kept confidential, and that personal results will not be made available. I also understand that group results will be summarised for all individuals taking part in the study and that individuals will not be identified in any publication arising from this project.

I understand that:
• If I have any health problems that I am concerned about, I should seek advice from my medical practitioner before participating in this programme.
• I will be randomly assigned to one of two supervised walking programmes, each lasting for 12 weeks. Each program consists of three outdoor sessions of up to 30 minutes per session, and the total duration of the programs is 12 weeks. The programmes are:
  o A pole walking program in which participants will walk with poles, similar to cross country ski poles
  o A walking program in which participants will walk at a moderate pace without poles
• I will be taking part in the following assessments, before the start of the walking program and after the last session:
  o A questionnaire about my health and physical function
  o Measurements of my general health, including blood pressure, height, weight, and waist measurements,
  o Measurements of physical function which will include a chair-stand test, an arm-curl test, a 3 meter up from a chair test, and a 6-minute walking distance test, and a hand grip test.
  o A score sheet to record any joint pain I may have
• I will wear a small, removable activity monitor on a belt for five days before the start of the walking program, during week 6 of the walking program, and after the last session of the walking program.

I have been given a copy of this consent form, as well as the information sheet.
I voluntarily participate in the study

Participant’s name (please print):  
Participant’s signature:  
Date:  

Legal guardian’s name (please print):  
Guardian’s signature:  
Date:  

Witness’ name (please print)  
Witness’ signature:  
Date:  

252
YES, I would like to receive a summary of the results of this study

This study has been cleared in accordance with the ethical review guidelines and processes of the University of Queensland. These guidelines are endorsed by the University’s principal human ethics committee, the Human Experimentation Ethical Review Committee, and registered with the Australian Health Ethics Committee as complying with the National Statement. You are free to discuss your participation in this study with project staff (contactable on 0400 490 008, email walkingwithpoles@uq.edu.au). If you would like to speak to an officer of the University not involved in the study, you may contact the School of Human Movement Studies Ethics Officer on **3365 6380** (Dr Tim Carroll).
A 2.11 Pre-screening tool: On Your Feet study

**On Your Feet**

**Pre-screening tool**

<table>
<thead>
<tr>
<th>Date __________________</th>
<th>Assessment number ________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant ID ________</td>
<td>Assessor ID ________________</td>
</tr>
</tbody>
</table>

AIM: to identify those individuals with a known disease, or signs or symptoms of disease, who may be at a higher risk of an adverse event during physical activity/exercise.

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Has your doctor ever told you that you have a heart condition or have you ever suffered a stroke?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Do you ever experience unexplained pains in your chest at rest or during physical activity/exercise?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Do you ever feel faint or have spells of dizziness during physical activity/exercise that causes you to lose balance?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Have you ever had an asthma attack requiring immediate medical attention at any time over the last 12 months?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>If you have diabetes (type I or type II) have you had trouble controlling your blood glucose in the last 3 months?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Do you have any diagnosed muscle, bone or join problems that you have been told could be made worse by participating in physical activity/exercise?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Do you have any other medical condition(s) that may make it dangerous for you to participate in physical activity/exercise?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IF YOU ANSWERED ‘YES’ to any of the 7 questions, please seek guidance from your GP or appropriate allied health professional prior to undertaking physical activity/exercise

IF YOU ANSWERED ‘NO’ to all of the 7 questions, and you have no other concerns about your health, you may proceed to undertake light-moderate intensity physical activity/exercise
A 2.12 Participant activity diary: On Your Feet study

On Your Feet

Activity logbook

Start date ____________  End date ____________

Participant ID ____________  Actigraph ID number ____________
How to wear your activity monitor

The activity monitor is attached to the belt and can be worn either above or below clothing. It is not necessary for this monitor to make contact with the skin. However, the monitor must be held snugly against the body to collect optimal data. The elastic runs through the back of the device, this side should be against your body/clothing, with the ‘front’ facing out and the arrow pointing up. Please wear the monitor on your right hip and keep the placement the same over the seven days. See picture for an example of how to put the belt on.

For a reliable measurement, we ask you to wear the monitor during all waking hours for 7 days. This monitor is not waterproof and must be taken off when showering, bathing or swimming. Please record the times you did not wear the belt monitor in the activity logbook as described below.

If you are having problems with this monitor, the instructions below will help you further:

The belt doesn’t stay in position:

- It may help if you use the belt loops of your trousers or skirt
- It may help if you tighten the belt

The monitor fell in the toilet/water:

- Please take the monitor out of the water as quickly as possible and contact one of our staff
How to complete your activity logbook

- Please complete this logbook every day for 7 consecutive days.
- General information about your day: date, day of the week, the time that you woke up in the morning, and the time you went to bed that night.
- The time you put the activity monitor on and off for the day and any time you did not wear it during the day, for example to go swimming or take a shower.
- If you would like to tell us anything else about your day - did anything unusual happen during the day?
DAY 1

Date: ………./………. 2012

Mon / Tue / Wed / Thurs / Fri / Sat / Sun

Time you woke up

Time you put the belt monitor on

Time you took the belt monitor off

Time you went to bed

Were there any points in the day that you took the belt monitor off?

O No

O Yes → please tell us when you did not wear the belt monitor

Time taken off

Time put on again

Reason not worn:

_________________________________________________________________

Time taken off

Time put on again

Reason not worn:

_________________________________________________________________

Were there any points in the day that you took the thigh monitor off?

O No

O Yes → please tell us when you did not wear the thigh monitor

Time taken off

Time put on again

Reason not worn:

_________________________________________________________________
Is there any other information you would like to tell us about your activities today?

_______________________________________________________________________

_______________________________________________________________________

NOTE: DAY 2-7 FOLLOWS IN THE SAME FORMAT

You have now completed this logbook. Please hand it over to us the next time we visit you.

Thank-you for participating in the

On Your Feet

study: we appreciate the time and effort you put into this!
A 2.13 Survey items: On Your Feet study

On Your Feet

Questionnaire

Date ________________  Assessment number ________

Participant ID ____________

Thank you for completing this survey

Your answers are completely confidential. Only the On Your Feet staff will see this material, and your information will be kept confidential and anonymous.

This survey is about you, your activities, and health

Please read each question carefully and answer all as accurately as you can. If you are unsure about a question, please choose the answer closest to what you think. There are no right or wrong answers; we would like to know about your experiences and opinions.
Most questions can be answered by circling a number, for example:

12. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)? (circle one)

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Some questions will ask you to write your response, for example:

15. In the last week, how many times did you do any vigorous gardening, or heavy work around the yard, which make you breathe harder or puff and pant?

3 times
### ABOUT YOUR HEALTH

**1. In general would you say your health is? (circle one)**

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**2. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much? (circle one in each category)**

<table>
<thead>
<tr>
<th></th>
<th>Yes, limited a lot</th>
<th>Yes, limited a little</th>
<th>No, not limited at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling or playing golf</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>b</td>
<td>Climbing several flights of stairs</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**3. During the past 4 weeks have you had any of the following problems with your work or other regular activities as a result of your physical health? (circle one in each category)**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**4. During the past 4 weeks, have you had any of the following problems with your work or other regular activities as a result of any emotional problems (such as feeling depressed or anxious)? (circle one in each category)**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. During the past 4 weeks, how much did pain interfere with your normal work (including both outside the home and housework)? (circle one)

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling.

6. How much of the time during the past 4 weeks (circle one in each category)

   | All of the time | Most of the time | A lot of the time | Some of the time | A little of the time | None of the time |
---|----------------|------------------|-------------------|------------------|---------------------|-----------------|

   a. Have you felt calm and peaceful?  

| 1 | 2 | 3 | 4 | 5 | 6 |

   b. Did you have a lot of energy?  

| 1 | 2 | 3 | 4 | 5 | 6 |

   c. Have you felt downhearted and blue?  

| 1 | 2 | 3 | 4 | 5 | 6 |

7. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)? (circle one)

   | All of the time | Most of the time | Some of the time | A little of the time | None of the time |
---|----------------|------------------|------------------|---------------------|-----------------|
| 1              | 2               | 3                | 4                  | 5                 |
For the following joints, select the number that best describes your pain in the past 24 hours (circle one number per joint only)

<table>
<thead>
<tr>
<th></th>
<th>No pain</th>
<th>Worst possible pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Neck</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>b</td>
<td>Lower back</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>c</td>
<td>Left shoulder joint</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>d</td>
<td>Right shoulder joint</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>e</td>
<td>Left hip joint</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>f</td>
<td>Right hip joint</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>g</td>
<td>Left knee joint</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>h</td>
<td>Right knee joint</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>i</td>
<td>Left ankle joint</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>j</td>
<td>Right ankle joint</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>
Have you ever had or been told by your doctor that you have any of the following? *(circle all that apply)*

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Heart problems (including angina)</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>High blood pressure</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>High cholesterol</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>Arthritis (osteoarthritis, rheumatoid arthritis, other arthritis)</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>Diabetes (high blood sugar)</td>
<td>1</td>
</tr>
<tr>
<td>f</td>
<td>Depression</td>
<td>1</td>
</tr>
<tr>
<td>g</td>
<td>Anxiety</td>
<td>1</td>
</tr>
<tr>
<td>h</td>
<td>Other medical condition</td>
<td>1</td>
</tr>
</tbody>
</table>

Which other medical condition _____________________________
This scale looks at how you are currently feeling. For each statement, circle a number from 1 to 5 that best describes you. For instance, if you usually fall asleep quickly when you want to, circle 5. Otherwise, circle a number from 1 to 4, depending on the extent to which you usually have difficulty falling asleep.

<table>
<thead>
<tr>
<th></th>
<th>Statement</th>
<th>Scale Representation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>It usually takes a long time to fall asleep</td>
<td>1 2 3 4 5</td>
<td>Fall asleep quickly</td>
</tr>
<tr>
<td>B</td>
<td>Sleep poorly</td>
<td>1 2 3 4 5</td>
<td>Sleep well</td>
</tr>
<tr>
<td>C</td>
<td>Tired or drowsy during the day</td>
<td>1 2 3 4 5</td>
<td>Feel rested</td>
</tr>
<tr>
<td>D</td>
<td>Rarely hungry</td>
<td>1 2 3 4 5</td>
<td>Excellent appetite</td>
</tr>
<tr>
<td>E</td>
<td>Often constipated</td>
<td>1 2 3 4 5</td>
<td>Do not get constipated</td>
</tr>
<tr>
<td>F</td>
<td>Often have aches and pains</td>
<td>1 2 3 4 5</td>
<td>Have no aches and pains</td>
</tr>
<tr>
<td>G</td>
<td>Low energy level</td>
<td>1 2 3 4 5</td>
<td>Full of pep and energy</td>
</tr>
<tr>
<td>H</td>
<td>Often stiff in the morning</td>
<td>1 2 3 4 5</td>
<td>Not stiff in the morning</td>
</tr>
<tr>
<td>I</td>
<td>Often restless or agitated</td>
<td>1 2 3 4 5</td>
<td>Feel relaxed</td>
</tr>
<tr>
<td>J</td>
<td>Often do not feel good</td>
<td>1 2 3 4 5</td>
<td>Feel good</td>
</tr>
</tbody>
</table>
12. In the last week, how many times have you walked continuously for at least ten minutes, for recreation, exercise, or to get to and from places?

__________ times

13. What do you estimate was the total time you spent walking in this way in the last week?

_______ hours and _______ minutes

14. In the last week, how many times did you do any vigorous gardening, or heavy work around the yard, which make you breathe harder or puff and pant?

__________ times

15. What do you estimate was the total time that you spent doing vigorous gardening or heavy work around the yard in the last week?

__________ hours and ____________ minutes

The next questions exclude household chores, gardening, or yard work

16. In the last week, how many times did you do any vigorous physical activity, which made you breathe harder or puff and pant? Eg jogging, cycling, aerobics, competitive tennis

__________ times

17. What was the total time you spent doing this vigorous physical activity in the last week?

__________ hours and ____________ minutes

18. In the last week, how many times did you do other more moderate activities that you have not already mentioned? Eg gentle swimming, social tennis, golf

__________ times
19 What do you estimate was the total time that you spent doing these activities in the last week?

______________ hours and ___________ minutes

20 Please estimate how many hours and minutes you spend sitting each day in the following situations: (please write your answer)

<table>
<thead>
<tr>
<th></th>
<th>On a week day</th>
<th>On a week-end day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours</td>
<td>Minutes</td>
</tr>
<tr>
<td>While travelling to and from places</td>
<td></td>
<td></td>
</tr>
<tr>
<td>While at work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>While watching television</td>
<td></td>
<td></td>
</tr>
<tr>
<td>While using a computer at home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In your leisure time, NOT including television (e.g., visiting friends, movies, dining out, etc.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Would you like to make any other comments about your experiences of walking in the program?

__________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________
## ABOUT YOU

### 21 What is your date of birth?

Day _______ month _______ year _______

### 22 Are you male or female? *(circle one)*

<table>
<thead>
<tr>
<th>Male</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>female</td>
<td>2</td>
</tr>
</tbody>
</table>

### 23 What is the highest qualification you have completed? *(circle one)*

- No formal education or school certificate | 1 |
- High school or leaving certificate | 2 |
- Trade/apprenticeship/ certificate/ diploma (e.g. Child Care, Technician) | 3 |
- University degree or higher degree | 4 |

### 24 Which of the following best describes your main current employment situation? *(circle one)*

- Full time employment | 1 |
- Part time employment | 2 |
- Not in paid employment (e.g. retired) | 3 |
25. **How do you manage on the income you have available? (circle one)**

- It is impossible 1
- It is difficult all the time 2
- It is difficult some of the time 3
- It is not too bad 4
- It is easy 5

26. **Where were you born? (circle one)**

- Australia 1
- USA/ Canada 2
- UK 3
- Europe 5
- An Asian country 6
- Other 7

Which other country? ___________________________
What is your present marital status? *(circle one)*

<table>
<thead>
<tr>
<th>Status</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never married</td>
<td>1</td>
</tr>
<tr>
<td>Widowed, divorced or separated</td>
<td>2</td>
</tr>
<tr>
<td>Married/defacto</td>
<td>3</td>
</tr>
</tbody>
</table>

Thank-you for participating in the *On Your Feet* study and for completing this questionnaire.
A 2.14 Measurement Form: On Your Feet study

On Your Feet
Assessor Measurement Form

Date _________________  Assessment number _______
Participant ID __________  Assessor ID ______________
DOB ______/_______/_______

<table>
<thead>
<tr>
<th>Test item</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure</td>
<td>______mmHg</td>
<td>______mmHg</td>
<td>______mmHg</td>
</tr>
<tr>
<td>Waist</td>
<td>______inch</td>
<td>______inch</td>
<td>______inch</td>
</tr>
<tr>
<td>Height</td>
<td>______inch</td>
<td>______inch</td>
<td>______inch</td>
</tr>
<tr>
<td>Weight</td>
<td>______lb</td>
<td>______lb</td>
<td>______lb</td>
</tr>
<tr>
<td>Test Item</td>
<td>Result</td>
<td>Comments</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Chair Stand Test (number in 30 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm Curl (number in 30 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-Minute Walk Test (number of meters)</td>
<td>M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Results</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.44 meter Up-and-Go Test (nearest 0.1 sec)</td>
<td>Practice (tick)</td>
<td>T1 _______ sec</td>
</tr>
<tr>
<td>Grip strength</td>
<td>T1 _______ lb</td>
<td>T2 _______ lb</td>
</tr>
</tbody>
</table>

R   L

Any other comments?
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
A 2.15 Participant feedback form: On Your Feet study

On Your Feet

Your results

Name__________________
Thank you very much for participating in the On Your Feet program. The program involved a number of tests at the beginning, followed by 12 weeks of either walking, or walking with poles in a group. At the end of the study, you did the tests again to see if your health had changed at all.

Your results for the two tests are shown in the following table.

Juliette Fritschi
30-10-13

<table>
<thead>
<tr>
<th>Test name</th>
<th>First test</th>
<th>Second test</th>
<th>Normal scores for your age</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much you weigh compared to your height?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chair stand – leg strength</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many times you can stand up and sit down in 30 seconds?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Arm curl – arm strength</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many times can you lift a small weight in 30 seconds?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6 minute walk test – fitness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How far you can walk in 6 minutes?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Up and go test – balance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How quickly can you stand, walk, turn and sit?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grip strength - hand grip</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How strong is your grip?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX THREE: Published versions of papers

A 3.1 Effects of pole walking on health in adults: A systematic review

This study has been published in the *Scandinavian Journal of Medicine and Science in Sports* (Impact Factor 3.174), and appears below as published.

The citation is as follows:

Abstract

The aim of this systematic review was to summarise the effects of pole walking (PW) programs on physical and psycho-social health. Randomised controlled and controlled trials were identified from literature searches in PubMed, Cochrane library, EMBASE, SPORTdiscuss, CINAHL and PEDRO. A total of 14 papers from 13 studies met the inclusion criteria. Eleven of the included studies had a quality score of 50% or higher. Most studies included mid to older aged men and women in clinical populations with various medical conditions. Only two studies included non-clinical populations. The majority of the PW programs consisted of supervised group sessions performed two to three times weekly for 8 weeks or longer. Most studies investigated the effects of PW on both physical and psycho-social health and the majority examined effects on four to five outcomes. The effects of PW on cardiorespiratory fitness were most extensively studied. The most frequently examined psycho-social measure was quality of life. All studies reported at least one beneficial effect of PW compared with the control group. The results of this systematic review indicate that PW programs have some beneficial effects on both physical and psycho-social health in adults with and without clinical conditions.

Key words: pole walking; randomised controlled trial; physical health; psycho-social health; quality of life
Introduction

Regular physical activity (PA) is associated with improved mental and physical health in adults regardless of age or health status (1). However, participation in PA and exercise in developed nations is low (2-4). Encouraging adults who are currently not achieving healthy levels of PA to increase their exercise through moderate intensity activities such as walking can be beneficial in terms of both individual and public health outcomes (5).

Walking is the most commonly reported form of physical activity in Western nations (6). Walking is self-regulated and, because of its low ground impact, has low risk of injury. It is often the preferred option for people who want to increase their physical activity, including aging adults and those affected by chronic conditions (7).

Pole walking (PW) is an outdoor, non-competitive form of exercise which originated in Finland, where it was developed as a summer conditioning exercise for cross country skiers. It is a form of walking with the addition of hand-held poles, used in opposition to lower limb locomotion, and has similar low impact, moderate intensity characteristics to walking (8). Since the development of walking poles in the 1980’s and 1990’s, PW has increased in popularity in Europe and is becoming more widespread in other Western nations (9). There are two main forms of PW: Nordic walking, which is common in Europe; and Exerstriding, which was developed and is almost exclusive to the United States. Key features of the Nordic walking technique are increased stride length, increased hip range of motion, and a grip/release hand grasp technique. Key features of the Exerstriding technique are a more normal gait, a higher arm position, and a continuous hand grip (9, 10).

Additional benefits of PW compared with regular brisk walking include higher oxygen uptake, increased heart rate and caloric expenditure without significantly increased perceived exertion (11), increased upper limb muscle activation (12), and possible reduction in vertical knee joint forces(13, 14).

PA levels in people who are overweight, elderly, or have chronic conditions such as heart disease are lower than in younger and healthier populations of adults (15), and the reporting of potential benefits of PW for these populations has led to an increase in the
number of PW programs offered by community and government organisations in various countries (16-18).

The health benefits of this type of exercise are however unclear because previous reviews did not include any assessment of the quality of the included studies (19, 20). The aim of this systematic review was therefore to critically examine both the findings and the quality of studies that have examined the effects of PW programs on physical and psycho-social health in adults.

Methods

Literature search

The bibliographic databases PubMed, Cochrane library, EMBASE, SPORTDiscus, CINAHL and PEDro were searched between February and October 2011. Trials of PW interventions were identified by searches for the following free terms in titles and abstracts: pole walking, polewalking, Nordic walking, walking with poles, walking poles, Exerstriding, pole striding, Nordic poles, power poles, and stick walking. An additional manual search of the reference lists of included papers was done to identify any further potentially relevant papers.

Inclusion criteria and selection process

Studies were included in the review if they met the following criteria: 1. Design: randomised controlled trial (RCT), or controlled trial (CT); 2. Population: adults over 18 years; 3. Intervention: program including a main component where participants walked with poles; 4. Control group: exercise program other than PW, non-exercise intervention, or non-intervention control group; 5. Outcome: subjective or objective measures of physical or psycho-social health. Only peer reviewed, full text papers were included. In addition, only papers written in English or other languages spoken by the research team (i.e. German, Dutch, French, Spanish, Finnish) were reviewed. Titles and abstracts of papers identified through the search were scanned by JF to exclude non-relevant papers. Following this, JF and JvU independently reviewed the full text of the remainder to ensure that inclusion criteria were met.
**Data extraction**

The following data were extracted: 1. Study design; population groups and numbers; age and gender; eligibility criteria; and recruitment setting and methods; 2. Details of PW interventions and control strategies; attendance, dropout, and numbers of participants for whom follow-up data were analysed; outcome measures; and the effect of PW on these outcomes. The outcome measures were categorized into physical, psycho-social or other outcomes with subcategories for the physical measures based on the outcomes assessed in the included studies.

Data on both between and within group differences were extracted and reported (Table 4, supporting information), but only studies that reported between group differences were included in the description of the effects of PW on the examined health outcomes (Table 2). Thus, because one study only reported within group differences (21), 12 studies were included in the description of the effects and in Table 2.

**Quality assessment**

The methodological quality of the studies was assessed independently by JF and JvU using a list based on the Delphi list, developed by Verhagen et al. (1998). Two criteria i.e. blinding of trainers and blinding of participants, were not rated in this review because of the difficulty in blinding either of these in trials of specific exercise modalities such as PW (22). The quality rating list used in this review included the following seven items: randomisation; concealed treatment allocation; group similarity at baseline; specified eligibility criteria; blinded outcome assessor; point estimates and measures of variability for between group differences; intention to treat analysis.

The criteria were scored using a “yes” (1 point), “no” (0 points), or “unclear” (0 points) answer format. Authors were contacted for clarification if an item was scored as ‘unclear’. All criteria were equally weighted, and for this review a quality score was generated as a percentage of the maximum score for each included study analysed. High quality in this review was defined as having a quality score of over 50%.
RCT = randomised controlled trial, CT = controlled trial

**Figure 1  Search process**

1. Records identified through database searching = 531
2. Duplicates removed = 368
3. Records screened = 368
4. Records excluded = 345
5. Full-text papers excluded, with reasons:
   - no RCT, or CT = 6
   - language other than that spoken by the team = 2
   - same study = 1
   Total = 9
6. Papers identified as eligible = 14
7. Additional records identified through reference lists of selected papers and screened, none eligible = 7
8. 14 papers included in qualitative synthesis describing 13 interventions
Results

Details of the search process are shown in Figure 1. Abstracts of 368 unique papers were initially reviewed. The full text of 23 papers was independently checked and nine were excluded. Thus 14 papers met the inclusion criteria (21, 23-35). One intervention was described in two papers, but with different outcome measures (33, 35). Both papers were therefore included and are considered as one intervention study in the results section.

Quality assessment

The results of the methodological quality assessment are presented in Table 1. Quality scores ranged from 29% to 86%. Eleven papers scored over 50% on the quality rating score. Authors were contacted for further information on blinding of the outcome assessor (six studies) and concealed treatment allocation (three studies).

Eight of the 11 randomised trials used concealed randomisation. Of all 13 included studies, intervention groups were similar at baseline in 11, eligibility criteria were specified in 12, outcome assessors were blinded in nine, intention to treat analysis occurred in five, and point estimates and measures of variability were reported in four.

Study population

Characteristics of the study participants are shown in Table 3 (supporting information). Participants in the studies were predominantly mid to older aged men and women from clinical populations (i.e. a diagnosed medical condition). Populations studied included type 2 diabetes, cardiovascular disease (28), peripheral artery disease (33, 35), musculoskeletal conditions (27, 30), chronic obstructive pulmonary disease (24), Parkinson’s disease (25, 31), Sjogren’s syndrome (32) and breast cancer (21). There were only two studies in non-clinical populations. These were both populations of middle-aged women (23, 29). Although the study by Fritz et al. (2011) targeted adults with diabetes mellitus, they included normal glucose tolerant adults in one of their three intervention groups.

Sample sizes ranged from 12 to 212 participants, and most studies included around 60 participants. The average age of participants in each study ranged from 45 to 69 years. Five studies included only female participants (21, 23, 29, 30, 32), and one included only male participants (28).
Details of the PW and control programs are reported in Table 4 (supporting information). The duration of most of the PW programs was 8 weeks or longer (mean 14.2 weeks, range 3 to 24 weeks). The exception was the PW program in the study by Kocur et al. (2009), which had duration of three weeks. Session frequency of the programs varied from one to five exercise sessions per week, and duration of the PW sessions from 20 minutes to 70 minutes. Most of the programs required participants to exercise at moderate intensity, which was operationalised using both subjective and objective measures, including ratings of perceived exertion, heart rate and accelerometer data. In five programs, intensity was varied during the sessions (23, 30, 31, 33, 35). This was achieved in four programs by incorporating “speed plays” in order to increase the intensity during parts of the sessions (30, 33, 35, 36). Breyer et al. (2010) required participants to exercise at a high intensity of 75% of maximum heart rate throughout the session, and the program of Strombeck et al. (2007) increased from moderate to high intensity. Intensity was not reported in three PW programs (25, 26, 35), and Hartvigsen et al. (27) reported that their participants exercised at variable but unspecified intensities.

In most programs, the instructors were physiotherapists, exercise or Nordic walking instructors or medical staff trained in PW. The type of instructor was not specified in two studies (33, 35, 36). Two PW programs used a combination of supervised and unsupervised sessions (23, 32). Hartvigsen et al. (2010) compared a supervised with an unsupervised PW group, while the study by Fritz et al. (2011) included only unsupervised PW participants. In the study by Langbein et al. (2002), the program changed from unsupervised to supervised during the course of the intervention, because of poor adherence in the unsupervised program.

The used technique for PW was reported in six studies (21, 23, 24, 28, 31, 33, 35). Four studies used the Nordic walking technique advocated by the International Nordic Walking Association (23, 24, 28, 31) and two studies used the Exerstriding technique (21, 33, 35). Three studies did not provide a description of the terrain (24, 26, 32). Of the remainder, all programmes were performed outdoors except two which reported indoor sessions during inclement weather (21, 33, 35). Of the outdoor programmes, five described the terrain as parkland or forest paths (25, 27, 30, 31, 34). One study reported an asphalt walking surface (28) and the rest did not report type of surface.
Eight studies included control groups which consisted of an exercise program other than PW (21, 23, 25, 28-31, 34). Six of these compared PW with walking (21, 23, 28-31). Ebersbach et al. (25) compared PW with LSVT-BIG (Lee Silverman Voice Therapy, which is a therapy that focuses on high intensity exercise with high-amplitude movements) as well as home exercises, and Gram et al. (34) compared PW with a program of exercise on prescription, (a combination of strength training and aerobic exercise) and a non-exercise control. The control programs were of similar or lower intensity than the PW programs (Table 4, supporting information).

Six studies included a non-exercise control group (24, 26, 27, 32-35). Nine studies compared PW with only one control group (21, 23, 24, 26, 27, 29, 30, 32, 33, 35). Four studies compared PW with two control groups (25, 28, 31, 34). Hartvigsen et al. (2010) compared supervised and non-supervised PW and included a third home exercise control group.

**Cardiorespiratory measures**

The effects of the interventions are summarised in Table 2. The most frequently examined physical outcomes were cardiorespiratory measures. Of these, six studies assessed endurance (24, 28, 30, 31, 33, 35, 36), five assessed oxygen uptake (23, 29, 32-35), and five assessed heart rate and blood pressure (23, 29-31, 34). Fewer assessed ratings of perceived exertion (24, 28, 29, 32) and ankle brachial index (33, 35).

Significant effects of PW compared with control groups were found for 16 out of 27 of the cardiorespiratory measures. Of these, the most frequent significant improvements of PW programs relative to controls were in endurance. Two studies that measured endurance found improvements relative to a non-exercise control (24, 33, 35), and two found improvements relative to a light intensity exercise (30, 31). Of the three studies measuring endurance which compared PW to a similar intensity exercise, two found an improvement in PW relative to a control group. One of these compared PW with a walking control (36). The other compared PW with cycle ergometer training (28).

Significant effects of PW on oxygen uptake (compared with a control group) were found in three studies (23, 32, 33, 35), of which one compared PW with similar intensity walking (36). Two studies that measured ratings of perceived exertion reported a significant effect in PW participants compared with a similar intensity control group and a non-exercise control group. Finally, in two studies, heart rate and blood pressure measures were
significantly improved compared with similar intensity walking (31) and light intensity walking (30). There was no effect of PW on ankle brachial index (33, 35).

**Functional status**

The effect of PW on functional status was examined in 5 studies, and measures included the timed up and go test (25, 28), the Unified Parkinson’s Disease Rating Scale (UPDRS) (25, 31), dynamic and static balance (29, 31), timed walk (25), Patient Specific Functional Scale (27), and the sit to stand test (28). Of the five studies which assessed functional status, two found a positive effect of PW relative to a control group (28, 31). In the study by Ebersbach et al. (2010), motor performance and timed up and go test improved in both LSVT-BIG and PW groups relative to baseline. However, there was a negative effect of PW on both measures compared with LSVT-BIG. The other two studies that measured functional status reported no significant effects of PW relative to the control group (27, 29).

**Pain**

The effect of PW on pain was also examined in five studies (27, 29-31, 35), of which three found significant improvements. Kukkonen-Harjula et al. (2007) examined the effect of PW on pain in five body areas in sedentary women, and found a significant decrease in sciatic back pain in the PW group compared with a walking control. Reuter et al. (2011) found a significant decrease in back, hand and leg pain in the PW group compared with a flexibility and relaxation control group in six body areas in adults with Parkinson’s disease. Langbein et al. (2002) found a significant decrease in claudication pain in the PW group compared with a non-exercise control group in adults with peripheral artery disease. No significant effects of PW were found on local pain score in a study of fibromyalgia patients, or on back pain in adults with low back pain (27, 30).

**Other physical measures**

Other physical outcomes assessed in less than five studies, included PA levels (24, 26, 28, 31), anthropometric measures (23, 26, 29, 34), muscle strength and flexibility (28, 29), fatigue (32), gait parameters (31), and blood glucose levels (34).

In the four studies that examined PA, there was an increase in PA in all PW groups relative to controls, except in Reuter et al. (2011), where there was no effect of PW on PA compared to a walking group. Of the four studies that included anthropometry, Fritz et
al. (2011) found a positive effect of PW on body mass index in adults with normal glucose tolerance compared with non-exercise controls, and Gram et al. (2010) found a positive effect of PW on fat tissue mass relative to a non-exercise control group. Kukkonen-Harjula et al. (2007) found no significant changes in waist circumference or weight relative to the control group. Figard-Fabre (23) found no significant differences between PW and walking groups in body mass, BMI, skinfold thickness or body fat percentage.

Of the two studies that examined the effect of PW on muscle strength, Kocur et al. (2009) found an improvement in arm curl strength in the PW group compared with both a control group and a walking group, and in the timed sit to stand test compared with the control group only. However, Kukkonen-Harjula et al. (2007) reported a decrease in one leg squat strength in participants with low fitness in the PW group compared with a walking control group. There was no effect of PW on flexibility in these two studies. In the only study that examined the effect of PW on fatigue, Strombeck et al. (2007) found a positive effect of PW on fatigue in Sjogren’s syndrome patients.

Reuter et al. (2011) examined the effects of PW on several gait parameters in adults with Parkinson’s disease, and found that stride time, stride length, and stride length variability all showed a significant improvement in the PW group compared with both the walking and flexibility and relaxation control group, and percentage of double stance improved in PW group compared with the flexibility and relaxation group only. Gram et al. (2010) found non-significant effects of PW compared with the control groups in blood glucose measures. Hartvigsen et al. (27) found no effects of PW compared with control groups on pharmacological treatment, time off work, other treatment and expectation to treatment.

**Psycho-social measures**

Four of the nine studies that examined the effects of PW on psycho-social measures assessed quality of life with the SF36 (24, 32-34). Other psycho-social measures included general and specific quality of life outcomes, fatigue as measured in a quality of life questionnaire, anxiety and depression (24-27, 30-32, 34, 35).

Six studies found significant psycho-social effects of PW relative to a control group. Breyer et al. (2010) found positive effects of PW on mood (Hospital Anxiety and Depression Scale-HADS) and generic quality of life (SF36) in patients with chronic obstructive pulmonary disease compared with a non-exercise control group. Fritz et al.
(2011) found improvements in satisfaction with both physical functioning and physical health in pole walkers compared with non-pole walkers with normal glucose tolerance and in quality of sleep, general health, and pain in pole walkers compared with non-pole walkers with diabetes. Langbein et al. (2002) found improvements in perceived ability to walk distance and walking speed in the PW group relative to the non-exercise control. Mannerkorpi et al. (2010) found that, in fibromyalgia patients, motivation and activity limitations significantly improved in the PW group compared with a light intensity walking group. In the study by Reuter et al. (2011), people with Parkinson’s disease had significantly improved concentration, memorization and recall of information in the PW group compared with those in a relaxation and flexibility group. Strombeck et al. (2007) found significantly reduced depressive symptoms in participants with Sjogren’s syndrome in the PW group compared with a low intensity exercise group.

**Dropout and attendance**

Dropout rate from the PW programs varied between 0% and 13% in twelve of the thirteen studies, and was 25% in the study by Sprod et al. (2005). Dropout rates were similar in both the PW and control groups in all studies which recorded them. The most commonly reported reasons for drop-out reported in the studies were physical or psychological illness, or injury unrelated to the interventions and lack of time for participants (24, 25, 27, 29, 30, 33). Attendance at the PW sessions was reported in eight studies (23, 26, 29-35) and varied from 50% to 96%; only three studies reported session attendance of less than 75% (26, 30, 34). Eight studies reported on reasons for non-attendance (24, 27-31, 33-35) and these same studies all reported adverse effects. In four studies, there were no adverse effects caused by the PW intervention (27, 28, 34, 35). Mannerkorpi et al. (2010) reported a case of acute trochanteritis, while Kukkonen-Harjula et al. (2007) reported three injuries: one ankle sprain, one overuse injury of the shoulder; and one heel injury. This was an injury rate of 1.4/1000 PW training hours, which was not statistically different from the injury rate in the non-exercise control group. In their study of Parkinson’s disease patients, Reuter et al. (2011) reported four falls, five cases of twisted ankles (of which four were minor), two cases of exercise induced hypotension, and two cases of shoulder pain. In two studies it was unclear as to whether one acute exacerbation of osteoarthritis and two cases of exacerbations of chronic obstructive pulmonary disease were caused by the PW training sessions (24, 33).
Discussion

The aim of this review was to describe and critically evaluate the effects of PW programs on physical and psycho-social health in adults. Fourteen papers from 13 randomised and controlled trials were identified in an extensive literature search. All 14 papers were published since 2002, with ten since 2010, suggesting that the area of PW research is in its infancy. The variety of study populations, control groups and outcome measures made comparisons between studies difficult. Nonetheless, all studies found at least one positive effect. PW particularly improved cardiorespiratory outcomes, functional status, physical activity, and quality of life. Effects on pain, anthropometry, muscle strength and flexibility, fatigue, gait parameters, and blood glucose levels were less clear.

The findings of this review are in line with the two previous reviews (19, 20) which showed improvements in cardiorespiratory outcomes, anthropometric data, pain levels and quality of life. The current review extends this evidence, by showing that adults with Parkinson’s disease, obesity, low back pain, diabetic indicators and fibromyalgia can also benefit from PW. Of the studies that examined the effects of PW on cardiorespiratory outcomes, all those that included endurance measures found beneficial effects of PW compared with control groups. In several studies, improvements in endurance were found in groups who are limited in their ability to walk functional distances, such as adults with Parkinson’s disease (25, 31), chronic obstructive pulmonary disease (COPD) (24), claudication pain (33, 35), and cardiovascular disease (28). However, the uniqueness of each population and their clinical characteristics makes generalisations about the benefits of PW for populations other than the ones described above difficult, and there is a need for caution when making claims about the fitness benefits of PW for people with other health conditions.

In systematic reviews of trials with clinical implications, quality rating is important, as it draws attention to potential bias and limitations. This can improve interpretation or study findings, and facilitate decision making about treatment effectiveness (37). Eleven of 13 studies scored 50% or above on the modified Delphi quality score, indicating the high quality of most of the studies. (23-31, 33, 34). The items on which studies did not score well included those which concerned blinding of outcome assessors, recording of point estimates and measures of variability, and intention to treat analysis. Blinding of participants, data collectors, outcome assessors, and data analysts, wherever possible, is
an important safeguard against potential bias, but these were not reported in five studies. Assessors who know if the participant is in the intervention or in the control group may, unconsciously, differentially assess outcomes, especially if they are subjective (38). Blinding of participants was not considered realistic for most of the studies in this review. Intention to treat analysis is defined as including all data from randomised participants in the analysis, retained in the group to which they were allocated regardless of whether they completed the intervention (39). Eight studies in this review did not include data from all randomised participants in the analysis (21, 24, 25, 27, 29, 32-35). Although it is often difficult to achieve high follow-up rates in studies that target clinical or frail populations, due to issues such as illness, injury or even death of participants, it is critical to make an effort to perform intention to treat analysis. Not using intention to treat protocols in the analysis can lead to a loss of power, due to reduced sample size, and, more importantly, the effects of an intervention could be overestimated if people not completing the study are excluded from the analysis. It is therefore recommended that either all subjects participate in all assessments, even if they may have dropped out from the intervention, or if possible, a last measure carried forward protocol or other form of imputation is used (40).

Finally, nine studies did not report point estimates, or measures of variability of between group differences. (21, 23, 26-28, 30-33, 35). This information is critical for comparing the effects of PW with control interventions, and provides information about the direction and the variability of the effects. Point estimates and measures of variability should therefore be included in future papers.

A description of PW technique was included in six of the reviewed studies (21, 23, 24, 28, 31, 33, 35). Although potential PW training effectiveness and benefits may differ depending on techniques and poles used, no studies have yet compared walking with different techniques and poles. It is difficult to draw conclusions about the qualitative or quantitative differences between Nordic walking and Exerstriding due to the small number of studies describing details of the used technique. Limited evidence in this review suggests that certain techniques may suit different populations. For example, Reuter et al., in their study of patients with Parkinson’s disease, found that the grip/release technique of Nordic walking was difficult for many of the patients (31). A recent study showed that in obese middle-aged women not familiar with the technique of PW, a
learning period of PW technique was needed to enhance the difference in cardiovascular demand between PW and walking (36). The provision of a clear description of the technique, training periods and poles used may therefore enable a better choice of technique and pole to suit specific clinical populations.

This review highlights a number of issues for further research. As the differences between the effects of PW and walking have not been extensively studied, and because walking is frequently the exercise of choice for those seeking to promote PA in clinical and inactive healthy populations, there is a need for more comparative studies of PW and walking. Only five of the reviewed intervention studies compared PW with walking at a comparable intensity (21, 23, 28, 29, 31); they found few additional benefits of PW over walking. The outcomes in these studies, however, were often general endurance measures, and not those which investigate specific differences between PW and walking. Walking with the addition of hand-held poles may be easier for some groups such as the elderly or those with balance problems. In order to examine the potential additional benefits of PW over walking, we suggest future studies also include population specific measures of outcomes such as measures of balance in older adults, upper limb muscle use and neck pain.

The lower limb effects of PW in clinical groups have not been investigated thoroughly. One characteristic of PW with clinical implications is that using poles could result in decreases in knee joint compressive forces (14, 41, 42). Populations such as those with knee joint osteoarthritis or total knee joint replacements, in which pain may be a limiting factor for exercise, may benefit from walking with poles. Of the three studies included in this review that investigated the effects of PW on lower limb pain (29, 31, 35), only one looked specifically at knee joint pain, and none studied the effects of PW in adults with knee conditions such as osteoarthritis. Hence, there is scope for further studies to test the effectiveness of PW as exercise for people with knee joint pathology.

Although evidence of the benefits of PW for many clinical groups is increasing, studies investigating the use of PW in generally healthy people without diagnosed conditions are underrepresented in the current review. In this review, all except three studies (which included sedentary, non-obese women, healthy obese women, and overweight individuals with normal glucose tolerance (23, 26, 29)) investigated PW in populations with clinical conditions. Populations such as the elderly, obese and sedentary individuals
have some of the lowest physical activity levels in the general population, and often have difficulty maintaining recommended levels of PA (43). PW may provide an alternative strategy for improving the physical and psycho-social health of these adults. We suggest that the effects of PW programs in healthy populations without clinical conditions, in terms of safety, PA maintenance, and health outcomes, are worth exploring in future studies.

Most of the studies were supervised. It is however difficult to draw conclusions about the role of supervision because of heterogeneity in program structure, walking techniques and learning processes. Langbein et al. (35) did however report much better adherence with their supervised than non-supervised group, to the extent that the non-supervised group was discontinued.

While there is a possibility that some studies were missed in the literature search, it is more likely that the small number of studies included in this review reflects the developing nature of this field of research. As PW is more prevalent in Europe, we included languages other than English in order to capture a more complete range of papers. As for all systematic reviews, the results of this review could have been affected by publication bias, i.e. studies with positive outcomes could have been more likely to be published and therefore included in this review.

**Perspective**

Research into the effects of PW programs for adults is an emerging field, and this review highlights several new studies in adults with and without clinical conditions. There is evidence that PW has beneficial effects on many physical and psycho-social outcomes as well as being a well-tolerated and safe exercise for diverse populations.

**Acknowledgements**

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### Table 1  Quality assessment of the included studies

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<td>Y*</td>
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<td>?</td>
<td>Y</td>
<td>Y</td>
<td>Y*</td>
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<td>Figard-Fabre et al. (2011)</td>
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<td>N</td>
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<td>Fritz et al. (2011)</td>
<td>Y</td>
<td>Y</td>
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<td>Y</td>
<td>Y*</td>
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<td>N</td>
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<td>N</td>
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<td>Reuter et al. (2011)</td>
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#papers scoring a point /total papers  
11/14  8/11  11/14  12/14  9/14  4/14  5/14  

Y=present; N=not present  
* Quality rated after obtaining additional information from the authors  
** Same study but different papers and outcomes
<table>
<thead>
<tr>
<th>Study, date</th>
<th>Population</th>
<th>Eligibility</th>
<th>Recruitment setting and methods</th>
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<tr>
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<td>Number of participants, Age (PW,control) (mean range/ standard deviation/CI)</td>
<td>Gender</td>
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<td><strong>Table 2  Design, recruitment and participants in the 13 studies reviewed</strong></td>
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<tr>
<td><strong>Breyer 2010 Austria</strong></td>
<td>Chronic obstructive pulmonary disease</td>
<td>COPD patients</td>
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<td>-N=60</td>
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<tr>
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<td>-61.9+/8.87, 59.0+/8.02</td>
<td>-27 M, 33 F</td>
<td></td>
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<tr>
<td><strong>Collins,2005 USA</strong></td>
<td>Peripheral artery disease</td>
<td>history of intermittent claudication, ABI of &lt; 0.95 at rest or &lt; 0.85 after exercise</td>
<td>-Mid Western Department of Veterans Affairs Hospital -surrounding community</td>
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<tr>
<td></td>
<td>-65.8+/7.1 years, 68.0+/8.6</td>
<td>-51 M, 1 F</td>
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<td><strong>Ebersbach,2010 Germany</strong></td>
<td>idiopathic Parkinson’s Disease</td>
<td>Fulfil diagnostic criteria for idiopathic PD Hoehn &amp; Yahr stages I–III</td>
<td>-referred from local outpatient clinics and office-based physicians</td>
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<td>-N=60</td>
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<td>-65.5+/9.0, 67.1+/3.6, 69.3+/8.4</td>
<td>-25 M, 36 F</td>
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<tr>
<td><strong>Figard-Fabre, 2011 Italy</strong></td>
<td>obese, middle aged women</td>
<td>BMI &gt;30 kg.m², reporting exercising&lt;1 hour/week over previous 6 months</td>
<td>-NR</td>
</tr>
<tr>
<td></td>
<td>-N=23</td>
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<td></td>
<td>-23 F</td>
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<td><strong>Fritz, 2011 Sweden</strong></td>
<td>overweight/obese individuals with normal glucose tolerance, impaired glucose tolerance, and type 2 diabetes mellitus</td>
<td>age 45–69 years</td>
<td>-newspaper advertisements -personal letters of invitation to 447 former participants in the Stockholm Diabetes Prevention Program</td>
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<td>-61 (55–64), 60 (57–64), 62.5 (59.5–64), 60 (56–63), 60.5 (58–64), 63 (59–64), 94 M, 118 F</td>
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<td><strong>Gram, 2010</strong></td>
<td>type 2 diabetes mellitus</td>
<td>type 2 diabetes &gt; 1 year</td>
<td>-diabetes outpatient clinic</td>
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</table>

- **Inclusion criteria**: Fulfil diagnostic criteria for idiopathic PD Hoehn & Yahr stages I–III
- **Exclusion criteria**: dementia (MMSE < 25) severe depression disabling dyskinesias co-morbidity affecting mobility or ability to exercise taking medication known to influence the variables measured having a medical condition that would limit exercise participation physical impairment symptoms of angina pectoris atrial fibrillation determined by electrocardiogram systolic or diastolic blood pressure > 160 or > 100 mmHg, respectively insulin treatment
<table>
<thead>
<tr>
<th>Location</th>
<th>Study Title</th>
<th>Key Inclusion Criteria</th>
<th>Key Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>Hartvigsen, 2010</td>
<td>- Low back pain and/or leg pain of greater than eight weeks duration</td>
<td>- Unable to sit on a stationary bike for at least 30 minutes in order to perform watt max bicycle test</td>
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<tr>
<td></td>
<td></td>
<td>- LBP with or without leg pain &gt; 8 weeks</td>
<td>- Secondary sector specialized outpatient back pain clinic</td>
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<td></td>
<td></td>
<td>- Averaged pain &gt; 3 during the past two weeks on the 11 point numeric rating scale</td>
<td>(referrals from primary care physicians and chiropractors when 4 weeks treatment in primary care by family physician, chiropractor, physiotherapist or combination has not resulted in satisfactory improvement)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Completed four weeks of treatment in the primary sector by a family physician, chiropractor, physical therapist, or a combination</td>
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<td></td>
<td></td>
<td>- Concluded all examinations, individual and group treatment at the back clinic with at least a 75% attendance rate</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Able to read and understand Danish</td>
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<tr>
<td></td>
<td></td>
<td>- Attended group exercises twice a week for four weeks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kocur, 2009 Poland</td>
<td>- Post-acute coronary syndrome treated with primary percutaneous coronary intervention 2–3 weeks earlier</td>
<td>- Previous episodes of cardiac arrest</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Exercise tolerance &gt; 6 metabolic equivalents in symptom-limited electrocardiography treadmill exercise test performed on admission to the cardiac rehabilitation centre</td>
<td>- Uncontrolled arrhythmias</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Ejiction fraction by echocardiography ≥40%</td>
<td>- Chronic or acute inflammation</td>
</tr>
<tr>
<td></td>
<td>Kukkonen-Harjula,</td>
<td>- Non-obese sedentary women</td>
<td>- Diabetes on insulin treatment</td>
</tr>
<tr>
<td>2007 Finland</td>
<td></td>
<td>- BMI 20–30 kg/m²</td>
<td>- Liver or renal failure</td>
</tr>
<tr>
<td></td>
<td>Langbein, 2002 USA</td>
<td>- Intermittent claudication pain</td>
<td>- Neoplastic disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Current diagnosis of PAD</td>
<td>- Cardiac rehabilitation service of a provincial hospital</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- A history of IC</td>
<td>- First five men each month who met the qualification criteria and who agreed to participate in the study</td>
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<tr>
<td></td>
<td></td>
<td>- ABI of less than 0.95 at rest or less - than 0.85 after exercise</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Pain from IC must have been the primary limiting factor to maximal exercise performance during a treadmill test</td>
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<tr>
<td></td>
<td></td>
<td>- Reported a diminished capacity to complete leisure-time and occupational activities because of claudication pain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mannerkorpi, 2010</td>
<td>- Fibromyalgia</td>
<td>- Department of Veterans Affairs Hospital’s Peripheral Vascular and Outpatient Clinics</td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td>- Women aged 20-60 years with fibromyalgia, defined by the ACR 1990</td>
<td>- Local physician groups - participation in health fairs - veteran publications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- A history of long-lasting generalized pain and pain in at least 11 of 18 tender points examined by</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Patients not speaking or reading Swedish</td>
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<tr>
<td></td>
<td></td>
<td>- Other severe somatic or psychiatric disease</td>
<td>- Newspaper advertisements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Ongoing or planned physical therapy, including exercise</td>
<td>- Health care centres in West Sweden</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Newspaper advertisement</td>
<td>- Participation in an earlier publication</td>
</tr>
<tr>
<td>Study</td>
<td>Disease</td>
<td>N</td>
<td>Age</td>
</tr>
<tr>
<td>-------</td>
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</tr>
<tr>
<td>Reuter 2011 Germany</td>
<td>Parkinson’s disease</td>
<td>90</td>
<td>62+/-3.2, 62.1+/-2.5, 63+/-3.1</td>
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<tr>
<td></td>
<td>Hoehn &amp; Yahr stage II and III</td>
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<tr>
<td></td>
<td>Sprod, 2010 USA</td>
<td>breast cancer survivors</td>
<td>12</td>
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<td></td>
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<td>-</td>
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<tr>
<td></td>
<td>Strombeck, 2007 Sweden</td>
<td>Sjogren’s syndrome</td>
<td>21</td>
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</tbody>
</table>

PW=pole walking; COPD=chronic obstructive pulmonary disease; PAD=peripheral artery disease; PD=Parkinson disease; N=number; M=males; F=females; MMSE=mini-mental state examination; BMI=body mass index; LBP=low back pain; NR=not reported; ABI=Ankle-Brachial Index; HR=heart rate; IC=intermittent claudication; HBA1C=Glycated haemoglobin; NYHA=New York Heart Association classification; ACR=American College of Rheumatology
<table>
<thead>
<tr>
<th>Study</th>
<th>Program and control</th>
<th>Attendance</th>
<th>Outcome measures.</th>
<th>Significant between group differences (p&lt;.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Duration</td>
<td>% session attendance</td>
<td>Physical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Follow-up assessments</td>
<td>% dropout</td>
<td></td>
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<td></td>
<td></td>
<td>N randomised</td>
<td>Physical</td>
<td></td>
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<td></td>
<td></td>
<td>N analysed</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Program features</td>
<td></td>
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<tr>
<td></td>
<td>Session frequency and duration</td>
<td></td>
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<tr>
<td></td>
<td>Intensity</td>
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<td></td>
<td>Organisation instructor</td>
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<td></td>
<td>Control group</td>
<td></td>
<td></td>
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<tr>
<td>Breyer, 2010</td>
<td>Austria</td>
<td>-session attendance NR</td>
<td>Physical</td>
<td>+0.40 m/s² +/− 0.1 4 (3M), +0.25 +/− 0.09 (3M, 6M)</td>
</tr>
<tr>
<td></td>
<td>-3M/6M/9M</td>
<td>-8%</td>
<td></td>
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</tr>
<tr>
<td>Program</td>
<td>3x weekly, 1 hr</td>
<td>A: PW:30, NEC:33</td>
<td>Physical</td>
<td>↓14.9 +/− 1.9 m/day (3M), 12.7 +/− 1.8 m/day (6M)</td>
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<tr>
<td></td>
<td>-75% of initial HR max</td>
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<td></td>
<td>-group based, initial 2 hr instruction by PW instructor, then medical staff</td>
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<tr>
<td>NEC</td>
<td>-no intervention</td>
<td>R: PW:32, NEC:33</td>
<td>Physical</td>
<td>↓1.29 +/− 26 m/day (3M), +133±14 m/day (6M), +105 ± 4 m/day (9M)</td>
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<td></td>
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<td></td>
<td>Physical</td>
<td>↓1.128 +/−15 m/day (3M), 12.0 +/−32 m/day (6M), 101 +/−36 m/day (9M)</td>
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<td></td>
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<td></td>
<td>Physical</td>
<td>↑79 +/− 28 m (3M), +70 +/− 16 m (6M), +58 +/− 17 (9M)</td>
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<td></td>
<td>Physical</td>
<td>↓ 3.4 +/− 1.8 (3M), 3.6 +/− 1.8 (6M), 3.7 +/− 1.6 (9M) vs baseline (4.4 +/− 2.2)</td>
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<td></td>
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<td></td>
<td>Physical</td>
<td>↑ 15.1 +/− 4.5 mins vs baseline (10.3 +/− 4.1 mins)</td>
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<td></td>
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<td></td>
<td>Physical</td>
<td>↑ 19.5 +/− 4.6 mL kg⁻¹ min⁻¹ vs baseline (16.7 +/− 4.0 mL kg⁻¹ min⁻¹)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Physical</td>
<td>↑ 31 +/− 31% decline in slope</td>
</tr>
<tr>
<td>Collins, 2005</td>
<td>USA</td>
<td>-session attendance NR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-6M/6M</td>
<td>-88 +/−23%.</td>
<td>Physical</td>
<td>↑ 23 +/− 22% decline in slope</td>
</tr>
<tr>
<td>Program</td>
<td>3x weekly, 30-60 min</td>
<td></td>
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<tr>
<td></td>
<td>-68-75% of predicted HR max</td>
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<tr>
<td></td>
<td>(incorporating 15-60 second “speed plays”) 80% of session</td>
<td></td>
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<tr>
<td></td>
<td>-individual based, supervised but instructor NR</td>
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<tr>
<td>NEC</td>
<td>ABI measurement 2x weekly</td>
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<td></td>
<td></td>
<td></td>
<td>Physical</td>
<td>↑ 31 +/− 31% decline in slope</td>
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<td></td>
<td></td>
<td></td>
<td>Physical</td>
<td>↑ 23 +/− 22% decline in slope</td>
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<td></td>
<td></td>
<td>Physical</td>
<td>↑ 43 +/− 38% decline in slope</td>
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</tbody>
</table>
The table compares the ABI (Abnormal Brain Imaging) scores, mental health-related quality of life (SF36) scores, physical health-related quality of life (SF36) scores, and psycho-social health-related quality of life (PDQ39) scores between PW (PD patients under usual care) and EOPW1 & EOPW2 (PD patients in the experimental intervention groups).

### ABI
- ABI score: -NS
- PW vs NEC: -NS
- PW vs EOPW1 & 2: -NS

### Physical
- Motor performance (UPDRS motor score): -NS
- TUG: -NS
- Timed walk 10 m: -NS

### Psycho-social
- Health-related QoL (SF36) physical: -NS
- Health-related QoL (SF36) mental: -NS
- PDQ39: -NS

#### Program Details
**Ebersbach, 2010 Germany**

- **PW 8W**
- **EOPW1: 4W**
- **EOPW2: 4W**
- **16 W**

**Program**
- 2x weekly, 1 hr
- NR
- Group-based sessions, physiotherapist trained as PW instructor

**EOPW1**
- LSVT-BIG therapy
- 4x weekly, 1 hr
- Intensity NR
- One-to-one sessions by physiotherapist

**EOPW 2**
- Home exercises
- Initial instruction by physiotherapist

### Results
- PW vs NEC: ↑ 5.1+/-. 7.7 score
- PW vs EOPW1 & 2: 0.58+/-.3.17 score
- PW vs EOPW1: 0.58+/-.1.72 s
- PW vs EOPW2: 0.59+/-.1.34 s

---

298
Figard-Fabre, 2011
Italy
Program
-12W
-6W, 12W
Program -3x weekly
-10 mins warm-up, then interval training of 4 mins of moderate intensity exercise, followed by 1 min of more intense exercise, repeated 6 times, then 10 mins cool down
-group based (1x weekly) and individual (2x weekly)
-group supervised by study investigators, individual non-supervised
EOPW walking
-3x weekly
-interval training as above
-group based (1x weekly) and individual (2x weekly)
-group supervised by study investigators

Fritz, 2011
Sweden
Program
-4M
-4M
Program -5 hrs weekly
-intensity NR
-individual based, non-supervised
NEC:
-habitual daily activity

-91%
-0%
R: PW: 12, EOPW: 11
A: PW: 12, EOPW: 11

<table>
<thead>
<tr>
<th>Physical</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>-body mass (kg)</td>
<td>-NS</td>
</tr>
<tr>
<td>-BMI (kg/m²)</td>
<td>-NS</td>
</tr>
<tr>
<td>-total skin-fold thickness (mm)</td>
<td>-NS</td>
</tr>
<tr>
<td>-body fat (%)</td>
<td>-NS</td>
</tr>
<tr>
<td>-HR (bpm)</td>
<td>-NS</td>
</tr>
<tr>
<td>-systolic BP</td>
<td>-NR</td>
</tr>
<tr>
<td>-diastolic BP</td>
<td>-NS</td>
</tr>
<tr>
<td>-maximal time to exhaustion (min)</td>
<td>-NS</td>
</tr>
<tr>
<td>-time at VT (min)</td>
<td>-NS</td>
</tr>
<tr>
<td>-relative VO₂ peak (ml.min⁻¹.kg⁻¹)</td>
<td>-NS</td>
</tr>
<tr>
<td>-Absolute VO₂ (l.min⁻¹)</td>
<td>-NS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>-body mass (kg)</td>
<td>-PW 84.6 (15.3) vs baseline 86.1 (15.2)</td>
</tr>
<tr>
<td>-BMI (kg/m²)</td>
<td>-NS</td>
</tr>
<tr>
<td>-total skin-fold thickness (mm)</td>
<td>-PW 88.6 (18.7) vs baseline 95.7 (25.3)</td>
</tr>
<tr>
<td>-body fat (%)</td>
<td>-PW 40.6 (3.1) vs baseline 41.5 (3.9)</td>
</tr>
<tr>
<td>-HR (bpm)</td>
<td>-NS</td>
</tr>
<tr>
<td>-systolic BP</td>
<td>-NS</td>
</tr>
<tr>
<td>-diastolic BP</td>
<td>-PW 79 (8) vs baseline 86 (9)</td>
</tr>
<tr>
<td>-maximal time to exhaustion (min)</td>
<td>-PW (6W, 12W)</td>
</tr>
<tr>
<td>-time at VT (min)</td>
<td>-PW (6W, 12W)</td>
</tr>
<tr>
<td>-relative VO₂ peak (ml.min⁻¹.kg⁻¹)</td>
<td>-PW (12W)</td>
</tr>
<tr>
<td>-Absolute VO₂ (l.min⁻¹)</td>
<td>-PW (12W)</td>
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</table>

<table>
<thead>
<tr>
<th>Physical</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>-BMI</td>
<td>↑ NGT PW vs NEC</td>
</tr>
<tr>
<td>-PA (VAS)</td>
<td>↑ NGT PW vs NEC</td>
</tr>
<tr>
<td>-quality of sleep</td>
<td>↑ T2 PW vs NEC</td>
</tr>
<tr>
<td>-physical functioning</td>
<td>↑ NGT PW vs NEC</td>
</tr>
<tr>
<td>-general health</td>
<td>↑ NGT PW vs NEC</td>
</tr>
<tr>
<td>-satisfaction with physical health</td>
<td>↑ T2 PW vs NEC</td>
</tr>
<tr>
<td>-pain</td>
<td>-NS</td>
</tr>
<tr>
<td>-role limitation attributable to physical health</td>
<td>-NS</td>
</tr>
<tr>
<td>-role limitation attributable to emotional health</td>
<td>-NS</td>
</tr>
<tr>
<td>-positive effect</td>
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<tr>
<td>-negative effect</td>
<td>-NS</td>
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<tr>
<td>-cognitive functioning</td>
<td>-NS</td>
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<td>-family functioning</td>
<td>-NS</td>
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<tr>
<td>-marital functioning</td>
<td>-NS</td>
</tr>
<tr>
<td>-sexual functioning</td>
<td>-NS</td>
</tr>
<tr>
<td><strong>Gram, 2010</strong> Denmark</td>
<td><strong>Hartvigsen, 2010 Denmark</strong></td>
</tr>
<tr>
<td>------------------------</td>
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</tr>
<tr>
<td><strong>Program</strong></td>
<td><strong>Program A</strong></td>
</tr>
<tr>
<td>-2x weekly for 2 M, then 1x weekly for 2 M, 30 min</td>
<td>-2x weekly, 45 min</td>
</tr>
<tr>
<td>-moderate intensity (&gt;40% of VO2 max) (Borg)</td>
<td>-varied intensity, dose and frequency same</td>
</tr>
<tr>
<td>-group based, physiotherapist</td>
<td>-group based, PW instructor</td>
</tr>
<tr>
<td><strong>EOPW</strong></td>
<td><strong>Program B</strong></td>
</tr>
<tr>
<td>-exercise on prescription</td>
<td>-one hr, initial PW instructor training, followed by non-supervised PW as much as they liked at home</td>
</tr>
<tr>
<td><strong>NEC</strong></td>
<td><strong>NEC</strong></td>
</tr>
<tr>
<td>-no exercise</td>
<td>-home</td>
</tr>
</tbody>
</table>

**Physical**
- glucose metabolism (HbA1c)  
- high density cholesterol/triglyceride  
- body weight  
- whole body fat tissue mass (dual X-ray densitometry)  
- lean tissue mass  
- waist/hip circumference  
- maximal oxygen uptake (VO2 max)  

**Psycho-social**  
- health-related quality of life (SF36)  
- special questionnaires on hrs spent on physical activity and activities of daily living  

**Other**  
- medication use, other treatment, time off work  
- expectation to treatment (Likert)  

**Physical**
- exercise capacity (treadmill exercise test)  
- 6MWT  

**Physico-social**  
- supervised PW mean 8.8 (11W, 26W, 52 W)  
- non-supervised PW mean 3.4 (26W)  
- mean 7.4 (10W, 26W, 52W)  
- supervised mean (10 W, 26W, 52W)  
- non-supervised (10W, 26W, 52W)  

**Other**
- ↑ supervised PW mean 8.8 (11W, 26W, 52 W)  
- ↑ non-supervised PW mean 3.4 (26W)  
- ↑ mean 7.4 (10W, 26W, 52W)  
- ↑ supervised mean (10 W, 26W, 52W)  
- ↑ non-supervised (10W, 26W, 52W)  

**Physical**
- ↑ PW vs EOPW2  
- ↑ 10.8 +/- 1.8 MET vs baseline (8.9 +/- 2.0)  
- ↑ 663.0 +/- 77.0 m vs baseline (580.2 +/- 62.9)
-213.37 kcal (accelerometer), 255.67 kcal (HR monitor), 13 (Borg)
-group based, physiotherapist

**EOPW 1**
walking
-5x weekly, 30 min
-183.8 kcal (accelerometer), 278.23 kcal (HR monitor), 13 (Borg)
-group based, physiotherapist

**EOPW 2**
calisthenics only (without PW and W)
-5x weekly, 30 min
-183.8 kcal (accelerometer), 278.23 kcal (HR monitor), 14 (Borg)

Kukkonen-Harjula, 2007
Finland
-13W
-13W

Program
-familiarization period for 2 W, frequency NR, then 4x weekly, 40 min
-instruction to "walk briskly so that breathing is enhanced."
-individually based, exercise instructors

EOPW:
-walking
-familiarization period for 2 weeks
-4x weekly, 40 min
-instruction to "walk briskly so that breathing is enhanced."
-individually based, exercise instructors

-25.9 +/- 4.8 reps vs baseline 22.3 +/- 4.6
-21.2 +/- 4.1 reps vs baseline 17.4 +/- 3.9
-0.2 +/- 10.3 cm vs baseline -4.5 +/- 12.2
-6.4 +/- 10.8 cm vs baseline -8.0 +/- 12.2
-4.4 +/- 0.6 s vs baseline 6.9 +/- 0.7

Physical
cardiorespiratory performance

-VO2 max
-RPE
-RER
-Ve
-peak VO2 LA
-LA max
-submaximal exertion
-O2 pulse
-HR
-LA
-weight
-waist circumference
-neuromuscular fitness
-leg strength (one leg squat) in low fitness participants
-dynamic balance
-one leg stance
-neck/shoulder mobility
-dynamic upper arm extension
-musculo-skeletal pain
-neck
-elbow/forearm

-↑ PW vs EOPW2
-↑ PW vs EOPW1&2
-↑ PW vs EOPW1
-NR
-NS
-NS
-NR
-NR
-NR
-NR
-NR
-NR
-NR
-NR
-NR

A: PW:40, EOPW1:20, EOPW2:20
A: PW:54, EOPW:52
EPOW2:20
EPOW2:20

-↑ 25.9 +/- 4.8 reps vs baseline 22.3 +/- 4.6
-↑ 21.2 +/- 4.1 reps vs baseline 17.4 +/- 3.9
-1.2 +/- 10.3 cm vs baseline -4.5 +/- 12.2
Langbein 2002 USA
-24W
-4W/8W/12W/16W/24W

Program
-2-3x weekly, 30-45-min
-interval training, but intensity NR
-individually based, supervised but instructor NR

Nec:
-ABI measurements
-2x weekly for the first 3 months, then monthly
-study staff

Session attendance NR supervised, <50% non-supervised, so changed to completely supervised 12%
R: PW:27, NEC:25
A: NR

Physical
-constant work-rate symptom-limited incremental treadmill exercise test
-symptom limited incremental treadmill exercise test

-peak O2

-rating of perceived leg pain

-ABI (doppler US scan)

Psychosocial

Mannerkorpi 2010 Sweden
-15W
-15W/6M

Program
-2x weekly, 40-45 min
-9-11 on the RPE scale ten min, then two min intervals of 13-15 on the RPE scale, alternated with two-min 10-11 on the RPE scale (aim for 20 min high intensity)

-group based, two leaders (physical therapists, physical therapy students or trained exercise leaders)

EOPW
-low intensity walking
-1x weekly, 40-45 min
-intensity as above
-organisation and instructor as above

Session attendance NR supervised, <50% non-supervised, so changed to completely supervised 12%
R: PW:34, EOPW:33
A: NR

Physical
-functional capacity (6MWT)
-exercise HR (ergometer test)

Psychosocial

Reuter 2011 Germany
-6M

Program

Session attendance NR supervised, <50% non-supervised, so changed to completely supervised 12%
R: PW:27, NEC:25
A: NR

Physical
-constant work-rate symptom-limited incremental treadmill exercise test
-symptom limited incremental treadmill exercise test

EOPW
-low intensity walking
-1x weekly, 40-45 min
-intensity as above
-organisation and instructor as above

Session attendance NR supervised, <50% non-supervised, so changed to completely supervised 12%
R: PW:34, EOPW:33
A: NR

Physical
-functional capacity (6MWT)
-exercise HR (ergometer test)

Psychosocial

-peak O2

-rating of perceived leg pain

-ABI (doppler US scan)

Psychosocial

MFI-20

-rating of perceived leg pain

-mental fatigue

Psychical

12m Webster walking

-peak O2

-rating of perceived leg pain

-mental fatigue

Psychical

MFI-20

-rating of perceived leg pain

-mental fatigue

Psychical

12m Webster walking
6M/12M (telephone survey only)

Program
-3x weekly, 70 min
-variable intensity
-group based sessions, physiotherapists trained as PW instructors

EOPW 1:
-walking
-frequency and duration as above
-variable Borg score
-group based sessions, same physios as PW

EOPW 2:
-flexibility and relaxation training in a gym
-frequency and duration as above
-variable Borg score
-group based, same physios as PW

R:PW:30, EOPW1:30, EOPW2:30
A:PW:30, EOPW:30, EOPW:30

tests
-24m Webster walking tests

gait parameters
-stride times
-% double stance
-stride length
-stride length variability

specific PD disability
UPDRS
-leg agility L
-leg agility R
-posture
-freezing
-alternating movements
-postural stability
-gait pattern
-exercise test (walking speed)

pain (VAS)
-neck
-hip
-iliosacral
-back
-hands
-legs

balance Berg-Balance scale

BP between 3 km/hr and 5 km/hr
-BP between rest and walking
-HR between 3 km/hr and 5 km/hr
-HR between rest and walking activity log
-sitting

-heavy work

Psycho-social
-PDQ39

↑ PW vs EOPW2
↑ 7.6+-0.6 km/hr from baseline (6.0+-0.4 km/hr)
↑ 9.4+-3.12 hr/week from baseline (5.2+-3.12 hr/week)
↑ concentrate, memorize, recall information PW vs EOPW2
<table>
<thead>
<tr>
<th>Sprod 2005 USA</th>
<th>Physical upper body muscular endurance</th>
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<tbody>
<tr>
<td>-8 W</td>
<td>-bench press -NR</td>
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<tr>
<td>-8 W</td>
<td>-lateral pull down -NR</td>
</tr>
<tr>
<td>Program</td>
<td>-shoulder press -NR</td>
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<tr>
<td>-2x weekly, 20 min</td>
<td>-shoulder ROM -NR</td>
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<tr>
<td>-40% to 50% of heart rate reserve</td>
<td>(goniometer measures)</td>
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<td>(Karvonen method)</td>
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<tr>
<td>- group based, cancer exercise rehabilitation specialist</td>
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<tr>
<td>EOPW:</td>
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<tr>
<td>-walking</td>
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<tr>
<td>-2x weekly, 20 min</td>
<td></td>
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<tr>
<td>-intensity as above</td>
<td></td>
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<tr>
<td>-organisation/ instructor as above</td>
<td></td>
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<tr>
<td>Session attendance NR</td>
<td>-↑ 6.8 repetitions to fatigue from baseline (-0.8 repetitions to fatigue)</td>
</tr>
<tr>
<td>R: PW: 8, EOPW: 8</td>
<td>-↑ 13 repetitions from baseline(5.2 repetitions to fatigue)</td>
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<tr>
<td>A: PW: 6, EOPW: 6</td>
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<tr>
<th>Strombeck, 2007 Sweden</th>
<th>Physical physical capacity VO₂ max l/min</th>
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<tbody>
<tr>
<td>-12 W</td>
<td>-↑ PW vs NEC -↑ .02 (-.01-.6)l/min</td>
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<tr>
<td>-12 W</td>
<td>-NS</td>
</tr>
<tr>
<td>R: 11PW/10C</td>
<td>-↑ 3 (-1.8)ml/kg/min</td>
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<tr>
<td>A: 9 PW/10C</td>
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<tr>
<td>Program</td>
<td>-aerobic capacity VO₂ max ml/kg/min</td>
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<tr>
<td>-3 x weekly, 45 mins</td>
<td>-NS</td>
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<tr>
<td>-60–70% of age-predicted HR max for 8 weeks, then 70–80% of age-predicted HR max for 4 weeks,</td>
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<tr>
<td>-group (1x weekly)and individual (2x weekly) based, trained walker for group sessions, non-supervised for individual sessions</td>
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<tr>
<td>NEC:</td>
<td>-fatigue VAS mm -↑ PW vs NEC NS</td>
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<tr>
<td>-range of motion exercises</td>
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<td>-3x weekly</td>
<td>-ProF -NS</td>
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<tr>
<td>-individual based, non-supervised</td>
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<tr>
<td>Session attendance NR</td>
<td>-↑ PW vs NEC NS</td>
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</table>

| PW=pole walking; EOPW=exercise other than Pole walking; NEC=non-exercise control; C=control; NGT=normal glucose tolerance; IGT=impaired glucose tolerance; T2=type two diabetes mellitus; NS=not significant; NR=not reported; M=months; W=weeks; LL=lower limb; UL=upper limb; VO2=maximal oxygen uptake; BP=blood pressure; HR=heart rate; ABI=ankle brachial index; RER=respiratory exchange ratio; RPE=ratings of perceived exertion; LA=lactate; MET=metabolic equivalent; VT=ventilator threshold; LBP=low back pain; EQ-5D=European Quality of Life-5 Dimensions; QoL=quality of life; MFI-20=Multi-dimensional fatigue inventory; 6MWT=6 minute walk test; TUG=timed up and go; WIQ=walking impairment questionnaire; LSVT-BIG=Lee Silverman Voice |  |
Therapy (exercise therapy for Parkinson’s disease); UPDRS=unified Parkinson disease rating scale; PDQ39=Parkinson disease questionnaire; LBPRS=low back pain rating score; SF=Medical outcomes study short form; PSFS=patient specific function scale; FIQ=fibromyalgia impact questionnaire; VAS=visual analogue scale; ProF=profile of fatigue; WIQ=walking impact questionnaire; HADS=hospital anxiety and depression scale; MFI=multidimensional fatigue inventory; OR=odds ratio; CI=confidence interval
Table 4  Outcome measures and results of 12 studies (13 papers) recording between group effects of pole walking on physical and psycho-social health (number of measures that showed significant change / total number of measures)*

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<td>N</td>
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<td>136</td>
<td>121</td>
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<td>80</td>
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<td>67</td>
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<td>60</td>
<td>49</td>
<td>23</td>
<td>52</td>
<td>21</td>
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<td>control</td>
<td>NEC</td>
<td>NEC</td>
<td>EOPW</td>
<td>EOPW 1</td>
<td>EOPW 2</td>
<td>EOPW 1</td>
<td>EOPW 2</td>
<td>NEC</td>
<td>EOPW 1</td>
<td>EOPW 2</td>
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<td>EOPW 1</td>
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**Physical outcomes**

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<tbody>
<tr>
<td>Endurance</td>
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<td>2/2†</td>
<td>2/2†</td>
<td>1/2†</td>
<td>1/1†</td>
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<td>1/1†</td>
<td>2/2†</td>
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<tr>
<td>Oxygen uptake/energy</td>
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<td>HR/BP</td>
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<td>1/4†</td>
<td>3/4†</td>
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<td>RPE</td>
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<td>3/3†</td>
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<td>ABI</td>
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<td>Functional status</td>
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<td>7/7†</td>
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<td>Pain</td>
<td>1/1†</td>
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<td>6/6†</td>
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<td>Muscle flexibility</td>
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<td>Gait parameters</td>
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<td>4/4†</td>
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<tr>
<td>Glucose bloods</td>
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**Psycho-social outcomes**

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<tbody>
<tr>
<td>QoL/wellbeing</td>
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<td>8/8‡</td>
<td>1/8‡</td>
<td></td>
<td></td>
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<td></td>
<td>2/2‡</td>
<td>2/2‡</td>
<td>1/1‡</td>
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<tr>
<td>Other measures</td>
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<td>4/4‡</td>
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<td>1/10‡</td>
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EOPW=exercise other than PW (EOPW in bold face indicates similar intensity walking); NEC=non-exercise control; QoL=Quality of life; RPE=ratings of perceived exertion; HR=heart rate; BP=blood pressure; ABI=ankle brachial index; PA=physical activity

Dark coloured=significant improvement in at least one outcome measure of PW; Medium coloured=non-significant outcome measure; Light coloured=significant decrease in at least one outcome measure of PW; reference number in bold face indicates high quality, defined as over 50%

*The paper by Sprod et al. was not included in this table because only within group differences were reported. The total number of studies is therefore 13. The paper by Gram et al. recorded two control groups, but PW was only compared with the NEC. Therefore only one group was included in this table.

**Same study, but different papers and outcome measures.

†=objective measures; ‡=subjective measures
References


A 3.2 Pole walking down-under: Profile of leaders, walkers, and programs in Australia and factors relating to participation

This study has been published in the Health Promotion Journal of Australia (Impact Factor 1.089), and appears below as published.

The citation is as follows:
Abstract

Issue addressed: Although pole walking (PW) has the potential to be a useful health-enhancing physical activity (PA), little is known about by whom or how it is being practised. The aims of this study were to describe (1) the characteristics of PW leaders, pole walkers and PW programs in Australia, and (2) participants’ perceptions of PW and their reasons for participation.

Methods: In 2012, PW leaders (n=31) and walkers (n=107) completed self-administered surveys that included questions about participants’ sociodemographic and health characteristics, PW programs and perceptions of PW. Data were analysed using SPSS.

Results: Leaders and walkers were generally born in Australia (leaders, 71%; walkers, 83%), older (leaders, 55 years [SD, 11.5]; walkers, 65 years [SD, 10.6]) and female (leaders, 77%; walkers, 79%). Most walkers (82%) walked regularly in groups, approximately once per week for about an hour, at light to moderate intensity. The program’s aims most strongly endorsed by PW leaders were to increase participant enjoyment (90%), increase PA levels (81%), provide a positive social experience (77%) and increase PA confidence (71%). The most strongly endorsed motivations for PW among walkers were to remain physically active (63%), improve fitness (62%) and personal and social enjoyment (60%).

Conclusions: In Australia, PW is being practised by a health conscious, older population. It is perceived as an enjoyable and health enhancing outdoor activity.

So what?: Health and exercise practitioners may find that PW is a beneficial form of PA for older Australians.
Introduction

The health benefits of regular physical activity (PA) are well known, and walking is an activity that is suitable for people of all ages, including those with chronic health conditions (1, 2). Walking with the addition of hand-held poles, or pole walking (PW), was developed in Europe and North America to maintain or improve fitness, and was recently introduced in Australia. PW is often taught and practiced under the guidance of trained PW leaders.

PW has similar low impact, moderate intensity characteristics to walking (3, 4). However, studies have found that cardiovascular responses are greater during PW than during regular walking at the same speed, while perceived exertion is similar (5, 6). A recent systematic review examining the effects of PW on health and wellbeing found beneficial effects of PW on cardiorespiratory function (fitness), body mass and waist circumference, pain levels, and quality of life, in both healthy adults and in those with chronic disease (7).

PW developed from the commonly practiced sport of cross country skiing, and, although widespread in Europe and Scandinavia, little is known about who participates in this activity in Australia (where skiing has a much lower profile), what type of programs exist for Australian pole walkers, or why they participate (8-10). Given the health benefits of PW, understanding the characteristics of PW programs in Australia, and of the people who regularly participate in them, would inform efforts to promote this activity in Australia.

The social ecological model (SEM) is widely used as a framework for understanding the factors which affect PA behaviour (11-13). It was used in this study to guide the development of questions about participation in PW, in order to improve understanding of the individual, social and environmental factors associated with participation in this activity.

The aims of this study were to describe (1) the characteristics of PW leaders, walkers, and programs in Australia, and (2) participants' perceptions of PW and reasons for participation.

Methods

Design

This was a cross-sectional study. Data were collected in May-July, 2012.
Participants

PW leaders

Two of the three organisations in Australia involved in training PW leaders agreed to participate in the study (14-16). The leaders affiliated with these organisations were personally informed of the study by phone or email by the research team. Leaders who registered interest in participating were sent a leader survey, which they were asked to complete and return by reply paid mail. Up to two telephone reminders were made to leaders who did not return their survey.

Pole walkers

Participating PW leaders were asked to distribute surveys to pole walkers who were currently walking with their groups or individually, but not leading groups. Participating pole walkers were asked to complete the pole walker survey, and return it to the research team by reply paid mail.

Ethics and Informed Consent

The study was approved by University of Queensland Human Research Ethics Committee. Participation in the study was voluntary, written study information was provided, and informed consent of PW leaders and walkers was assumed by the return of the completed survey.

Measures

Standard questions were used to assess the sociodemographic characteristics of both leaders and walkers; these included age, sex, marital status, education, employment status, occupation, and country of birth. In addition, each questionnaire included specific questions for the leaders or walkers (details below).

Specific questions for PW leaders

The leaders’ survey consisted of 31 questions grouped into three sections: 1) sociodemographic information; 2) professional and PW program characteristics; and 3) program aims. In addition to the sociodemographic characteristics detailed above, PW leaders were asked a number of questions regarding their professional characteristics, including how long they had been PW leaders, exercise qualifications, and whether they worked for local health or community organisations. Questions about the PW program
characteristics included: number of groups; number of session attendees; session frequency, intensity (ranging from “as hard and fast as they can manage (vigorous)”, to “light intensity”, or “at variable intensities”), content and duration; and environment. Leaders were also asked about session and pole charges, and availability of options to buy or rent poles. Furthermore, they were asked whether they targeted particular age groups- for example, younger people (aged 18-45 years), middle-aged people (aged 45-65 years), older people (aged 65 years or over), or no specific age range- and people with specific health conditions, including chronic disease, obesity, chronic pain, balance problems, mental health issues, lower limb joint replacements, or other health conditions. Leaders were also asked to rate the importance of several statements concerning the program aims on a five point Likert scale, from 1 (“not at all important”) to 5 (“very important”). At the conclusion of the survey, leaders had the opportunity to add comments.

**Specific questions for pole walkers**

The pole walkers’ survey consisted of 43 questions grouped into four sections: 1) sociodemographic information; 2) health, health behaviours and PW history; 3) program and equipment characteristics; and 4) reasons for participation, perceptions of PW, and perceptions of differences between PW and walking. Questions about health included self-reported health, pain (location) (17), joint replacements (location), falls in the past 12 months, and health conditions (18). Self-reported weight and height were used to calculate body mass index (BMI) (kg/m²) (19).

Physical activity (PA) and sedentary behaviour (SB) were assessed using the Active Australia Survey (AAS) and the five domain sitting questionnaire respectively (20, 21). The AAS is used in Australian national surveys (22, 23). The questions assess frequency and time spent walking, and in moderate and vigorous leisure time activity in the past week. Any time greater than 840 minutes (14 hours) for a single activity type was recoded to 840 minutes as per the data management protocol (24). Time in each activity was then multiplied by a value of 3.33 METs (Metabolic Equivalents, or multiples of resting oxygen uptake) for walking and moderate activity, and 6.66 METs for vigorous activity. Total MET.minutes were categorized as daily PA of none (<33 MET.mins), some (33-499 MET.mins), or meeting guidelines (≥500 MET.mins) (24).

The five domain sitting questionnaire assesses the number of hours spent sitting at work, while travelling, watching television, using a computer when not at work, and during other...
recreation on a usual week day and weekend day (21). Average hours of sitting per day were calculated as: \( \frac{5 \times \text{average weekday sitting in the 5 domains} + 2 \times \text{average weekend day sitting in the 5 domains}}{7} \) (21).

Questions about PW history and programmes included how long participants had been walking with poles, whether they walked in a group or individually, and how often they walked. Questions about equipment included the cost of poles.

Finally, to address the second aim, pole walkers were asked to rate their agreement with a number of statements about reasons for participation in PW, perceptions of PW, and perceived differences between PW and regular walking, on a 5-point Likert scale, from 1 (“strongly disagree”) to 5 (“strongly agree”).

At the conclusion of the survey, walkers were given the opportunity to say what was easy or difficult about PW, and to add any other comments about their PW experiences.

**Analysis**

Data were analysed using descriptive statistics in SPSS version 20 (SPSS Inc., Chicago, IL). Written responses to the open ended questions in the PW leader and pole walker surveys were used to illustrate quantitative results.

**Results**

**Leaders**

Thirty-one of the thirty-six contacted PW leaders returned the completed surveys (86%). Their sociodemographic characteristics are shown in Table 1. Ages ranged from 33 to 78 years, with a mean of 55 years (SD, 11.5). Most were female and born in Australia.

Leaders’ professional characteristics are shown in Table 2. Most leaders had been leading groups for an average of 4.25 years (SD, 2.9), and had exercise or health qualifications.

Most PW programs were organised within facilities such as Community Health Centres.

Program characteristics are shown in Table 2. The majority of leaders led one group of approximately eight regular participants per week. Most sessions were of light to moderate intensity and included warm-up and cool down periods. Average PW time during the session was 43 minutes (SD, 10.5).

PW sessions were held in a variety of different environments, including sports grounds, public parks, urban areas, public facility grounds, bushland, and beaches (Table 2).
average session charge was AUD$3.70 (range AUD$0-$15). Free poles were supplied by more than half the leaders. The average cost of hiring poles was AUD$4.60 per session (range AUD$ 0-$15), and average cost to purchase poles was AUD$148 (range AUD$70-$200).

Most leaders reported that they did not target a certain age group. However, there were specific groups for people with chronic disease, chronic pain, lower limb joint replacements, balance problems, obesity, and mental health conditions.

PW leaders reported the most strongly endorsed program aims were: participant enjoyment, increasing PA levels, ensuring a positive social experience, and increasing PA confidence (See Figure 1). Participant enjoyment was endorsed as very important by 90% of leaders, supported by comments similar to the following by a female leader (age 49) that ‘it is great fun’. Increasing PA levels was classed as very important by 81% of leaders. This was reflected in the following comment by a 71 year old female leader“…We do only walk at a gentle pace but the distance we walk has increased substantially from 1 km to 3 km and occasionally further.” Ensuring a positive social experience was endorsed as very important by 77% of leaders. A female leader (59 years) said, “We include a social lunch once a month after the PW session- beneficial to my seniors’ mental health and a reward for attending programs”. Finally, 71 % of leaders reported that increasing PA confidence was very important for their participants. A 78 year old male leader commented “We help to extend… or to at least sustain present activity levels.”

**Pole walkers**

Pole walkers’ surveys were distributed to 148 walkers, and 107 (72%) were completed and returned. The average age of pole walkers was 65 (SD, 10.6) years. Most were female, retired, and born in Australia (Table 1).

Responses to the questions about health, health behaviours and PW history are shown in Table 3. A total of 87% participants rated their health as either good, very good or excellent. However, the majority experienced bodily pain, 20% had experienced one or more falls in the past year, and most reported various health conditions. Average BMI was 27 kg/m² (SD, 5.1). The majority met current PA guidelines, and sat for more than 6 hours per day.
Regarding PW history, program and equipment, pole walkers had participated in PW for between one month and 10 years, with an average of almost 3 years (SD 26.5 months). Most participants walked with a group once per week. However, 39% reported two to seven PW sessions per week. Most pole walkers purchased their own poles, at an average cost of AUD$112 (SD, 56.6), although the cost varied from $12 to $220. Pole walkers’ reasons for participation and perceptions of PW are shown in Figure 2a.

Almost two thirds of walkers strongly agreed with the following reasons for PW: remaining physically active (63%), improving fitness (62%), personal enjoyment (60%), and social enjoyment (60%). Many responses to open ended questions related to the extra activity achieved, and especially the extra stability provided by the poles. For example, a 79-year-old male commented “I felt safe and secure knowing there is less chance of falling”. Several comments related to increased fitness gained by using poles. A 57-year-old male walker commented “I find that pushing really hard with poles in soft sand, or up hills (or both) can have me breathing nearly as hard as in my running days”. Although most walkers who commented on the social aspect of PW groups were not specific about PW, there were some unique social benefits to exercising with poles. For example, a 72-year-old male commented “Being on crutches or a walking stick has reduced my mobility. PW lets me exercise and enjoy the wonderful company of other people without standing out. Everybody uses poles.” More generally, several walkers specified positive elements of their environment as being part of the enjoyment of PW. For example, a 68-year-old female walker (aged 68) commented on the enjoyment in “…seeing the early morning sun rise or the kangaroos”.

Half the pole walkers strongly agreed that PW was easy to learn and maintain (49% and 52%, respectively), and 61% strongly agreed that they were confident that they would walk with poles in the next month, but only 25% strongly agreed that they found it easy to walk regularly when difficulties arose (Figure 2a). Most walkers (87%) agreed that there was a difference between PW and regular walking. 51% strongly agreed they had stronger arms and 46% strongly agreed that PW used more energy than regular walking (see Figure 2b).
Table 1  Sociodemographic characteristics of the pole walking leaders and pole walkers

<table>
<thead>
<tr>
<th></th>
<th>Leaders N=31</th>
<th>Walkers N=107</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;55</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>55-69</td>
<td>13</td>
<td>43</td>
</tr>
<tr>
<td>70+</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>77</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single (never married/previously married)</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Married/defacto</td>
<td>27</td>
<td>90</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school, leaving certificate or less</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Trade/apprenticeship/certificate/diploma</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>University degree or higher degree</td>
<td>16</td>
<td>53</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full time</td>
<td>11</td>
<td>36</td>
</tr>
<tr>
<td>Part time</td>
<td>13</td>
<td>41</td>
</tr>
<tr>
<td>Not in paid employment</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>18</td>
<td>60</td>
</tr>
<tr>
<td>Skilled tradesperson/labourer</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Retired</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>No paid job, student</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Country of birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>22</td>
<td>74</td>
</tr>
<tr>
<td>United Kingdom/Europe</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Other (USA, Asia)</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>
Table 2  Professional characteristics of the leaders and characteristics of their pole walking programs (n=31)

<table>
<thead>
<tr>
<th>Professional characteristics</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration leading groups (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 4 years</td>
<td>11</td>
<td>35</td>
</tr>
<tr>
<td>4-6 years</td>
<td>12</td>
<td>39</td>
</tr>
<tr>
<td>Over 6 years</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td><strong>Exercise qualifications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise/fitness qualifications</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td>Health qualifications</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td><strong>Program characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average number of participants per session</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-6</td>
<td>14</td>
<td>45</td>
</tr>
<tr>
<td>7-12</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>≥ 12</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td><strong>Session intensity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vigorous</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Moderate</td>
<td>11</td>
<td>36</td>
</tr>
<tr>
<td>Light-moderate</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td>Variable</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td><strong>Environmental setting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sports ground</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>Public park</td>
<td>24</td>
<td>77</td>
</tr>
<tr>
<td>Urban area</td>
<td>12</td>
<td>39</td>
</tr>
<tr>
<td>Public facility grounds</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Bushland</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>Beach</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td><strong>Costs and charges</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per session (AUD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free</td>
<td>11</td>
<td>39</td>
</tr>
<tr>
<td>&lt; $5</td>
<td>12</td>
<td>43</td>
</tr>
<tr>
<td>$5-$15</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Cost of buying poles (AUD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; $150</td>
<td>23</td>
<td>77</td>
</tr>
<tr>
<td>≥ $150</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td><strong>Duration of each session (min) mean (SD)</strong></td>
<td>43 (11)</td>
<td></td>
</tr>
</tbody>
</table>

* Total may not add up to n=30 or 100%, as multiple answers were possible

PW=pole walking; min=minutes; SD=standard deviation; AUD=Australian dollars
Figure 1  Importance of pole walking program aims as rated by the pole walking leaders (% agreement) (N=31)*

CV=cardiovascular; PA=physical activity

* In order of decreasing proportion indicating very important
Table 3  Health, health behaviours and pole walking history of pole walking participants (N=107)*

<table>
<thead>
<tr>
<th>Health</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-rated health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Fair</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Good</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Very good</td>
<td>47</td>
<td>44</td>
</tr>
<tr>
<td>Excellent</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td><strong>Pain</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>Spinal pain</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Other pain</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td><strong>Joint replacement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>89</td>
<td>88</td>
</tr>
<tr>
<td>Knee</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Hip</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Shoulder</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2(^{nd}) joint replacement (hip)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Falls in the past 12 months</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>84</td>
<td>80</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>&gt;1</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td><strong>Health conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>Arthritis</td>
<td>51</td>
<td>48</td>
</tr>
<tr>
<td>Depression, anxiety or stress</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>Bronchitis, asthma and other lung conditions</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Angina, high blood pressure, high cholesterol and other heart conditions</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Diabetes</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Other</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td><strong>Body Mass Index (kg/m(^2))</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 25</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>25-30</td>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>≥30</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td><strong>Health behaviours</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Physical activity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None (&lt; 33 MET.min/week)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Some (33-499 MET.min/week)</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Meeting guidelines (≥ 500 MET.min/week)</td>
<td>82</td>
<td>81</td>
</tr>
<tr>
<td>Physical activity (min/week; median (IQR))</td>
<td>400 (240/705)</td>
<td></td>
</tr>
<tr>
<td><strong>Sitting time (min/day; mean +/-SD)</strong></td>
<td>385 +/-173</td>
<td></td>
</tr>
<tr>
<td><strong>History of participating in PW</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 12 months</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>12-35 months</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>36-60 months</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>≥ 60 months</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td><strong>Group/individual sessions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk with a group</td>
<td>88</td>
<td>82</td>
</tr>
<tr>
<td>Walk with one other</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Walk alone</td>
<td>18</td>
<td>17</td>
</tr>
</tbody>
</table>

Kg=kilograms; m=meters; PA=physical activity; SD=standard deviation; MET=metabolic equivalent; min=minutes

*Totals may not add up to n=107 or 100% because of missing data or multiple answers.
Figure 2  Pole walkers’ reasons for participation, and perceptions of pole walking (% agreement) (N=107)

![Figure 2 Pole walkers’ reasons for participation, and perceptions of pole walking (% agreement) (N=107)](image)

Figure 3  Pole walkers’ perceptions of differences between pole walking and walking (% agreement) (N=107)

![Figure 3 Pole walkers’ perceptions of differences between pole walking and walking (% agreement) (N=107)](image)
Discussion

In contrast with countries such as Finland, where it has been well established for over 20 years (25), PW is relatively new to Australia. This study aimed to explore the characteristics of PW leaders, walkers, and programs in Australia, and to describe participants’ perceptions of PW and reasons for participation. The results indicated that PW is predominantly instructed and practiced by older women who were born in Australia. Most participants walked regularly in groups about once per week, at light to moderate intensity, for about an hour, and had walked regularly for several years. This indicates that PW has the potential to contribute towards achieving the minimum PA levels of 150 mins/week recommended in public health PA guidelines (26).

In this study we used the social ecological model to understand better the broad range of factors associated with participation in PW (11, 12). The majority of participants identified fitness and health benefits as important reasons for participating in PW. Most pole walkers felt that, compared with walking, PW resulted in greater fitness, arm strength, and balance and less stiffness and pain. This is in line with previous studies which have identified the health benefits of PW in several adult populations, especially in relation to fitness benefits (7, 27). PW may provide an activity for those who wish to increase their health and fitness more than walking will allow, but who are unable to participate in high impact activities, such as older adults, or those undergoing rehabilitation.

Self-efficacy, or confidence about being able to perform a particular activity, is positively associated with PA participation in older adults (28). PW requires a measure of technical skill, and half the pole walkers in this study found the technique difficult initially. However, most reported high levels of confidence in maintaining the technique once learnt, and the technical achievement may be the reason many pole walkers were long time participants in the activity. Additionally, PW may be important for PA confidence in this age group when outdoors, as poles were perceived to be useful for balance on rough ground, sand and hills. PW may therefore be a valuable alternative to walking for those with balance issues.

Further factors identified by walkers were personal enjoyment of the activity (individual) and social support (social) provided by the groups. Both enjoyment (29-31) and social support (32-34) have been consistently identified as correlates of a wide variety of activities older people engage in. Interestingly, both leaders and walkers shared several
characteristics, such as age and sex, and thus leaders may contribute to peer as well as leader support (35).

Importantly, the SEM emphasises the dynamic interplay among diverse factors which underpin participation in PA. A clear example of this interplay was the participants’ appreciation of outdoor environments (environmental factor) and how this improved their personal enjoyment (individual factor) of PW. The majority of the PW settings were parkland, sports grounds or bushland. PW is an accessible type of activity because it does not require specialised facilities and can be done in many locations. Furthermore, Australia’s relatively mild climate and amount of “green space” available for recreation are suited for outdoor activities. Australian studies reported that adults positively associate environmental aesthetics with PA (32, 33). Moreover, almost two thirds of participants (aged between 60 and 67 years) in a large Australian population based study indicated a preference for outdoor activities, with more than four fifths preferring low cost PA, and more than half preferring to do PA with people their own age (34). Context preferences such as types and locations of PA, and preferences for group or individual participation varied. However, PW may be a valuable option for those older adults who prefer outdoor activities that are inexpensive and can be done with their peers.

This is the first study to obtain information about the characteristics of PW leaders and walkers in Australia. Because both participating organisations have been established since 2000 (15, 16), most active leaders were able to be located. Non-participation of leaders and walkers from the third organisation could affect the results if these pole walkers differed from the participants of the other two. Additionally, if those with unfavourable PW experiences were less likely to participate, a selection bias could affect results with more positive attitudes towards PW being reported. However, response rates for both leaders and walkers were high.

**Conclusion**

PW leaders and pole walkers are mostly older, health-conscious women, who walk in small groups outdoors at a light to moderate intensity level. Despite its predominance in Scandinavian countries, the study’s findings suggest that PW is also suitable for the Australian environment. Participant perceptions of enjoyment and health benefits, together with the added advantage that poles enhance stability and can reduce fear of falling, may
make this activity a useful alternative to walking in health promotion programs for mid-aged and older adults.

Acknowledgements

The authors thank PoleAbout and Nordic Academy for providing access to PW leaders and all of the individuals who completed the surveys. JOF was supported by an Australian Post Graduate Research Scholarship and a National Health and Medical Research council program grant (#569940).
References


A 3.3 On your feet: protocol for a randomised controlled trial to compare the effects of pole walking and regular walking on physical and psycho-social health in older adults

This study has been published in the *BMC Public Health* (Impact Factor 2.321), and appears below as published.

The citation is as follows:

Abstract

**Background:** Physical activity is associated with better physical and mental health in older adults. Pole walking is a form of walking which may have additional health benefits in older adults, because of the addition of hand held poles, and consequent upper limb involvement. However, few studies have examined the potential additional effects of pole walking on physical and psycho-social health in older adults compared with walking. The aim of this study is to compare the effect of a pole walking program with the effects of a regular walking program, on physical function and psycho-social wellbeing, in older adults in assisted living facilities.

**Methods/design:** Sixty men and women from assisted living communities over 65 years will be recruited from senior retirement facilities and randomised into a group based, pole walking program, or walking program. The pole walking group will use the Exerstrider method of pole walking. Total duration of the programs is 12 weeks, with three sessions per week, building from 20 minute to 30 minute sessions. The primary outcome is physical function, as measured by items from the Seniors Fitness Test and hand grip strength. Secondary outcomes include physical activity levels, sedentary behavior, joint pain, and quality of life. All outcomes will be assessed before and after the programs, using valid and reliable measures.

**Discussion:** The study will add to the evidence base for the effects of pole walking, compared with walking, on physical and psycho-social health and physical function, in healthy older adults. This will improve understanding about the feasibility of pole walking programs and its specific benefits in this population.

**Trial registration:** Australian New Zealand Clinical Trials Registry ACTRN12612001127897.
Background

Being physically active is associated with better physical and mental health in adults, and it is well documented that there is no age limit to health benefits related to regular physical activity (PA) (1). Regular PA leads to improvements in cardiorespiratory fitness, muscle strength, endurance and flexibility (2). It is also associated with a decrease in the overall burden of disease, as well as improvements in psychological wellbeing, quality of life and cognitive functioning (2, 3). In older adults, there is now good evidence that regular PA increases average life expectancy and reduces disability (4, 5). PA which incorporates specific strength, flexibility and balance training, is also associated with a reduction in the risk of falls in this age group (6, 7).

Australian PA guidelines for older adults recommend accumulation of at least two and one half hours of moderate intensity PA on most, preferably all, days of the week for health benefits (8). US guidelines for older adults add that some PA is better than none, and that older adults who participate in any amount of PA will gain health benefits (5, 9). However, PA participation among older adults is low (10-12). For example, of Australians aged 65–74 years, only one in three met PA guidelines in 2007–8, and the proportion was just over one in five in those over 75 years (10). The proportion of adults aged over 65 years is expected to increase from 13% of the total Australian population in 2007 to between 23% and 25% in 2056 (13). Consequently, there will be a significant increase in the number of older adults who could potentially obtain health benefits from regular participation in PA. It is therefore important to find feasible ways for older adults to increase their PA levels.

Walking is one PA option for older adults, as it can be undertaken regardless of age, health status, and ability (14, 15). It is the most frequently reported form of PA in this population group (16, 17). For example, data from the USA Behavioural Risk Factor Surveillance System (BRFSS) show that 44% of men, and 45% of women, aged over 65 years, reported leisure time walking in 2000 (18). In addition, walking is the most frequently reported activity among older adults who meet the USA PA guidelines/recommendations (18). In Australia, walking for leisure is reported by 46% of adults over 65 years, and of those, 53% engage exclusively in walking (17). Walking at, or above, 3–4 km per hour is categorized as moderate intensity PA (19), and confers health benefits when recommended frequencies and durations are adhered to.
Pole walking (PW) is an outdoor, non-competitive activity. It is a form of walking, with the addition of hand-held poles, which utilizes upper body muscles (20). It has similar low impact, moderate intensity characteristics to walking (21). There are several additional effects of PW compared with moderate intensity walking. During PW, the average oxygen uptake, heart rate, and caloric expenditure are higher than for walking at the same speed (21-23). Importantly, these additional benefits are achieved without significantly increased perceived exertion (22, 24-26). Evidence of a reduction in knee joint loading when PW is ambiguous (27-29), although some studies have shown lower knee joint forces in participants who walk with poles than in those who don’t (30, 31). The use of poles may provide extra stability for walkers and reduce falls or fear of falls. However, to our knowledge, no studies have measured balance and stability during PW. Because of these characteristics, PW appears to be a suitable form of PA for older adult populations.

PW is used in PA programs by community and government organizations in several countries, and many participants in these programs are older adults (32-34). For example, 44% of older Polish sport and recreation session participants at Universities of the Third Age attended PW sessions (32). A recent systematic review of the effects of PW on health found a number of randomised controlled trials of the effects of PW in a range of both clinical and non-clinical populations (35). These include middle aged, non-obese women (36), adults with type 2 diabetes (37,38), cardiovascular disease (24), peripheral artery disease (39, 40), musculo-skeletal (41, 42) conditions, chronic obstructive pulmonary disease (43), Parkinson’s disease (44, 45), Sjogren’s syndrome (25) and breast cancer (46). Most of these intervention studies lasted between 8 and 24 weeks, were of moderate intensity, and conducted 2–3 times per week (35). This found that PW is simple, feasible, and effective, and has several beneficial physical and psycho-social effects in mid to older aged adults (35).

There are a number of different PW techniques. The Nordic walking technique, which emerged from the sport of cross country skiing, is practiced and taught throughout the world (47). In the United States, another style of PW, known now as the Exerstrider method, has developed separately from Nordic walking in Europe (48). The Nordic walking technique uses a longer stride length and greater hip range of motion than regular walking, and a grasp/release hand grip. The Exerstrider method uses a normal gait, a high forward arm position, and a continuous hand grip. There are indications that the Nordic walking
technique is more difficult for older people than Exerstriding (45, 49). For example, Figard-Fabre et al. found that, in obese mid-aged women, after four weeks of Nordic walking training, fewer than 50% of the participants were able to grasp three of the eight technical characteristics of the technique (49). In another study of adults with Parkinson’s disease, many participants had difficulties with the Nordic walking technique (45). These difficulties may also be experienced by older adults, who have shorter stride length, and smaller hip joint range of motion than younger adults (50).

Although PW seems to be a suitable form of PA for older adults, few studies have examined the effects of PW on physical and psycho-social health in exclusively older adult populations (35). To our knowledge, only one study has examined the effects of PW in healthy adults aged over 65 years (51). This study found significant improvements in functional capacity, but not in gait parameters, or walking speed, in older adults who walked twice weekly for nine weeks, compared with a non-exercise control. In addition, few studies have compared the effects of PW with regular walking (RW) in older adults (51, 52). Therefore, the aim of this trial is to compare the effects of PW with the effects of RW, on physical function, physical activity and sitting time, and wellbeing, in adults aged 65 years or over. The null hypothesis is that there is no difference in these outcomes between participants in the PW group and the RW group.

Methods/design

Design

An overview of the study design and timeframe is found in Figure 1. The study is a randomised controlled trial with two arms: a PW program; and a RW program. The study protocol was approved by the Research Ethics Committee at The school of Human Movement Studies, The University of Queensland.

Study sample and recruitment

Participants will be recruited from four senior living facilities at different locations, but with similar environmental characteristics. The lead researcher will initially contact management staff in the senior living facilities by phone. This phone contact will be followed by a personal visit to the facility managers to introduce the study and the lead researcher. An “Active Aging” presentation will then be offered to the residents of the villages. The presentation will consist of information about the benefits of PA for older
adults. The study will be explained in detail and an opportunity for attendees to ask questions and register their interest in participating will be given at the end of the presentation. All attendees will be given an information brochure about the study and the eligibility criteria.

People interested in participating will be contacted personally by the lead researcher. She will then provide any additional information and explanations participants may require, and will screen potential participants for eligibility. Inclusion criteria are: aged 65 years or older. Exclusion criteria include: medically unfit to participate in a walking program; unable to speak or understand English; having a shoulder or elbow flexion range of motion (ROM) of less than 90 degrees; and having pathological conditions of the upper extremity.

In addition to specific verbal or written questions to check the eligibility criteria, the lead investigator will use the Sports Medicine Australia (SMA) pre-exercise screening tool to ascertain medical eligibility to participate in the moderate intensity PA programs (53). Written informed consent from the participants will be obtained prior to the start of the study.

Sample size

There are no previous data on the effects of PW compared with RW on physical function and psycho-social health. Sample size estimates were therefore based on the premise that the PW group would achieve changes at least 20% greater than those observed in the RW group, in selected measures of the Seniors Fitness Test (30-second chair-stand test, 30-second arm-curl test, timed up and go test, and a 6-minute walk test) (54). This difference is thought to be a clinically relevant difference in functional status (52). Of those subtests, the largest number of participants needed for a statistically significant 20% difference was for the arm curl test. Based on a 20% difference in normative data for women aged 65–69 years for the arm curl test (mean, 17, SD, 4.1), a power of 0.80 and significance of 0.05, and using the formula \( n = 2 \left( \frac{z^*s^2}{\Delta^2} \right) \), we estimate that 23 participants per group would be needed to detect a between group difference of 20% (i.e. mean, 3, SD, 4.1) in the change score (52).
Figure 1 Overview of study design and timeframe

Initial population of older adults from 4 retirement village sites

Telephone screening interview

Site 1

Randomisation Site 1 (n=15)

PW

Site 2

Randomisation Site 2 (n=15)

PW

Site 3

Randomisation Site 3 (n=15)

PW

Site 4

Randomisation Site 4 (n=15)

PW

Baseline assessment
Senior Fitness Test and Grip strength test, Accelerometry, Active Australia Survey, Sedentary Behaviour Questionnaire, SF-12, Vitality Plus Scale, Numerical Rating Scale

0 weeks

1-12 weeks

12 week intervention period

Follow up assessments

6 weeks

12 weeks

Follow up assessments

PW=pole walking; RW=regular walking; n=number; SF-12=12 Item Short-Form Health Survey
Randomization

After baseline assessment of eligible participants at one site, the lead researcher will notify an external researcher of the participant identification numbers. The external researcher will randomly assign 50% of the participants to the PW intervention and 50% to the RW intervention using a random number generator in SPSS and inform the lead researcher of group allocation. This process will be repeated for each site separately. Thus, the total number will be approximately 30 participants in the PW group and 30 in the RW group, with one PW group, and one RW group, with seven to eight participants in each group, at each of four sites.

Blinding

Outcome measures will be assessed by trained assessors who will be blinded for group allocation before and after the programs. However, participants and exercise instructors will not be blinded because of the difficulty in blinding either of these in trials of specific PA/exercise modalities such as PW (55).

Outcome measures

Outcome measures will be assessed before commencing the program and at a follow-up testing session one week after the end of the program. The primary outcome measures are selected physical function items of the Seniors Fitness Test (30 second chair stand, 30 second arm curl, timed up and go test, and 6 minute walk test) and grip strength (54). Secondary outcome measures are behaviour (PA levels and sitting time), and wellbeing (joint pain, quality of life, vitality).

Primary outcome measures

Senior fitness test

The Senior Fitness Test is used to assess physical function, according to standard protocols (54). This is a widely used test battery for evaluating the effect of exercise interventions in older adults, with 6 subtests which measure the physical abilities needed to perform activities of daily living. However, two of the subtests, for upper and lower limb flexibility, will not be used, as flexibility is not an outcome of interest in this study. Therefore, the tests used in this trial will be: 30-second chair-stand test (the number of times in 30 seconds a participant can stand fully from a seated position without using their
arms); 30-second arm-curl test (the number of times a 2.27 kg (5 lb) weight can be curled fully on the dominant side); 2.44 m (8 ft) timed up and go test (the time in which participants can stand from a chair, walk 2.44 m, then return and sit down); and the 6-minute walk test (the maximum distance a participant can in six minutes) (56). All tests will be measured once, except the timed up and go test, which will consist of a practice, then two trials. The Seniors Fitness Test has acceptable test-retest reliability (R=0.81-0.98), construct validity against a range of indicators, such as age and exercise status, and criterion validity (r=0.71-0.82) (54).

**Hand grip strength test**

Hand grip strength is associated with functional limitations, premature mortality, and the development of disability in older adults (57). Hand grip strength will be measured by the amount of static force that the participant’s dominant hand can squeeze around a dynamometer. A Jamar dynamometer will be used as it is accurate, and shows good inter-rater and test-retest reliability and validity in the older adult population (58, 59). Hand grip strength will be measured in the seated position as per the standard testing protocol approved by the American Society of Hand Therapists (ASHT) (60). Three trials of grip strength for each hand, with a 60 second rest period between trials, and each with a three second maximum grip, will be conducted and the maximum value recorded (61).

**Secondary outcome measures**

**Behaviour**

**Objectively measured physical activity and sitting time**

A tri-axial accelerometer (ActiGraph GT3X+) will be used to assess levels of physical activity and sedentary behaviour in all participants in both the PW and the RW groups before, during (week 6), and at the end of the program (week 12). Participants will be shown by the lead researcher how to position the ActiGraph accelerometer, which will be worn on an elastic clip-on belt, above the left iliac crest. Participants will be asked to put it on when they first get up in the morning and wear it until going to bed at night. In addition, participants will be asked to complete an activity diary to verify the time that the accelerometer was worn. Valid wear time will be defined as a minimum wear time of 10 hours per day for 4 days (62, 63). Sedentary behaviour will be defined as <200 cpm, light
intensity activity as 200–2689 cpm, moderate intensity activity as 2690–6166 cpm, and vigorous intensity activity as >6167 cpm (64, 65).

Self reported physical activity

The Active Australia Survey is a self-administered survey which is widely used to assess PA in Australian national and state surveys, and intervention studies (66). Items have acceptable measurement properties for ambulatory older adults (67). It consists of a set of questions which assess frequency and total time spent walking, and in moderate and vigorous leisure time activity in the past week. Time in each activity is multiplied by a generic metabolic equivalent value of 3.33 METs for walking and moderate activity, and 6.66 METs for vigorous activity, and the sum of all MET.minutes per week is categorized as no PA, (<33), some PA (33–499), or meeting PA guidelines (≥500-999), or high PA (≥1000).

Self-reported sitting time

Sitting time will be assessed by a five domain sitting questionnaire (68). The questionnaire assesses the number of hours spent sitting at work, while travelling, watching television, and using a computer when not at work, and during other recreation. These domain specific questions have acceptable reliability and validity (68).

Wellbeing

Pain

Pain levels in the neck, lower back, hip, knee and shoulder joint will be assessed using the Numerical Rating Scale (NRS), consisting of an 11 point interval scale labelled from 0 to 10, with 0 being no pain, and 10 being the worst pain possible (69). This scale was chosen because it is easy for older adults to understand, and is sensitive to change, valid and reliable (69).

Quality of life

The SF-12 (12 Item Short-Form Health Survey) is a self-administered questionnaire used to assess quality of life, and it is frequently used as a succinct overall assessment of health (70). The SF-12 has good internal consistency and test–retest reliability in older adults (71). Two summary scales will be derived, the physical and mental summary scales. They will be scored using norm based methods (70).
**Vitality**

The vitality plus scale is used to assess the perceived benefits of exercise by older adults (72). It is a self-administered 10 item, multi-dimensional scale, which assesses sleep, energy, aches and pains, restlessness, stiffness, cheerfulness, constipation and appetite. Constructs of vitality relevant to exercise are therefore captured in a concise, reliable, and valid instrument, which is also easy for older adults to use (72).

**Intervention**

**Program duration, frequency and intensity**

The exercise sessions will take place at outdoor areas adjacent to the facilities which are convenient to the participants. Program duration is 12 weeks, with a session frequency of 3 times per week. Session durations for the PW and the RW groups will be 20 minutes at the start of the program, increasing to 30 minutes by week 6. Participants will be advised not to change other lifestyle habits, including PA, during participation in the program. The PW and RW sessions will be at different times and/or days so that the groups are separate throughout the program. The exercise sessions will consist of a 5 minute warm up, followed by 20 mins of RW or PW at the first session, and a cool down/ stretching period of 5 mins. After six weeks, the RW/PW component will increase to 30 minutes. Participants will be asked to walk at a comfortable intensity. The reason for this is that many of the participants are expected to be frail and non-exercisers. Therefore, to reach a moderate intensity may be unrealistic for them.

**Pole walking technique to be used**

The Exerstrider technique and poles will be used in the PW group. As this PW technique requires a natural gait, continuous hand grip and no arm extension, it has fewer technical requirements for older adults to learn and perform consistently, than the Nordic walking technique (49). The first exercise session will be used to teach the Exerstrider technique to the PW group, and as an instruction session in the RW group.

**Group structure and supervision**

The intervention programs will consist of supervised group sessions, as there is a positive association between PA maintenance and social support from instructors and group members in older adults (73). Sessions will be supervised by qualified recreational
therapists who are known to the participants and experienced in leading exercise groups. Both the PW and RW group instructors will receive the same instruction and information concerning the PW and RW session procedures. PW and RW group routes will be the same at each site. In addition, the PW group instructors will be trained in The Exerstrider method. The training package is a standard one developed for use in retirement facilities by the developer of Exerstriding and master trainer of the method (personal communication). Participants in the PW group will receive a free set of Exerstrider poles and training at the beginning of the program. The RW participants will be advised at the beginning of the program that they will be given the opportunity to receive poles and training in their use at the end of the program.

The trial will be monitored by the study leader, who will visit each of the PW and RW groups once weekly to ensure compliance with study protocols. In the case of adverse events, instructors will contact facility medical staff who will arrange for onsite first aid or other intervention as appropriate. The medical staff will inform the study leader within 12 hours. The study leader will register adverse events with the University of Queensland ethics committee within 48 hours.

**Attendance and dropout**

Attendance will be registered at each session by the session supervisor. Participants who do not attend a session will be contacted following the session by the group exercise instructor, and the reasons for their absence will be recorded. If participants indicate that they intend to discontinue the program, the reasons for this will also be recorded, and they will be encouraged to attend the post intervention assessments. If this does not occur, a last measure carried forward protocol will be used.

**Data analysis**

To ensure that randomization resulted in equal distribution of sample characteristics in both intervention groups, baseline characteristics in the intervention and control groups will be compared using t-tests for normally distributed continuous data, appropriate non-parametric tests for non-normally distributed continuous data and chi square tests for categorical variables. Between group differences in study outcomes will be examined using repeated measures of covariance (ANCOVA), adjusted for variables that are associated with both the explanatory and outcome measures; based on previous
publications, these may include factors such as age, sex and number of medical conditions.

Both intention to treat analysis, including all participants who were enrolled in the study, and provided both baseline and follow up data, and per protocol analyses, including only participants who completed the program, will be analyzed. The level of significance will be set at 0.05. All analyses will be conducted using SPSS version 20 (SPSS Inc., Chicago, IL).

Discussion

This paper describes the protocol for a randomised controlled trial comparing the effects of PW and RW on physical function, physical activity and sitting time, and wellbeing, in older adults. Although effects of PW on fitness have been well-researched (22, 23, 74, 75), no studies have compared the effects of PW with RW on physical function in healthy older adults.

Several different versions of PW exist, and studies have found that different techniques and poles can lead to different outcomes in effectiveness and safety (49). The choice of the Exerstrider method is a unique feature of this study as it is a simple technique designed for PA, rather than fitness, and thus suited to the older adult population.

In older populations, considerations other than cardiovascular fitness are important for physical and mental health. Maintaining strength to perform activities of daily living, maintain PA levels, and prevent falls, are critical to maintaining independence in older adults (4). If independence is reduced in this population, quality of life is also reduced and there is an increased risk of institutionalization (76). Falls in older adults are often a factor in reduced activity levels, leading to poorer physical function (77). An activity such as PW, which potentially provides increased stability during exercise compared with RW, may improve overall PA levels and associated health benefits. Thus, PW has the potential to be a safe, effective and easily maintained activity option for older adults. This study will enable better understanding of the potential of PW for increasing PA levels and promoting physical and mental health in healthy older adult populations.
Abbreviations
PA, Physical activity; PW, Pole walking; RW, Regular walking; ROM, Range of motion; BRFSS, Behavioral risk factor surveillance system; ANCOVA, Repeated measures of covariance.

Competing interests
The author(s) declare that they have no competing interests.

Authors’ contributions
JF developed the original design of the study. JF, JvU and WB were involved in further developing the design and the protocol for carrying out the study. JF wrote the first draft of the manuscript. All authors read, edited draft versions and approved the final manuscript.

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